

## Essays on foreign direct investment, technology transfer and international trade: ricardian approaches and empirical evidence

Mohamed Saadi

### ► To cite this version:

Mohamed Saadi. Essays on foreign direct investment, technology transfer and international trade : ricardian approaches and empirical evidence. Economics and Finance. Université Paris-Est, 2010. English. NNT: 2010PEST3011. tel-00592187

## HAL Id: tel-00592187 https://theses.hal.science/tel-00592187

Submitted on 11 May 2011  $\,$ 

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Université Paris-Est U.F.R. de Sciences Economiques Ecole doctorale Organisations, Marchés, Institutions

## THÈSE

Pour obtenir le grade de Docteur de l'Université Paris-Est Spécialité : sciences économiques

Présentée et soutenue publiquement par

## Mohamed Saadi

le 19 octobre 2010

Titre :

### Essays on foreign direct investment, technology transfer and international trade

Ricardian approaches and empirical evidence

Directeur de thèse M. Dominique Redor, Professeur à l'Université Paris-Est Marne-La-Vallée

### JURY :

Mme. Mélika Ben Salem,M. Alain Desdoigts,M. Lionel Fontagné,M. Joël Hellier (rapporteur),M. Dominique Redor,M. Jean Marc Siroën (rapporteur),

Professeur à l'Université Paris-Est Marne-La-Vallée Professeur à l'Université Paris-Est Marne-La-Vallée Professeur à l'Université Paris 1 Panthéon -Sorbonne Professeur à l'Université de Nantes Professeur à l'Université Paris-Est Marne-La-Vallée Professeur à l'Université Paris-Dauphine

L'université Paris-Est n'entend donner aucune approbation ni improbation aux opinions émises dans cette thèse. Ces opinions doivent être considérées comme propres à leur auteur.

A mes parents, à mes sœurs, à ma grand-mère, à Tapan Biswas

### Remerciements

Merci à tous ceux qui m'ont permis de faire de cette thèse autre chose qu'un travail solitaire.

Je tiens à remercier en premier lieu Dominique Redor d'avoir été un directeur attentif et ouvert et pour la confiance et la liberté qu'il m'a accordées durant la rédaction de cette thèse ainsi que pour ses conseils réguliers, ses remarques avisées et son soutien.

De même, je remercie Henry Thompson, Terutomo Ozawa, Kiyoshi Kojima, Tapan Biswas, Kwan Choi, Norihito Tanaka, Subrata Ghatak, Alain Desdoigts, Jekaterina Dmitrijeva et Sylvain Zeghni qui ont commenté et rapporté certains de mes travaux. Je témoigne ma vive gratitude à Dani Rodrik et Bailey Klinger (de l'Université de Harvard) pour leur aide très précieuse dans l'utilisation de l'indicateur de sophistication des exportations et pour leurs encouragements. Je remercie également Monji Ben Chabaâne (IEQ Tunis) pour ses conseils et sa coopération en matière de collecte de données.

Je remercie Joël Hellier et Jean-Marc Siroën qui ont accepté d'être rapporteur de cette thèse, ainsi que Mélika Ben Salem, Alain Desdoigts et Lionel Fontagné qui ont accepté d'être membre de ce jury.

Je remercie sincèrement toute l'équipe du laboratoire Organisation et efficacité de la production (OEP) – ERUDITE à l'Université Paris-Est Marne-La-Vallée. Je pense particulièrement à Jean-Christophe Pereau, Mélika Ben Salem, Hervé Defalvard, Manon Dos Santos, Alain Desdoigts Fabian Gouret et Jekaterina Dmitrijeva. Je remercie également Nicolas Noisel et Guillaume Launey pour leur disponibilité et leur coopération dans les différents dossiers de financement de mes participations aux conférences en France et à l'étranger.

J'adresse aussi mes remerciements aux participants des séminaires et conférences dans lesquels des travaux extraits de mes chapitres ont été présentés (EEFS, 2006, 2007; 2008; 2009; JEPA, 2006; AFSE, 2007; RIEF; 2007; ACDD, 2006; Université Montesquieu; 2006, Séminaires OEP).

Merci à l'équipe pédagogique de l'Université Paris-Est Marne-La-Vallée de m'avoir accueilli comme enseignant, et particulièrement à Dominique Redor, Hervé Defalvard, Sylvain Zeghni, Melika Ben Salem, Alain Desdoigts et Marc Ferracci, à qui je dois des années de travaux dirigés mémorables. Je remercie également Anne-Cécile Paumier, Isabelle Farkas, Cristina.Coatanroch, Noro Rafidison pour leurs coopérations dans l'organisation des enseignements.

La rédaction de cette thèse doit beaucoup à Jean Sutcliff et Julien Trudy. Leurs cours et ateliers d'anglais pour les doctorants et leur coopération en corrigeant certains de mes travaux ont grandement contribué à l'amélioration de ma thèse. Ces formations m'ont permis de bien présenter mes travaux dans des conférences internationales et de créer des contacts avec des chercheurs américains, japonais, anglais, etc.

Je remercie les agents de sécurité de l'Université Paris-Est Marne-La-Vallée qui m'ont permis, suivant une autorisation d'accès durant les périodes de fermeture, de travailler au laboratoire dans des bonnes conditions.

Enfin, je remercie tous ceux qui partagent ma vie hors travail, et qui directement ou indirectement, m'ont soutenu dans ce projet de thèse.

### Abstract

Ricardo is commonly celebrated for the theoretical achievements -his theory of growth which introduces us to the concept of trap of industrialism and his theory of comparative advantage that introduces us to the idea that technological differences across countries is the basis of international trade. What role Ricardo's theories have given to foreign direct investment (FDI) has remained a less explored issue. Thus, it is certainly relevant to study the implications of FDI and technology transfer for these theories. This thesis puts back the Ricardian growth bottleneck and the Ricardian trade approaches toward FDI and technology transfer at the forefront of analysis, builds and develops new theoretical settings and predictions. Moreover, this thesis provides new empirical applications.

This thesis consists of four chapters. Two parts emerge. In the first part, we mainly revisit and reformulate the Japanese economic thought toward outward FDI, within the Ricardian context. We also implement econometric estimation to test the relevance and usefulness of this theoretical approach to outward FDI from catching-up countries. In the second part, we provide theoretical frameworks with empirical applications. We focus on the effects of technological inflows, especially via inward FDI, on the host developing countries and we develop new Ricardian approaches with empirical follow-up on the predictions.

In **chapter 1**, we focus on outward FDI as an escape response to home country growth bottlenecks, which represents an important but under-explored phenomenon in the FDI literature. We review the push-factor approaches based on the pressure effect of the *"Ricardian bottlenecks"* to explain outward FDI. We reconsider Ozawa's macroeconomic theory of Japanese outward FDI, extend it and argue for a widespread applicability of FDI aimed at overcoming generalized *"Ricardian bottlenecks"*, especially, nowadays, natural resource-scarcity and the insatiable quest for energy, industrial raw materials and fuels. Our empirical findings confirm that outward FDI from emerging countries and transition economies (catching-up countries) acts as an escape response to *"Ricardian bottlenecks"* and strengthen the reasonableness, the usefulness and the empirical robustness of Ozawa's macroeconomic theory of FDI.

In **chapter 2**, we reformulate Kojima's correspondence principle within Ricardian setting and point out that OFDI originating from the comparatively disadvantaged industry in the developed country and going to the comparatively advantaged industry in the developing country should follow the direction of absolute profit rates which is a reflection of the comparative advantage patterns.

In chapter 3, we mainly focus, in the first section, on the welfare effect of North-South technology transfer within Ricardian setting. We single out the respective role of the relative size of both countries, the efficiency of the technology which is transferred, and the elasticity of substitution between the goods which are produced. In the second section of chapter 3, we explore what are the consequences of free technology transfer, licensing and FDI on the North-South welfare. We also provide an empirical analysis of the effect of licensing and foreign presence on the developing countries' terms of trade. We find that inward FDI and royalties' payment deteriorate the terms of trade of the developing and emerging countries.

In **chapter 4**, we combine an extended continuum Ricardian trade setting which rank sophistication of exports by their technology intensity with the new advanced wave of empirical literature on export sophistication. Using data from the developing and emerging countries, we test the core theoretical prediction that foreign involvement and export penetration facilitate technological progress and upgrades export sophistication of a country by leading it to expand the range of goods that it produces toward sectors with rising productivity. In our next step, we bring the debate on the deterioration of the developing countries' terms of trade back into the limelight. Importantly, we show that despite the increase in their export sophistication, the developing countries continue to face terms of trade deterioration.

**Key words**: Ricardian theory, FDI, technology transfer, licensing, terms of trade, welfare, export sophistication.

## **Résumé :** Essais sur l'investissement direct étranger, le transfert technologique et le commerce international : approches ricardiennes et analyses empiriques

Ricardo est célébré pour ses théories- sa théorie de la croissance qui nous enseigne le concept de la trappe à stagnation industrielle et sa théorie de l'avantage comparatif selon laquelle les différences de technologie déterminent la direction de l'échange international. Quel rôle les théories ricardiennes ont-elles consacré à l'investissement direct étranger (IDE) demeure une question peu explorée. La prise en compte de l'IDE et du transfert de technologie par ces théories est l'objet principal de cette thèse. Elle met l'accent sur les approches ricardiennes de la croissance et du commerce international pour traiter l'IDE, le transfert technologique. Elle construit et développe de nouvelles approches théoriques et prédictions dans un cadre d'inspiration ricardienne. Des analyses économétriques sont ensuite effectuées pour tester ces prédictions.

Cette thèse se compose de quatre chapitres. Deux parties qui contiennent chacune deux chapitres sont présentées. La première partie propose une revisitation et une reformulation des approches macroéconomiques de l'IDE suivant une approche ricardienne. La deuxième partie traite les relations entre l'IDE, le transfert technologique, la sophistication des exportations et les termes de l'échange des pays en développement et fournit des analyses empiriques à l'appui pour tester les prédictions ricardiennes.

Le premier chapitre réexamine et généralise l'approche de l'IDE par la théorie ricardienne de croissance. Ce chapitre prolonge l'analyse d'Ozawa, met l'accent sur « les goulots d'étranglement ricardiens » et le risque de trappe à stagnation industrielle à *la Ricardo-Hicks* et examine les facteurs « push » expliquant l'investissement direct sortant. Les prédictions de cette approche sont ensuite testées sur un panel de pays émergents et en transition. Les résultats économétriques portant sur un panel de pays émergents et en transition confirment les prédictions théoriques de l'approche macroéconomique d'Ozawa en matière d'IDE sortant.

Le second chapitre développe un modèle ricardien classique en introduisant l'IDE Nord Sud. Nous reformulons le « *principe de correspondance* » développé par Kojima. Nous montrons que la correspondance entre les taux de profits absolus et les avantages comparatifs explique l'émergence de l'IDE originaire des secteurs comparativement désavantagés dans les pays développés et destinés aux secteurs comparativement avantagés dans les pays en développement.

Le troisième chapitre, dans sa première section, développe un modèle ricardien Nord-Sud avec transfert de technologie. Notre contribution consiste à examiner le rôle de l'élasticité de substitution entre les biens dans les conséquences du transfert technologique sur les termes de l'échange et le bien-être des pays. Les conditions d'une baisse des termes de l'échange pour le pays en développement sont explicitées, et finalement sont précisées les conditions dans lesquelles le bien être du pays en développement peut baisser à la suite de ce transfert de technologie. La seconde section prolonge l'analyse aux cas du transfert technologique via l'IDE et les licenses. Les tests empiriques montrent que les IDE entrants et le versement de royalties s'accompagnent d'une baisse des termes de l'échange pour les pays en développement. Le quatrième chapitre associe le modèle ricardien avec un continuum de biens aux travaux empiriques de Hausmann, Hwang et Rodrick (2007) et de Rodrik (2006) sur la sophistication des exportations. Un modèle empirique est développé afin d'établir les liens qui existent entre la présence des firmes étrangères et la sophistication des exportations des pays en développement. Ensuite, la question des termes de l'échange des pays en développement est mise en évidence. Les tests empiriques sur un panel de pays en développement montrent que l'augmentation de la sophistication des exportations des pays en développement s'accompagne d'une baisse de leurs termes de l'échange

**Mots-clés** : théorie ricardienne, IDE, transfert technologique, licence, termes de l'échange, bien-être, sophistication des exportations.

## Contents

	General Introduction
First Part.	REVISITING AND REFORMULATING THE MACROECONOMIC APPROACHES TO FDI: RICARDIAN SETTINGS
Chapter 1.	Generalized Ricardian growth bottlenecks and outward FDI : New evidence on the emerging multinationals
1.1	Introduction
1.2	On the Ricardian growth approach toward FDI
1.2.1	Is the Ricardian growth theory passé - or still relevant?
1.2.2	FDI from natural resource scarce industrialized economies: a vibrant research topic
1.2.2.1	Natural resource scarcity and growth
1.2.2.2	Resource seeking FDI: a Ricardian approach
1.2.2.3	A replication of the Japanese Ricardian-trap stage of transnationalism
1.2.2.4	Fuelling the industrial development and economic growth of "Asian Drivers" – China and India.
1.2.3	Push effect of land and labour shortages
1.2.3.1	Push effect of land (housing market bottleneck) and industrial site shortages
1.2.3.2	Push effect of labour shortage
1.3	An empirical follow-up on Ozawa's macroeconomic theory of outward FDI: new evidence from catching-up countries
1.3.1	Econometric methodology and estimation' results from an incomplete panel
1.3.2	Additional tests and robustness checks
1.3.3	Estimations and results from a balanced panel
1.4	Conclusion
1.A	Appendix for chapter 1
Chapter 2.	North-South trade and reformulated Kojima's «correspondence
—	principle»: A Ricardian trade approach
2.1	Introduction
2.2	Ricardian trade approaches toward FDI : a review of literature
2.2.1	Direct investment as a capital flow
2.2.2	FDI, technology transfer, product-cycle and trade
2.2.3	FDI and unit labour costs
2.3	Macroeconomic approach to FDI
2.3.1	Kojima's model of comparative investment profitabilities
2.3.1.1	Heckscher - Ohlin setting
2.3.1.2	Correspondence between comparative advantages and comparative profit rates
2.3.2	Pro-trade FDI and the flying geese model
2.3.2.1	The flying geese model: theory and evidence
2.3.2.2	FDI-cum-trade approach
2.3.2.3	Transferability of the flying geese model

2.4	North - South FDI and reformulated "correspondence principle": a Ricardian approach	98
2.4.1	FDI and comparative advantage: a brief review of literature	98
2.4.1.1	Theoretical aspects	99
2.4.1.2	Some empirical aspects	104
2.4.2	Reformulating Kojima "correspondence principle": a Ricardian setting	105
2.4.2.1	Conditions for North-South FDI	112
2.4.2.1.1	Technological superiority	112
2.4.2.1.2	Industry-specificity of capital	115
2.4.2.2	The reformulated correspondence principle and the technology-trade-welfare link	117
2.4.2.2.1	Closing the model	118
2.4.2.2.2	The reformulated "correspondence principle" and the welfare analysis	118
2.5	Conclusion	121

Second Part	THE EFFECT OF TECHNOLOGICAL INFLOWS ON WELFARE, TERMS OF	
	TRADE AND EXPORT SOPHISTICATION OF THE DEVELOPING COUNTRIES:	
	NEW RICARDIAN PREDICTIONS AND EVIDENCE	122

Chapter 3.	Technology transfer and North-South trade : a theoretical and empirical assessment	124
3.1	Introduction	124
3.2	Technology transfer, consumer preferences and welfare in a Ricardian model	125
3.2.1	The structure of consumer preferences and the terms of trade in the Ricardian model	125
3.2.1.1	Immiserizing specialization of developing countries	126
3.2.1.2	Introducing technology transfer in the Ricardian Model with CES utility function	127
3.2.2	Technology transfer, specialization and developing country' welfare	129
3.2.2.1	A two-good setting	129
3.2.2.2	Extension of the model to n commodities	136
3.3	Mode of technology transfer and North-South trade and welfare: Revisiting Kojima – Ozawa propositions	139
3.3.1	Kojima and Ozawa macroeconomic approach to FDI and technology transfer	140
3.3.1.1	Kojima – Ozawa propositions on technology transfer	140
3.3.1.2	Free technology transfer	144
3.3.2	and Ozawa right?	152
3.3.2.1	Technology transfer via licensing	154
3.3.2.1.1	Licensing	154
3.3.2.1.2	Welfare effect of technology transfer via licensing	155
3.3.2.2	Technology transfer via FDI	156
3.3.2.2.1	FDI and quasi-rents	156
3.3.2.2.2	Welfare effect of technology transfer via FDI	160
3.3.3	The effect of licensing and inward FDI on the developing country terms of trade: an empirical analysis	161
3.3.3.1	Measure of terms of trade	163
3.3.3.2	Model, estimation and results	164
3.3.3.3	Robustness check: alternative measures of real royalties	176

3.3.3.4	Estimations and results from a large incomplete panel	180
3.4	Conclusion	188
3.A	Appendix of chapter 3	189

Chapter 4.	Export sophistication of developing countries:	200
	an empirical follow-up on an extended DFS (1977) framework	
4.1	Introduction	200
4.2	The link between openness and technological progress	203
4.2.1	Foreign presence, productivity and technological progress	203
4.2.2	Openness and technology diffusion	207
4.2.2.1	Technology diffusion through imports	208
4.2.2.2	Technology diffusion through exports	209
4.3	An extended continuum Ricardian setting	210
4.3.1	Goods and technology	211
4.3.2	Importing superior technology, technological inflow and diffusion	219
4.3.3	Technology gap within a comparative advantage framework	223
4.4	Linking theory to empirics	235
4.4.1	Measure of export sophistication	236
4.4.1.1	The North-South trade cut-off ( $\tilde{z}$ )	236
4.4.1.2	Construction of the HHR export sophistication measure	238
4.4.2	Export sophistication: Testable estimation, data and econometric analysis	244
4.4.2.1	Model 1.	244
4.4.2.2	Estimation and results	255
4.4.2.3	Model 2	267
4.4.2.4	Estimation and results	270
4.4.2.5	Additional tests using relative export sophistication	277
4.4.2.6	Estimation' results from a large incomplete panel	283
4.4.3	Putting back the terms of trade deterioration at the forefront of the analysis	293
4.4.3.1	Is there a trap for the developing countries?	293
4.4.3.2	Testable estimation. data and econometric analysis	300
4.4.3.3	Instrumental variable estimation and exogeneity checks	316
4.5	Conclusion	321
4.A	Appendix for chapter 4	323
	General conclusion	328
	References	332

## **General Introduction**

Ricardo is commonly celebrated for the theoretical achievements-his theory of growth which introduces us to the concept of trap of industrialism and his theory of comparative advantage which introduces us to the idea that technological differences across countries matter in the international trade. What role Ricardo's theories have given to foreign direct investment (FDI) has remained a less explored issue. Thus, it is certainly relevant to study the implications of FDI and technology transfer (TT) for these theories. This thesis focuses on the Ricardian approaches toward FDI and TT, puts back the Ricardian growth bottleneck and the Ricardian trade setting at the forefront of analysis and provides empirical applications to test new predictions.

The Ricardian growth theory is the very first macroeconomic theory of stagnation due to profit decline. Ricardo pointed out how the irremovable scarcity of arable land (on which agricultural output is subjected to the law of diminishing marginal returns) and the Malthusian population growth phenomenon would increase food prices and money wages and eventually erode the entrepreneur's profit (reinvestable capital). The net outcome is the complete evaporation of investable funds and the arrival of a stagnated economy (see Ozawa, 1982, 2005). Ricardo's theory of growth stagnation was maintained by Hicks (1973, 1974, 1981). Hicks applied it to a fast-growing economy and stated that irremovable scarcity of labour and land would in the end, constrain the pace of economic growth<sup>1</sup>. Hicks's growth model can be combined with Ricardo's theory of stagnation into what may be called the "*Ricardo-Hicksian trap of industrial development*" (Ozawa, 1979a,b, 1993, 2005, 2009). According to this Ricardo-Hicksian theory of growth bottlenecks<sup>2</sup>, an industrial economy cannot expand indefinitely, as sooner or later it must encounter "*irremovable scarcities*" of key productive factors such as land (for industrial sites), natural resources and labour - called the "*Ricardo-Hicksian shortage of key productive factors*"<sup>3</sup>.

<sup>&</sup>lt;sup>1</sup>Hicks emphasized how "the impulse of an invention" which he defined as the "mainspring of economic growth" proceeds to work itself out, eventually succumbing to the law of diminishing returns in an industrial world.

<sup>&</sup>lt;sup>2</sup>A generalization of the Ricardian trap of growth bottlenecks (Hicksian generalization of the Ricardian theory of stagnation). <sup>3</sup>Ozawa's macroeconomic theory of Japanese FDI is based on the classical growth theory-the Ricardo-Hicksian trap of industrial stagnation.

There is a plethora of studies on the developing countries as recipient of FDI (see Lipsey, 2004). By contrast, much less attention has been paid to the developing countries' position as FDI sources. The novelty of our approach is to focus on the generalized Ricardian growth theory - called the "*Ricardo-Hicksian bottlenecks theory of industrialization*"<sup>4</sup> and to study the determinants and the home country '*push*' factors for emerging multinationals. Why do emerging countries invest and send their capital abroad ? What are the home-country characteristics and forces that push for outward FDI (hereafter OFDI for short)? Is Ozawa's (1979a,b) macroeconomic theory for OFDI (based on the "*Ricardo-Hicksian bottlenecks theory of industrialization*") passé – or still relevant<sup>5</sup>? Answers to these questions depend on the emerging countries and transition economies' motives and need careful econometric study.

The Ricardian trade approach to FDI and technology transfer <sup>6</sup> has become more important in the new advanced literature on technology and trade. This evolution has led Ricardian analytical models to take center stage."*The main advantage is that the Ricardian model allows for technological differences, which in practice seem very significant*" (Mbaye and Golub, 2002, p.230)<sup>7</sup>. This model provides the simplest framework in which one can examine how national differences in technological capabilities give rise to specialization and trade. A country's technology is captured by a set of labour input coefficients per unit of output of each commodity. The inter country differences in unit labour requirements are linked to the technical knowledge or "*blueprints*" that can be transferred abroad (Beladi *et al.*, 1997). Noteworthy, Taylor (1993) pointed out the relative simplicity and the proven usefulness and fruitfulness of the Ricardian trade approach in examining many issues. He illustrated, in comparative steady-state exercises, the "*tractability of the Ricardian approach, the ease with which determinate results can be obtained, and the importance of comparative and absolute advantages*" (Taylor, 1993, p.241). According to the survey of Grossman and Helpman

<sup>&</sup>lt;sup>4</sup>See Ozawa (2009, p.60).Ozawa (2009) speaks about the Ricardo-Hicksian limits of industrialism.

<sup>&</sup>lt;sup>5</sup>Ozawa, T. (1979a), "International Investment and Industrial Structure: New Theoretical Implications from the Japanese Experience", *Oxford Economic Papers*, vol.31:pp.72–92.

Ozawa, T. (1979b), Multinationalism, Japanese style: The political economy of outward dependency, Princeton University Press.

<sup>&</sup>lt;sup>6</sup> FDI- investment that gives an investor control over the firms that operate in foreign countries- is growing in importance as a channel of international technology transfer (TT). The issue of TT and the credibility of committed policies are hotly debated contemporary issues. Transfer of technology in the international context has been quite an interesting and vibrant research topic. It refers to any process by which a country gains access to technical information of a foreign country and successfully absorbs it into its production process.

<sup>&</sup>lt;sup>7</sup>See also Ceglowski & Golub (2007), Edwards & Golub (2004), Golub (1995, 1999), Golub &Hsieh (2000) and Harrigan (2003).

(1995), the Ricardian model is widely used as a "*building block*" in the literature on technology and trade.

The Ricardian trade approaches have experienced a renaissance and a resurgence of interest for the analysis of trade patterns, technology transfer and FDI<sup>8</sup> in the 2000s. Importantly, this thesis pays special attention to the inter-country effects of technology shocks and FDI in a globalized trading world and accentuates the usefulness of the Ricardian trade approaches.

To narrow the North-South technology gap, the developing countries have to adopt new technologies. FDI and trade have an important role to play in carrying out this task. These countries have become quite eager to attract FDI. This eagerness may be explained by the enhanced awareness that FDI can serve as an important channel of TT<sup>9</sup>. A related literature focuses on the technological content of FDI and considers technology and managerial talent as the key ingredients of FDI. (Root, 1994; Bai *et al.*, 2004; Bitzer *et al.*, 2008; Campos and Kinoshita, 2002; Cheng *et al.*, 2001, 2005; Kojima, 2000; Saggi, 2009)<sup>10</sup>.

Following Antràs (2005) and Lu (2005, 2007), North-South FDI refers to the process of TT and takes the form of building up production sites in the South and modifying operating procedures to suit Southern conditions that requires Southern labour input. FDI is traditionally regarded as package of capital, technology and management. With the increasing integration of the global capital market and the development of domestic capital markets in many host countries of multinationals firms (hereafter MNFs for short), capital mobility from the home countries of MNFs to the host countries seems to have become the least important ingredient of FDI (Cheng *et al.*, 2005). For example, Krugman (2000) provides some evidence about the lack of a strong positive correlation between total capital flows and FDI flows<sup>11</sup>. Blomstrom

<sup>&</sup>lt;sup>8</sup>See Bombardini *et al.* (2009), Bond (2007), Cheng *et al.*(2005), Costinot (2009a,b,c), Costinot and Komunjer (2008), Crozet (2009), Jones(2008a,b), Jones and Ruffin (2008), Marjit and Beladi (2009), Matsuyama(2007), Okubo (2009), Ruffin (2009), Ruffin and Jones(2007), Samuelson(2004) and Ju and Yang(2009).

<sup>&</sup>lt;sup>9</sup> A huge literature points out the importance of FDI as a relevant channel of TT. See Glass and Saggi (2002, 2008), Görg and Greenaway (2004), Hoekman *et al.*(2005), Keller (2010), Lipsey (2004), Saggi (2002, 2009), Singh & Marjit (2003) and for a review of literature. *"Attracting FDI is an effective way of introducing advanced technology to host countries"* (Liu and Wang, 2003, p.945).
<sup>10</sup> Bai *et al.* (2004) investigated the revenue sharing in joint ventures with 2 enterprises. The authors presented a model of

<sup>&</sup>lt;sup>10</sup> Bai *et al.* (2004) investigated the revenue sharing in joint ventures with 2 enterprises. The authors presented a model of team production motivated by the stylized facts found from a sample of 200 joint-venture contracts in China. In their study, 95% of the foreign partners provide patent, design, trademark and equipment, 56% provide technical training and 49% provide technical and management support. Cheng *et al.*(2001, p.169) speak about"*FDI, or equivalently technology transfer*". <sup>11</sup> Krugman (2000) studied the case of Asian countries that underwent the 1997 financial crisis and noted that the

<sup>&</sup>lt;sup>11</sup> Krugman (2000) studied the case of Asian countries that underwent the 1997 financial crisis and noted that the characteristic feature of capital flows during some financial crises is the contrast between capital outflows associated with portfolio investments, and the simultaneous inward FDI.

and Kokko (1994) showed that Swedish MNFs expanded FDI despite restriction on financing such investment with funds raised in Sweden. They argued that the main reason for FDI by Swedish firms has been technological advantages. Bitzer *et al.*(2008) find that OFDI is a significant channel for diffusion of knowledge from the developed countries to the host countries. In this case, FDI will entail important knowledge transfer in terms of training, skill acquisition, production methods and new organisational and managerial techniques. Cheng *et al.* (2005, p.478) regard "*FDI as synonymous to technology (and managerial skill) transfer*".

The theoretical and the empirical background of our Ricardian trade settings are the following. Many developing countries, in their technological absorptive effort, were observed to adopt a policy of technology import and acquisition of superior technologies through MNFs, FDI and licensing as means of technological upgradation and economic development (see Tarun and Marjit, 2003). We focus on the North-South effects of technology shocks and highlight the convenience of Ricardian model in studying FDI, TT, welfare and export sophistication of the developing countries. In discussing technology within a Southern perspective, we shall assume that technical progress is represented by new and better sets of blueprints that may be transferred via FDI and licensing or for free. The core objective is to develop Ricardian trade approaches that model technology transfer via FDI and to explore its implications within a North-South perspective. We also provide an empirical follow-up on these approaches.

Two parts emerge in this thesis. In the first part, we mainly revisit and reconsider the Japanese economic thought<sup>12</sup> (Kojima, 1978, 2000; Kojima and Ozawa, 1984; Lee, 1984; Ozawa, 1979a,b, 2007, 2009) toward OFDI, within the Ricardian context. We also implement an econometric estimation to test the relevance and usefulness of this theoretical approach to OFDI from the catching-up countries. In the second part, we provide new theoretical framework with empirical applications. We focus on the effects of technological inflows, especially via inward FDI, on the host developing countries and we develop new Ricardian approaches with empirical follow-up on the predictions.

<sup>&</sup>lt;sup>12</sup> The key contributors of this school are Kojima and Ozawa. They develop micro-macro models which combine micro variables with macro variables to account for trends in a nation's dynamic comparative advantage.

The contributions and novelties of this thesis are as follows:

In chapter 1, within a dynamic perspective, we re-examine the Ricardian growth approach toward FDI. We focus on OFDI as an escape response to home country growth bottlenecks, which represents an important but under-explored phenomenon in the FDI literature. We review the push-factor approaches based on the pressure effect of the "Ricardian bottlenecks"<sup>13</sup> to explain OFDI. We reconsider Ozawa's (1979a,b) work on Japanese OFDI, extend it and argue for a widespread applicability of FDI aimed at overcoming generalized "Ricardian bottlenecks", especially, nowadays, natural resourcescarcity and the huge need- hunger- for industrial raw materials and fuels. We show that the history of Japanese "Ricardian bottlenecks" pushing for OFDI replicates itself in many countries. We confirm that the Ricardian growth theory, when generalized and well interpreted offers a simple and yet powerful framework, reveals usefulness and conveniently provides a relevant set-up in examining these issues. In our next step, we implement an empirical follow-up on Ozawa's macroeconomic theory of OFDI to provide new evidence on the emergence of MNFs from rapidly catching-up countries. Our empirical findings confirm that OFDI acts as an escape from the "Ricardian bottlenecks" and strengthen the reasonableness, the usefulness and the empirical robustness of Ozawa' macroeconomic theory considerably.

In **chapter 2**, we develop a new theoretical model to determine the relationships between country's comparative advantage, its OFDI and the international division of labour between investing developed and host developing countries in a competitive world. Using a two-country, two-good Ricardian trade model (*à la* Negishi (1982)), we explain the emergence of North-South FDI and we examine its impact on the North-South trade and welfare. We reformulate Kojima's "*correspondence principle*" within this Ricardian setting and point out that OFDI originating from the comparatively disadvantaged industry in the developed country and going to the comparatively advantaged industry in the developing country should follow the direction of absolute profit rates which is a reflection of the comparative advantage patterns. Concerns over the impact on welfare are expressed. We show that the developed country's welfare improves with this direction of FDI due to an improvement in its terms of trade.

<sup>&</sup>lt;sup>13</sup>This term is borrowed from Ozawa (1982, 1992, 2005, 2009) and Dunning et al (1998).

In chapter 3, we mainly focus, in the first section, on the welfare effect of North-South technology transfer. We build a two-good, two-country Ricardian model in which the developed country transfers its superior technology to the industry where the developing country has a comparative advantage. We examine the welfare effect of TT and we single out the respective role of the relative size of both countries, the efficiency of the technology which is transferred, and the elasticity of substitution between the goods which are produced. In the second section of chapter 3, we reconsider TT à la Kojima – Ozawa from a developed country comparatively disadvantaged industry and going to developing country comparatively advantaged industry. We examine the consequences of free TT, licensing and FDI on the North-South welfare in a two-good, two-country Ricardian model. Using a Cobb-Douglas utility function, we show that the developed country, which has an absolute advantage based on technologies in both goods, gains by transferring its advanced technology in the developing country's export sector. This result is general and holds if the technology is freely transferred, sold (through licensing), or transferred via FDI by Northern MNFs. Even if the developed country receives no income from abroad, it benefits from the transfer due to an improvement in its terms of trade. On the other hand, we cast doubt on Kojima-Ozawa propositions about the mutual welfare gain and we show that FDI and licensing may decrease the developing country's welfare because of the income transferred to the developed country. Bringing the terms of trade debate into limelight, we provide an empirical analysis on the effect of licensing and foreign presence on the terms of trade of the developing countries.

In **chapter 4**, we combine an extended continuum Ricardian trade setting which rank sophistication of exports by their technology intensity with the new advanced wave of empirical literature on export sophistication (EXPY<sup>14</sup>). We provide both a theoretical and empirical analysis on the relationship between trade, foreign involvement and technological upgrading via technological absorptive effort. We put back Ricardian technological intensity of export at the forefront of the analysis and study the determinants of the evolution of the level of sophistication of a country's exports by extending Hausmann, Hwang and Rodrik's (2007) (hereafter HHR for short) paper. We adapt their measure of export sophistication used in an economic growth framework to an international trade and FDI framework.

<sup>&</sup>lt;sup>14</sup>EXPY is the original notation of Rodrik (2006) for overall export sophistication level of a country.

In this later chapter, an increase in the MNFs' ability of TT over time will cause increasingly sophisticated goods to go through the product cycle. An increase in the Ricardian trade cut-off ( $\tilde{z}$ ) upgrades the Southern country export basket and improves its sophistication level. Such export sophistication is observable. We deal with this issue by adopting the method developed by HHR (2007) to obtain a compounded index of the technological content of a country's exports<sup>15</sup>. We therefore examine predictions involving observable export sophistication from HHR's EXPY index data (as opposed to unobservable shifts in  $\tilde{z}$ ). A high EXPY index corresponds to a high "z". The Ricardian index "z" may be interpreted as a measure of the technological intensity or the level of sophistication of exports (Cheng et al., 2000, 2005; Krugman, 1986; Porcile et al., 2006; Yang and Yao, 2007; Zhu and Trefler, 2005). It is therefore, of interest to establish whether there is a positive link between importing superior technology via FDI and export sophistication. We extend HHR (2007) and Rodrik (2006) papers to explore the effect of TT via openness and foreign involvement on the export sophistication. Using data from the developing and emerging countries, we test the core theoretical prediction that foreign involvement and export penetration facilitate technological progress and upgrades export sophistication of a country by leading it to expand the range of goods that it produces toward sectors with rising productivity<sup>16</sup>.

A question, not explored by HHR (2007) and Rodrik (2006) and the new advanced empirical literature on the export sophistication (export productivity or technological content) and its growth effect, arises: does the increase in the sophistication of the developing countries' exports changes the deterioration of the terms of trade? The present thesis is also concerned with this question, in addition to the determinants of the export sophistication. We bring the debate on the deterioration of the developing countries' terms of trade back into the limelight. Importantly, we find that the increase in the export sophistication of the developing country's overall export basket is accompanied by a deterioration of its terms of trade. Indeed, the increase in the export productivity and the implied sophistication is accompanied by a

<sup>&</sup>lt;sup>15</sup> The definition is based on a method developed by Rodrik (2006) and HHR (2007) to measure the technological contents of a country's exports. The key element of the HHR method is what we call the technological sophistication index for each exported product. It is the average per-capita GDP of countries that export the product, weighted by each country's relative weight of the product in world trade. Then, the technological content index of a country's exports is defined as the weighted average of the technological sophistication index of the country's exported products. It is usually the case that higher labour productivity corresponds to higher technological contents.

<sup>&</sup>lt;sup>16</sup> We are indebted to Dani Rodrik and Bailey Klinger for providing us with the data on export sophistication used in the works of HHR (2007) and Rodrik (2006). We wish to thank Usha Nair-Reichert, Dominique Redor, Alain Desdoigts and Fabian Gouret for their helpful suggestions and comments. We thank participants at the European and Economic Financial Society (EEFS) conference in Warsaw in June 2009.

downward pressure on the export prices. Many of high growth developing and emerging countries have experienced deterioration in their terms of trade despite having a diversified export structure which is in line with related literature<sup>17</sup>.

<sup>&</sup>lt;sup>17</sup> UN (2008), UNCTAD (2008a), Sarkar (1997, 2001, 2004, 2005), Ram (2004), Bhattacharya & Raychaudhuri (2004), Mollick *et al.* (2008), Amiti & Freund (2007) and Lemoine & Ünal-Kesenci (2008).

First part

## REVISITING AND REFORMULATING THE MACROECONOMIC APPROACHES TO FDI

**RICARDIAN SETTINGS** 

### Introduction to the first part

The aim of this part is to re-examine and reformulate the macroeconomic approach to FDI based on the Japanese school. This economic thought (Japanese macroeconomic theories of FDI) expands analysis beyond the micro level of the firm and market structure by incorporating macroeconomic variables. The key contributors of this school are Kojima and Ozawa. They develop micro-macro models, which combine micro variables such as relative factor endowments and intangible assets, with macro variables like trade policy and industrial policy, to account for trends in a nation's dynamic comparative advantage (Kojima, 1977b, 1978, 2000; Kojima and Ozawa, 1984, Ozawa, 1979a, b, 2005, 2007). Kojima (1978), within Heckscher-Ohlin framework, stated that the Japanese OFDI, particularly in developing countries, is driven by the motivation to exploit locational comparative advantages. Ozawa (1979a, b) extends Kojima's (1977b, 1978) macroeconomic theory and considers country's OFDI as a means to escape from the threatening macroeconomic theory was inevitably being led by its fast economic growth.

In chapter 1, we re-examine the Ricardian growth approach toward OFDI. We draw on the Hicksian generalization of the Ricardian theory of stagnation and we focus on OFDI undertaken as an escape response to home country growth bottlenecks. We review the pushfactor approaches based on the pressure effect of the "*Ricardian bottlenecks*" to explain OFDI. We reconsider Ozawa's (1979a, b) work on Japanese OFDI, extend it and argue for a general applicability of FDI aimed at overcoming generalized "*Ricardian bottlenecks*". In our next step, we implement an econometric estimation.

In chapter 2, we reformulate Kojima's (1977b, 1978) "correspondence principle" within Ricardian trade setting and point out that OFDI originating from the comparatively disadvantaged industry in the developed country and going to the comparatively advantaged industry in the developing country should follow the direction of absolute profit rates which is a reflection of the comparative advantage patterns. We show that the developed country's welfare improves with this direction of FDI, even without receiving income from abroad, due to an improvement in its terms of trade.

# **Chapter 1**

## Generalized Ricardian growth bottlenecks and outward FDI: new evidence on the emerging multinationals<sup>18</sup>

### 1.1 Introduction

The FDI theory has so far been built most extensively around industrial organization economics, the theory of the firm and economics of internalization. Hymer (1976) and Kindleberger (1969) proved that the advantage of monopolistic firms and the imperfection of domestic and international markets are crucial factors in the firm's FDI. The monopolistic theory of FDI was then proposed and was called the Hymer - Kindleberger approach of MNFs. According to this theory, FDI occurs because the investing firm possesses superior ownership advantages. In the context of this theory, firms and markets are considered as alternative forms of organizing production. Buckley and Casson (1976) suggested that a MNF would internalize its activities in a foreign country via FDI if the internalization cost is inferior to the cost associated with export or to other forms of entry. Firms incur significant costs of doing business abroad relative to domestic firms in those host countries. Therefore, for a firm to become a multinational, it must have offsetting advantages.

Dunning (1980, 1988, 1993) built the ownership-location-internalization (OLI) paradigm. This paradigm states that in order to invest abroad a firm uses ownership (O), location (L), and internalization (I) advantages. The ownership advantage stems from the firm's ownership of intangible assets, such as technology, patents and skilled management. The location advantage arises from the pull factors of foreign markets, such as abundant natural resources, large market size, cheap factors of production and friendly business environment. These factors attract firms to produce abroad. The internalization advantage stems from the firm's commitment in investing abroad in order to avoid higher transaction

<sup>&</sup>lt;sup>18</sup> We thank Terutomo Ozawa, Subrata Ghatak and Henry Thompson for their helpful comments and suggestions on an earlier version of this chapter without empirical application, entitled "*On the Ricardian trade-growth approaches toward FDI*" presented at the European Economic Finance Society (EEFS) conference in Prague in May 2008.

costs of licensing or subcontracting in the host market. Whenever the three advantages are gathered firms will invest abroad<sup>19</sup>. The host country must have location-specific advantages that mainly include *"Ricardian-type endowments"*, i.e., availability of natural resources and labour; as well as the appropriate legal and commercial environment in which resources are used, i.e., market structure, and governmental legislation and policies.

The modern formal economic literature on FDI and multinationals was launched by Helpman (1984) and Markusen (1984). In fact, Helpman (1984) viewed FDI through the factor proportions theory. He embedded multinationals into the monopolistic competition trade model and showed that FDI is motivated by factor endowment differences between countries. He built his model on the separation of the firm into two activities, one appropriate for skill-abundant countries and the other best carried out in skill-scarce countries. Helpman (1984) and Helpman and Krugman's (1985) approach is known as vertical FDI defined as investments that "geographically fragment the production process by stages of production". They support the notion of vertically integrated firms, but allow no investments between very similar countries. Markusen (1984) assumed the existence of firm-level (as opposed to plantlevel) scale economies arising from the joint-input nature of knowledge capital across geographically separated production facilities. He modelled FDI as a way that firms could achieve multi-plant economies while avoiding trade costs. Markusen's approach is known as horizontal FDI defined as "foreign production of products and services roughly similar to those that the firm produces for its own market" Markusen (2002, p.5). Markusen's (1984) model captured the notion of horizontally integrated firms that undertake the same activity in multiple countries, but allowed no motive for vertical specialization $^{20}$ .

Markusen (1997, 2002) integrates both vertical and horizontal motives for FDI allowing the firm the options of building multiple plants or geographically separating headquarters from a single plant. This approach is referred to as the "*knowledge-capital model*" because it assumes that knowledge is geographically mobile and a joint input to multiple production facilities. According to Yeaple (2006), this model is the "*centrepiece*" of

<sup>&</sup>lt;sup>19</sup>If the location advantage does not exist but the firm possesses the others, it will opt to export. The greater the ownership advantages the firm possesses, the greater the incentive to internalize; the greater the attractiveness of an external country relative to the domestic country, the greater the probability of the firm to engage in foreign production.

<sup>&</sup>lt;sup>20</sup> Theoretical refinements of these ideas can be found in Helpman (1985), Horstmann and Markusen (1987, 1992), Brainard (1993), Markusen (1995, 1997), Markusen and Venables (1998, 2000) and Feenstra (2004). For an example of a purely vertical model of FDI, see Helpman (1984). For an example of a purely horizontal model of FDI, see Markusen and Venables (2000).

the theory of MNFs<sup>21</sup>. Several empirical studies have estimated these models. Brainard (1993; 1997), Carr *et al.* (2001), Markusen & Maskus (2002) and Blonigen et *al.* (2003) give support to the horizontal model. Waldkirch (2010), Shatz and Venables (2000), Hanson *et al.* (2001, 2005), Yeaple (2003) and Braconier *et al.* (2005) support the vertical model and thus a role for comparative advantage<sup>22</sup>. Although initially rejected, more support for vertical FDI arose in recent years mainly for two reasons: an increasing share of vertical fragmentation in the world economy and better measurement of criteria responsible for vertical investment<sup>23</sup>. According to Waldkirch (2010, p.2), the rejection of vertical FDI is puzzling because of the increased share of the developing countries as recipient of FDI and the rising vertical specialization which gives support to the complementarity relationship between FDI and trade.

The Japanese school<sup>24</sup> expands analysis beyond the micro level of the firm and market structure by incorporating macroeconomic variables. The key contributors of this school are Kojima and Ozawa. They develop micro-macro models, which combine micro variables such as relative factor endowments and intangible assets, with macro variables like trade policy and industrial policy, to account for trends in a nation's dynamic comparative advantage (Kojima, 1977b, 1978; Kojima and Ozawa, 1984, 1985; Ozawa, 1971; 1978, 1979a,b). Kojima (1978), within Heckscher-Ohlin framework, stated that Japanese FDI activities, particularly those in developing countries, are driven by the motivation to exploit locational comparative advantages that arise from the economic differences between Japan and host developing countries. This implies that Japanese FDI tends to provide export- platform for goods that embody the factors in which the host country has comparative advantage (and Japan comparative disadvantage). Ozawa (1979a,b) extends Kojima's (1977b, 1978) macroeconomic theory and considers country's OFDI as a means of escape from the *"Ricardian bottlenecks"* into which an industrialized country was inevitably being led by its fast economic growth.

<sup>&</sup>lt;sup>21</sup>Markusen and Maskus (2003) in their survey concentrated on the general-equilibrium trade theory view of the multinational firm, reviewing recent theoretical and empirical analysis.

<sup>&</sup>lt;sup>22</sup> See also Marin *et al.* (2003) for German vertical OFDI.

<sup>&</sup>lt;sup>23</sup>A possible source of bias is the use of data on FDI originating in or going to developed countries, usually the United States. "Most partner countries are other developed countries, in which case horizontal MNFs would indeed be expected to dominate despite the presence of some developing partners" Waldkirch (2010, p.2).

<sup>&</sup>lt;sup>24</sup> Oslington (2000) reviews the Japanese contributions to the theory of international trade and investment with reference to Japan's intellectual and cultural heritage, its pressing national priorities. Kojima (1978) and Kojima & Ozawa (1984) used a H-O structure to study the pro-trade FDI.

In this chapter, we try to explain the rise of OFDI and MNFs from the emerging markets. We focus on OFDI undertaken as an escape response to home country growth bottlenecks which represents an important but under-explored phenomenon in the FDI literature. We review, within a dynamic perspective, the push-factor approaches based on the pressure effect of the "Ricardian bottlenecks" to explain some types of OFDI. We reconsider Ozawa's (1979a, b) work on Japanese OFDI, which is based on the classical growth-"Ricardo-Hicksian bottlenecks theory of growth", extend it and argue for a widespread applicability of FDI aimed at overcoming generalized "Ricardian bottlenecks", especially, nowadays, natural resource-scarcity and the huge need- hunger- for industrial raw materials and fuels. We show that the history of Japanese "Ricardian bottlenecks" pushing for OFDI replicates itself in many countries. We confirm that the Ricardian growth theory, when generalized and well interpreted offers a simple and yet powerful framework, reveals usefulness and conveniently provides a relevant set-up in examining these issues. We also provide an empirical follow-up on Ozawa's macroeconomic theory of OFDI using a panel of 23 emerging countries and transition economies (the catching-up countries). Our empirical findings confirm OFDI' escape response to "Ricardian bottlenecks" and strengthen the usefulness of Ozawa' macroeconomic theory.

The remainder of this chapter is as follows. Section 1.2 focuses on the theoretical implications of the Ricardian growth theory for OFDI. We explain that OFDI acts as an escape response to growth bottlenecks. We pay special attention to Ozawa's (1979a, b, 2009) macroeconomic theory of FDI based on the *"Ricardo-Hicksian bottlenecks theory of industrialization"*. Any fast-growing and rapidly catching-up country is mainly concerned with the elimination of the Ricardo-Hicksian growth barriers. In section 1.3, we provide an empirical follow-up on Ozawa's macroeconomic theory and new evidence from the catching-up countries.

### **1.2** On the Ricardian growth approach toward FDI

What we want to argue, in this section, is that the Ricardian growth theory should have the ability to explain the phenomenon of FDI and capture the reality of international production. We focus on OFDI as a means of escape from Ricardian growth bottleneck. We reconsider Ozawa's (1979a,b) macroeconomic theory of FDI, applied to the Japanese economy, extend it and argue for its widespread applicability in many countries.

Ozawa (1979a, b) extends Kojima's macroeconomic theory. He states that a country's OFDI can be influenced by internally driving out factors. He addresses the question of "why invest abroad" from the domestic perspective. The internal driving forces for OFDI are essentially to escape from the threatening macroeconomic bottlenecks- shortages of key productive factors- into which an industrialized country was relentlessly being led by its own high-powered economic growth. He sees the OFDI as the consequence of increasingly expensive Japanese labour, natural resource shortage, increasingly expensive land and government encouragement to relocate. The push has come from industry cycles rather than product cycles. Ozawa (1979a, b) notes Japan's increasing investment in resource projects at the end of the sixties and in the early seventies. He sees it as the consequence of the historic shift in the 1970's of world demand pressing on a global shortage of raw materials and fuels. So long as supplies were abundant, trade routes for importing vital resource served Japan excellently. Imports had initially been a means of escape from the shortage of natural resources at home. However, it soon became evident that access to natural resources through import was dependable and no longer secure. Japan was confronted with the worldwide rise in demands for natural resources which led to global shortage. In order to circumvent these uncertainties of foreign supplies of industrial resources, Japan began to invest in natural resources rich countries<sup>25</sup>.

<sup>&</sup>lt;sup>25</sup> Farell *et al.* (2004) added that since the mid-1980s, Japan has been one of the largest sources of FDI in the world. Japanese corporations actively pursued OFDI in response to higher labour costs (caused by labour shortage) and to land shortage and the need to secure natural resources and markets.

Ozawa (1979a, b) stated that the monopolistic theory of FDI is not quite appropriate to explain the early post-war Japanese experience. He argued that it does not explain why Japanese firms in resource-processing industries invested abroad and does not explain either why Japanese firms, especially the small and medium-sized, suddenly and simultaneously took on multinational characteristics in the late 1960s, even though they had not yet, by the monopolistic theory criteria, quite reached the stage at which they would have evolved naturally into MNFs. Ozawa emphasized that Japanese OFDI in those days was driven by the macroeconomic forces of newly emerged factor scarcities at home, growing environmental constraints<sup>26</sup>, and increasing uncertainties about the supply of key industrial resources, rather than by the growth of their internal capacities to operate on a global scale.

Lee (1984, p.721) in his discussion of the Japanese macroeconomic theories of FDI casts doubt on Ozawa's approach based on the Ricardian trap of industrialism and on its general applicability to other cases. He states that "Ozawa's view reflects the experience of the Japanese economy, which lacks natural resources... Ozawa's view of Japan foretells the world to come ? Or it is a singular phenomenon from which we cannot generalize? Only history will be able to tell". We think that Lee failed to consider other cases of Asian countries. His work seems incomplete in the sense that resources-based FDI from South Korea and Taiwan in the 1980s were similar to the Japanese FDI at the end of the sixties and early seventies.

For the purpose of this section, we try to generalize the push-factor approach based on the pressure effect of the "*Ricardian bottlenecks*" to explain OFDI. We reconsider Ozawa's macroeconomic theory based on the Ricardian growth bottleneck theory and ask again if his view of Japan based on this classical growth model, predicts the emerging industrialized economies to come and if it can be transposed in the case of the MNFs which emerged from other countries. Is it a widespread phenomenon from which we can generalize? Should the answer to that question be affirmative, then the issue of whether or not any such approach is in fact relevant in explaining OFDI in many countries needs to be addressed. This provides the background to evaluate the similarity between Chinese and Indian FDI and the Asian NIEs (i.e., South Korea, Taiwan, Hong Kong and Singapore) and the Japanese OFDI. We

 $<sup>^{26}</sup>$ In those days, the rising environmental cost of heavy and chemical industrialization at home due to the air and water pollution caused by resource-processing activities, became intolerably high at the height of heavy and chemical industrialization.

show that Ricardian growth bottleneck remains an appealing framework to understand the macroeconomic push factors for OFDI and as a response to Lee (1984), we show that the model of generalized "*Ricardian bottlenecks*" pushing for OFDI repeats itself in other countries. Push factors for OFDI from many Asian countries are quite similar to those of Japanese FDI undertaken in the early 1970s, with a 15- to 30 year intertemporal gap. The Japanese experience of Ricardian bottlenecks to industrial development and OFDI has been transposed in the case of MNFs from many countries, especially nowadays the case of resource seeking FDI from China and India.

### **1.2.1** Is the Ricardian growth theory passé – or still relevant?<sup>27</sup>

The Ricardian growth theory is the very first macroeconomic theory of stagnation due to profit squeeze. Ricardo pointed out how the irremovable scarcity of arable land (on which agricultural output is subjected to the law of diminishing marginal returns) and the Malthusian population growth phenomenon would increase food prices and money wages and eventually erode the entrepreneur's profit (reinvestable capital). The net outcome is the complete evaporation of investable funds and the arrival of a stagnated economy (Ozawa, 2005).

Ricardo emphasized that economic growth depends on capital accumulation, which in turn relies on profits. He pessimistically saw the inevitability of the stationary state. Can the economy escape from stagnation? Ricardo pointed out that the day of reckoning could be postponed if free trade was pursued. He argued that North -South trade provided a growth-sustaining escape mechanism by enabling two regions to specialise The South, a land abundant economy, had a comparative advantage in producing agricultural goods. The North removes capital stock from its own agricultural production and reallocates it in the production of manufactured goods. Through its import of wage goods from the South more cheaply, it maintains a higher rate of profit and sustains capital accumulation (Ricardo, [1817] 1951; Molana and Vines, 1989). However, Fiaschi and Signorino, (2003, p.12) added that *"if the importation of cheaper agricultural commodities from abroad is unable to counteract the action of diminishing returns in domestic* [North] *agriculture, the process of economic growth inevitably comes to a halt"*. According to Findlay's (1980) interpretation of the Ricardian growth model, the world economy must tend toward a stationary state. Trade can thus

<sup>&</sup>lt;sup>27</sup> We apologize for the variation in section title (Is the flying geese passé – or still relevant?) used in Ozawa (2009).

postpone, but not stop, the cessation of growth because of diminishing returns. According to Ozawa (2005, pp.158-159), Ricardo did not focus on another important solution-which is FDI- as a means of transplanting industrial activities to new locations abroad where arable land is still abundant and wages are still low<sup>28</sup>. All the three possible escape responses to Ricardo's bottlenecks - Trade liberalization, technological progress and offshore productions - are conducted by the advanced mature economies.

Ozawa (1979a, p.85) added that "the Ricardian model applied to a closed economy without trade (cheap food imports and other imported wage goods would certainly stem rising labour costs); and the irremovable scarcity of key input factors emphasized by Hicks (1974) is expected, under normal circumstances, to occur only in the long run when the economy matures". However, many economies best typified by Japan, in the earlier seventies, and more recently Singapore, Hong Kong, South Korea and Taiwan, despite their openness to trade, reached these growth barriers experiencing acute land and labour shortages and rising wage rates (see Wu and Chen, 2001). For these countries, direct investment was an escape from industrial stagnation brought about by increasing scarcities of natural resource, land and labour. As economic growth was restricted by a shortage of resources, necessary adjustments to the industrial structure meant that mature technologies and industries needed to be transferred abroad.

We focus on the generalized Ricardian growth theory; called the "*Ricardo-Hicksian bottlenecks theory of industrialization*". Ricardo's theory of growth stagnation was strongly supported by Hicks (1973, 1974, 1981). Hicks applied it to a fast-growing economy and stated that irremovable scarcity of labour and land would in the end, constrain the pace of economic growth. Hicks's growth model can be combined with Ricardo's theory of stagnation into what may be called the "*Ricardo-Hicksian trap of industrial development*" (Ozawa, 1979a, b, 1993, 2005). According to this Ricardo-Hicksian theory of growth bottlenecks, an industrial economy cannot expand indefinitely, as sooner or later it must encounter "*irremovable scarcities*" of key productive factors such as land (for industrial sites ), natural resources and labour- the Ricardo-Hicksian shortage of key productive factors. Hicks (1973, pp. 218-219)

<sup>&</sup>lt;sup>28</sup> "This solution was, however, understandably impractical for Ricardo, since he saw a prohibitively high transaction cost of doing so (as seen earlier). Because of the lack of efficient communications and transport services in his day, overseas investment meant insurmountable difficulties" (Ozawa, 2005, pp.158-159).

emphasized how the *"impulse of an invention"* proceeds to work itself out in industrial world. He stated that:

"Obviously, in a limited world, the expansion that is due to a single improvement [a major innovation]cannot go forever. If railway building, for example, went on forever, the world would in the end become clustered up with railways. The profitability, or productivity, of a railway depends on its location; the time must come when a new railway project which will yield any surplus over cost, must be hard to find. For unlimited expansion, of a particular kind, such as that induced by a particular invention, there is not enough space.

Space, however, is not the only issue. Any indefinite expansion must encounter scarcities. Some, such as the bottlenecks previously discussed, are removable; in time, they can be overcome. Others-by necessity or in the world as it is and has been -are irremovable. It is by irremovable scarcities that expansion, such as we have been discussing, is brought to a stop.

The first economist to see this at all clearly was Ricardo...He supposed that the supply of labour was indefinitely extensible; it would increase without limit, so long as subsistence for the increasing labour force could be provided; so his operative scarcity was scarcity of agricultural land. This was responsible for his 'declining rate of profit'. Because of the scarcity of land, provision of an unchanged subsistence for an increasing labour force would become more expensive from the point of view of the employer, even though there was no rise in the real consumption of the labourer himself. With labour costs rising, the rate of profit would fall...

...it would still be true, even in the socialist economy, that irremovable scarcity (of land or of labour) would cause the rate of return on the spreading of the original improvement to diminish. In either case, the impulse of the original improvement would in time peter out.

When it is so interpreted (or generalized), the Ricardian theory still holds; and I maintain that it is rather fundamental"

Ozawa (2009, p.59) notes that "industrialization at each stage is not an endless process and cannot go on forever".

We draw on Hicks's core arguments which state that when it is so generalized, the Ricardian growth theory still holds; and this is "*rather fundamental*." According to Ozawa (2009, p. 60), "the idea that any economic growth triggered by a lead sector "that is, a major innovation that spawns a brand-new industry – hence a new growth stage is, sooner or later, bound to hit the limit can thus be called the Ricardo-Hicksian bottlenecks theory of industrialization. The natural environment is fast becoming an irremovable scarcity in any growing economy, especially in land-scarce small economy.... This provides an additional reason for the emergence of multinationals firms from the rapidly catching-up countries that quickly run into environmental constraints".

Ozawa (2005) considers the case of modern economy and explains the relevance and implications of the Hicksian generalization of the Ricardian theory of growth to the phenomenon of increasing factor incongruity. He argues that "*rents represent not only the return to land and food prices, but also the prices of natural resources (such as industrial* 

raw materials and fuels) that are used, as well as the environmental costs of economic growth"<sup>29</sup>.

The profits and the continual capital accumulation are the conditions for a persistent growth of the modern economy (fundamental law of growth in the capitalist economy). The bounds of productivity growth have to absorb any increase in the real wages and the access to industrial inputs needs to be secured at the lowest possible costs. That is to say, the increase in wages and rents - potential *Ricardo-Hicksian bottlenecks* - that causes a profit squeeze needs to be avoided. The labour seeking type, the resource seeking type and the house cleaning <sup>30</sup>type of FDI act as escape responses to the Ricardo-Hicksian trap of industrial development at home. This macro-motivated type of FDI emerges under the forces of what may be identified as the "*law of increasing factor incongruity*" (Ozawa 1992, 1993, 2005).

# **1.2.2** FDI from natural resource scarce industrialized economies: a vibrant research topic

The leitmotif of this sub-section is that any fast growing country that goes for a resource-intensive heavy industrialization searches aggressively for resources abroad by investing in resource rich countries. We focus on the resources-based FDI from resources-scarce but industrialized economies-the "*Ricardian economies*" - best typified by Japan in the 1970s. We explain the push effect of natural resource shortage for OFDI from industrialized countries (for example, China and India) feeling the pressure of the Ricardian bottlenecks on their industrial development and seeking to secure stable long-term supplies of raw materials and natural resources.

We examine the implications for FDI aiming at overcoming natural resource-scarcity bottlenecks to economic growth. When any resource-scarce country reaches a stage of growth based on resource-intensive heavy industries, it is pushed to seek out resources abroad via FDI which contributes to efficiency by breaking industrial supply bottlenecks. In general, the early forms of a country's OFDI are primarily resource seeking. This type of FDI integrates

<sup>&</sup>lt;sup>29</sup> Ozawa (2005, p.160)

<sup>&</sup>lt;sup>30</sup>Ozawa notes that FDI has served as a house-cleaning-and-renovating vehicle for Japan as it has steadily upgraded its domestic production facilities and repeatedly metamorphosed from one phase of industrialisation to another.

backwardly into the search for raw materials which either do not exist in the home investing country or are only available in amounts inadequate for industrial development. Several of the resources seeking FDI from developing countries follow the earlier resource seeking FDI from the UK, the USA and more recently, Japan, which are largely dependent on foreign natural resources for their domestic industrial requirements.

#### **1.2.2.1** Natural resources scarcity and growth

How natural resources scarcity would be a bottleneck for economic growth is well predicted in Ricardo's classical growth model, which used agricultural land as the main constraining factor<sup>31</sup>. Yet his model, generalized, applies equally to both the world as a whole(in the long run) and a particular economy, especially a natural resource scarce one, in an unexpectedly short run whenever economic growth is distinctly rapid (Barnett and Morse, 1969; Ozawa, 1982). "What are the prospects of economic growth from the point of view of the future availability of these natural resources?" Ricardian growth theory "had little doubt as to the long-term prospects of economic growth. Scarcity of natural resources would lead to diminishing returns to productive efforts. Consequently, any process of economic growth would sooner or later slow down and grind to a halt. In fact, this view on scarcity became a doctrine, as Barnett and Morse [1969, p.1] have pointed out –the "doctrine that an inherently limited availability of natural resources sets an upper bound to economic growth". This doctrine gained for economics its reputation as the "dismal science"" Linnemann (1977, p.466).

Khang (1970, p.193) built a generalized Ricardian growth model of a resource poor open economy<sup>32</sup>. He argued that "one obvious way for a country to avoid the Ricardian outcome is through the acquisition of natural resources (or raw materials) through trade and, indeed, many modern industrial economies with narrow natural resource bases pursue such a policy"<sup>33</sup>. He showed that such an economy in the absence of trade will face a "Ricardian outcome" in the long run, but this later situation can be avoided with imported raw material, provided the rate of export market expansion of such an economy is no less than its natural

<sup>&</sup>lt;sup>31</sup>Ricardo predicted that natural resources scarcity "*would lead to eventually diminishing returns to economic effort, with retardation and eventual cessation of economic growth*" (Barnett and Morse, 1969, p.2) <sup>32</sup>Khang (1968) built a neoclassical growth model of a resource-poor open economy. However, the model's applicability

<sup>&</sup>lt;sup>32</sup>Khang (1968) built a neoclassical growth model of a resource-poor open economy. However, the model's applicability diminishes when the economy under study has a broad natural resource base.

<sup>&</sup>lt;sup>33</sup>Khang (1970, p.193)

growth rate. In this sense, his model is regarded as a generalized Ricardian growth model. The author concluded that land fixity need not be an "*embarrassment*" in the modern growth model. Its constraining effects will be offset, under some conditions<sup>34</sup>, by raw material imports.

We note that we live in a finite world where Hicks's *law of irremovable scarcities* eventually sets in. There is now a renewed interest in the issues associated with natural resource scarcity. Availability of material resource will constitute a bottleneck for continued economic growth of the industrialized countries. The main concern in a large number of industrial and emerging economies, with high economic growth is the natural resource availability and the rising vulnerability to supply disruption. The urge to secure foreign supply bases via FDI is even stronger now in the present day, especially for oil and natural gas<sup>35</sup>. Yet short of those natural resources essential for sustained industrial growth, the Chinese economy has an outward dependency on foreign suppliers of raw materials and energy and so has to escape from the specter of Ricardo-Hicksian trap of industrial stagnation in the long term.

#### **1.2.2.2** Resource seeking FDI: a Ricardian approach

The shortage of agricultural land, which is the main constraining factor on economic growth in the classical growth model, can be interpreted in a broader sense to include shortage of natural resources. It applies equally to the world as a whole and to a particular economy, especially where natural resource is scarce. This model predicted how natural resources, ultimately finite in supply, would constitute a bottleneck for economic growth. According to Ozawa (1982), the Ricardian trap of industrialism is ineluctable. It explains the forces underlying the outward research of the resource-poor industrialized countries, which therefore may be called the Ricardian economies, for foreign natural resources. Ozawa (1992) considers the increase in factor incongruity as primary resource-seeking outward investment, which induced the search for secure supplies of natural resources abroad. In particular, as a natural-resource-scarce "*Ricardian economy*" experiences rapid industrialization, it inescapably becomes more and more dependent on foreign resources. The more industrialized such a resource-scarce economy is and the faster its pace of industrialization, the greater the need for

<sup>&</sup>lt;sup>34</sup>The rate of export market expansion has to be greater than or equal to the population growth rate.

<sup>&</sup>lt;sup>35</sup>The resource seeking type FDI took two basic forms: (1) the "invest and import" approach in which equity ownership, mostly partial, of foreign resources is sought in order to ensure import supplies and (2) the "loan and import" approach in which direct loans are extended in exchange for long term supply contracts (Ozawa,1975, 1977, 1980, 1982; 1996).

imported resources, hence the more strongly motivated that economy is to go after resources abroad. This incongruity between the resource requirements of the economy and its own endowments<sup>36</sup> can only be dealt with by means of FDI in resource-extractive industries abroad in order to secure long-term supply bases.

Rising supply uncertainty in resource-exporting countries made the vulnerability of some developed and emerging countries on foreign industrial resources critical. For these countries, trade was initially a means they had to escape from the shortage of natural resource. However, it soon became evident that access to foreign resources via international trade was no longer as secure and as stable as before, considering the rise in worldwide demands for natural resources. To remove the uncertainties of foreign supplies of industrial resources<sup>37</sup>, these countries' resource seeking outward direct investment became relevant. This tendency became especially pronounced during the 1950-1973 period of global economic growth. This type of investment was coming from the natural-resource-scarce but industrialized countries, notably from Japan and to a somewhat lesser extent from West Germany and other European economies. Japan and West Germany, in particular, have gradually established their own supply bases abroad during the post-war years. The industrialized resource scarce countries are eager to secure their own direct supply bases by means of FDI. Investors from the countries feeling the severe pressure of the Ricardian trap of industrialism were not only extractive firms but also resource processing firms (such as aluminium smelters, copper smelters, iron and steel makers, and petrochemical producers), and they formed investment consortiums (Kojima, 1978, p. 197-219; Ozawa, 1982).

Japan's surge of FDI at the end of the 1960s and earlier seventies was generated by internal forces associated with the huge growth of heavy and chemical industries in the spatially constrained island economy. Japan is poor in the very natural resources that are required by its heavy and chemical industries. As Japan emerged as the world's leading producer and exporter of resource- and energy-intensive goods, such as steel, aluminium, ships, heavy machinery, and chemicals, the security of resource supplies from abroad became a high priority in policy considerations. Drawing on the analytical insights of Ricardo and Hicks in explaining the irremovable scarcity of resources as constraints in modern economic growth, Ozawa (1979a,b) regarded this phase of Japanese FDI as a response to the Ricardo-

<sup>&</sup>lt;sup>36</sup>The rising vulnerability of dependence on imported industrial resources cannot be ruled out.

<sup>&</sup>lt;sup>37</sup>Kojima (1978, p.199) speaks about the fear of delivery interruptions.

Hicksian trap and called it the "*Ricardo-Hicksian trap stage of transnationalism*". The author observed that the Japanese economy fell into a Ricardo-Hicksian trap, whereby its shift to heavy and chemical industries led to an unsustainable resource-dependent position. "*At the centre of the predicament lay the country's own lack of natural resource*" (Randerson and Dent, 1996, p.51). The Ricardo-Hicksian trap essentially originated from constraints placed by an irremovable scarcity of resources on the economy's ability to make substantial levels of reinvestable profits. OFDI provided an escape from this trap by securing stable supplies of industrial raw materials and by relocating abroad some resource intensive industries (Dent and Randerson, 1996; Randerson and Dent, 1996).

Because of the resource constraints, the phase of economic growth based on heavy and chemical industrialisation, inescapably led to the Ricardo-Hicksian trap of industrial production and to the impracticality of continuing the expansion of resource intensive industries in a geographically confined space (Ozawa, 1993). Countries like Japan, South Korea and Taiwan sought to escape from this trap by transplanting abroad resource processing activities. Outward resource seeking investments, made earlier to support the expansion of heavy and chemical industrialisation at home and set up within natural resource development areas, resulted in the growth of resource processing investments (Ozawa, 1993, 1996).

#### **1.2.2.3** A replication of the Japanese Ricardian-trap stage of transnationalism

Since chemical and heavy industries are highly resource and energy intensive, the Ricardian trap of industrial production is ineluctable and explains the forces resulting in outward reach of the industrialized resource-scarce countries - the "*Ricardian economies*"-for foreign resources. Securing resource supplies from abroad becomes of vital importance for these countries. Early on, many industrialised countries best typified by Japan relied on trade for importing natural resources but soon began to secure the supply sources by FDI (Ozawa, 1993, 1996). According to the stylized facts on FDI trends in Asian region (see the survey of Tolentino, 1993, 2000), the industrial development of heavy and chemical industries in Taiwan in the 1960s and 1970s led to the dominant role of OFDI to relocate abroad some of the more resource intensive and often pollution prone industries in the 1970s and 1980s to escape from the Ricardo-Hicksian trap of industrialisation and economic growth. Similarly, the industrial development of heavy and chemical industries in South Korea in the 1970s and 1980s led to the emergence of its OFDI in natural resource extraction and heavy and chemical
industries in those decades. To the extent that South Korean and Taiwanese FDI could be compared with the pattern of Japanese FDI since the second World War, the phase of Japanese FDI in heavy and chemical industries during the Ricardo-Hicksian trap stage of Japanese FDI has been transposed in the case of the history of South Korean MNFs and in the case of Taiwanese MNFs. It seems that we can substitute the words "Korean" and "Korea", "Taiwan" and "Taiwanese" for "Japanese" and "Japan", respectively, in the explanation of OFDI, and that the "*Ricardian bottlenecks*" approach still holds. In addition, outward resources-based investments from the Philippines in the 1980s seem to follow some features of the Japanese experience (see Tolentino, 1993, 2000; Dent, 1996; Randerson and Dent, 1996; Kimura and Lee, 1998).

# **1.2.2.4** Fuelling the industrial development and economic growth of "Asian Drivers"<sup>38</sup>-China and India

As emphasized above, natural resource scarcity acts as bottleneck to economic growth. Any economy, but especially resource scarce one, that goes through growth based on natural resource intensive industries struggles to secure stable supplies of resources abroad. The motivation to secure access to natural resources is becoming more and more important, reflecting a rise in demand from emerging developing countries to support their economic growth. OFDI might seek natural resources to acquire and secure a continual supply for the investing country. The growing demand for various natural resources has been a key driver in the recent expansion abroad of State-owned MNFs from Asia.

China and India's great appetite for energy and metal has boosted international prices. The recent energy crunch gave way to stories about China's and India's efforts to invest in oil projects and companies in the world, in particular in Russia, Canada, Australia, Latin America, Central Asia, and Africa. China and India are hungry for energy<sup>39</sup>. With a combined population that accounts for one third of humanity, the two "*Asian Drivers*" are now going through a phase of rapid industrialization, creating a huge demand for energy consumption. Neither country produces enough energy to satisfy its own needs. Their fast-growing imports of oil, natural gas, and other materials have put substantial pressure on the global energy and

<sup>&</sup>lt;sup>38</sup> The term "Asian Drivers" is used to describe China and India (see Jensen and Edwards, 2006).

<sup>&</sup>lt;sup>39</sup> China is currently active than India in the quest for industrial raw materials abroad. See Pamlin and Long (2007), Hong and Sun (2006), Zweig and Jianhai (2005), Wu and Chen (2001), Cai (1999), Ozawa(2008) and Morck *et al.*(2007) for more details on the resources-based Chinese outward investment.

resource markets (Kant, 2008; Buckley *et al.*, 2008). Given many reports of billion dollar deals in 2006 and 2007 involving resource rich countries in Africa, central Asia and elsewhere, resource grabbing was a key driving force behind China's and India's OFDI (International Energy Agency, 2007; Buckley, 2007; Buckley *et al.*,2007; Buckley *et al.*,2008;Goldstein *et al.*,2006;UNCTAD, 2007,2008b). The share of mining activities in Chinese OFDI stock increased from 13.29% in 2004, to 15.12% in 2005, to 19.75% in 2006 (Ministry of Commerce of the People's Republic of China, 2006). The share of extractive activities in Indian OFDI stock increased from 1.47% in 2000, to 11.44% in 2004 (Kumar and Chadha, 2008).

Internal forces pushed China and India to invest abroad in natural resource projects. China's and India's rapid industrialization needs to secure adequate supplies of natural resources and raw materials. The capacity to secure stable supplies of raw materials that cannot be supplied adequately in China and India has been an objective shared with many other East Asian countries, including Japan in the 1960s and early 1970s. The resource scarcity in China and India, the inadequacy of imports to secure natural resources from abroad, domestic industrialisation and the 2007 and 2008 oil crunch act as bottlenecks to their economic growth. China and India strive to break the natural resources scarcity bottleneck to economic growth. They see OFDI as a solution to securing stable supplies of natural resources and raw materials to support their industrial development<sup>40</sup>. In these aspects, this *"Fuelling the Dragon"*, type of FDI is replication of the Japanese stage of multinationalization as an escape response to the Ricardian trap of industrialisation that prevailed between the late 1960s and early 1970s.

The potential for further OFDI from China and India remains high. As demands grow, competition abroad over natural resources between China and India will continue to be intense. According to the US Department of Energy Report (1996) on China's energy and its forecast to the year 2015, if China allows its commercial energy supply to fall much further behind demand, massive energy imports will be necessary in order to avoid severe bottlenecks in industrial production. The Chinese will face major oil shortages within the next decade. By

<sup>&</sup>lt;sup>40</sup> OFDI originating from the countries feeling the acute pressure of the Ricardian trap of industrialism are not only in extractive activities but also resource-processing activities.

<sup>&</sup>lt;sup>41</sup>See Jiang (2009).

2015, the domestic shortfall will have reached 8.8 million barrels a day. Thus, China can be expected to dramatically increase its outward investments, in order to secure access to the natural resources it requires to meet the demands of its rapidly emerging population and its super-growth. Giljum et al.(2008) by modelling scenarios towards a sustainable use of natural resources and with regard to global resource use trends, forecast a significant growth of resources extraction, particularly in developing countries, reflecting the growing demand for natural resources of emerging economies such as China and India. They argue that, until 2020, countries other than the traditional industrialised ones will gain increasing importance in the world economy and are expected to have significant economic growth rates. In particular, the East and South East Asian NIEs are developing at a rapid pace. They predict average economic growth rates of around 6.5% for China and more than 4% for India, Indonesia and Taiwan and other countries, which will lead to the significant shift of the shares of world regions in global material extraction until 2020. Providing that China and India continue to grow and industrialize further, their contribution to world energy and mineral demand will increase. Chinese and Indian companies in extractive resources will continue to work with foreign governments and companies in their search for natural resources, raw materials and oil and gas reserves abroad (Jenkins and Edwards, 2006; UNCTAD, 2008b).

#### **1.2.3** Push effect of land and labour shortages

#### 1.2.3.1 Push effect of land (housing market bottleneck) and industrial site shortages

According to the Ricardian theory, the economic growth is constrained by the availability of land. Hicks (1974, p.218) explained that "scarcity of land and labour for food production must have this effect [industrial stagnation]; so may scarcity of land as a source of minerals, or of power; or for many other purposes"<sup>42</sup>. Khang (1970, p.194) added, within a Ricardian approach, that the rate of the export market determines the success or failure of an economy's effort to escape from the constraining effect of land fixity.

<sup>&</sup>lt;sup>42</sup> We recall that Hicks (1973) observes "... For unlimited expansion of a particular kind, such as that induced by a particular invention, there is not enough space. .... Space, however, is not the only issue. Any indefinite expansion must encounter scarcities. Some [bottlenecks] ... are removable; in time they can be overcome. Others – by necessity or in the world as it is and has been – are irremovable. It is by irremovable scarcities that expansion ... is brought to a stop ... When it is so interpreted (or generalised), the Ricardian theory still holds; and I maintain that it is rather fundamental" (336–348, emphasis added).

For the purpose of this section, we focus on the illustrative example of land scarce, small but populous and investing economies such as some East Asian countries. We argue that the shortage of land for industrial sites and housing market resulted in an increase in wages and land cost that pushed firms to invest abroad to cope with these barriers<sup>43</sup>. In fact, in some countries a serious lack of land became apparent. These economies, typically Japan (specially at the end of the sixties and early seventies) and more recently Singapore<sup>44</sup>, Honk Kong, Taiwan and South Korea, confined within a small geographical space, as in *Ricardo's microcosm*, were clearly pushing against their scanty physical limit for industrial expansion (Ozawa, 1978, p. 521; Zhu, 2002).

Ho (1992, 1995) argued that one of the contributing factors to high wages which are determined by the "social notion of subsistence" à la Ricardo<sup>45</sup>, has been high rentals for housing services. Depending on the geographical features of a country, the provision of housing services can be subject to severely increasing cost<sup>46</sup>. He advances a Ricardian interpretation of the growth experience and focuses on the link of wages to growth via profits. A capitalist economy has continuously to accumulate capital to reproduce itself, and to survive the competition from other capitalist economies. The funds from which investments can be made is the 'surplus', distributed in the form of profits, from the production system. "The classical notion of a surplus is, in general terms, equal to gross output less the 'necessary consumption' or the wage of workers, and less the amount put aside for the replacement of used-up means of production". This in turn determines the size of the surplus from which investment funds are drawn and hence, the speed of capital accumulation. Ho (1992, 1995) focuses on the Hong Kong experience and shows that the main concern in this country was wage costs. This concern was in turn due to the high costs in procuring the two

<sup>&</sup>lt;sup>43</sup>Akbar and McBride (2004, p.93) argue that as housing market bottlenecks continue, the attractiveness of Hungary as a location for manufacturing FDI may be threatened.

<sup>&</sup>lt;sup>44</sup>Zhu (2000, 2002) focuses on the Singapore case and shows that competition for land and thus rising costs along with economic growth pushed some firms abroad in order to manage with the shortage of industrial sites. The major constraint of Singapore is the scarcity of the land for industrial purposes. Land cost remains a factor of concern to manufacturing. The rising price of industrial land exerted a push effect on some Singaporean companies industrial to invest in its neighbouring Asian developing countries. Taking the Taiwanese textile and shoe industries, as early as the late 1980s, the shortage and the rising cost of land were pushing a large number of firms, pulled by the availability of cheap land for factory construction, to move production to mainland China or Southeast Asia.

Similarly, Son and Kim (1997) Hannah et al. (1993) pointed out the problem of land scarcity and housing bottleneck in South Korea.

<sup>&</sup>lt;sup>45</sup> Ricardo stated that the level of the natural wage depends on the *'habits and customs'* of the people.

<sup>&</sup>lt;sup>46</sup> However, as Ho (1995) has illustrated in a Ricardian model, "*if the rental income accruing to landlords* [Hong Kong Government]*can somehow be channelled into subsidising the provision of the non tradable wage good*[Housing services], *the arrival of the "stationary state*"[ characterized by production stagnation] *can be postponed*". Ho (1995) argued that this solution was temporary. The stylized facts showed that the scarcity of land pushed firms in labour intensive industries (textiles, shoe) to expand abroad in neighbouring Asian countries (China) to cope with the rising cost of land and labour at home.

dominant wage-good items, namely food and housing services, in a typical worker's budget. Both food and housing services require land as an input in their production and Hong Kong was land scarce. The housing services are a non-tradable wage good. Since food was tradable, the solution of the increasing cost problem could be through imports, à la Ricardo. Since the housing services were non-tradable, the provision of this wage good is assumed to be subject to increasing cost. A country cannot resort to imports to avoid this obstacle. The possibility of solving the problem of increasing cost in their provision through trade is ruled out. Although Hong Kong is open to trade opportunities (import of food), the severe scarcity (fixity) of land and rising land costs led to rising wages (i.e., the subsidence requirement for housing). These wage increases, not matched by productivity growth, pushed for outward expansion. According to Ho (1992) and Thompson (2003), in the 1980s and 1990s, a large number of firms from Hong Kong relocated in the special economic zones and across mainland China. Such relocation allows these firms to have access to factory space. "And for the Chinese workers that are hired, their subsistence requirement for housing services is not taken care of inside Hong Kong but in and around those economic zones in China" (Ho, 1992, p. 225). Such direct investment activities have certainly escaped from the problem of having to meet the requirement for housing services inside Hong Kong. Thus, we could consider investment in China by Hong Kong companies as forced relocation brought about by rising labour costs and acute land shortage at home<sup>47</sup>. Interestingly enough, the Hong Kong experience was soon replicated by Singapore, Taiwan and South Korea<sup>48</sup> which has in many respects the same problem of land scarcity and housing as in Hong Kong.

#### 1.2.3.2 Push effect of labour shortage

Following Ricardo's insights on workers' behaviour, a shortage of labour appears in growing economies (Fiaschi and Signorino, 2003). The earlier industrialists in the Asian region, Japan, Korea and Taiwan, upgraded technology in manufacturing, and encouraged OFDI to overcome emerging labour shortages at home. These shortages had precipitated the export of capital to take advantage of low wages in neighbouring Asian countries (Manning, 2002).

<sup>&</sup>lt;sup>47</sup> Given the social notion of subsistence, Hong Kong investment appears to have responded more rapidly to a congenial working environment than to formal incentives provided by the Chinese authorities.

<sup>&</sup>lt;sup>48</sup> According to Ho (1995), the soaring wage rates and land prices sharply increased the production costs in South Korea.

Hicks (1974, p.219) in his generalization of the Ricardian theory of stagnation (the Ricardian trap of growth bottlenecks) pointed out the effect of labour shortages. He stated that, like the land scarcity case, "*it is of the greatest importance to notice*" that scantiness of labour results in industrial stagnation. He explains

"It would be a great deal of difference-in the rather old fashioned capitalist economy which Ricardo was of course assuming- whether the operative scarcity (or the main operative scarcity) was shortage of land or shortage of labour. In the former case (Ricardo's) scarcity of land would raise rents; but in the latter, the shortage of labour would raise wages".

In the post war period, the major technological impulse in Japan came from outside, in the form of import of technology introduced mostly under licensing agreements. The inflow of foreign technologies and capital investments resulted in an important rise in productivity of labour and competitiveness of trade. Ozawa (1979a,b) in his extension of Kojima's theory and based on the Ricardo-Hicksian growth approach, argued that domestic firms pressed and pushed by labour shortage at home, may choose investing abroad as an alternative, as labour shortage and rising wages hinder production at home. In fact, when Japan prospered in the 1960s, wage income rose with the efficiency gain in the modern sector, and the reduced number of new entrants to the Japanese labour market (due to both falling birth rates and longer years of schooling) further increased the labour shortage facing the traditional industries. At the end of the 1960s, the Japanese economy rapidly reached a point where the acceleration trend ceased. In terms of the Ricardo-Hicksian theory of stagnation, Japan's industrialisation was inescapably headed for a slowing down. Japan, though densely populated and considered a labour-abundant country, faced a severe labour shortage (particularly those of young factory workers) and rising wages in the mid 1960s. This strained labour market exerted a push effect on Japanese firms and fostered labour-seeking FDI in the neighbouring Asian countries. Against this background, as early as the late 1960s, Japanese firms began to transplant labour-intensive production to the neighbouring economies, notably Taiwan, Hong Kong, Singapore, and South Korea (newly industrialized economies (NIEs)); where labour, particularly young labour, was still abundant as factory workers. Interestingly enough, the Japanese experience was soon replicated by the NIEs themselves where labour shortages-'Ricardian bottlenecks'-became so severe that the rapid development in the industrial sector became threatened<sup>49</sup>. As the rising wages and labour shortage intensified in

<sup>&</sup>lt;sup>49</sup>Ozawa (1979a, b) added that labour-resource oriented FDI from Japan was the least expected phenomenon in this heavily populated country with reference to this period (1960s). Shortage of low-skilled labour pushed wages up. These wage increases were not matched by productivity growth.

Japan and NIEs in the late 1980s, there was increasing pressure to invest abroad. The shortage of labour and rising labour costs pushed some small firms to move production. OFDI began in the early 1980s from the NIEs first to the ASEAN-4 (Thailand, Malaysia, Indonesia, and the Philippines) and then quickly to China. The ASEAN-4 themselves began to invest in China (Culter *et al.*, 2003).

Similarly, Urata and Kawai (2000) and Blomstrom *et al.* (2000) show that the rapid expansion of the Japanese economy in the 1980s resulted in a labour shortage, which led to a hike in the Japanese wage rate. This in turn further decreased the competitiveness of Japanese products, particularly for labour-intensive manufactured products. The increasing shortage of labour was a particularly important push factor that has activated FDI by a large number of small and medium firms. FDI also facilitated Japan's adjustment to its changing comparative advantages as its domestic economy evolved from light manufacturing towards more advanced industries.

Dunning *et al.* (1998) study the new wave of OFDI originating from Asian countries such as Taiwan, South Korea and Hong Kong. They integrated both the Ozawa approach and OLI paradigm in order to study the flying geese model of development in the South East Asian region. They state that in the '*tandem industrialisation*' process, the advanced nation's superiority in industrial structure and technological progress is transmitted via FDI to lower-echelon nations. The upgrading from labour intensive manufacturing (such as textiles, sundries and other light industry goods) to industries based on scale economies (such as heavy and chemical industries, automobiles, and electric/electronic goods) led to a divergence between location (L) advantages (such as cheap labour) and the ownership (O) advantages needed in subsequent stages. This industrial upgrading is accompanied by "*Ricardian bottlenecks*". The shortage of low-skilled labour in traditional industries pushed nominal wages up. These wage increases were not matched by productivity growth, which led to an increase in unit labour costs. These increases in labour costs push firms originating from traditional industries to relocate abroad in order to maintain their competitiveness.

China's continued rapid growth will eventually begin to drive up wages, which will reduce the global competitiveness of its most labour-intensive industries (Coxhead, 2007; Quershi and Wan, 2008). Interestingly enough, rising production costs and labour shortages in China's coastal regions have begun to influence the geographic distribution of FDI between Chinese regions. There has been a worsening labour shortage in coastal provinces such as Guangdong. In response, the minimum wage has increased in recent years. For example, the minimum wage increased by 17.4% in Shenzhen in 2006. This increase in labour shortage and in its cost pushes firms in traditional industries to relocate in other low cost regions within China. Some provinces in the central and western regions of the country received higher FDI inflows than in previous years, while in the more advanced areas, such as the Pearl River and Yangtze River Deltas, investments have been shifting towards higher value-added activities such as computer peripherals, telecom equipment and semiconductors (UNCTAD, 2007, p. 42).

# **1.3** An empirical follow-up on Ozawa's macroeconomic theory of outward FDI: new evidence from catching-up countries

There is a plethora of studies on the developing countries (especially China) as recipient of FDI. However, the role of the developing and transition countries as investing economies has received little attention. In this sub-section, we examine the determinants of OFDI from the emerging countries and transition economies and we focus on the role of home country '*push*' factors in explaining the rise of MNFs (from these countries). Why do these countries invest and send their capital abroad? What are the home country's characteristics and forces that push for OFDI? Is Ozawa's macroeconomic (Japanese) theory for OFDI (based on "*Ricardo-Hicksian bottlenecks theory of industrialization*") passé – or still relevant? Answers to these questions depend on the emerging multinationals' motives and need careful econometric study.

Countries, in the resource-intensive heavy and chemical industrialisation phase, become more dependent on foreign resources, especially if it concerns a resource-poor nation. If prices of these resources increase and profit squeeze occurs, natural resource-seeking FDI takes place to secure a stable supply. Profit squeeze may also occur because of increased international competition. Ozawa labels the threat that such subsequent profit squeeze leads to stagnation at the macroeconomic level as "*Ricardian bottlenecks*" which, according to the author, can be solved by OFDI. Pollution and increasing environmental costs may also encourage '*house cleaning*' investments in other less strict countries.

We have reconsidered Ozawa's view of the Japanese OFDI and have showed that his arguments still hold. We show that the generalized Ricardian growth framework remains an appealing framework to understand the macroeconomic push factors for OFDI. OFDI should be considered as a means of removing the uncertainties of foreign supplies of industrial resources. In addition, OFDI allows firms to cope with land (for industrial sites) and labour shortages. To test empirically these Ricardian predictions, a dataset is prepared to examine the relationships between the home country macroeconomic factors and the level of its OFDI.

The aim of this section is to analyse the home country determinants (the push factors) that instigate the developing country's firms to become MNF. We examine the effect of the energy consumption, labour force, population density, GDP per unit of energy use, fuel imports and pollution on OFDI. The above predictions of the theory will be tested on the basis of a sample of emerging countries and transition economies over 1990-2006 period using new advanced techniques<sup>50</sup> for (slightly) incomplete and balanced panel. Our empirical specification takes the following form:

$$\log(OFDI_{it}) = \partial + \alpha_i + \alpha_t + \partial_1 \log(Energy)_{it} + \partial_2 \log(labour)_{it} + \partial_3 GDPper \, energy \, use_{it} + \partial_4 pop \, density_{it} + \partial_5 Trade \, Balance_{it} + \partial_6 Pollution_{it} + \partial_7 fuel_{it} + v_{it}$$
(1)

where "OFDI" is the real outward FDI. We use OFDI in stock deflated by the consumer price index taken from the World Bank's World Development Indicators (see Garcia-Herrero and Koivu, 2008; Bénassy- Quéré *et al.*, 2001). We use three measures for the "Energy" regressor: energy use (kt of oil equivalent), energy use per capita and energy dependency (net energy imports as percentage of energy use). The "labour" regressor is total labour force. "pop density" and "Trade Balance" regressors are respectively population density (people per sq. km) and external balance on goods and services (% of GDP). The "GDP per energy use" regressor is measured in constant 2005 PPP \$ per kg of oil equivalent. Fuel imports are measured as percentage of merchandise imports. The Pollution regressor is measured by  $CO_2$  emissions and  $CO_2$  intensity. "i" is country and "t" is year.  $\alpha_i$  and  $\alpha_i$  are respectively country specific (country specific dummy variable) effects and time specific effects in panel

<sup>&</sup>lt;sup>50</sup> see Baltagi *et al.*(2008), Cameron and Trivedi (2009), Baum (2006), Schaffer (2007) and Hoechle (2007)

data<sup>51</sup>. We model OFDI only with respect to home country factors. We test and confirm the predictions of Ozawa' macroeconomic theory of OFDI and the replication of the Japanese experience: history repeats itself.

<sup>&</sup>lt;sup>51</sup> All computations have been done on Stata for Windows (version 10).

Variable name	Definition	Source
log(OFDI)	Author calculation	Data on outward FDI (in US \$ at
	First measure:	taken from LINCTAD statistics
	• First measure.	taken nom one nad statistics.
	Real OFD1 in stocks (in natural logarithm) = $\log \left[\frac{OFD1 m stock}{consumer price index}\right]$	
	• Second measure:	Data on the consumer price index
	Real OFDI in stocks (in natural logarithm)= $\log \left[ \frac{OFDI \text{ in stock}}{\text{wholesale price index}} \right]$	price index are taken from the World Bank's World Development
		Indicators (WDI).
		Data on OFDI in stock are for the
		1990- 2007 period. For Russia,
		Croatia and Czech Republic there
		are missing data on OFDI at the
log(energy use)	Energy use (kt of oil equivalent) (in log form)	World Bank's WDI database
log (energy use )	Energy use (kg of oil equivalent) (in log form)	Data on energy are for the 1990 –
Net energy imports (% energy use )	Net energy imports (energy dependency) are estimated as energy use less production.	2006 period.
log (1+ net energy imports/ energy use )	both measured in oil equivalents.	· · · · · ·
log(labour)	Labour force, total (in log form).	World Bank's WDI database
Employment to population ratio (100*emp/pop)	Employment to population ratio, ages 15-24, total (%) in level and in log.	Data on employment to population
Total employment	in log.	ratio are for the 1991-2007 period.
Labour participation	Labour participation rate, total (% of total population ages 15+) in level and in log.	
GDP per unit of energy use	• GDP per unit of energy use (constant 2005 PPP \$ per kg of oil equivalent) in level and in log	World Bank's WDI database
	GDP per unit of energy use is the ratio of gross domestic product (GDP) per kilogram of	
	oil equivalent of energy use, with GDP converted to 2005 constant international dollars	
	using purchasing power parity (PPP) rates.	
	To produce comparable and consistent estimates of real GDP across economies relative	
	to physical inputs to GDP— that is, units of energy use- GDP is converted to 2005	
	constant international dollars using purchasing power parity (PPP) rates.	
	• GDP per unit of energy use (PPP \$ per kg of oil equivalent )	
	in level and in log	

Table 1.1. Variables used in analysis: measurement and data sources

Pop density Urban population growth log(Urban population)	Population density (people per sq. km)	World Bank's WDI database
Fuel imports Fossil fuel consumption Agricultural raw materials imports Electricity production log(1+ Electricity production from natural gas / total electricity production)	Fuel imports (% of merchandise imports) Fossil fuel energy consumption (% of total) Agricultural raw materials imports (% of merchandise imports) Electricity production from natural gas sources (% of total)	World Bank's WDI database
Trade Balance (% GDP) log(1+ trade balance/GDP)	External balance on goods and services (% of GDP)	World Bank's WDI database
Pollution	$CO_2$ emissions from solid fuel consumption (% of total), $CO_2$ intensity (kg per kg of oil equivalent energy use); $CO_2$ emissions (metric tons per capita), $CO_2$ emissions (metric tons )	World Bank's WDI database

List of emerging and transition investing countries used in our study : Argentina, Brazil, Chile, China, Colombia, Costa Rica, Croatia, Czech Republic, Hong Kong, Hungary, India, Indonesia, South Korea, Israel, Malaysia, Mexico, Peru, Philippines, Poland, Russian Federation, South -Africa, Thailand and Turkey.

Selection criteria of countries in our study :

- Ramamurti, R. and Singh, J. (2009), *Emerging multinationals in emerging markets*, Cambridge University Press.
- List of emerging developing and transition investing economies reported in UNCTAD's (2006) World investment report (WIR).
- Given the relatively long sample period in our study, several countries currently defined as industrial (for example, South Korea and Hong Kong) are included in the developing countries. UNCTAD's (2006) WIR reported South Korea and Hong Kong as investing developing countries.
- World Bank, (2008): Geographic classifications and data reported for geographic region are for low –income and middle –income economies as defined by the world bank http://web.worldbank.org
- More financially integrated developing countries (Israel included) reported in Prasad, E., Rogoff, K., Wei, S-J. and Kose, M.A. (2003), "The Effects of Financial Globalization on Developing Countries: Some Empirical Evidence", International Monetary Fund Occasional Paper 220. Washington: International Monetary Fund.
- Navaretti et al. (2004) study inward FDI and consider some EU neighbouring developing countries: Hungary, Czech Republic, Poland, Croatia.

In order to perform multicollinearity test, we compute the Variance Inflation Factor (VIF) for each regressor. VIF is widely used measure of the degree of multicollinearity of the *i*th independent variable with the other independent variables in a regression model. This measure shows how the variance of an estimator is inflated by the presence of multicollinearity. When an independent variable,  $X_i$  is regressed on *k* other independent variables, the covariance matrix is  $Cov \hat{\beta}_i = \sigma_e^2 (X'_i M_k X_i)^{-1}$ . The inverse of this correlation matrix is used in detecting multicollinearity. The diagonal elements of this matrix (the variance inflation factors) are given by  $VIF_i = 1/(1 - R_{ik}^2)$ , where  $R_{ik}^2$  is the  $R^2$  from regressing the  $X_i$  on k other variables. When there is perfect multicollinearity,  $R^2$  equals one, and VIF approaches infinity. The larger the value of VIF, the more collinear is the variable. There is evidence of the multicollinearity problem if the mean VIF is greater than 6 and the largest individual VIF is greater than 10 (Gujariti, 2004; Enders, 2004; Baum, 2006; Kennedy, 2003; Chatterjee and Price, 1991)<sup>52</sup>. In order to assess robustness, we take into account both conditions at the same time. No variables in our regressions presented here reached this criterion.

#### **1.3.1** Econometric methodology and estimation results from an incomplete panel

First, we use an incomplete (slightly) panel data because of the lack of some observations. We start our econometric estimation with a fixed effects model, controlling for country and time-specific effects. We have to take into account heteroscedasticity and serial correlation potential problems in the residuals. Since a modified Wald test for groupwise heteroskedasticity rejects the null hypothesis of homoscedasticity, we rely on robust standard errors. We test our models for autocorrelation of residuals with Wooldridge's (2002) test for serial correlation; the statistics obtained indicate that there is serial correlation of the residuals. A serial correlation of residuals implies estimators which are less efficient as their standard errors may be underestimated and therefore their statistical significance overstated. Therefore, we use an estimator, which is robust with respect to heteroscedasticity and autocorrelation consistent

<sup>&</sup>lt;sup>52</sup>See also Poncet (2004), Vu (2008), Bismans and Damette (2008), Berman and Hericourt (2008), Rezgui (2004) and Cassette *et al.* (2010).

<sup>&</sup>lt;sup>53</sup> Heteroscedasticity test is a modified Wald test for groupwise heteroscedasticity (see Greene, 2003). Autocorrelation test is a Wooldridge test for autocorrelation in panel data (see Wooldridge, 2002).

(HAC) kernel estimator and Newey-West<sup>54</sup> correction on standard errors (see Cameron and Trivedi, 2009; Zimmerman, 2009; Ahlquist and Prakash, 2008; Schaffer, 2007; Peterson, 2009; Baltagi *et al.*, 2008; Colacelli, 2010). We also re-run our regressions using Driscoll-Kraay correction on standard errors. We do so by employing a version of the variance-covariance matrix estimator for spatially and/or serially correlated data following Driscoll and Kraay (1998) (see Hoechle, 2007; Egger and Raff, 2010).

As recommended by Peterson (2009), Egger and Raff (2010), Baltagi *et al.* (2008) and Hericourt & Poncet (2009), we apply various estimation techniques to our data in order to assess robustness of the key variables' significance to multiple corrections on standard errors. Following Du and Hayes (2009), Hutzschenreuter and Gröne (2009), Zimmerman (2009), Martínez-Zarzoso *et al.* (2009), Kendix and Walls (2010) and Fleisher *et al.*(2010), we provide (see the notes below our tables of regressions) the details on the Stata packages used for testing our regressions. We report the results from OFDI regressions in Tables 1.2 and 1.3. It is interesting to note that the estimated coefficients on energy consumption, energy dependency, labour force, employment to population ratio, total employment, fuel imports (% total imports ) (and electricity production from natural gas (% total electricity production) ), GDP per energy use and population density are statistically significant in all fixed effect regressions. Our findings show strong conclusive evidence supporting our approach on the push effect of the "*Ricardian bottlenecks*" for OFDI.

How does OFDI vary across countries? Figure 1.1 shows a scatter plot of OFDI  $(\log[\frac{OFDI \text{ in stock}}{consumer \text{ price index}}])$  against energy use. There is a positive correlation between these two variables. This correlation is robust to the year and OFDI's deflator choices. In Figures 1.2, 1.3, 1.4 and 1.5, we pay special attention to China and India's great appetite for energy. With a combined population that accounts for one third of humanity, the two "Asian Drivers" are now going through a phase of rapid industrialization, creating a huge demand for energy consumption. Neither country produces enough energy to satisfy its own needs. Thus, their OFDI secures access to energy. In addition, we provide scatter plots (Figures 1.6 and 1.7) of Chinese and Indian OFDI against employment to population ratio, ages 15-24, total (%). The employment to population ratio is negatively associated with OFDI. In Figures 1.8 and 1.9,

<sup>&</sup>lt;sup>54</sup> Newey-West-HAC robust standard errors are chosen as the alternative cluster-robust standard errors need a rather large number of clusters (here countries) for reliable inference (see Nichols and Schaffer, 2007). Standard errors are fully robust with respect to serial correlation as well as general heteroscedasticity (see Baum *et al.*,2007).

we draw the scatter plot of Chinese and Indian OFDI against labour participation rate. The labour participation rate is negatively associated with their OFDI.



Figure 1.1: Relationship between emerging countries' OFDI and energy use (in logs), 2006

• Unless otherwise noted, data for China do not include data for Hong Kong, China (World Development Indicators, 2009).

• Source: Data on OFDI in stock , consumer price index and energy use are taken from World Bank -WDI database





Figure 1.3: Relationship between energy use per capita and Chinese OFDI





Figure 1.4: Relationship between energy use and Indian OFDI

Figure 1.5: Relationship between energy use per capita and Indian OFDI





### Figure 1.6: Relationship between employment/ population ratio and Chinese OFDI (in log)

(Years reported from right to left)



#### Figure 1.7: Relationship between employment/ population ratio and Indian OFDI (in log) (Years reported from right to left)

In our regressions, we use three measures of energy consumption: energy use, energy use per capita and energy dependency measured by net energy imports as percentage of energy use<sup>55</sup>. Our results show that the increase in the energy consumption boosts OFDI from the emerging countries and transition economies. The energy variable is positive and significant at 1% and 5% in all regressions. The increase in the energy consumption exacerbates the country's energy dependency (and vulnerability) and OFDI provides an escape from these uncertainties by securing access to future energy needs to sustain economic growth. From Tables 1.2 and 1.3, the energy use per capita variable is positive and significant at 1% and 5 % in all regressions. The estimated coefficient on energy use per capita varies from 2.8 to 3.9. Taking the midpoint of this range, the results imply that a 10% increase in the energy use per capita increases OFDI by 33.5 percentage points.

The estimated coefficients on energy imports (net (% energy use)), which measure energy dependency, are positive and significant. Thus, the increasing domestic energy consumption and the high-energy intensity act as a push effect for OFDI. The energy resource-seeking investments are still required to ensure energy supply security. This suggests that the emerging countries and transition economies invest abroad to secure access to energy which is necessary to maintain a high rate of economic development. Given the geopolitical importance of energy consumption, controlling energy resources may also be of strategic importance. Any fast growing country that goes for a resource-intensive heavy industrialization searches aggressively for resources abroad by investing in resource rich countries.

In order to check the absence of bias from the inclusion of specific countries and to assess robustness, we re-run our regressions by dropping Hong Kong, which is an important source of FDI, from the original sample (Table 1.3). We also exclude Russia Federation as an important exporter of natural gas from the original sample (Table 1.3). Our findings remain robust to these exclusions. Thus, there is no bias from the inclusion of Hong Kong and Russia in our panel.

<sup>&</sup>lt;sup>55</sup> Net energy imports are estimated as energy use less production, both measured in oil equivalents.

The empirical findings also indicate that the share of fuel imports (% of merchandise imports) plays critical role in determining OFDI from the emerging countries and transition economies. Avoiding the dependence and the vulnerability to fuel imports is a major concern. For these countries, the OFDI secures the supply of oil and raw materials.

The estimated coefficient on the total labour force reported in Tables 1.2 and 1.3 varies from (-3.3) to (-6.8). Taking the midpoint of this range, the results imply that a 10% decrease in the labour force (labour shortage) increases the OFDI by 50 percentage points. Ozawa (2005, p. 41) speaks about the *"labour shortage paradox in a labour abundant economy"*. OFDI acts as an escape response to labour shortage and rising wages at home.

We also include employment to population ratio, defined as the proportion of a country's working-age population that is employed. We consider employment to population ratio, ages 15-24, total (%). Employment to population ratios are generally negatively correlated to school enrolment and retention rate. A decrease in youth employment to population ratios can be a positive trend if related to increased enrollments: the higher the enrollment, the lower the employment (World Bank, 2009; Brixiova *et al.*, 2009). In our sample, the employment to population ratio declined rapidly while school retention rate increased which resulted in labour shortage. Rising incomes and enhanced opportunities for higher education encouraged an increasing number of young people to seek higher education which results in a decline in the supply of young shop-floor workers. Thus, the specter of labour shortage which leads to an increase in wages cannot be ruled out.

Table 1.4 reports regressions including labour force with primary education and labour force with secondary education as right-hand side (RHS) variables. Importantly, we find that both measures have a negative and significant effect on OFDI. This result is very interesting since it confirms the results of our regressions with total labour force as regressor. Labour shortage (which is often followed by an increase in wages) acts as a macroeconomic internal force and pushes firms in labour intensive industries to invest abroad to cope with these Ricardian type bottlenecks. This result is in line with the arguments of Dunning *et al.* (1997), Ozawa (1993, 1996, 2005, 2009) and Tolentino (1993, 2000).

The emerging countries' first stage industrialisation is primarily based on labourintensive manufacturing sectors, using cheap and abundant labour, and/or on the primary sector. This stage only lasts on condition that wages are kept low. When downward pressure on profit (because of rising wages) occurs, labour seeking FDI acts as an escape response to labour market bottlenecks and labour intensive production will be transplanted in low-wage countries (see Ozawa, 1992, 2005, 2009; Van Hoesel, 1998, 1999).

Our empirical results show that the decrease in the employment to population ratio, which enters significantly in all regressions, pushes for investing abroad to cope with a backdrop of rising labour shortages and rising labour costs at home. Moreover, we include the total employment as regressor and we find qualitatively similar results. We also re-run regressions with labour participation rate- the percent of the population supplying labour to the market- as a measure of the labour regressor. A decline in the labour force participation rate results in a contraction of the labour force. We show that the decrease in the labour participation ratio, chiefly the drop in labour force participation among young people, significantly increases OFDI. Investment abroad acts as a way of escaping from the declining participation rates of youth and the tightened labour market at home (see Ozawa, 2005 for more details).



#### Figure1.8: Relationship between labour participation ratio and Indian OFDI

(Years reported from right to left)



## Figure 1.9: Relationship between labour participation ratio and Chinese OFDI (Years reported from right to left)

The estimated coefficient on the urban population growth is positive as expected but not significant. However, the estimated coefficient on the population density is positive and statistically significant in all of these specifications. Thus, OFDI acts as a response to the pressure on the housing services and to the increase in costs and land price.

The relative scarcity of land and rising price of food, combined with the declining share of the population in the labour force (labour participation rate), will increase the cost of labour and therefore of labour-intensive goods, pushing for investing abroad in these industries to cope with home bottlenecks.

Poncet (2007, p.12), without empirical proof, suggests that "rising costs of production in the home economy (especially labour costs), does not seem to be an issue for China certainly due to their considerable reserves of labour, both skilled and unskilled". However, Cheung and Suny (2009, p.321-322) find that wages and raw materials in Chinese OFDI' host countries yield significant estimates that are consistent with the resource-seeking motive: to go for low cost locations and to seek natural resources. The authors note that according to the MOFTEC Offshore Plant Project (2000), 22.5% of the surveyed Chinese enterprises considered 'cheap labour' in the developing countries to be one of the most attractive factors for investing abroad<sup>56</sup>. Wu and Yeo (2002) note that the increase in Chinese OFDI in manufacturing industries is associated with the emergence of more outward-looking Chinese firms. Some Chinese firms invest abroad to adopt a diversification strategy in making revenues and transplanting matured industries in low-income countries. Their involvement in low-technology and labour intensive manufacturing industries in neighbouring developing countries (e.g. bicycle production in Ghana, textiles and video players in South-East Asia) as well as resource-based industries in resource-rich countries have grown (Deng, 2004; Poncet, 2007; Buckley et al., 2008).

The estimated coefficient on GDP per energy use is positive and statistically significant in all specifications. The economic growth acts as a push effect for OFDI. OFDI is positively influenced by a country's stage of development. The significance of GDP regressor shows that OFDI can be motivated by gaining market access, which confirms the horizontal type FDI motive. The need to use domestic production capacity because of the smallness of

<sup>&</sup>lt;sup>56</sup> MOFTEC'S Offshore Plant Project (2000) 'Inward Flow Should Be Accompanied by Outward Flow: Policy Analyses of China's Offshore Plant Operations,' *International Trade* 5, 9–13.

the home market (for their products), is regarded as an important factor for OFDI. Sluggish domestic demand and excess industrial productive capacity has pushed firms to invest abroad (see Poncet, 2007; Kant, 2008; Buckley *et al.*, 2008).

From Tables 1.2 and 1.3, the estimated coefficient on (external) trade balance (as percentage of GDP) is positive and statistically significant. The surge in emerging and transition economies' holding of foreign exchange reserves encourages their OFDI. Exports tend to induce OFDI. In markets with which the emerging and transition countries have large trade surpluses, OFDI may increasingly turn out to be a substitute channel to supply those markets. More generally, the greater integration of the emerging and transition countries in the world economy and the strengthening of international competition, the more MNFs originating from these economies will expand abroad to get a portfolio of locational assets that helps them to improve their international competitiveness<sup>57</sup>.

Ozawa (2009, p.60) in his macroeconomic approach of OFDI based on Ricardo-Hicksian bottlenecks theory of industrialization notes that "while ecological problems are the inevitable companions of industrialization, once an economy reaches a certain level of development, those problems begin to subside because people come to value the environment more than many more factories and because proper environmental regulations are to adopted". Thus, an extremely high density of industrial activities aggravate the malignancies of pollution, congestion and ecological destruction. This gives to OFDI a new role to serve as a catalyst to houseclean the home (investing) country. In Tables 1.14, 1.15 and 1.18, the coefficient of  $CO_2$  emissions reported in some regressions is positive and statistically significant. The pollution may exert a push effect for OFDI. This is in line with Ozawa's arguments for the "house cleaning" type of OFDI by heavy and chemical industries.

Such a simple econometric estimation does not take into account potential problems of endogeneity. This could lead to some of our variables being not significant or having the wrong sign. Following the literature on the relationship between OFDI and trade of the home country (see Kojima, 2000; Lipsey, 2004; Markusen and Maskus, 2003; Blonigen, 2005), a simultaneous causality between OFDI and trade balance can arise. Capital surplus coming from positive trade balance can finance and stimulate OFDI. Openness of the economy to international trade facilitates capital mobility and OFDI and allows learning via the

<sup>&</sup>lt;sup>57</sup> See Poncet (2007), Buckley *et al.* (2008), UNCTAD (2006).

acquisition of information, knowledge and skills necessary for the establishment and the growth of the international operations of domestic companies. On the other hand, OFDI can boost intra-firm trade and the exports of intermediary goods from the investing country to the host country, raising concerns of reverse causality in the estimation. Therefore, we additionally estimate our model with instrumental variables (IV) to deal with this suspicious endogeneity. We also check the exogeneity of fuel imports divided by total imports, GDP per energy use and the energy use variable.

Table 1.5 reports the results of fixed effects instrumental variables (IV) regressions<sup>58</sup>. We systematically check the validity of our instruments via Hansen's J-test of over identifying restrictions. Insignificant Hansen J-test statistics indicate that the orthogonality of the instruments and the error terms cannot be rejected, and thus that our choice of instruments is appropriate. The test statistics reported in Table 1.5 do not reject the orthogonality of the instruments and the error terms, and thus we can conclude that our choice of instruments was appropriate<sup>59</sup>. We complement this test by the Partial R<sup>2</sup> of excluded instruments and the firststage F-test. Partial R<sup>2</sup> are systematically higher than 10% which provides satisfactory explanatory power of instruments for the regressor instrumented. We also report the robust Fstat form of the Cragg-Donald statistic (Kleibergen-Paap F statistic); this statistic has been suggested by Stock and Yogo (2005) as a global test for the presence of weak instruments (i.e. it tests the null hypothesis that a given set of instruments is weak against the alternative that it is strong). This statistic is also reported together with the critical values, as tabulated by Stock and Yogo (2005). The test rejects the null hypothesis if the computed statistic exceeds the critical value. The results with respect to the quality of the instruments are overall quite satisfactory. Our instruments pass the Cragg-Donald test comfortably in all cases. We obtain a Kleibergen-Paap Wald F-statistic above the informal threshold of 10 suggested by Staiger and Stock (1997) to assess the validity of instruments. All Kleibergen-Paap Wald F statistics shown in Table 1.5 are greater than the Stock and Yogo 10 or 15 percent critical values<sup>60</sup>. All of the test statistics are displayed at the bottom of Table 1.5.

<sup>&</sup>lt;sup>58</sup> All computations have been done on Stata for Windows (version 10).

<sup>&</sup>lt;sup>59</sup> The failure to reject this statistic means that the instruments can be considered as exogenous. Davidson and MacKinnon (1993,p. 236) point out that these tests should be calculated and reported routinely whenever one computes IV estimates.

<sup>&</sup>lt;sup>60</sup> Kleibergen-Paap F statistic is reported together with critical value Stock-Yogo weak identification test for 10% and 15% maximal IV size distortion as tabulated by Stock and Yogo (2005). If there are three or more instruments (thus, there are two or more overidentifying restrictions), the relative-bias criterion can be used (Cameron and Trivedi, 2009; p. 194).

In order to test the appropriateness of relying on the IV estimator, we perform the Durbin-Wu-Hausman test statistic, which tests the endogeneity in this IV regression. The rejection of the null hypothesis means that the endogeneity of the regressors has a significant effect on the estimated coefficients and we have to rely on the IV estimation. Since these test statistics do not reject the null hypothesis of exogeneity of regressors tested (at the 10% confidence level), IV estimates are not efficient (Pagan, 1984). The instrumented regressors are exogenous. We have no endogeneity problem<sup>61</sup>.

<sup>&</sup>lt;sup>61</sup> See the econometric methodology of Havrylchyk and Poncet (2007), Hering and Poncet, (2009), Guariglia and Poncet, (2008), Hericourt and Poncet (2009).

						consum	i price ii	шсл							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
log (energy use per capita )	2.78*** (4.04)	3.3756*** (3.49)											3.336*** (3.59)	3.8077*** (4.23)	
log (energy use )			4.457*** (3.53)	5.022*** (3.96)	3.616*** (3.06)	2.6466*** (3.57)	3.39*** (2.99)	3.10*** (3.22)	2.4957** (2.40)						
log (1+ Energy imports, net/energy use) <sup>a</sup>										0.685*** (2.88)	0.544*** (2.63)	0.601*** (3.00)			0.547*** (2.62)
log(labour )	-3.937** (2.46)	-3.3634** (1.98)	-4.27*** (2.59)	-4.556** (2.37)	-4.924*** (2.66)	-5.57*** (2.96)	-5.23*** (2.86)			-3.336** (2.15)	-5.55*** (2.81)	-4.555** (2.39)			
log(100*emp/pop )								-1.708** (2.19)	-1.96** (2.26)						
log (total employment )													-1.409** (2.43)	- 0.944** (2.03)	-1.968*** (2.89)
GDP per energy use (constant 2005	0.676***	0.8276***	0.8667***	0.963***	0.827***	0.683***	0.86***	0.8289***	0.812***	0.326**	0.407***		0.8215***	0.808***	0.459***
PPP \$ per kg of oil equivalent)	(4.58)	(3.57)	(3.35)	(3.44)	(3.28)	(4.48)	(3.33)	(3.58)	(3.25)	(2.30)	(2.66)		(3.60)	(3.96)	(2.92)
log(GDP per energy use )												3.042*** (3.38)			
Pop density	0.003***	0.0031***	0.0029***	0.0033***	0.0029***	0.0029***	0.003***	0.002***	0.0025***	0.003***	0.003***	0.0034***	0.0027***	0.0022***	0.0028***
	(5.23)	(5.06)	(4.34)	(3.46)	(5.49)	(5.23)	(5.01)	(3.19)	(4.28)	(4.78)	(5.76)	(6.43)	(4.43)	(3.41)	(4.98)
Trade Balance (% GDP)	0.036**	0.037**	0.04***	0.04***		0.035**	0.036**	0.031**	0.03**	0.045***			0.0344**	0.0349***	
	(2.51)	(2.48)	(2.74)	(2.78)		(2.50)	(2.47)	(2.43)	(2.39)	(2.85)			(2.48)	(2.54)	
$\log(1 + \text{trade balance /GDP})^{b}$											4.151*** (2.58)	4.787*** (3.00)			3.316** (2.34)
Fuel imports (% of merchandise	0.09**	0.11**			0.11***	0.94**	0.11***		0.066*		0.135***	0.136***	0.0736*		0.085**
imports)	(2.36)	(2.46)			(2.57)	(2.44)	(2.56)		(1.73)		(2.85)	(2.92)	(1.94)		(2.07)
CO <sub>2</sub> emissions from solid fuel				0.002											
consumption (% of total)				(0.11)											
Electricity production from natural gas (% of total)								0.015* (1.69)						0.0164* (1.80)	
Year dummies	No	Yes	Yes	Yes	Yes	No	Yes	Yes							
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Number of observations	378	378	383	360	378	378	378	363	359	370	365	365	359	363	347

 Table 1.2. Dependant variable: log[
 OFDI in stock
 ] over the period 1990-2006

*Notes*: We use an incomplete (slightly) panel because of the lack of some observations. <sup>a b</sup> In order to report the logarithmic form, we use the transformation log(1+x) to cope with negatives values and zeros in x. In our model, a Hausman test suggests that the appropriate error structure is fixed-effects rather random-effects and Breusch & Pagan Lagrangian multiplier test strongly rejects the presence of random effects. Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. Wooldridge (2002, pp.282-283) derives a simple test for autocorrelation in panel-data models, and the user-written program "xtserial "(Drukker, 2003) performs this test in Stata. Wooldridge's test for autocorrelation rejects the null of no autocorrelation. As the basic structure of the dataset is an incomplete longitudinal panel, we use Schaffer's xtivreg2 Stata command" [without instruments and using Ordinary Least Square (OLS) estimation] with "bw" (kernel=Bartlett; bandwidth selection) and robust options to report HAC kernel estimator (Schaffer, 2007, Ahlquist and Prakash, 2008; Baum *et al.*, 2007). In addition to its use with endogenous regressors, xtivreg2 Stata command estimates basic fixed effect models with exogenous regressors (Schaffer, 2007). This command does not report the constant. A bandwidth (bw) of 2 is selected along with robust standard errors. We find qualitatively similar results when we select bw of 1. We find the same results by using Newey? Stata command and "*force*" option with incomplete panel. In order to test whether or not the residuals are cross-sectionally (spatially) uncorrelated. Correspondingly, the test's alternative hypothesis presumes that spatial dependence is present. The Pesaran's CD test and Friedman's CD test do not reject the null hypothesis of spatial independence. Besides do not suffer from any multicollinearity pr

	Dep	endant va	riable: lo	$g \left[ \frac{OF}{consum} \right]$	DI in stock er price ind	] -	Hong Kor	ng exclude	ed -	Dependa	nt variable	e: log [	OFDI in st	tock e_index ]-	Russia ex	cluded-
	(1)	(2)	(2)	(4)	(5)	(6)	(7)	(9)	(0)	(1)	( <b>2</b> )	(2)	(4)	(5)	(6)	(7)
log (anargy use par capita)	(1)	(2)	3 906***	(4)	(3)	(0)	(7)	(0)	(9)	(1)	(2)	(3)	(4)	(3)	2 25***	2 (99***
log (energy use per capita )	(3.36)		(3.90)							(3.70)					(3.53)	(3.79)
log (energy use )		2.615**									3.424***	2.687**				
		(2.41)									(2.90)	(2.54)				
log (1+ Energy imports,				0.618***	0.67***	0.728***	0.681***	0.6598***	0.716***				0.723***	0.74***		
net/energy use)				(2.78)	(3.28)	(3.05)	(2.63)	(3.11)	(2.74)				(3.22)	(3.19)		
log (labour)	-4.150**			- 6.848***	-5.369***	-5.378**	-3.7188**	-4.3746**	-3.783**							
	(2.24)			(3.22)	(2.49)	(2.38)	(1.98)	(2.10)	(2.00)							
log(100*emp/pop)		-2.268**	-1.887**							-1.74**	-2.138**	-2.255**	-5.46***	-4.611**		
		(2.52)	(2.28)							(2.15)	(2.51)	(2.52)	(2.79)	(2.41)		
log(total employment)															-1.48**	-0.99**
															(2.50)	(2.13)
GDP per energy use	1 02***	1 004***	1 092***	0 5396***	0.638***					0.8669***	0.838***	0 8478***	0 411***		0.82***	0 797***
(constant 2005 PPP \$ per kg	(3.98)	(3.63)	(4.06)	(3.13)	(4 59)					(3.68)	(3.31)	(3,37)	(2,70)		(3, 63)	(3.76)
of oil equivalent)	(5.50)	(5.65)	(	(5.15)	(					(5.00)	(5.51)	(5.57)	(=:/0)		(5.65)	(5.70)
log(GDP per energy use)						2 743***	3 053***	2 9***	2 99***					2 876***		
log(GDI per energy use)						(3.41)	(3.90)	(6.30)	(3.86)					(3.24)		
Pop density	0.0235***	0.0133**	0.0173***	0.03***	0.032***	0.0318***	0.0313***	0.0207***	0.03***	0.0027***	0.0025***	0.0026***	0.003***	0.003/***	0.0028***	0.002***
1 op density	(2.97)	(2.00)	(2.61)	(3.42)	(3.85)	(3.02)	(3.01)	(3.12)	(2.95)	(4.45)	(3.00)	(4.38)	(5.03)	(6.58)	(4.55)	(3, 43)
Trada Dalanca (% CDD)	(2.97)	(2.00)	0.029***	(3.42)	0.04***	(3.02)	0.044***	(3.12)	(2.95)	(4.45)	(3.33)	0.02**	0.020**	(0.58)	0.025**	0.026***
Trade Balance (% GDP)	0.0416***	$0.035^{+++}$	0.038***	$0.042^{+++}$	(2.81)		$0.044^{+++}$			$0.0335^{++}$	0.034/***	(2, 20)	0.039**		0.035**	0.036***
la a (1) Trada	(2.00)	(2.09)	(2.80)	(2.04)	(2.81)	5 114***	(2.97)	4.0***	1 57***	(2.47)	(2.03)	(2.39)	(2.30)	A ( ( ***	(2.31)	(2.00)
$\log(1+1)$ rade						5.114***		4.8***	4.5/***					4.00***		
balance/GDP)	0.100(**	0.0(1*	0.0(0*	0 105***	0.1000***	(3.10)		(2.87)	(2.95)	0.075(**		0.0720*	0 1 4 4 4 4	(2.85)	0.070**	
Fuel imports (% of	0.1006**	0.061*	0.062*	0.125***	0.1088***					0.0/56**		0.0/28*	0.14***	0.139/***	0.0/9**	
merchandise imports)	(2.46)	(1.69)	(1.78)	(2.94)	(2.97)	0.500544				(1.97)		(1.86)	(2.93)	(2.96)	(2.04)	
log (100*fuel						0.5235**										
imports/merchandise						(2.10)										
imports)																
Electricity production from							0.025*									0.0162*
natural gas (% total)							(1.95)									(1.77)
log (1+ Electricity								2.956**	3.192*							
production from natural								(1.97)	(1.92)							
gas/total electricity																
production)																
year dummies	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Number of observations	361	343	343	348	348	348	353	353	353	349	349	348	354	354	348	349

#### Table 1.3. Dependant variable: log (OFDI) over the period 1990-2006: Hong Kong or Russia excluded

Notes: Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. We use Schaffer's xtivreg2 Stata command (without instruments) with "bw" (A bandwidth (bw) of 2 is selected) and "robust" options, as the basic structure of the dataset is an incomplete longitudinal panel (Schaffer, 2007; Ahlquist and Prakash, 2008). This command does not report the constant. Stata's xtivreg2 command allows the model to be estimated with HAC standard errors. The Newey–West (Bartlett kernel function) is used for the generation of HAC estimators of the covariance matrix. Schaffer xtivreg2' Stata command has a wide range of kernels available beyond the Bartlett kernel ("Newey-West") used by "Newey2" Stata command. According to Schaffer (2007), as well as panel IV, -xtivreg2- Stata command will do fixed effects estimates for the case where all regressors are exogenous.

٠

					OEDI in at	o o le					OEDL in star	1.
		Dependa	int variab	ole $\log\left[\frac{1}{ca}\right]$	onsumer price	$\frac{\partial c\kappa}{\partial l}$ ]		Dependa	ant variat	ole $\log\left[\frac{1}{W}\right]$	holesale price	$\left[\frac{1}{index}\right]$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)
log (energy use per capita )	5.014*** (3.84)	5.575*** (4.08)	5.686*** (4.30)	5.886*** (4.07)	6.496 *** (4.66)	5.536*** (4.45)	6.429*** (4.72)	5.685*** (4.31)	6.55*** (4.37)	5.519*** (4.30)	6.523*** (4.48)	6.545*** (4.47)
log(labour force with primary education % of total )	- 0.717** (2.21)	-0.515* (1.69)	- 0.509* (1.85)					-0.556* (1.97)				
log( labour force with primary education )						-0.6** (2.15)				-0.692** (2.41)		
log(labour force with secondary education % of total )				-0.799*** (3.24)	-0.738*** (3.74)				-0.636*** (3.02)			
log( labour force with secondary education)							-0.816*** (3.76)				-0.749*** (3.23)	-0.7485*** (3.23)
log(GDP per energy use)	4.93***	5.88***	5.859***	6.44***	6.98***	5.479***	6.66***	6.03***	7.237***	5.437***	6.96***	6.997***
<b>P</b> 1 2	(4.13)	(4.29)	(3.40)	(4.33)	(3.69)	(4.05)	(3.70)	(4.07)	(3.60)	(3.83)	(3.64)	(3.64)
Pop density						0.0009 (0.19)		0.002 (0.41)		0.0015 (0.39)		
Trade balance (% GDP)		0.066***	0.068**		0.073***	0.066***	0.072***	0.0588**	0.066**	0.055**	0.065**	
log(1+ trade balance /GDP)		(2.08)	(2.33)		(2.07)	(2.71)	(2.71)	(2.20)	(2.51)	(2.20)	(2.54)	6.665** (2.32)
Urban population growth			0.03		0.108		0.072		0.0565		0.027	0.0235
Electricity production from natural gas sources (% of total)			(0.12) 0.024* (1.95)		(0.44) 0.0214* (1.87)	0.025** (2.15)	0.021* (1.86)	0.0387*** (3.99)	(0.22) 0.034*** (3.31)	0.038*** (3.91)	(0.11) 0.0339*** (3.34)	0.0339*** (3.35)
Time specific effects (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	18	18	18	18	18	18	18	18	18	18	18	18
Number of observations	163	163	163	163	163	163	163	157	157	157	157	157

#### Table 1.4. Robustness checks: labour force with primary education and secondary education as right hand side (RHS) variables

Notes:

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• GDP per energy use (constant 2005 PPP \$ per kg of oil equivalent)

Dependant variable	Newey-	IV	IV	IV	IV	IV
	West	Instrumented :	Instrumented :	Instrumented :	Instrumented :	Instrumented :
$\log\left[-\frac{OFDI \text{ in stock}}{1}\right]$		GDP per energy use	log(energy use per	trade balance	fuel imports	log(energy use per capita)
consumer price index			capita)			and GDP per energy use
log (energy use per capita)	3.3756***	3.136**	2.40**	2.214***	2.826***	2.9694 **
(constant 2005 PPP \$ per kg of oil equivalent)	(3.49)	(2.27)	(2.24)	(2.81)	(3.10)	(2.24)
log(labour)	-3.3634**	-4.0705**	-1.9587	-2.684*	-3.0004*	-3.1288*
	(1.98)	(2.09)	(1.18)	(1.93)	(1.86)	(1.65)
GDP per energy use	0.676***	0.9786***	0.616***	0.5813***	0.717***	0.7545**
1 00	(4.58)	(2.81)	(3.57)	(3.52)	(3.52)	(2.41)
Pop density	0.003***	0.003***	0.0025***	0.002***	0.0028***	0.0028***
	(5.23)	(5.60)	(4.49)	(4.60)	(4.83)	(4.89)
Trade balance (% GDP)	0.036**	0.0276**	0.0324**	0.29*	0.0281*	0.0288**
	(2.51)	(1.97)	(2.39)	(1.68)	(2.14)	(2.10)
Fuel imports (% of merchandise imports)	0.09**	0.1266***	0.0496	0.056	0.095**	0.098**
	(2.36)	(2.73)	(1.58)	(1.59)	(2.03)	(2.28)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R <sup>2</sup>	0.4670					
Prob > F		0.0000	0.0000	0.0000	0.0000	0.0000
Root MSE		0.9705	0.6991	0.6752	0.8233	0.8399
First-stage F-stat		37.107***	121.62 ***	122.60 ***	195.74***	286.57*** for log (energy use per capita ) 32.07*** for GDP per energy use
Partial R <sup>2</sup> for excluded instruments		0.2535	0.5953	0.4619	0.7092	Shea Partial R <sup>2</sup>
						log (energy use per capita ) 0.4871 GDP per energy use 0.2120
Hansen J statistic of overidentifying restrictions		0.004	0.718	2.379	2.024	0.002
p-value		0.9490	0.3968	0.1230	0.1549	0.9664
Kleibergen-Paap rk Wald F statistic		37.107	121.618	122.60	195.74	20.70
Stock-Yogo weak ID test critical values:						
10% maximal IV size		19.93	19.93	19.93	19.93	13.43
15% maximal IV size		11.59	11.59	11.59	11.59	8.18
Instruments (excluded ) for IV regressions		log(land) and	First lag and second	First lag and second lag	First lag of fuel imports	log(land), import quantum index and first
		import quantum	lag of log(energy use	of trade balance	and fossil fuel energy	lag of log(energy use per capita)
		index	per capita)		consumption (% of total)	
Underidentification test (Kleibergen-Paap rk LM statistic)		23.598***	38.456***	41.934***	28.997***	28.859***
Durbin-Wu-Hausman endogeneity test		0.184	0.515	0.576	0.254	0.180
p-value		0.6677	0.4729	0.4480	0.6145	0.9140
Number of observations	378	333	340	339	355	315

#### Table 1.5. IV regressions: checking exogeneity of GDP per energy use, energy use per capita, trade balance and fuel imports

*Notes*: Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. As discussed in Greene (2003) and Wooldridge (2002), an adjusted R<sup>2</sup> in IV estimation does not have a meaningful interpretation. Instead of an Adjusted R<sup>2</sup>, the Stata package we use provides the root mean square error

(RMSE) defined as  $\sqrt{\varkappa \sum_{i} (y_i - \hat{y}_i)^2}$  that we report in our table. The endogeneity problems are diagnosed by the command xtivreg2 in Stata. Our first stage F-statistics are consistently above 10, consistent with Staiger and Stock's

(1997) "rule of thumb". Hansen J tests show that the instruments are appropriately uncorrelated with the disturbance process. We perform the Durbin–Wu–Hausman test for exogeneity of regressors. The null hypothesis of exogeneity cannot be rejected in all specifications. In presence of heteroskedastic errors, the Kleibergen-Paap rk statistics perform a LM test and reject the null of under-identification.

#### **1.3.2** Additional results and robustness checks

In order to assess the robustness of our results, we repeated the regressions for various additional variables, measures, specifications and methods. The set of robustness checks is a follows.

- We introduce the electricity production from natural gas sources (% of total electricity production) instead of fuel imports. We find that the increase in the electricity production from natural gas sources has a positive and significant effect on OFDI. Our finding suggests that OFDI secures access to natural gas sources abroad, which are necessary to the electricity production at home.
- In Tables 1.10 and 1.11, we mainly focus on the energy dependency instead of the energy use. Our findings remain robust to this test. The energy dependency acts as a strong push factor for investing abroad to secure access to natural resources and raw materials.
- We also report fixed-effects regressions with Driscoll-Kraay correction on standard errors (Table 1.6). Importantly, the significance of the key variables (labour and energy consumption) remains robust to the estimation technique choice.
- In Table 1.7, we report regressions with right hand side (RHS) variables lagged one year. The sign and the significance of the key regressors are robust to this test. Labour, energy use, GDP per energy use, fuel imports and population density, lagged one year and contemporaneous are significant. Our findings are robust to lagging labour, energy use, GDP per energy use, fuel imports and population density by one year.
- In Tables 1.8 and 1.9, we report OFDI difference regressions. This is useful as the evolution of OFDI is pronounced in the time dimension. The difference regression equation estimates the link between changes in OFDI and changes in the hypothesized determinants. Note that the time-differencing level equation(1) would yield a difference equation without country fixed effects, while our difference equation includes country fixed effects to control for the effects of unobserved country features on changes in the OFDI (see Xu and Lu, 2009; Xu and Wang, 2000; Mansfield and Reinhardt, 2008 for

econometric methodology). The results from OFDI difference regressions are consistent with the ones obtained from OFDI level regressions. The sign and the significance of the key regressors are robust to this test. Interestingly, energy consumption and labour appear to significantly affect the directional change in OFDI. Larger increase in OFDI occurred in countries with higher growth of energy use and with higher growth of fuel imports (as share of total imports) and electricity production from natural gas (as share of total electricity production). The positive estimated coefficient on energy use implies that a catching-up country would see a larger rise in its OFDI the faster the increase in its energy use. In addition, the results show a robust negative association between changes in a country' OFDI and changes in labour measures (labour force, employment to population ratio, total employment). A catching-up country would see a larger rise in its OFDI the faster the decrease in its labour force and its employment to population ratio. Countries with acute labour shortage tend to see more rapid increase in their OFDI.

• To ensure that our results are robust to the choice of the deflator of FDI, we therefore rerun our regressions using real OFDI measured by log[ OFDI in stock Wholesale price index]. Because of the lack of data on the Chinese wholesale price index in the World Bank's WDI database, we use Hong Kong's wholesale price deflator (see Rahman and Thorbecke, 2007). Since many of Hong Kong's exports are re-exports from China, this measure may be a useful proxy for Chinese export prices or wholesale prix index. Our specification is also robust to the exclusion of China from our sample when we do not provide a proxy for Chinese wholesale price index. Our findings are robust to the deflator choice [see Tables (1.4), (1.9)-(1.15) and (1.18)].

						msumer price	с тиел								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
log (energy use per capita )	2.78***	3.3756***								3.5297***		1.82***	2.105***	3.12***	3.336***
	(4.56)	(4.29)								(4.69)		(3.68)	(2.98)	(4.46)	(4.29)
log (energy use )	, , ,		4.7135***	4.457***	5.022***	2.767***	3.616***	2.6466***	3.39***		2.4957***			· · · ·	
			(3.53)	(3.85)	(5.11)	(4.36)	(3.70)	(4.24)	(3.66)		(3.21)				
log(labour )	-3.937***	-3.363***	-3.95***	-4.27***	-4.556***	-5.2***	-4.924***	-5.57***	-5.23***			-2.837***	-2.78***	-3.445***	
	(5.13)	(3.55)	(3.70)	(4.55)	(3.27)	(4.06)	(3.97)	(4.94)	(4.72)			(3.53)	(4.70)	(4.62)	
log(100*emp/pop)				, í	, , , , , , , , , , , , , , , , , , ,					-1.524**	-1.96**		, í		
										(2.42)	(2.60)				
log(total employment )															-1.409***
															(3.40)
GDP per energy use ( ppp	0.676***	0.8276***	0.826***	0.8667***	0.963***	0.64***	0.827***	0.683***	0.86***	0.8639***	0.812***			0.686***	0.82***
constant 2005)	(6.68)	(4.68)	(3.99)	(4.03)	(4.52)	(6.88)	(4.18)	(6.61)	(4.17)	(4.04)	(3.44)			(6.79)	(4.03)
log (GDP per energy use)												1.358**	1.69***		
(PPP \$ per kg of oil equivalent)												(4.59)	(6.76)		
Pop density	0.003***	0.0031***	0.0028***	0.0029***	0.0033***	0.0029***	0.0029***	0.0029***	0.003***	0.0027***	0.0025***		(1111)		0.0028***
1	(7.29)	(6.51)	(6.74)	(5.38)	(3.49)	(10.27)	(8.17)	(7.72)	(6.51)	(5.02)	(5.07)				(5.23)
urban population growth	(		()	()	()		()	(111)			(****)	0.021	0.056	0.03336	()
												(0.28)	(0.81)	(0.48)	
Trade balance (% GDP)	0.036***	0.037**		0.04***	0.04***			0.035**	0.0358**	0.0327**	0.03**		(*** )	0.036***	0.0344**
	(2.69)	(2.39)		(3.11)	(3.76)			(2.67)	(2.42)	(2.16)	(2.04)			(2.75)	(2.13)
$\log (1 + \text{trade balance /GDP})$					()							3.589***	3.975***		
												(2.98)	(2.75)		
Fuel imports (% of merchandise	0.093***	0 11***				0 1***	0 11***	0 094***	0 1085***	0.069**	0.066*	()	(e)		0.0736***
imports)	(3.29)	(2.79)				(3.31)	(2.72)	(3.28)	(2.86)	(2.19)	(2.07)				(2.30)
log(Fuel imports (% of	(0.127)	(,)				(0.00)	(=:/=)	(0.20)	()	(,)	(,)		0.339**		(*)
merchandise imports))													(2.52)		
log (1+ Electricity production												3.009**			
from natural gas/total electricity												(2.28)			
production)															
Electricity production from														0.089***	
natural gas (%total electricity														(3.06)	
production)														× ,	
CO <sub>2</sub> emissions from solid fuel					0.002										
consumption					(0.10)										
Time specific effect (year	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No	Yes
dummies)															
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R <sup>2</sup>	0.3075	0.3246	0.2358	0.2545	0.2401	0.2931	0.3125	0.3092	0.3272	0.3109	0.2874	0.1578	0.1519	0.2621	0.3150
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Number of observations	378	378	383	383	360	378	378	378	378	359	359	383	378	378	359

## Table 1.6. Robustness checks: Dependant variable $\log\left[\frac{OFDI \text{ in stock}}{consumer \ price \ index}}\right]$ - Fixed effects regression with Driscoll-Kraay standard errors

• Notes: t-statistics (absolute values) are reported under coefficient estimates. Statistics are robust to heteroskedasticity and autocorrelation. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. Statistics are robust to heteroskedasticity and autocorrelation. We use Hoechle's xtscc Stata command (see Hoechle, 2007) to report Driscoll-Kraay estimation. The Driscoll-Kraay estimates of the standard errors use one time lag. Constants not shown.

Dependant variable       log[     OFDI in stock	Regres	ssion with N standar	lewey-West d errors	(HAC)		Regression v robust star	with heteroske	edasticity	Regression with Driscoll-Kraay standard errors				
consumer price index							r						
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
log (energy use per capita ) lagged	3.057***	2.97***	3.2***	3.044***	3.057***	2.97***	3.2***	3.044***	3.057***	2.97***	3.2***	3.044***	
	(5.42)	(3.43)	(3.59)	(3.49)	(6.80)	(4.16)	(4.42)	(4.24)	(7.78)	(4.24)	(4.54)	(4.57)	
log(labour ) lagged	-2.79**	-2.858**	-3.136**	-2.942**	-2.79**	-2.858**	-3.136***	-2.942***	-2.79***	-2.858***	-3.136***	-2.942***	
	(2.10)	(2.07)	(2.22)	(2.13)	(2.57)	(2.56)	(2.74)	(2.63)	(3.78)	(3.87)	(4.04)	(3.91)	
GDP per energy use lagged	0.753***	0.7498***	0.738***	0.7488***	0.753***	0.7498***	0.738***	0.7488***	0.753***	0.7498***	0.738***	0.7488***	
	(5.59)	(3.71)	(3.64)	(3.69)	(6.86)	(4.50)	(4.40)	(4.48)	(7.36)	(4.20)	(4.25)	(4.2)	
Pop density lagged	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	0.0026***	
	(4.89)	(4.61)	(4.58)	(4.55)	(5.90)	(5.63)	(5.59)	(5.54)	(5.75)	(5.46)	(5.68)	(5.57)	
Trade balance (% GDP) lagged	0.0198*	0.0198*	0.015	0.018	0.0198**	0.0198**	0.015	0.018*	0.0198**	0.0198**	0.015	0.018	
	(1.87)	(1.69)	(1.33)	(1.52)	(2.22)	(2.03)	(1.59)	(1.82)	(2.52)	(2.04)	(1.53)	(1.54)	
Fuel imports (% of merchandise imports) lagged	0.0659**	0.072*	0.074**	0.073**	0.0659**	0.072**	0.074**	0.073**	0.0659***	0.072**	0.074**	0.073**	
	(1.97)	(1.95)	(2.02)	(1.99)	(2.40)	(2.35)	(2.43)	(2.39)	(2.75)	(2.05)	(2.07)	(2.08)	
Agricultural raw materials imports			0.174*				0.174*				0.174***		
			(1.66)				(1.84)				(3.31)		
Agricultural raw materials imports lagged				0.0485				0.0485				0.0485	
				(0.44)				(0.51)				(0.60)	
Year dummies	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	
Within R <sup>2</sup>									0.3656	0.3766	0.3835	0.3772	
R <sup>2</sup>	0.8484	0.8511	0.8527	0.8512									
Adj R <sup>2</sup>	0.8363	0.8314	0.8328	0.8311									
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23	
Number of observations	378	378	378	378	378	378	378	378	378	378	378	378	

#### Table 1.7. Robustness checks: RHS variables lagged (one year) over the period 1990-2007

Notes :

• The t-statistics (absolute value in parentheses) are based on standard error estimates obtained from the covariance matrix estimators in the column headings. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• Newey produces Newey–West standard errors for coefficients estimated by OLS regression. We compute Newey-West standard errors which provide t-statistics that are robust to autocorrelation and heteroscedasticity. The error structure is assumed to be heteroscedastic and possibly autocorrelated up to some lag. In our regressions, the Newey-West estimates of the standard errors use one time lag. Estimators require the use of "*Newey2*" Stata command and "*force*" option with incomplete panel (see Zimmerman, 2009).

• We use the new Stata command "xtivreg2" (without instruments and using OLS estimation) with "robust" option to report regression with heteroskedasticity robust standard errors. According to Schaffer (2007), as well as panel IV, -xtivreg2- Stata command will do fixed effects estimates for the case where all repressors are exogenous.

• We use the Stata command "xtscc" (from Hoechle, 2007) to report Driscoll-Kraay correction on standard errors. The Driscoll-Kraay estimates of the standard errors use one time lag. Statistics are robust to heteroskedasticity and autocorrelation.

• All regressions include country fixed effects. Constants are not shown.

											consun	ler price il	пиех				
	OFDI diffe	erence regressi fixed effects	ions without														
	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$\Delta \log$ (energy use)			4.0013*** (5.36)	3.848*** (4.48)	3.617*** (3.91)	4.2489*** (3.98)	4.0186*** (4.46)	4.078*** (4.06)	4.1777*** (4.30)					4.147*** (4.10)			
$\Delta$ log (energy use per capita )		3.578*** (4.96)								3.939*** (4.38)	3.109*** (3.98)	4.0546*** (4.46)	4.237*** (3.77)		4.21*** (4.11)	3.519*** (3.62)	3.48*** (4.06)
$\Delta \log(\text{labour})$	-4.89*** (2.91)	-3.506 ** (2.16)	-4.43*** (2.67)	-5.4478** (2.32)	-4.496** (1.97)	-5.20** (2.44)	-4.374** (2.21)	-4.4578** (2.00)	- 4.35** (2.38)	-4.468** (2.22)	-4.142** (2.18)	-4.376** (2.21)	-4.628** (2.30)	- 4.57** (2.03)	-4.648** (2.23)	-4.747** (2.27)	-4.759** (2.21)
$\Delta$ GDP per energy use	0.346** (3.62)	0.348*** (3.56)		0.3837*** (3.55)	0.35*** (3.02)											0.354*** (2.96)	0.3459*** (3.24)
$\Delta \log (\text{GDP per energy use})$			3.505*** (4.04)			3.66*** (3.09)	3.32*** (3.34)	3.397*** (3.10)	3.544*** (3.30)	3.222*** (3.28)		3.347*** (3.36)	3.634*** (3.01)	3.43*** (3.13)	3.55*** (3.26)		
$\Delta$ log GDP per energy use (PPP \$ per kg of oil equivalent)											2.045*** (2.62)						
$\Delta$ Pop density	0.0013* (1.87)	0.0015** (2.27)	0.0015* (1.92)	0.0003 (0.30)	0.0008 (0.74)	0.0018** (2.28)			0.0022** (2.36)				0.0025*** (2.87)	0.001 (0.90)	0.0028** (2.50)	0.002** (2.52)	0.002** (2.31)
$\Delta$ log(urban population )							0.394 (0.05)			4.0189 (0.57)	3.1399 (0.41)	3.897 (0.56)					
ΔUrban population (%population)								0.058 (0.29)									
$\Delta \log (100*Trade/GDP)$			0.409* (1.79)				0.343 (1.38)					0.339 (2.41)					
$\Delta$ (100*Trade/GDP)	0.0046* (1.90)	0.0045* (1.88)							0.003 (0.98)	0.0026 (1.00)	0.003 (1.13)				0.003 ( 0.98)		0.0012 (0.39)
$\Delta$ (100* trade balance /GDP)				0.016* (1.91)	0.007 (0.89)	0.006 (0.77)							0.005 (0.67)	0.009 (1.18)		0.0026 (0.33)	
∆log (1+ trade balance /GDP)								0.8616 (1.05)									
$\Delta$ log (1+ Electricity production from natural gas/total electricity production)			1.6299** (2.20)				1.65** (2.42)	1.642** (2.36)				1.65** (1.37)					
$\Delta$ (100 * Electricity production from natural gas/total electricity production)	0.0129** (2.10)	0.013** (2.14)		0.012** (2.02)	0.0125** (2.02)					0.014** (2.48)	0.0144** (2.54)			0.0125** (2.08)			
$\Delta$ (100* Fuel imports /marchandise imports)						0.047** (2.16)			0.0429** (2.24)				0.0416** (2.17)		0.043** (2.13)	0.035* (1.84)	0.0358* (1.89)
Year dummies	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Number of observations	360	360	360	360	360	355	360	360	355	360	360	360	355	360	355	355	355

## **Table 1.8.** OFDI difference regressions- Dependant variable: $\Delta \log \left[\frac{OFDI \text{ in stock}}{consumer \text{ price} \text{ index}}\right]$ )

Notes :

• Heteroskedasticity robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• Wooldridge's test for autocorrelation does not reject the null of no autocorrelation.

1 abic 1.7.	OF DI uni	ierenee reg	1 (5510115 -	Dependa		$\mathbf{L}$ . $\Delta \mathbf{R}$	Wholes	ale price inde.	x		
	OFDI differer without fi	nce regressions xed effects	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(1)	(2)									
$\Delta \log$ (energy use)	4.094*** (5.37)	4.624*** (5.75)	5.217*** (4.30)	5.135*** (4.53)	4.626*** (4.70)	2.909*** (3.17)	3.4197*** (3.53)	2.35*** (3.01)	2.855*** (3.41)	5.08*** (4.76)	
$\Delta \log$ (energy use per capita )											5.07*** (4.76)
$\Delta \log(\text{labour})$	-6.068*** (3.50)	-5.185*** (3.20)	-5.485** (2.16)	-5.5667** (2.08)	-5.907** (2.01)	-4.205** (2.33)	-4.118** (2.15)	-4.138** (2.27)	-3.981** (2.04)	-4.67** (2.10)	-4.68** (2.11)
$\Delta$ GDP per energy use	0.412*** (3.95)							0.18** (2.20)			
$\Delta \log(\text{GDP per energy use })$		3.998*** (4.47)	4.5327*** (3.43)	4.444*** (3.62)	3.893*** (3.66)	2.18** (2.37)	2.673*** (2.73)		0.2499*** (2.77)	4.297*** (3.68)	4.287*** (3.68)
$\Delta$ Pop density	0.0014* (1.89)	0.0016** (2.36)	0.002 ** (2.31)	0.002* (2.15)	0.0001 (1.08)	0.0004 (0.48)	0.0007 (0.64)	0.00033 (0.39)	0.00049 (0.47)		``````````````````````````````````````
$\Delta$ log(urban population)										0.002 (0.00)	4.38 (0.66)
$\Delta$ (100*Trade/GDP)	0.0019 (0.80)	0.0032 (1.38)		0.0008 (0.29)	0.0016 (0.68)						
$\Delta$ (100* trade balance /GDP )			0.003 (0.45)								
$\Delta \log(1 + \text{ trade balance /GDP })$										0.548 (0.74)	0.497 (0.68)
$\Delta$ export value index						0.0045*** (3.50)	0.003 (1.45)	0.0046*** (3.42)	0.0027 (1.18)		
$\Delta$ log (1+ Electricity production from natural gas/total electricity production)										1.545** (2.13)	1.54** (2.12)
$\Delta$ (100 * Electricity production from natural gas/total electricity production)	0.013** (2.05)	0.0139** (2.29)			0.012* (1.83)	0.017*** (2.88)	0.0158** (2.53)	0.017*** (2.88)	0.0159** (2.54)		<u>```</u>
$\Delta$ (100* Fuel imports /marchandise imports)			0.04** (2.02)	0.04* * (2.02)							
Year dummies	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	23	23	23	23	23	20	20	20	20	23	23
Number of observations	341	341	336	336	341	296	296	296	296	341	341

1

#### 

Notes :

• GDP per energy use (constant 2005 PPP \$ per kg of oil equivalent )

• Heteroskedasticity robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• Wooldridge's test for autocorrelation does not reject the null of no autocorrelation.

Dependant variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$\log\left[\begin{array}{c} OFDI \text{ in stock} \\ Wholesale \text{ price index} \end{array}\right]$								China excluded						
Energy imports, net (% of energy use)	0.013** (2.05)	0.0128** (2.01)	0.012** (2.14)	0.012** (2.13)	0.013** (2.06)	0.012** (2.11)	0.012** (2.25)	0.01** (2.01)	0.0114** (2.23)	0.0108** ( 2.01)	0.011** (2.13)			
log (1+ Energy imports, net/energy use )												0.664** (2.19)	0.7** (2.26)	0.74** (2.12)
log( labour)	-2.575* (1.89)	-2.576* (1.90)			-3.25** (2.39)									-4.069*** (2.65)
Employment/population ratio (%)			-0.078*** (5.35)	-0.07*** (3.21)		-0.0612*** (3.09)	-0.0549*** (3.55)	-0.0536** (2.57)	-0.038** (2.38)	-0.052*** (2.75)	-0.0349** (2.20)			
log(100*emp/pop)												-1.77*** (2.67)	-1.799*** (2.67)	
GDP per energy use (constant 2005 PPP \$ per kg of oil equivalent )			0.5057*** (5.66)	0.459*** (2.93)	0.288* (1.83)	0.512*** (3.03)	0.505*** (5.74)	0.526*** (3.32)	0.496*** (5.96)	0.55*** (3.26)				
GDP per energy use (PPP \$ per kg of oil equivalent)											0.24*** (4.15)			
log (GDP per energy use ) (constant 2005 PPP \$ per kg of oil equivalent )	1.767** (2.43)												3.348*** (3.79)	2.827*** (3.47)
log (GDP per energy use ) (PPP \$ per kg of oil equivalent)		1.648** (2.33)										3.21*** (3.77)		
Pop density						0.0023*** (3.90)	0.0023*** (4.82)		0.0016*** (3.38)	0.0016*** (2.89)	0.0013*** (3.06)	0.002*** (3.89)	0 .002*** (3.56)	0.002*** (3.58)
Trade Balance (% GDP)						0.025* (1.75)	0.024** (2.18)		0.0159 (1.50)	0.0188 (1.47)	0.0085 (0.78)			
log(1 + trade balance/GDP)												2.99** (2.16)	3.01** (2.17)	4.23*** (2.64)
Electricity production from natural gas (% total)								0.035*** (3.82)	0.0236*** (3.47)	0.027*** (3.31)	0.02*** (2.97)	0.027*** (3.39)		
log(1+ electricity production from natural gas /total)													3.558*** (3.29)	4.454*** (3.52)
Year dummies	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	23	23	23	23	23	23	23	22	23	23	23	23	23	23
Number of observations	364	364	347	347	364	347	347	331	347	347	347	3.35	335	351

### Table 1.10. Robustness checks - Energy dependency (Energy imports, net (% of energy use)) as RHS variable

Notes:

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. We use the new Stata command "xtivreg2" (without instruments and using OLS estimation) with "bw" (A bandwidth (bw) of 2 is selected) and "robust" options to report HAC kernel estimation. According to Schaffer (2007), as well as panel IV, -xtivreg2- Stata command will do fixed effects estimates for the case where all regressors are exogenous.
<b>Dependant variable</b> $\log\left[\frac{OFDI \text{ in stock}}{Wholesale \text{ price index}}\right]$	(15)	(16)	(17)	(18)	(19)	(20)	(21)
log (1+ Energy imports, net/energy use )	0.739***	0.823***	0.893***	0.61***	0.593***	0.718***	0.737**
	(3.86)	(2.65)	(2.53)	(2.72)	(2.69)	(2.62)	(2.14)
log( labour)			-4.39***			-4.32**	-4.049***
			(2.78)			(2.27)	(2.68)
log(100*employment/population)	-1.53***	-2.115***					
	(2.68)	(2.92)					
Labour participation rate				-0.228***			
				(2.98)			
log (Labour participation rate)					-13.859***		
					(2.87)		
log (GDP per energy use )	2.82***	3.05***	2.419***	3.3***	3.309***		
(constant 2005 PPP \$ per kg of oil equivalent )	(5.94)	(3.52)	(3.10)	(3.57)	(3.60)		
log (GDP per energy use )						2.6***	2.687***
(PPP \$ per kg of oil equivalent)						(7.35)	(3.40)
Pop density	0.0026***	0.0028***	0.003***	0.003***	0.003***	0.0022***	0.0023***
	(7.81)	(4.78)	(4.84)	(6.26)	(6.20)	(4.34)	(3.60)
$\log(1 + \text{trade balance/GDP})$	2.709***	3.37**	4.758***	4.15***	4.388***	4.377***	4.332***
	(2.65)	(2.28)	(2.76)	(2.58)	(2.65)	(2.45)	(2.66)
log(1+ electricity production from natural gas/total)						4.17***	4.330***
						(4.02)	(3.47)
Fuel imports (% of merchandise imports)				0.1128**	0.114**		
				(2.32)	(2.31)		
Year dummies	No	Yes	Yes	Yes	Yes	No	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	23	23	23	23	23	23	23
Number of observations	335	335	351	346	346	351	351

### Table 1.11. (Continued) Robustness checks: Energy dependency (Energy imports, net (% of energy use)) as RHS variable

Notes :

Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. We use the new Stata command "xtivreg2" (without instruments and using OLS estimation) with "bw" (A bandwidth (bw) of 2 is selected) and "robust" options.

#### Table 1.12. Robustness checks:

**Dependant variable** log[ OFDI in stock

OFDI in stock	1
Wholesale price index	1

		Statistics robust to heteroskedasticity and autocorrelation										St	Statistics robust to heteroskedasticity and clustering on country				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(1)	(2)	(3)	(4)	(5)	
log (energy use)	(-)		3.2366*** (3.21)	4.10*** (3.76)	(*)		2.181** (2.32)	(*)		(**)	()	4.256*** (2.96)	(=)	(5)	3.8*** (2.75)	3.43** (2.46)	
log (energy use per capita)	3.637*** (3.84)	3.5087*** (3.71)			2.4697*** (2.89)	2.689*** (2.80)		3.63*** (2.75)	4.237*** (4.52)	2.046*** (3.10)	4.222*** (4.48)		4.222*** (3.05)	4.3439*** (3.15)			
labour participation rate		-0.19*** (2.72)	-0.23*** (3.18)	-0.211*** (2.91)	-0.24*** (2.85)		-0.153** (2.45)										
log(labour)	-4.86*** (2.74)					-3.54** (2.08)		-5.098*** (2.60)									
log( total employment )									-1.34*** (3.00)	-1.455*** (2.99)	-1.482*** (3.38)	-2.54*** (3.07)	-1.482** (2.25)				
log(100*emp/pop)														-2.071** (2.65)	-2.77*** (2.80)		
Employment /population																-0.06** (2.66)	
GDP per unit of energy use (constant 2005 PPP \$ per kg of oil equivalent )	0.875*** (3.31)	0.9699*** (3.59)	0.9918*** (3.36)	1.047*** (3.66)				0.964*** (3.43)	0.854*** (4.07)	0.52*** (7.78)	0.8898*** (3.93)	0.969** (2.52)	0.88984** (2.54)	0.939** (2.63)	0.9658** (2.47)	0.92** (2.51)	
GDP per unit of energy use (constant 2005 PPP \$ per kg of oil equivalent ) in log						4.5*** (3.34)	4.615*** (3.51)										
GDP per energy use (PPP \$ per kg of oil equivalent)					0.7247*** (2.84)												
Pop density	0.003*** (4.46)	0.0027*** (4.45)	0.0026*** (4.26)	0.0016*** (2.73)	0.0015*** (2.97)	0.0033*** (5.72)	0.003*** (6.41)	0.0035*** (4.89)	0.0018*** (3.37)	0.0016*** (3.78)	0.0019*** (3.05)	0.0017*** (3.50)	0.0019*** (3.37)	0.0018*** (3.40)	0.0016*** (3.54)	0.0014*** (2.86)	
Trade Balance (% GDP)	0.034** (2.18)	0.0299** (1.97)	0.026* (1.85)	0.02 (1.50)	0.024 (1.55)	0.039** (2.54)	0.0329** (2.34)	0.036** (2.12)		0.014 (1.25)	0.0232* (1.76)	0.02 (1.23)	0.02319 (1.22)	0.022 (1.21)	0.0177 (1.17)	0.0015 (0.25)	
Trade (% GDP)									0.0004 (0.11)								
Fuel imports (% of merchandise imports)	0.098* (1.90)	0.087* (1.86)	0.079* (1.88)		0.096** (2.37)	0.0997* (1.87)	0.0856* (1.74)	0.11** (2.04)									
Electricity production from natural gas (% total)				0.0317*** (3.59)					0.02988*** (3.65)	0.0185*** (3.09)	0.0276*** (3.64)	0.026** (2.29)	0.0276** (2.45)	0.0267** (2.40)	0.026** (2.20)	0.028** (2.06)	
CO <sub>2</sub> emissions per capita								0.081 (0.47)									
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	
Number of observations	359	359	359	364	359	359	359	336	347	347	347	347	347	347	347	347	

*Notes*: t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. We use Stata command "xtivreg2" (without instruments and using OLS estimation) with the option "bw" (A bandwidth (bw) of 2 is selected) and robust. All regressions include country specific effects. Constants not shown. We use Stata command "xtivreg2" (without instruments and using OLS estimation) with cluster (country) to report Statistics robust to heteroskedasticity and clustering on country.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
												Russia	Russia	Russia	Russia
												excluded	excluded	excluded	excluded
log (energy use per capita)	2.497***	2.645***	2.525***	2.663***	2.86***	3.281***	3.404***	3.210***	3.409***	3.364***	2.585***	2.226**		4.2***	3.637***
	(2.72)	(2.77)	(2.72)	(2.77)	(2.94)	(3.56)	(3.86)	(3.83)	(3.92)	(3.96)	(3.32)	(2.23)		(4.10)	(3.87)
log ( energy use )		, , ,											3.2***	<u>````</u>	
													(3.50)		
log(labour)	-3.863**	-4.153**	-3.79**	-4.095**	-3.269**									-3.29***	-4.067**
	(2.17)	(2.37)	(2.04)	(2.23)	(2.03)									(2.77)	(2.25)
log( labour participation rate )										-7.837*	-7.83**	-9.5**	-7.83**		
										(1.83)	(2.37)	(2.09)	(2.05)		
log(100*employment/population)						-1.505**	-0.989*	-1.083**	-0.9685*						
						(2.48)	(1.79)	(1.96)	(1.77)						
GDP per energy use (constant 2005														0.883***	0.822***
PPP \$ per kg of oil equivalent )													ا	(3.48)	(3.29)
log (GDP per energy use )	3.915***	3.8286***	3.939***	3.8476***		5.33***	4.88***			3.7395***	4.6139***	3.906***			· · ·
(constant 2005 PPP \$ per kg of oil	(2.99)	(2.87)	(3.04)	(2.92)		(4.03)	(4.21)			(3.86)	(3.67)	(3.20)	ا		
equivalent)													ا		
log (GDP per energy use )					4.631***			4.396***	4.613***				4.7085***		
(PPP \$ per kg of oil equivalent)					(3.42)			(4.15)	(4.27)				(4.31)		
Pop density					0.003***	0.002***	0.002***		0.0023***		0.003***		0.002***	0.002***	0.0028***
					(5.69)	(4.38)	(4.54)		(4.59)		( 6.62)		(4.92)	(3.32)	(4.30)
Urban population growth			0.0365	0.0267								0.0647			
			(0.40)	(0.29)								(0.76)	 		
Trade Balance (% GDP)	0.0377**	0.033*	0.038**	0.0333 **	0.0406***	0.026**	0.0288**	0.028**	0.03**	0.037**	0.036**	0.0369**	0.0295**	0.027*	
	(2.35)	(1.81)	(2.41)	(2.02)	(2.59)	(2.20)	(2.22)	(2.11)	(2.28)	(2.31)	(2.42)	(2.34)	(2.17)	(1.94)	
Trade (%GDP)															0.00636
													ا		(0.95)
Fuel imports (% of merchandise	0.096*	0.098**	0.0967*	0.0984*	0.105*						0.0909*	0.09*			0.1092**
imports)	(1.76)	(1.97)	(1.77)	(1.82)	(1.95)						(1.82)	(1.75)	 		(1.98)
Agricultural raw materials imports		0.1268		0.1246											, í.,
		(1.09)		(1.07)									 		
Electricity production from natural						0.03***	0.03***	0.036***	0.028***				0 .033***	0.033***	
gas (% total)						(3.73)	(3.84)	(4.19)	(3.67)				(3.87)	(3.83)	
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	23	23	23	23	23	23	23	23	23	23	23	22	22	22	22
Number of observations	359	359	359	359	359	347	347	347	347	364	359	348	350	350	348

# Table 1.13. Robustness checks:Dependant variable $\log \left[ \frac{OFDI \text{ in stock}}{Wholesale \text{ price index}} \right]$

Notes : Stars indicate statistical significance levels: \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.

٠

Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. We use the new Stata command "xtivreg2" (without instruments and using OLS estimation) with "bw" (A ٠ bandwidth (bw) of 2 is selected) and "robust" options. All regressions include country specific effects.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
log (energy use per capita)	4.41*** (4.56)	4.145*** (4.61)	3.14*** (2.67)								3.476*** (3.90)					
log ( energy use )	(	()	(_,,,)	2.325** (2.44)	2.022** (2.17)	2.288** (2.44)	2.49** (2.43)	4.356*** (3.75)	3.588*** (2.77)	2.373** (2.06)	(0.0.0)	3.324*** (3.58)	2.067** (2.21)	3.3289*** (3.67)	3.432*** (3.87)	3.392*** (3.78)
log (labour)			-6.62*** (2.81)						, , ,						· · · ·	
log( labour participation rate )							- 8.143** (2.00)								-7.786** (2.02)	-8.113** (2.08)
abour participation rate	-0.168** (2.45)	-0.16** (2.41)		-0.129* (1.96)				-0.221*** (2.95)	-0.213*** (2.82)	- 0.249*** (2.74)						
log(100*employment/population)	, , ,	, , ,			-1.71*** (2.63)	-1.60** (2.49)			, , ,		-1.003* (1.82)	-1.53** (2.51)	-1.726*** (2.64)	-1.508** (2.49)		
GDP per energy use (constant 2005 PPP \$ per kg of oil equivalent )	0.929*** (3.72)	0.9709*** (3.99)						1.01*** (3.44)	1.1038*** (3.56)							
GDP per energy use (PPP \$ per kg of oil equivalent)			0.777*** (3.03)							0.7617*** (2.99)						
log (GDP per energy use ) (constant 2005 PPP \$ per kg of oil equivalent )				4.942*** (4.28)	5.17*** (3.90)		4.996*** (4.27)				4.86*** (4.18)	5.297*** (4.00)	5.1456*** (3.87)			5.034*** (4.39)
log (GDP per energy use ) (PPP \$ per kg of oil equivalent)						4.923*** (4.02)								5.011*** (4.09)	4.80*** (4.55)	
Pop density	0.0027*** (4.12)	0.0018*** (3.06)		0.002*** (4.82)	0.002*** (4.21)	0.002*** (4.33)	0.002*** (4.85)	0.0025*** (3.90)	0.0019*** (3.44)	0.0007 (1.47)	0.002*** (4.19)	0.0019*** (4.02)	0.0019*** (3.80)	0.002*** (4.12)	0.0019*** (4.47)	0.0018*** (4.33)
Urban population			0.006 (0.06)													
Trade Balance	0.034** (2.12)	0.025* (1.72)	0.032* (1.84)	0.0199 (1.47)	0.021 (1.66)	0.022* (1.74)	0.021 (1.52)	0.028** (1.98)	0.019 (1.27)	0.013 (0.89)						
log(1 + trade balance/GDP) *			0.042 (0.24)	0.247** (2.18)							3.155** (2.26)	2.85** (2.24)	2.36* (1.73)	2.967** (2.28)	3.0334*** (2.19)	2.93** (2.15)
CO2 emissions per capita			0.126** (2.09)		0.313*** (2.96)	0.264*** (2.64)	0.24** (2.13)		0.1909 (1.61)	0.2* (1.67)			0.3137*** (2.99)			
Electricity production from natural gas sources (% of total).		0.032*** (3.72)		0.0387*** (4.44)	0.034*** (4.08)	0.032*** (3.96)	0.0387*** (4.43)		0.034*** (3.92)	0.032*** (3.60)						
log(1 + electricity production from natural gas/total electricity) *											3.76*** (3.69)	3.715*** (3.50)	4.254*** (3.87)	3.448*** (3.34)	4.258*** (3.71)	4.486*** (3.84)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Number of observations	364	364	336	341	324	324	341	364	341	341	347	347	324	347	364	364

# Table 1.14. Robustness checks:Dependant variable $\log[\frac{OFDI \text{ in stock}}{Wholesale \text{ price index}}]$

• Notes: Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. We use "xtivreg2" Stata command (without instruments) with "bw" (A bandwidth (bw) of 2 is selected) and "robust" options to report HAC kernel estimation. All regressions include country specific effects.\* In order to report the logarithmic form, we use the transformation log (1+x) to cope with negatives values and zeros in x.

Table 1.15. Robustness checks:	<b>Dependant variable</b> $\log[\frac{1}{v}]$	OFDI in stock Wholesale price index	-	Fixed-effects regression with Driscoll-Kraay standard errors
--------------------------------	---	-------------------------------------	---	--

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log (energy use ner canita)	3 78***	3 756***	2.81***	2.4***	4 15***	3 85***	4 567***	4 557***
log (cherg) use per cupitu)	(6.46)	(6.87)	(5.07)	(4.00)	(6.27)	(5.01)	(4.82)	(5.28)
log(100*employment/population)	(0110 )	(007)	(0.07)	(1100)	(0121)	(0.01)	(1102)	-2.14***
g(								(3.99)
log(labour)	-4.458***	-4.845***	-3.5466***	-3.81***	-4.396***	-5.153***	-3.42***	
	(4.15)	(4.45)	(4.81)	(5.30)	(4.02)	(4.10)	(5.26)	
GDP per energy use ( constant 2005 PPP \$ per kg of oil	0.822***	0.884***			0.855***	0.8698***	0.926***	0.946***
equivalent)	(5.56)	(4.87)			(5.44)	(4.05)	(3.83)	(4.27)
log (GDP per energy use) constant 2005 PPP \$ per kg of			4.159***	4.2247***		, <i>, , , , , , , , , , , , , , , , , , </i>		, , ,
oil equivalent			(11.15)	(8.54)				
Pop density	0.003***	0.0035***	0.0033***	0.0035***	0.0032***	0.003***	0.0021***	0.0018***
	(5.94)	(6.92)	(10.05)	(11.30)	(5.93)	(5.78)	(4.41)	(3.87)
Trade Balance	0.0344**	0.0367***	0.0367***	0.034**	0.0312**	0.0285*	0.0261**	0.0183
	(2.58)	(2.83)	(2.74)	(2.68)	(2.58)	(1.69)	(2.17)	(1.40)
Fuel imports (% of merchandise imports)	0.07377**	0.0849**	0.0777**	0.088***	0.074**	0.1**		
	(2.43)	(2.59)	(2.61)	(2.78)	(2.50)	(2.25)		
CO <sub>2</sub> emissions per capita		0.0605		0.1485*				
		(0.65)		(1.71)				
Agricultural raw materials imports					0.1066**	0.15**	0.0388	0.105*
					(2.08)	(2.48)	(0.49)	(1.97)
Electricity production from natural gas sources (% of total).							0.0336***	0.026***
							(3.37)	(3.21)
Constant	44.009***	49.716***	33.66***	40.05***	39.81***	53.775***	21.443***	-29.099***
	(3.18)	( 3.25)	(3.52)	(3.87)	(3.02)	(3.01)	(2.75)	(4.06)
year dummies	No	No	No	No	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.3682	0.3582	0.3682	0.3512	0.3708	0.3911	0.3655	0.3913
Number of countries	23	23	23	23	23	23	23	23
Number of observations	359	336	359	336	359	359	359	343

Notes:

• Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• Statistics are robust to heteroskedasticity, serial correlation and cross-sections dependence. We use the new Stata command "xtscc" (from Hoechle, 2007) to report Driscoll-Kraay correction on standard errors. Driscoll-Kraay estimates of the standard errors use one time lag.

#### **1.3.3** Estimations and results from a balanced panel

In this sub-section, we ask whether our results from the incomplete panel are robust to panel format. In addition to our empirical investigation using the new advanced econometric method for incomplete panel, we re-run our regressions by using a balanced panel to assess the robustness of our results and to check the absence of missing data bias from the estimations in the incomplete panel case. Owing to the lack of some observations, we exclude the data corresponding to Russia, Croatia and Czech Republic. Importantly, our results are robust to the panel format and are qualitatively similar to the results from the incomplete panel (see Tables 1.16, 1.17, 1.18 and 1.19). The appropriateness of our results in both cases gives credence to the conclusion there are internal macroeconomic factors that push for investing abroad and that OFDI acts as an escape response to the "*Ricardian bottlenecks*" in the emerging countries and economies in transition.

<b>Dependant variable</b> log [ <i>OFDI in stock consumer price index</i> ])	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
log (energy use per capita )	1.699***	1.6159***	3.885***	3.686***	4.136***	3.966***	3.8298 ***	3.978***	2.0487**	1.994**
	(2.95)	(2.75)	(3.94)	(3.86)	(4.43)	(3.97)	(4.11)	(3.98)	(2.30)	(2.11)
log(labour )	-3.737**	-3.565**	-3.66**	-3.92**	-3.9244**	-4.604**	-4.299**	-4.309**	-4.008**	-3.59**
	(2.11)	(2.03)	(2.01)	(2.14)	(2.30)	(2.43)	(2.53)	(2.31)	(2.27)	(2.06)
GDP per energy use (PPP \$ per kg of oil equivalent).			0.85***	0.874***	0.794***	0.829***	0.7838***	0.8775***		
			(3.77)	(3.77)	(4.42)	(3.45)	(4.55)	(3.77)		
log(GDP per energy use )									1.985***	2.505**
									(3.38)	(2.42)
Pop density		0.0026 ***	0.003***	0.003***			0.0029***	0.003***	0.003***	0.003***
		(6.29)	(5.69)	(5.34)			(5.22)	(5.18)	(7.51)	(6.30)
Trade Balance	0.0272*	0.0275*		0.0269*	0.023*	0.0196	0.0228*	0.021	0.02	0.0238*
	(1.81)	(1.84)		(1.95)	(1.66)	(1.42)	(1.69)	(1.57)	(1.45)	(1.66)
Fuel imports (% of merchandise imports)			0.129***	0.126***	0.0995**	0.125***	0.104***	0.1275***	0.1078**	0.128***
			(2.79)	(2.78)	(2.47)	(2.73)	(2.61)	(2.83)	(2.55)	(2.65)
Agricultural raw materials imports					0.151	0.180	0.161	0.1563	0.146	0.12
					(1.41)	(1.44)	(1.50)	(1.25)	(1.22)	(0.91)
Constant	42.196*	31.489	2.687	7.444	20.333	30.278	13.273	10.8165	27.66	32.0168
	(1.69)	(1.25)	(0.10)	(0.27)	(0.90)	(1.16)	(0.60)	(0.40)	(1.10)	(1.25)
Year dummies	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.7540	0.7643	0.8155	0.8177	0.7999	0.8054	0.8136	0.8190	0.7969	0.8014
Adj R <sup>2</sup>	0.7230	0.7337	0.7908	0.7926	0.7839	0.7786	0.7981	0.7934	0.7800	0.7733
Number of countries	20	20	20	20	20	20	20	20	20	20
Number of observations	340	340	340	340	340	340	340	340	340	340

Table 1.16. Dependant variable log (OFDI) - regression with Newey-West standard errors

Notes:

• GDP per energy use (PPP \$ per kg of oil equivalent).

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. The Newey-West estimates of the standard errors use one time lag.

• Regression with Newey-West standard errors: Robust "t -student, based on Newey-West standard errors, are reported in parentheses. Statistics are robust to heteroskedasticity and autocorrelation. Newey produces Newey-West standard errors correction for coefficients estimated by OLS regression. We choose Newey-West standard errors that allow for an AR (1) process in the error term. The error structure is assumed to be heteroskedastic and possibly autocorrelated up to one lag.

• The largest VIF is below 3 and the mean VIF is below 2.

<b>Dependant variable</b> $\log \left[ \frac{OFDI \text{ in stock}}{consumer \text{ price} \text{ index}} \right]$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log (energy use per capita )		1.84*** (2.63)	2.043*** (2.88)	2.006*** (2.76)	2.205*** (2.99)		
log ( energy use per capita ) lagged (one year)						3.588*** (3.96)	3.486*** (3.85)
log(labour )	-4.212** (2.25)	-3.62** (2.00)	-3.5** (1.99)	-3.984** (2.14)	-3.848 ** (2.13)		
log(labour force ) lagged (one year)						-3.54** (2.15)	-3.557** (2.16)
GDP per energy use ( constant 2005 PPP \$ per kg of oil equivalent) lagged (one year)		0.6288*** (3.51)	0.652*** (3.55)	0.611*** (3.34)	0.6228*** (3.38)	0.785*** (3.89)	0.778*** (3.91)
Pop density	0.0025*** (6.78)	0.003*** (5.43)	0.003*** (5.39)	0.003*** (5.30)	0.003*** (5.24)	0.0027*** (4.67)	0.0026*** (4.69)
Trade balance		0.029 ** (2.10)	0.028** (2.06)	0.024* (1.77)	0.023* (1.75)		0.011 (0.91)
Trade balance lagged (one year)						0.007 (0.61)	
Fuel imports (% of merchandise imports)		0.096** (2.24)		0.097** (2.28)		· · · · ·	
Fuel imports (% of merchandise imports) lagged (one year)	0.082** (2.05)		0.095** (2.28)		0.096** (2.31)	0.084** (2.24)	0.084** (2.25)
Agricultural raw materials imports				0.129 (1.04)	0.1237 (1.02)	0.2325** (2.05)	0.218* (1.86)
Constant	55.25** (2.03)	19.87 (0.74)	17.29 (0.66)	24.24 (0.88)	21.64 (0.81)	5.85 (0.24)	7.035 (0.29)
year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.8174	0.8401	0.8408	0.8409	0.8416	0.8456	0.8459
Adj R <sup>2</sup>	0.7943	0.8171	0.8180	0.8175	0.8183	0.8238	0.8241
Number of countries	20	20	20	20	20	20	20
Number of observations	340	320	320	320	320	340	340

## Table 1.17. Dependant variable: log (OFDI) - regression with Newey-West standard errors

Notes:

• Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

Regression with Newey-West standard errors: robust "t -student, based on Newey-West standard errors, are reported in parentheses. Statistics are robust to heteroskedasticity and autocorrelation. Newey produces Newey-West standard errors correction for coefficients estimated by OLS regression. The Newey-West estimates of the standard errors use one time lag.

	•		01	Wholesale pri	ce index 🥈	8		v				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log (energy use per capita )	4.898***	5.08***	4.71***	4.007***	4.6355***	4.004***	4.313***	3.1068***	1.4323**	1.52**		1.381**
	(3.51)	(3.64)	(3.58)	(3.75)	(3.69)	(3.73)	(3.63)	(3.30)	(2.30)	(2.45)		(2.21)
log (energy use per capita ) lagged											2.368***	
											(2.83)	
log(labour )	-4.353***	-4.0097***	-4.3679***	-5.7676***			-3.699***	-1.7677*	-2.395**	-2.258**		-3.0738**
	(3.27)	(3.22)	(3.36)	(3.12)			(3.03)	(1.72)	(2.21)	(2.14)		(2.05)
log(labour) lagged											-1.883**	
											(2.06)	
Labour participation rate					-0.206***	-0.214***						
					(2.69)	(2.91)						
GDP per energy use ( constant 2005 PPP )	0.793***	0.86***	0.863***	0.9575***	0.914***	1.1056***	0.9236***					
	(2.77)	(3.04)	(3.00)	(3.22)	(3.16)	(3.55)	(3.26)					
log(GDP per energy use, constant 2005 PPP)								4.8939***				
								(3.81)				
log(GDP per energy use, constant 2005 PPP)									3.305***		4.1238***	
lagged									(3.79)		(3.68)	
log(GDP per energy use PPP) lagged										3.1449***		3.543***
										(3.86)		(3.56)
Pop density		0.0028***	0.0028***	0.003***		0.0028***	0.0018***	0.002***	0.0018***	0.0019***		0.0029***
		(4.09)	(3.80)	(4.33)		(4.30)	(2.77)	(3.97)	(3.60)	(3.69)		(2.99)
Pop density lagged											0.0018***	
											(3.96)	
Trade balance (% GDP)			0.028*	0.0226		0.018	0.0158	0.02634*	0.0256*	0.0257*		0.0117
			(1.84)	(1.54)		(1.28)	(1.14)	(1.86)	(1.74)	(1.74)		(0.95)
Trade balance (%GDP) lagged											0.015	
				0.114644		0.10.10.00					(1.36)	
Fuel imports (% of merchandise imports)				0.1146**		0.1048**						
				(2.04)		(2.06)	0.020***	0.045(***	0.020***	0.02(5***		
Electricity production from natural gas (% of							0.039***	0.0456***	0.038***	0.0365***		
Electricity production )							(4.58)	(5.03)	(4.86)	(4.62)	0.0242***	0.040(***
electricity production from natural gas (% of											0.0342***	(2.86)
CO2 emissions from solid fuel consumption											(4.55)	(5.80)
CO2 emissions from solid fuel consumption												(1.84)
Constant	50 0/6***	17 23**	56 508***	36.5	15 73**	16 307**	15 3808**	11.463	36.002*	38 506*	20.124	(1.04)
Constant	(2.60)	(2.34)	(2.68)	(1.26)	(2.52)	(2.48)	(2.28)	(0.50)	(1.80)	(1.87)	(1.10)	(1.73)
vear dummies	(2.00) Ves	Ves	(2.00) Ves	Ves	(2.32) Ves	(2.40) Ves	(2.20) Ves	Ves	Ves	Ves	Ves	Ves
Country fixed effect	Ves	Ves	Ves	Ves	Ves	Ves	Ves	Ves	Ves	Ves	Ves	Ves
R <sup>2</sup>	0.8055	0.8179	0.8202	0.8434	0.8195	0.8516	0.8321	0.8309	0.8643	0.8641	0.8716	0.8688
Adi R <sup>2</sup>	0.7786	0 7919	0.7937	0.8195	0.7946	0.8290	0.8066	0.8052	0.8428	0.8426	0.8521	0.8464
Number of countries	17	17	17	17	17	17	17	17	17	17	17	17
Number of observations	289	289	289	289	289	289	289	289	272	272	289	255
	207	207	207	207	207	207	207	207	212	212	207	200

**Table 1.18. Dependant variable**  $\log\left[\frac{OFDI \text{ in stock}}{\sqrt{n} + 1 + 1 + 1 + 1 + 1}\right]$  - regression with Newey-West standard errors

• Notes: We use the first lag of RHS variables. Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. The Newey-West estimates of the standard errors use one time lag. Three countries are dropped because of the lack of data on wholesale price index..

											constance p	nice nicen				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
$\Delta$ log (energy use)	2.853*** (3.76)	2.799*** (3.58)		2.566*** (3.92)	3.153*** (4.40)	2.94*** (4.65)	3.166*** (4.49)							2.557*** (3.78)		
$\Delta \log$ (energy use per capita )	(0110)	(0.00)	2.689*** (3.51)	((*)_)	()	()	(	2.452*** (3.76)	3.2*** (4.48)	1.806*** (3.36)	1.773*** (3.15)	1.76*** (3.12)	1.7986*** (3.33)	(0110)	2.45*** (3.63)	2.298*** (3.79)
$\Delta \log(\text{labour})$	-3.699** (2.28)			-3.71** (2.36)	-4.97*** (2.69)	- 4.094*** (2.58)	- 4.87*** (2.69)	-3.558** (2.26)	- 4.7*** (2.56)	-3.339** (2.16)	-3.359** (2.17)			-4.12*** (2.70)	-3.978*** (2.58)	
$\Delta \log(\text{Labour participation rate})$		-3.824** (2.17)	-3.818** (2.16)													
$\Delta$ Labour participation rate												- 0.062** (2.20)	-0.0618** (2.19)			-0.0649** (2.25)
$\Delta$ GDP per energy use (constant 2005 PPP)				0.2249*** (3.35)	0.29*** (4.01)	0.2747*** (4.25)	0.2927*** (4.11)	0.216*** (3.24)	0.29*** (4.07)					0.27*** (4.05)	0.2634*** (3.98)	0.1926*** (3.03)
$\Delta \log (\text{GDP per energy use})$ (constant 2005 PPP)	2.111*** (2.73)	2.07*** (2.66)	2.01*** (2.60)													
$\Delta$ GDP per energy use (PPP \$ per kg of oil equivalent)										0.129** (2.14)	0.1317** (2.06)	0.1289** (2.01)	0.1266** (2.09)			
$\Delta$ Pop density	0.0005 (0.43)			0.0005 (0.45)	0.00017 (0.19)	0.0014* (1.93)	0.0011 (1.40)	0.0008 (0.79)		0.001 (0.94)	0.0008 (0.76)	0.0002 (0.24)	0.0005 (0.45)	0.0013* (1.66)		0.0004 (0.41)
ΔUrban population (%population)		0.05 (0.25)	0.0616 (0.31)													
$\Delta$ (100*Trade/GDP)										0.0017 (0.58)			0.0017 (0.56)			0.0015 (0.51)
$\Delta$ (100* trade balance /GDP )				0.0058 (0.97)	0.0157** (2.37)	0.0038 (0.62)	0.014** (2.14)	0.005 (0.79)	0.0156*** (2.38)		0.0017 (0.28)	0.0015 (0.26)		0.00455 (0.74)	0.004 (0.66)	
$\Delta \log (1 + \text{ trade balance /GDP})$	0.7007 (1.09)	0.673 (1.00)	0.6104 (0.91)													
$\Delta$ log (1+ Electricity production from natural gas/total electricity production)	1.98*** (2.86)	2.014*** (3.13)	2.055*** (3.27)													
$\Delta$ (100 * Electricity production from natural gas/total electricity production)				0.0157*** (2.83)	0.0148*** (2.69)			0.0156*** (2.82)	0.015*** (2.65)	0.016*** (2.85)	0.016*** (2.88)	0.016*** (2.94)	0.0162*** (2.90)			0.016*** (2.85)
$\Delta$ (100* Fuel imports /marchandise imports)						0.037* (1.86)	0.03* (1.86)							0.0417** (2.04)	0.0415** (2.03)	
$\Delta$ (CO <sub>2</sub> emissions per capita)														0.0142 (0.27)	0.018 (0.35)	
Year dummies	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Number of observations	320	320	320	320	320	320	320	320	320	320	320	320	320	300	300	320

# Table 1.19. OFDI difference regressions - Dependant variable: $\Delta \log[\frac{OFDI \text{ in stock}}{consumer price index}]$

Notes :

• Heteroskedasticity robust t-statistics (absolute values) are reported in parentheses. Stars indicate statistical significance levels: \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

This study examines the association between OFDI of emerging countries and transition economies and the internal macroeconomic determinants. Our econometric results show that OFDI acts as an escape response to the macroeconomic forces at home- called *Ricardian bottlenecks*. Energy consumption and dependency, GDP per energy use, labour shortage, population density, the share of fuel imports to total imports, the share of electricity production from natural gas to total electricity production, the trade balance and the deteriorating environmental conditions are positively related with OFDI for a wide range of emerging countries.

Our empirical findings consistent with the theoretical predictions and based on an incomplete panel data, confirm this escape response to the "*Ricardian bottlenecks*". In our next step, we re-run our regressions by using a balanced panel to assess the robustness of our results and to check the absence of missing data bias from the estimations in the incomplete panel case. Owing to the lack of some observations, we exclude the data corresponding to Russia, Croatia and Czech Republic. Importantly, our results are robust to the panel format and are very similar to the results from the incomplete panel. The appropriateness of our results in both cases gives credence to the conclusion there are internal macroeconomic factors that push for investing abroad and that OFDI acts as an escape from the "*Ricardian bottlenecks*" in the emerging countries and economies in transition.

## 1.4 Conclusion

In this chapter, we have taken a somewhat narrow approach to a broad literature on FDI. We focused on theoretical and empirical analyses that adopt a Ricardian growth approach to FDI.

The Ricardian growth theory, when generalized and interpreted in a broader sense, has the ability to explain the phenomenon of FDI and capture the reality of international production. We have reconsidered Ozawa's view of the Japanese OFDI and have showed that his arguments still hold. We show that the generalized Ricardian growth remains an appealing framework to understand the macroeconomic push factors for OFDI. Many economies best typified by Japan, in the early seventies, and with intertemporal gap Singapore, Hong Kong, South Korea and Taiwan, despite their openness to trade, reached Ricardian growth barriers. For these countries, economic growth was restricted by a shortage of resources, land and labour and necessary adjustments to the industrial structure meant that mature technologies and industries had to be transferred abroad. OFDI should be considered a means of removing the uncertainties of foreign supplies of industrial resources. The best example will be the Chinese and Indian resource seeking investment to cope with its hunger for natural resources. Also, OFDI allows firms to cope with land (for industrial sites) and labour shortages. We show that the history of the Japanese "*Ricardian bottlenecks*" pushing for OFDI repeats itself in many countries.

Our empirical analysis confirms this escape response to the "*Ricardian bottlenecks*" and strengthen the reasonableness, the usefulness and the empirical robustness of Ozawa's macroeconomic theory considerably. Importantly, we find that countries with higher energy dependency have higher OFDI levels and countries with faster increase in the energy use tend to see more rapid increase in their OFDI. We also show that countries with acute labour shortage tend to see more rapid increase in their OFDI. The results are robust to a variety of econometric specifications.

**1.** A Appendix for chapter 1 Multicollinearity is examined using Variance inflation factors (VIF). The VIFs look fine here. The results confirm that our variables do not suffer from any multicollinearity problem.

Variables	log (energy use per capita )	log(labour )	GDP per energy use	Pop density	Trade Balance	Fuel imports	
					(%GDP)	(%of merchandise imports)	
VIF	2.17	2.45	2.77	1.61	1.21	1.16	Mean VIF=1.89

Variables	log (energy use )	log(100*emp/pop)	GDP per energy use	Pop density	Trade	Fuel imports	
					Balance(%GDP)	(% of merchandise imports)	
VIF	2.36	1.24	2.73	1.44	1.18	1.11	Mean VIF=1.68

Variables	log (energy use )	log(100*emp/pop)	GDP per energy use	Pop density	Trade	Electricity production from gas	
					Balance(%GDP)	(% of merchandise imports)	
VIF	2.34	1.26	2.80	1.41	1.51	1.34	Mean VIF=1.78

Variables	log (energy use per capita )	log(total employment)	GDP per energy use	Pop density	Trade	Electricity production from gas	
					Balance(%GDP)	(% of merchandise imports)	
VIF	2.45	2.44	2.60	1.59	1.21	1.15	Mean VIF= 1.91

Variables	log (1+ Energy imports, net/energy	log(total employment)	GDP per energy use	Pop density	log(1+ trade	Fuel imports	
	use)				balance /GDP)	(% of merchandise imports)	
VIF	1.67	1.46	1.64	1.60	1.29	1.41	Mean VIF= 1.51

# **Chapter 2**

## North-South FDI and reformulated Kojima's *"correspondence principle"*: a Ricardian trade approach<sup>62</sup>

### 2.1 Introduction

In this chapter, we seek to study the comparative advantage motivation for FDI. We provide a theoretical analysis of the implications of comparative advantage for FDI in a Ricardian model. Our analysis should be especially instructive in light of the trade oriented FDI model pioneered by Kojima (1973,1977b,1978) on the relationship between a country's comparative advantage and its FDI. As noted by Kojima (1977b,p.103)"trade-oriented FDI works only in a competitive world in which standardised commodities are produced and traded and competitiveness is determined by traditional comparative advantage theory à la Ricardian theory or the Heckscher-Ohlin theory". However, he studied only the case of H-O theory. In fact, the Kojima model is based on the H-O two-country, two-product, two-factor world. Kojima terms his model "macroeconomic" and uses it to contrast trade oriented Japanese type investment with anti-trade oriented US type investment<sup>63</sup>. The economic forces which encouraged Japanese investment arise from a "correspondence principle" discovered by Kojima which states that a country's "comparative profitability" (the ratio of profit rates in two industries) is higher in an industry in which it has comparative advantage and that FDI should follow the direction indicated by comparative profit rates which in turn are a reflection of comparative advantage under competitive conditions. The basic hypothesis is that FDI should originate in the source country's comparatively disadvantaged industries so that it can complement comparative advantage patterns.

 <sup>&</sup>lt;sup>62</sup> A paper based on our reformulation of Kojima correspondence principle in this chapter is submitted. We thank Kiysohi Kojima; Terutomo Ozawa and Norihito Tanaka for their helpful comments on an earlier version.
 <sup>63</sup> We note that Kojima's theory of FDI is based on his observation of the Japanese FDI in the 1960s and 1970s and thus with

<sup>&</sup>lt;sup>63</sup> We note that Kojima's theory of FDI is based on his observation of the Japanese FDI in the 1960s and 1970s and thus with the structure of the Japanese economy of that period.

Unlike Kojima, we focus on absolute profit rates to explain the direction of FDI and we use the Ricardian trade model that allows international differences in technologies rather than the H-O trade model that takes into account international difference in factor endowments in order to study trade oriented FDI. In addition, our theoretical framework allows us to examine issues that are different from most of the present research on international trade and FDI. Instead of explaining two-way trade and FDI among developed countries (North-North trade and FDI), our model is intended to complement the existing literature by explaining FDI from technologically more advanced economies in technologically less advanced economies (North-South trade and FDI). We attempt to reformulate Kojima's correspondence principle. We show that FDI originating from comparatively disadvantaged industry in the source developed country and going to the same industry (comparative advantage) in the host developing country follows the direction of absolute profit rates that correspond to the Ricardian comparative advantages.

The remainder of this chapter is as follows. In section 2.2, we review the Ricardian trade approaches toward FDI. In section 2.3, we present and explain Kojima's macroeconomic theory of FDI. In section 2.4, we reformulate Kojima's correspondence principle within Ricardian setting. In section 2.5, we conclude.

#### 2.2 Ricardian trade approach toward FDI: a review of literature

Ricardo is commonly celebrated for the theoretical achievements: his theory of growth and his theory of trade. We have taken in chapter 1 a somewhat narrow growth approach to FDI. Now, it is certainly relevant to study the implications of FDI for the Ricardian trade approach. We provide a review of Ricardian trade approaches toward FDI and MNFs. We discuss the reasonableness of the use of the Ricardian trade structure for studying capital mobility, FDI and multinationals. We examine whether the Ricardian trade theory proves useful and conveniently provides a relevant set-up in examining these issues.

#### 2.2.1 Direct investment as a capital flow: a Ricardian approach

One of the most important fields of study in international capital movements is the analysis of foreign direct investment. It is well known that FDI is closely related to the changing patterns of the international division of labour. This fact implies the need to incorporate international capital movements into models of international trade. The interaction of international capital mobility and trade in goods may change the pattern of trade compared to the case where only trade in goods occurs. Several authors have shown that factor movements and trade in goods are complementary and augment each other if trade is not induced by a difference in relative factor endowments, but different production technologies, distortions in product and factor markets, external economies of scale, or imperfect markets (e.g. Markusen, 1983; Wong, 1986, 1995; Melvin, 1995; Neary, 1995). We begin with early analyses that viewed the activities of MNF as essentially a part of the theory of portfolio capital flows where FDI was considered as a portfolio flow in response to relative international capital scarcities. Early theoretical work on international capital movements applied the basic H-O model or at least some sort of basic competitive factor-proportions model and focused on the welfare effects of capital flows and the optimal combinations of tariffs and taxes on investments (Jones, 1967; Kemp, 1969; Brecher and Feenstra, 1983).

Caves (1971) distinguished direct investment from portfolio flows of homogenous capital. He used the Jones (1971) specific-factors model instead of H-O structure<sup>64</sup>. He argued that direct investment is associated with firm-specific capital, and thus investment moved from an industry in the parent country to the same industry in the host country. The specificity of capital is a defining feature of MNF, as Caves (1971, 1996) pointed out that foreign investment involves the transfer of a bundle of sector- specific assets, technology and equipment, managerial know-how, marketing techniques from one production facility to another abroad. Goldberg and Klein (2001) argue that domestic and foreign capitals are completely industry specific. The industry-specificity of foreign capital reflects that direct investment involves some active management of an asset. The direct management of foreign investment requires some industry-specific knowledge and particular expertise<sup>65</sup>. Markusen

<sup>&</sup>lt;sup>64</sup>In the late 1960s and early 1970s, many economists focussed on patterns of international trade and production when capital was mobile between countries. Significant contributions in this topic have been made by Kemp (1962, 1966, 1969), Inada and Kemp (1969), Jones (1967), Chipman (1971) and Uekawa (1972).

<sup>&</sup>lt;sup>65</sup> See Thompson (1983, 1985, 1992, 1993, 1997) for more details on the industry-specificity of capital and management.

and Maskus (2003. p.322) argued that "capital, whether of the homogeneous H-O variety or the sector-specific variety, tends to flow from where it is abundant to where it is scarce".

Jones (1967), following Kemp's (1966) pioneering contribution discussed, in H-O context, the patterns of international trade and production when capital is mobile between countries. He suggested that it would be unlikely to have both countries incompletely specialised with capital mobility. Kemp (1966) and Jones (1967) consider two countries producing two goods with the capital and labour under constant returns to scale, but production functions differ across countries and only capital is mobile across national boundaries. They showed that the basic insight of Ricardo is completely preserved even in a model with perfect capital mobility. In fact, in the Kemp-Jones model, technological differences and perfect capital mobility across countries are introduced into the H-O model. The model shows that trade patterns in such a world is "Ricardian" since they reflect technology differences rather than factor endowments. In other words, the analysis of comparative advantage between countries could be adequately carried out by analyzing differences in labour productivity among countries. If capital is mobile across countries and technology differences, then trade patterns could be summarized by cross-country differences in labour productivity<sup>66</sup>.

Jones (1994) used an extension of the Ricardian model to analyse the questions which Uekawa (1972) investigated. The former provides a simple way of extending Ricardian model to handle capital by assuming that labour and capital are used in fixed proportions in just one industry<sup>67</sup>. He employed a Ricardian technology *-rigid technology case*<sup>68</sup>-in order to reveal how alternative contributions to costs- comparative labour costs and absolute capital costs- can precisely offset each other so that at a unique common rate of return to internationally mobile capital both countries could be incompletely specialized. Fergusson (1978) shows that comparative advantage takes on a Ricardian character in a standard two-factor model under perfect international capital mobility. He argued that international capital mobility in a H-O model gives such a model a distinctive "*classical*" Ricardian form. It is true that under some

<sup>&</sup>lt;sup>66</sup> Chipman (1971) and Uekawa (1972) discussed the case of flexible technology. Chipman (1971) discussed the question of complete and incomplete specialization under international capital mobility. Chipman's (1971) model was extended by Uekawa's (1972) model in which the technology of producing each commodity was compared in order to establish conditions sufficient to ensure that both countries could be incompletely specialized at a common commodity price ratio and a single rate of return to internationally mobile capital.

<sup>&</sup>lt;sup>67</sup> In the narrow interpretation of the Ricardian trade model, factor substitution between capital and labour is ruled out since labour is the only productive factor.

<sup>68</sup> Jones (1994, p. 86).

conditions, capital mobility and trade in goods may be perfect substitutes insofar as international trade leads to factor-price equalization. However, if there are Ricardian industry-specific technological differences between countries, international trade alone does not lead to factor price equalization. This *non-equalization result* with differences in production technology is an important usual result in Ricardian trade models.

A well-known implication of the Ricardian model is that uniform absolute advantage does not cause international trade. Jones (1980) used an extension of a simple Ricardian model to show a trade – inducing effect of absolute advantage when an internationally footloose input (say capital or FDI) is added to the standard two country two good Ricardian trade model. In this context, he argued that absolute and comparative advantage jointly determine trade patterns and income distribution and the range of policies affecting international trade is much wider than the traditional theory of comparative advantage implies. Jones (1980, p. 258) stated that

"Although each nation can, by the law of comparative advantage, find something to produce, it may end up empty-handed in its pursuit of industries requiring footloose factors. Once trade theorists pay proper attention to the significance of these internationally mobile productive factors, the doctrine of comparative advantage must find room as well for the doctrine of "relative attractiveness", where it is not necessarily the technical requirements of one industry versus another that loom important, it is the overall appraisal of one country versus another as a safe, comfortable, and rewarding location for residence of footloose factors".

According to Jones (1980), although under the law of comparative advantage<sup>69</sup>, it is perfectly possible that those sectors of the industry working mainly with mobile factors find their way abroad. Ricardian comparative advantage must, therefore, be supplemented by a doctrine of "*relative attractivity*", which influence the choice of site by the mobile factors of production. Relative productivities will not necessarily play a determining role, and in this sense absolute advantage will be the operative principle, not comparative advantage. The rise of capital mobility and the increased share of trade in intermediate goods imply that capital or, analogously, the production of the intermediate inputs can move to where it is most profitable. What determines the international division of labour and the direction of international trade will depend not on comparative advantage, but on the attractiveness of a location.

<sup>&</sup>lt;sup>69</sup> which in its original form is based on complete factor immobility-every nation may specialize in some field of production

Caves (1996) has emphasized, for highly mobile capital, that absolute rather comparative advantage becomes relevant for the location of production. Jones (2000) has noted that absolute advantage may influence patterns of specialization if some inputs to production are mobile between nations. According to Jones (2000), the introduction of internationally mobile capital into the Ricardian trade theory reduces the relevance of comparative advantage in the determination of trade patterns. With free capital mobility, a good will be produced only where it is most profitable, typically where unit labour costs are lowest. If one country has an absolute advantage in all goods, this country will attract foreign capital. Jones (2000) explained

"The idea of comparative advantage is linked to the notion that inputs are trapped by national boundaries, so that the only decision that needs to be made concerns the allocation within the country of these inputs [...]. [A] world in which some inputs are internationally mobile or tradable is a world in which [...] the doctrine of comparative advantage, with its emphasis on the question of what a factor does within the country, needs to share pride of place with the doctrine of absolute advantage guiding the question of where an internationally mobile factor goes. (p. 136) [...]. Once international mobility in an input is allowed, absolute advantage becomes a concept that takes its rightful place alongside comparative advantage in explaining the direction of international commerce". (p.137)

Within a modified Ricardian setting à la Jones (1980, 2000), Golub et al. (2007) show that service links are important determinants of FDI and exports in manufacturing for developing countries. They consider two goods X and Y. The manufactured good X is produced with both labour and a footloose input (say FDI). The traditional good Y is produced with labour alone. The production costs in country i are  $c_X^i = a_{LX}^i \cdot w^i + a_{KX}^i \cdot r = p_X$ and  $c_Y^i = a_{LY}^i \cdot w^i = p_Y$ , where  $c_X^i$  is the average cost for good X in country i,  $a_{LX}^i$  is the unit labour requirement for good X in country i,  $a_{KX}^i$  unit capital requirement for good X in country i,  $w^i$  wage in country i. The authors consider capital as the footloose factor with global return r to the footloose factor and  $p_X$ ,  $p_Y$  the world prices of good X and Y.

Country i has a comparative advantage in good X when 
$$\frac{a_{LX}^i}{a_{LY}^i} + a_{KX}^i \frac{r}{p_Y} < \frac{a_{LX}^j}{a_{LY}^j} + a_{KX}^j \frac{r}{p_Y}$$
.

Absolute advantage in attracting the footloose input (say capital or FDI) now matters in addition to comparative advantage (relative unit labour requirements) in determining which country produces X. The authors provide an interesting empirical analysis that states policies and institutions that improve the productivity of the footloose factor in country i relative to country j such that  $a_{KX}^i < a_{KX}^j$  will tend to create a comparative advantage in producing X for country i <sup>70</sup>.

<sup>&</sup>lt;sup>70</sup> The authors argued that only those countries that are attractive to FDI will develop manufacturing industries if manufacturing for export requires technology transfer via FDI. They argued that the adequacy of local infrastructure is likely to be an important determinant of inward FDI in manufacturing.

Concerns over the relationship between FDI and international trade are expressed in a large literature. Based on a modified version of the H-O trade model, several studies find a negative relationship between outward FDI and exports. In particular, when the assumption of factor immobility is relaxed, exports and FDI turn into substitutes (see Mundell, 1957). On the other hand, it has also been proven that foreign investment may be a complement to trade if production functions vary in both the home and the host country. The proponents of the complementary relationship between FDI and trade follow a Ricardian tradition by including differences in technologies across countries (Kemp, 1966; Jones, 1967; Purvis, 1972; Markusen, 1983; Svensson, 1984; Markusen and Svensson, 1985). In fact, Markusen (1983) concluded that if trade is a refection of endowment differences à la H-O, commodities and factors are substitutes, while if trade is driven by Ricardian technology, commodities and factors can be complements. Purvis (1972) extended the H-O model by considering different production functions among countries. He showed that trade and factor flows were complements in the sense that both were required to establish world production efficiency. He illustrated how trade in goods and factors movements might be complements instead, in the sense that opening up factor mobility could cause the previous level of international trade in goods to rise. Ruffin (1984) considered the work of Kemp (1966) and Jones (1967) and added the complementarity between trade and capital movements in the Kemp-Jones model [Ricardian character] helps explain the enormous expansion of both international trade and capital movements. Such a combination is difficult to explain with a simple H-O view of the world.

Klein and Goldberg (2001) examine the impact of FDI by MNFs on the pattern and volume of trade. They use a specific-factor model as their analytical framework. They examine whether FDI serves as a complement to trade or a substitute for trade based on the Rybczynski theorem whereby an increase in a factor of production used intensively in one sector has an effect on production both in that sector and in other sectors. Within a Ricardian approach, they argue that under the assumption of equal labour productivities and different productivities of capital, a country with higher capital productivity will export the capital-intensive good and import the labour intensive good. If capital is internationally mobile, it will move to the country with high capital productivity, where it earns higher returns. Thus,

through the Rybczynski effect, it will lead to higher production and exports of the capitalintensive good and more imports of the labour-intensive good. In such a model, factor movements and trade are obviously complementary. Similarly, Cheng *et al.* (2005) and Qiu (2003) using a Ricardian setting and considering FDI as synonymous to technology transfer show complementarity between FDI and trade.

#### 2.2.2 FDI, technology transfer, product-cycle and trade

The Ricardian model has recently experienced a resurgence of interest for the analysis of trade patterns. The purpose of this section is to focus on the relationship between FDI, product cycle and trade which is driven by Ricardian considerations<sup>71</sup>. The Ricardian structure allows for an examination of the gains from trade, and it may be used to examine trading equilibrium with FDI, product cycles and the resulting TT equilibrium. Because it takes cross-country technology differences as the basis of trade, the Ricardian model is well suited to study TT and FDI (Cheng *et al.*, 2005, Jones, 2008a, b).

According to the Ricardian trade theory, national income rises due to gains from trade realized through specialization and reallocation of resources into comparatively advantaged industries. However, we should note that initially there is no outward shift of the country's production possibility curve because there is neither factor growth nor technological progress. This point can be developed in terms of a Ricardian model of export of technology<sup>72</sup>. Beladi *et al.* (1997) in a Ricardian trade model consider the case in which the home country, has an absolute advantage in each good, passes on its superior technology for producing what at home would be an import-competing good, i.e., the comparatively disadvantaged good. The inter country differences in unit labour requirements are linked to the technical knowledge that can be transferred abroad. Superior technology is embedded in capital equipment, so that FDI may be required in order to affect TT. The authors show that the terms of trade for the home country receives no

<sup>&</sup>lt;sup>71</sup> Dunning (1993) notes that the Ricardian thinking of resource advantages across regions plays an important role in conceptualizing multinational strategies. FDI has long been considered as an important channel for technology diffusion. Maskus and Webster (1995) argue that the Ricardian comparative advantage is linked to the home country and comprises differences in technology and managerial efficiency, which are exactly the same elements likely to give rise to differences in labour productivities. These productivity differences are related to OFDI. They argue that investment arises precisely because profit maximising firms are better able to exploit the above type of advantage through investment rather than exporting. <sup>72</sup>See DFS(1977), Krugman (1979), Pugel (1982), Collins (1985) and Ruffin and Jones ( 2007).

revenues for the transfer of its superior technology in producing its import commodity to the foreign country, it benefits from this transfer.

The incentives for exploiting technological advantage through foreign production are especially great in the context of North-South trade. In fact, Vernon (1966) argues that the North produces and exports the bulk of newly invented goods. The South specialises in goods that have been around for longer. Vernon's product cycle argument shows that FDI should occur in industries that are maturing and, hence, declining in R&D expenditures. Similar implications are to be found in DFS (1977) Ricardian analysis of trade, where differences in relative productivity between two countries result in each country specializing in the industries where it maintains a relative technical advantage. Productivity gains localized to a few export industries force the marginal industries to leave the market. Two implicit alternatives are for home firms: to transfer production to the foreign market if they are at a home location disadvantage but otherwise maintain a competitive position in the foreign market, or to increase investments in R&D expenditures in order to renew the technological base of export or import competing industries.

Krugman (1979) and (1986) models are conventional Ricardian trade models that borrow techniques from the new trade theory to examine the effects of technology on trade. Krugman (1979) developed a simple model of trade in which new goods are produced in the industrialized North and exchanged for old goods produced in the South. Krugman in his "*product life cycle*" model extended DFS's (1977) model and examined the effects of continuous product innovation. In order to concentrate on the effects of product cycles on trade flows and relative wages, Krugman (1979) specified a very simple form of technological transfer, with new goods becoming old goods at an exogenous rate and emphasized the slow diffusion of technologies from North to South. He showed that the long-run relative wage of the North varies positively with its rate of new product development, but negatively with the rate of technological diffusion to the South. He added that "technology transfer [through foreign investment] shifts demand towards goods produced in South so that capital moves South and the relative income of Southern workers rises<sup>73</sup>".

Krugman's (1986) model is similar in spirit to his model of 1979 but focuses on process innovation. He developed a Ricardian model of the relationship between technology

<sup>&</sup>lt;sup>73</sup> Krugman (1979, p.264, emphasis added).

and trade that implies an interaction between the characteristics of countries and goods. Technological differences between the North and the South stem from country-specific adoption lags in applying newly developed techniques. Countries can be ranked by the level of technology; goods can be ranked by technology intensity. Krugman shows that technical advance will be accompanied by a rise in the technology intensity of a country's exports. Each country finds a niche on the scale of goods that corresponds to its position on the technology ladder. He showed a basic asymmetry between the effects of technological progress in more and less advanced countries. He considered the effects of technological progress in two cases: progress in an advanced country that marrows the gap. In the first case, the progress of the ladders opens up greater opportunities to trade, and thus raises real income in both countries. "Catch-up" by the follower tends to hurt the leader by eliminating the gains from trade.

Krugman's technology gap<sup>74</sup> model has only one factor, labour. In his model, with Southern catch-up, production migrates to the South, raising demands for Southern labour. As a result, the South's wage rises relative to the North's wage. Hence, the terms of trade must improve in the South while deteriorating in the North. It further implies that the North may be harmed by Southern catch-up. In other words, the real income of the technological leader depends on its lead<sup>75</sup>.

Cheng *et al.* (2005) complement Krugman's analysis and investigate the impact of TT via FDI made possible by the existence of given technology gaps. The authors incorporate expatriates, the specific factor for FDI, into a static continuum Ricardian model to feature both international trade and TT via FDI. They show that due to technological differences between countries (difference in technologies leads to factor price differentials), TT via FDI that requires the use of a specific resource can occur even in the absence of imperfect competition. Within a North-South perspective, they show that TT via MNFs increases world output and trade in goods and services. They show that in the case of infinitely elastic supply of expatriates, the specific factor for FDI, (*i*) an increase in the ratio of the Southern to

<sup>&</sup>lt;sup>74</sup> Technical advance in the advanced country, which opens a technology gap, benefits the less developed country as well. "Catch-up" by the less advanced country, which closes the gap, hurts the technological leader.

<sup>&</sup>lt;sup>75</sup>Krugman (1979, 1986) asked whether a country needs to keep running in order to stay in the same place. In other words, in a dynamic world does a country that fails to innovate suffer a decline in its standard of living? Krugman shows that in both cases the answer is a qualified yes.

Northern labour supplies, an increase in the efficiency of TT, or decrease in the wage rate for the expatriates increases the range of MNF production, (*ii*) an increase in the efficiency of TT will affect Northern and Southern workers' welfare in opposite directions, and (*iii*) an increase in the efficiency of TT increases aggregate welfare if the unit cost of MNF products increases with product sophistication less than linearly. In the case of a general supply curve of expatriates, the authors show that an expansion of the supply of expatriates increases the range of products produced by MNFs. They show, on the one hand, that an increase in the South's labour force expands the range of products produced by Southern firms except when the supply of expatriates is horizontal. On the other hand, an increase in the North's labour force expands the range of products produced in the North.

#### 2.2.3 FDI and unit labour costs

The Ricardian trade model provides an integrated framework for understanding the macro- and microeconomic factors determining trade flows, as most elegantly shown in DFS (1977). In addition to its clear intuitive appeal, relative unit labour cost is the key relative price in a Ricardian model of trade (Golub and Hsieh, 2000). The basic idea is that relative unit labour cost is influenced both by sector-specific variables (productivity and wages) as well as the real exchange rate. The standard Ricardian model assumes a uniform wage rate across sectors (because of perfectly competitive labour markets). But, this assumption is relaxed in Golub and Hsieh (2000), Edwards and Golub (2004) and Mbaye and Golub (2002) empirical works. In their theoretical background, they expose some of the standard Ricardian formulations. They consider  $a_i = \frac{L}{Q}$ , where  $a_i$  represents the unit labour requirement for sector *i*, *Q* is the value-added, and L is labour employment. *w* denotes the wage and *e* the exchange rate between home and foreign currencies. If labour is the only factor of production, home average costs of production are equal to unit labour costs *w.ai*. Expressed in domestic currency, foreign unit labour cost are *e.wi\*.ai\**. International competitiveness in sector *i* then depends on relative unit labour cost  $c_i = \frac{a_i w_i}{a_i^* w_i^* e}$  which can be written as

 $c_i = \begin{pmatrix} a_i \\ a_i^* \end{pmatrix} \begin{pmatrix} w_i \\ w_i^* e \end{pmatrix}$  that illustrates the decomposition of relative unit labour costs into relative productivity and relative wages converted into a common currency.

Many empirical studies focus on the relation between FDI and unit labour cost (ULC), which is a Ricardian concept. ULC is the cost of labour per unit of output, i.e. the ratio of wages to productivity. The Ricardian focus on relative ULC provides a powerful framework for analyzing international competitiveness (Golub, 1995; Edwards and Golub, 2004; Mbaye and Golub, 2002). Relative ULC is the key relative price in a Ricardian model of trade. The basic idea is that relative unit labour cost is influenced both by sector-specific variables (productivity and wages) as well as the real exchange rate. Golub and Hsieh (2000) use bilateral trade flows as the dependent variable and relative productivity and relative unit labour costs as explanatory variables and show a positive and significant correlation between relative productivity and exports. Mbaye and Golub (2002) argued that in a world where capital is mobile and production is footloose between countries, the relative price of non-tradable inputs- labour- (than outputs) that matters.

Golub (1995, 2000) provides a critique of the "*sweatshop labour argument*" based in Ricardian trade theory which holds that a country's wage level tends to align itself with the level of labour productivity through adjustment in wages and exchange rates. Golub (1995) and Meyer (1995) argue that productivity-adjusted labour costs are relevant determinant of FDI.

Larudee and Koechlin (1999) acknowledge that national average wage bears some relationship to national average productivity. However, they add that wage differentials between countries can have an independent influence on flows of FDI. Even when two countries have the same average reported ULC, FDI from the high-wage to the low wage country will likely occur. In other words, the host country average wage has independent influence on FDI flows to that country. They add that a MNF will choose a production site based on its costs, including the expected ULC, in the host country. They argue that MNF's ULC will be less than the host country's average ULC which imply that FDI may flow between a high-wage and low-wage country with the same average ULCs. However, many economists focus on the role of ULC. Hatzius (2000) argues that the liberalisation of FDI has made ULCs more important to domestic investment and long-run labour demand. He provides evidence from British and German data that is consistent with this view. He shows that high unit labour costs increase FDI outflows and lower FDI inflows. Carstensen and Toubal (2004) use dynamic panel data methods to examine the determinants of FDI into Central and Eastern European Countries (CEECs). They show that low relative ULC has significant effect

determining the flows of FDI into the CEECs. Billington (1999) argues that low unit labour costs tend to encourage FDI.

#### 2.3 Macroeconomic approach to FDI

The objective of this section is to discuss the 'macroeconomic' approach put forward by the two Japanese economists, Kiyoshi Kojima and Terutomo Ozawa. Kojima (1973,1975 1978,1982, 1991) and Kojima and Ozawa (1984,1985), have suggested that Japanese FDI has empirically been largely 'pro-trade oriented' - in the sense that such investment has tended to stimulate trade flows between Japan and the host economy- whereas American (and other Western) FDI has been, on the whole, 'anti-trade oriented'. Since trade -oriented FDI implied investments in industries in which the source country has a comparative disadvantage and the host country has a comparative advantage, it would accelerate trade between the two nations and lead to an industrial restructuring in both countries. In contrast, anti-trade oriented FDI would imply investment in industries in which the source country has a comparative advantage and the host country has a comparative disadvantage. Thus, international trade would be reduced and industry would be restructured in direction opposite to that recommended by comparative advantage (Kojima, 1978, 2000; Goldstein et al., 1991).

#### 2.3.1 Kojima's model of comparative investment profitabilities

Kojima's integrated theory of international trade and FDI. He gives theoretical framework to analyse the role of FDI and its effect on international trade expansion. The theory is based on the Heckscher-Ohlin principle of comparative advantage (or costs) (Kojima 1973, 1975, 1978, 1982, 1991, 2000). Kojima's basic theorem is that FDI should complement comparative advantage patterns in different countries. Such investment must therefore originate from the comparatively disadvantaged (or marginal) industry of the source country which leads to lower-cost and expanded volume of exports from the host country. The author states that while international specialisation and trade follow the principle of comparative costs, FDI decision making is undertaken according to comparative profitability. If it is proved that comparative costs and comparative profit rates correspond to each other-the "correspondence principle"-, it can be said that both trade and FDI should be directed by a common theory, that is, the principle of comparative costs which is equivalent in turn to the principle of comparative profit rates.

Kojima considers comparative advantage between two countries, or between one country and the rest of the world within a factor proportions setting. FDI leads to structural adjustment and changes in the components of import and export, if it transfers a package of capital, technology and managerial skills from an industry which has a comparative disadvantage in the investing country to the recipient country, where it develops a comparative advantage. It facilitates the reorganisation of the international division of labour that increases production and trade. Thus, FDI in these circumstances complements the changes in the patterns of comparative advantage.

Kojima' macroeconomic theory is essentially an extension of the neoclassical factors proportions theories by including technology and management skills. Kojima considers a package of managerial resources as general factor of production together with labour. He added some arguments:

- First, the H-O model may be formulated using labour and managerial resources instead of labour and capital. Kojima (1978, p.79) defines "managerial resources as capital which includes not only material capital, but also human capital such as technology and skills".
- Second, Kojima proves that the differences in the comparative profit rates are related to
  the comparative cost differences. International trade follows the direction dictated by the
  comparative costs which is also the direction indicated by the comparative profit rates.
  FDI should be made in the direction suggested by the comparative profit rates. In this
  way, international trade and FDI are explained under the same principle of international
  division of labour, i.e. comparative costs or comparative profit rates.

#### 2.3.1.1 Heckscher-Ohlin setting

Since the "*correspondence principle*" is less studied, underknown and revisited, we present in the following the original version of Kojima which starts from the production function (see Kojima, 1973, 1977b, 1978; Lee, 1990)

$$Q = f(L, K, T, M)$$

where Q denotes the output produced, L and K labour and capital, T technology used and M managerial skills or organisational technique. FDI transfers the package of K, T and M, but it is assumed that endowment of K is not affected significantly because the amount of capital involved is marginal to total capital formation both in the investing and receiving countries. Technology and management used in country A (advanced industrialized country or Japan) are assumed to be superior to those in country B (developing country) before the FDI from country A to B takes place. But, FDI makes it possible for country B to use superior technology and management. Kojima argues that technology and management are not specific but general factors, transferable as part of a package or separately between countries on a competitive basis.

The structure of comparative advantage before and after FDI and the profit rates is given by

Comparative costs before FDI					
	Country A	Country B			
X goods	100 \$	150 \$			
Y goods	100 \$	300 \$			

Comparative profit rates for country A						
	Domestic investment	Direct foreign investment				
X industry	$r_{X} = 10\%$	$r_X' = 13\%$				
Y industry	$r_{Y} = 10\%$	$r_{Y}' = 5\%$				

Country B produces both X goods (traditional labour intensive goods, for example textiles) and Y goods (new capital –knowledge intensive goods, for example machines ) at higher costs than country A, for example because of lack of technology and management as compared with country A. Country A (developed country) has a comparative advantage in industry Y and country B has a (potential) comparative advantage in industry X. Country A has relative abundance of K in comparison with country B (that is  $K_A / L_A > K_B / L_B$ ) while X goods are more labour-intensive than Y goods in both countries, that is  $K_{XA} / L_{XA} < K_{YA} / L_{YA}$  and  $K_{XB} / L_{XB} < K_{YB} / L_{YB}$ , as in the H-O theorem. Comparative costs are therefore given by

$$\frac{C_{XA}}{C_{YA}} / \frac{C_{XB}}{C_{YB}} = \frac{100}{100} / \frac{150}{300} = 2 > 1$$

where C denotes production cost.

Now if North invests in South and factors T and M are transferred from country A to country B, the new comparative costs are represented by the following figures.

Comparative costs when country A invests in country B's X industry						
	Country A	Country B				
X goods	100 \$	75 \$				
Y goods	100 \$	300 \$				

What would be the profitability of investment in production of good X and good Y in country A when goods are traded at international prices? Under the assumption of perfect competition in the product market, the rate of profit from domestic investment in the X and Y industries,  $r_x$  and  $r_y$  respectively, is assumed to be the same, say 10%, in country A where free competition is said to prevail. The rate of profit rate from direct investment in country B's X industry,  $r_x$ ' is say 13% and would be higher than  $r_y$ ' because X industry in country B produces at lower cost than in the investing country and becomes competitive in international markets, thus increasing the profit margin. Following the comparative investment profit abilities, country A should be better off if it increased investment in Y industry at home and in X industry in country B. Comparative profit rates are given by

$$\frac{r_x}{r_y} / \frac{r_x}{r_y} = \frac{13}{5} / \frac{10}{10} = 2.6 > 1$$

Kojima states that the core argument for trade-oriented FDI is that FDI should follow the direction indicated by the comparative profit rates, which in turn are a reflection of the comparative advantage under competitive conditions. Thus, FDI is not only complementary to trade but it is also an accelerator in reorganising trade patterns in the direction of comparative advantage. Because of the direction of the comparative profit rates, FDI from country A takes place only in X industry in country B, and results in the new comparative cost pattern. The comparative cost differential is widened due to FDI transforming the X industry in country B from a potentially advantageous to strongly competitive exportable industry. Due to such dynamic changes in the pattern of comparative advantage, country A may show (and benefits from) a contraction of investment in and production of X goods, and a shift of its resources towards FDI and domestic investment in the Y industry of which the comparative advantage is strengthened. X goods are now imported in country A.

#### 2.3.1.2 Correspondence between comparative advantages and comparative profit rates

Whether production of X or Y is more promising for a country is judged by the principle of comparative costs. This however is a theoretical criterion. Firms make their decisions on the basis of comparative investment profitability, which would be a very useful criterion if it corresponds exactly to comparative costs under certain conditions. According to full- cost principle, firms sell product at an average cost per unit of products plus a certain profit. Let P stand for selling price, Q for the volume of sales (which is equal to the quantity produced) and PQ for total revenue which is denoted by T.

$$PQ = T \tag{1}$$

The total revenue T consists of total cost, C and profit R

$$T = C + R \tag{2}$$

Using (2), equation (1) becomes

$$P = \frac{T}{Q} = \frac{R}{Q} / \frac{R}{T} = \frac{\pi}{r}$$
(3)

where  $\pi \equiv \frac{R}{Q} \equiv P - \frac{C}{Q}$ , which shows profit per unit of sales or "mark-down", and

 $r \equiv \frac{R}{T} = \frac{R}{PQ} = \frac{P - C/Q}{P} = 1 - \frac{C/Q}{P}$ , which shows the ratio of profits to total sales or the

"mark-down ratio". The r is equivalent to so called "mark-up ratio" which is usually shown as a percentage of total cost, used by Kojima as a percentage of total revenue and may be called "mark-down ratio" to the sale price. Therefore, r/(1-r) corresponds to the ordinary mark-up ratio. The r is not profit rate of capital invested but that of total sales. This may be a defect of the model, for the former is usually used as a theoretical concept of profit rate. However, it is not easy to determine how much capital is used in certain production and sales activity for certain periods, particularly in the case of FDI activity. The profit rate of total sales might be the criterion used by firms in a competitive market in their investment decision. The relationship (3) is established in the home country for each of the good X and Y

$$\frac{P_x}{P_y} = \frac{\pi_x}{r_x} / \frac{\pi_y}{r_y} = \left(\frac{\pi_x}{\pi_y}\right) \left(\frac{r_y}{r_x}\right)$$
(4)

This relationship also applies to the foreign country denoted by ('):

$$\frac{P_x'}{P_y'} = \left(\frac{\pi_x'}{\pi_y'}\right) \left(\frac{r_y'}{r_x'}\right)$$
(5)

Let us assume the home country has its comparative advantage in Y goods production:

$$\frac{P_x}{P_y} > \frac{P_x'}{P_y'} \tag{6}$$

Under these comparative cost conditions, according to equations (4) and (5), the following relationship should necessarily exist:

$$\left(\frac{\pi_x}{\pi_y}\right)\left(\frac{r_y}{r_x}\right) > \left(\frac{\pi_x'}{\pi_y'}\right)\left(\frac{r_y'}{r_x'}\right)$$
(7)

Kojima adds the assumption that

$$\left(\frac{\pi_x}{\pi_y}\right) = \left(\frac{\pi_x'}{\pi_y'}\right) \tag{8}$$

Firms usually retain a certain profit margin profit margin or "mark-down" per unit of sales, that is  $\pi$ . According to Kojima, mark-down for each item would be the same in various firms throughout the home economy if competition prevailed among firms. The degree of competition for each item is the same in the foreign economy. This satisfies assumption (8)

that 
$$\left(\frac{\pi_x}{\pi_y}\right) = \left(\frac{\pi_x'}{\pi_y'}\right)$$

It follows that

$$\left(\frac{r_x}{r_y}\right) < \left(\frac{r_x'}{r_y'}\right) \tag{9}$$

Under the assumption (8), comparative costs where  $\frac{P_y}{P_y} > \frac{P_y}{P_y}$  correspond to comparative profit rates on total sales where  $\binom{r_x}{r_y} < \binom{r_y}{r_y}$ . In other words, in the industry in which a country has comparative advantage, the ratio of profits to total sales is relatively

higher. This is the "*correspondence principle*" between comparative costs and comparative profit rates. According to this principle, firms are able to rely on the comparative profit rate judgments instead of the cumbersome theory of comparative advantage (see Kojima, 1973, 1975, 1977b, 1978; Lee, 1990).

In what follows, we discuss Kojima's approach. The argument of Kojima starts with a distinction between 'Japanese-type Direct Investment' and 'American-type Direct Investment'. The Japanese type complements trade through comparative advantage. It transfers technology and managerial skill from an industry in the home country which is losing its comparative advantage to one in the host country with a potential comparative advantage which leads to an increase in trade between the host and investing countries. American-type foreign investment flows from industries in which the US has a comparative advantage to the host country's comparatively disadvantaged industry. This type of FDI destroys trade. Following the Japanese type, technology transfer via FDI is easily absorbable and is an engine of development. The economic forces which motivate Japanese investment stem from the "correspondence principle" which links comparative advantage and price-cost margins (ratio of profit to sales). Kojima's argument is entirely theoretical, without empirical evidence. The mechanism which makes the argument work is the "correspondence principle". In the above two-country, two-good model, Kojima shows that if the ratio of the mark-up of price over average cost for two industries is the same in both countries(equation 8), then the comparative advantage industry in each country possess higher price-cost margin. According to Geroski (1979) the assumption of identical ratios of mark-ups (which the author calls mark downs) seems to be an extreme special case, and in any case positive mark-ups are inconsistent with his assumption of competition.

#### 2.3.2 **Pro-trade FDI and the flying geese model**

#### 2.3.2.1 The flying geese model: theory and evidence

The purpose of this subsection is to give a brief survey of the "*flying geese*"<sup>76</sup> (FG) model of development. In the second half of the 20th century, the FG pattern of development was used to describe the rapid development observed in Japan and its presence in the industrialization of the NIEs and the ASEAN4. The FG pattern of development, recently used to explain the rapid economic growth in East Asia, was originally developed by Kaname Akamatsu in the 1930s (cited in: Kojima, 2000) was popularized in articles written in English (see Kojima, 2000; Ozawa, 2001,2003, 2005, 2009; Cutler *et al.*, 2003).

This model has been developed in the case of Japan and South-East Asian countries, Japan being the lead-goose in the V-shape of migrating geese, with other South-East Asian countries following it. According to this model, dynamic economic development in a developed country and gradual transfer of economic activities to the neighboring countries promote the economic development of the latter as well. In this FG model, latecomers go into industries in which they have a rising comparative advantage and import technology from a more mature economy whose advantage in that industry is declining. The mature economy goes into newer industrial projects using more advanced technology and blueprints in which they have an innovative edge (Kojima, 2000; Damijan and Rojec, 2007, 2008; Korhonen, 1994, Hiley, 1999; Rana, 1990). As noted by Kojima (2000), the FG theorem intends to explain the catching-up process of industrialization in latecomer economies.

<sup>&</sup>lt;sup>76</sup>The *"flying geese*" pattern of economic development is well-known throughout the world as a way of describing rapid economic growth in East Asia. It describes a sequential development of manufacturing industries and the catching-up process of industrialization in developing open economies which consists of two patterns

<sup>(</sup>i) Industry growth traces out the three successive curves of import, production and export

<sup>(</sup>ii) Industries' diversification and upgrading from consumer goods to capital goods and/or from simple to more sophisticated products.

By studying the Japanese industrial development in the pre-war, Akamatsu discovered these two patterns, which looked like a *flying geese* formation.

• This model points out the catching-up process of industrialization in the developing open economies and argues that a less developed country is able to catch up, depending on the upgrading of a leader country. The catching-up process is carried out via trade and pro-trade FDI. As the leading country moves up on the technology ladder, it relocates industries of lower technology level via FDI to less developed countries (Kojima, 1991, 2000)<sup>77</sup>.

Kojima (1973, 2000) expanded the FG paradigm and applied it to FDI and MNFs-led growth. This expanded FG paradigm states that, as host countries industrialize and go through industrial upgrading in an open economy context, the type of FDI flowing from home countries changes in character towards higher skills; in turn, less sophisticated activities originating from relatively advanced host countries will be transferred to new comer host countries. This process strengthens the basis for, and the benefits from, trade (UNCTAD, 1995, pp. 258–260).

Several papers explore the Japanese role in the economic development of the NIEs and the ASEAN4. Japanese FDI has been used to recycle comparative advantage (Culter *et al.*, 2003). Rana (1990), Dowleang and Cheang (2000) and Ginzberg & Simonazzi (2005) conducted formal tests. Rana (1990) found that the shifts in comparative advantage were significant from Japan to the NIEs and ASEAN4 and from the NIEs to the ASEAN 4. Similarly, Dowleang and Cheang (2000) tested the validity of the FG development theory by using comparisons of export shares, Revealed comparative advantage (RCA) and FDI ratio<sup>78</sup>. They give support to the FG paradigm for the period of 1970 to 1995. Economic development is transmitted from Japan to the NIEs and ASEAN4. Comparative advantage also shifted from the NIEs to the ASEAN4 in 1985 to 1995.

<sup>&</sup>lt;sup>77</sup> Kojima (2000) quotes Akamatsu (1962, p. 17) "the less-advanced "wild geese" are chasing those ahead of them, some gradually and others rapidly, following the course of industrial development in a wild-geese-flying pattern. The advanced "wild geese," which are in the lead flying onward, incessantly achieving technological innovations and trying to maintain a certain distance of heterogeneous (or dissimilar) difference from less-advanced "wild geese"<sup>78</sup> Rana (1990) and Dowling & Cheang (2000) argued that the FG theory is similar to that of the "product cycle" theory,

<sup>&</sup>lt;sup>78</sup> Rana (1990) and Dowling & Cheang (2000) argued that the FG theory is similar to that of the "product cycle" theory, developed by Vernon (1966). Dowling and Cheang (2000) further pointed out that the key difference between the two theories is the perspective taken. "Product cycle" theory takes the perspective of the developed countries while FG theorem takes the perspective of the developing country.

#### 2.3.2.2 FDI-cum-trade approach

Kojima extended Akamastu framework and focused on the role of "*pro-trade oriented FDI*" which constitute a pillar for the FG model. Kojima analyzed the trade-oriented nature of FDI. There is a progression from industries in which Japan loses its comparative advantage, and the host country strengthens an advantage. This process would result in Japanese FDI being "*trade-oriented*". Japan, the investing country, would benefit if it disinvests from a comparatively disadvantaged industry, in order to produce the same product in a host country at lower cost than at home. The product can then be exported to the investing country as well as to other markets. Pro-trade FDI is one of the key mechanisms that promoted Asian exports.

The Kojima's approach makes it possible to establish a theory that integrates international trade and FDI, two activities that lead to a dynamic reorganization in the international division of labour. The direction of international trade is determined by a given pattern of comparative costs that makes each country specialized in, and exports, its comparatively advantaged products, while decreasing the home output of, and importing, its comparatively disadvantaged products. This leads to static gains from the international division of labour for both trading partners. Importantly, FDI transfers a package of capital, technology and management skills, improving production functions and reducing costs in the host country, and thus results in dynamic structural changes along the lines of comparative costs. If FDI occurs in an industry in which the investing country has a comparative disadvantage, the recipient country can develop or strengthen a comparative advantage in the same industry. This type of industrial transplants organizes the international division of labour, increasing production and consumption gains from trade for both countries. FDI works, here, in a complementary fashion to create and increase international trade. If FDI moves out from a comparatively advantaged industry in the investing country without prospects of developing a comparative advantage in the same industry in the host country, it causes a loss of efficiency: Such FDI substitutes for and decreases international trade (see Kojima, 1978; Ozawa, 2007).

Following Kojima arguments, we should consider the doctrine of comparative costs (or, more generally, the principle of international division of labour) when we consider FDI, as in the case of treating international trade. The trade oriented FDI does not substitute for international trade but complements it. It is beneficial for an investing country if FDI goes abroad from its comparatively disadvantaged industry to produce goods in the host country at costs lower than at home through the transfer of efficient technology and management and importing them back to the home country(or exporting them to third markets). Such FDI is pro-trade oriented (ie. trade creating) in the sense that it expands exports from the host developing country. Burton and Saelens (1987) study the Japanese strategies for serving overseas markets in electronics. They show that Japanese FDI in electronics is a response to a crucial force. FDI developed as a reaction to induced losses in comparative advantage. Zhang and Hock (1996), Sun (2001) and Dowling and Cheang (2000) examine the connection between FDI and comparative advantage in Asian economies and shows that Kojima arguments can hold.

The FG paradigm "provides a description of the life-cycles of various industries from one country to another through trade and FDI in response to shifts in competitiveness" (UNCTAD, 1996, p. 75). The FG pattern of industrial development is transmitted from a lead goose to follower geese. Pro-trade FDI, as a means of transfer of the investing country comparative disadvantage industry to the host country, has facilitated the regional transmission of FG industrialisation. This type of comparative advantage augmenting FDI leads to an expansion of production and trade in the regional economies involved. For a lead goose country (say, A), the phase of post-catch-up situation prevails. Exports of consumer goods increase up to a peak and then decrease because such labour-intensive consumer goods (say, textiles) are losing comparative advantage due to a rapid rise in wages. A follower goose, say country B, whose wage level is much lower, now begins to produce textiles. This production is facilitated if lead goose A's firms make FDI by transferring capital, superior technology, and managerial skills as a package to the follower goose B. This improves the productivity of A's foreign production, which represents a comparative advantage industry in country B. Its products are sold in both local and foreign markets, and some portion is imported back to country A (i.e. reverse imports). Meanwhile, country A's exports of capital goods to country B increase with an enlarged scale of production and reduced costs. The most important characteristic of pro-trade FDI is that direct investment is originating from an investing country's comparatively disadvantaged industry and going to host country's
comparatively advantaged industry (the same industry). FDI thus augments comparative advantages in both countries, resulting in an expanded basis for trade. As long as this type of FDI is promoted, an FG stimulus of industrialization is transmitted from a lead goose to follower geese, leading to enlarged trade (see Kojima, 2000 for more details).

## 2.3.2.3 Transferability of the flying geese model

Few authors discuss the transferability of the Asian FG model to other regions. Meyer (1995) argues that FDI in CEE countries does not follow the pattern of the Asian model of development. However, Katolay (2004) applied FG metaphor to emerging FDI patterns in Europe and the Southern Mediterranean countries. He argues that the new division of labour in Europe and the Mediterranean region would be possible to predict by the FG metaphor of FDI, borrowed from the Japanese/Asian context. The author argues that the FG is at best in an embryonic stage. Labour-intensive activities relocated from accession countries now go more to developing Asia (especially China) than to lower-income European countries and Southern Mediterranean countries.

Rojec and Damijan(2008) verify the existence of the FG in the case of inward FDI in Central European countries. They focus on the structural characteristics of the relocation process via EU-15 FDI to new (EU) member states from Central Europe (NMS-8)<sup>79</sup> and apply FG model to explain the changing pattern of inward FDI into NMS in terms of technological intensity of industries. The authors find that the relocation via efficiency-seeking FDI in NMS goes increasingly in medium & high technology industries while low-technology industries are losing their attractiveness for foreign investors. They argue that the efficiency-seeking export oriented FDI in manufacturing prevails in the relocation process. The analysis shows that FDI is an important if not the main vehicle of manufacturing sector restructuring and productivity growth in the analyzed Central European countries, along the lines of FG model. They confirm the transferability of the FG pattern of FDI in NMS in the sense that labour intensive low technology FDI is increasingly replaced by medium technology FDI. EU-15 will increasingly relocate via FDI their low technology and low wage industries to the countries outside the EU-25, while the NMS will receive more and more medium technology and lower-end segments of high technology industries. The analogy with the EU-15 as the

<sup>&</sup>lt;sup>79</sup> Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. The paper has been written before 1 January 2007; therefore, it does not include Bulgaria and Romania.

lead-goose and NMS as the following geese is obvious. The authors show (i) that most FDI in NMS manufacturing is of a pro-trade nature which is a channel of catching-up process along the lines of the FG model<sup>80</sup>; and (ii) that the bulk of FDI into NMS is originating from EU-15.

# 2.4 North-South FDI and reformulated *"correspondence principle"*: a Ricardian approach

This section attempts to reformulate Kojima's *correspondence principle*, which links comparative advantages and comparative profit rates in the H-O model, and to apply it to the Ricardian context. We show that FDI originating from comparatively disadvantaged industry in the source developed country and going to the same industry (comparative advantage) in the host developing country follows the direction of absolute profit rates that correspond to the Ricardian comparative advantage.

### 2.4.1 FDI and comparative advantage: a brief review of literature

As noted by Yeaple (2001, p.1) "the pendulum has swung quite far against comparative advantage, which is a concept that would seem inseparable from the field of international trade and investment". Kojima (1973, p.12) states that "the most important criterion in undertaking foreign direct investment should be to take into consideration the present and potential pattern of comparative advantages between investing and host countries".

Recent advances in the literature of the links between international trade and investment emphasize the trade impact of dynamic changes in comparative advantage resulting from FDI. As noted by many economists (e.g. Kojima, 2000; Frobel *et al.*,1980; Wilkinson *et al.*,2001; Sun, 2001; Lee, 1990), FDI plays a particularly important role in facilitating an international division of labour.

<sup>&</sup>lt;sup>80</sup> Damijan and Rojec (2007) state hat the catching-up via FDI along the lines of FG model is going on mostly in industries at the lower end of the technological intensity spectrum.

### 2.4.1.1 Theoretical aspects

Although there has been some empirical studies showing that more FDI tend to go to the host country's comparative advantage sectors (see Lipsey, 2004, Jensen, 2002; Yeaple, 2003, 2006; Sun, 2001) the theoretical literature of international trade and FDI does not give any explicit and clear answer to the question that links comparative advantage to FDI's sector location. Kojima (1973, 1978), Kojima and Ozawa (1984) developed a variant of Mundell's (1957) model in order to explain both international trade and FDI. They argue that while exports should take place on the basis of the country's comparative advantage in a product, FDI activity, on the other hand, should occur when a country has a comparative disadvantage in a product, or when its comparative advantage has been eroded, to allow foreign skills or capital to be combined with host country factors to reduce production costs. Kojima (1977, 1978) terms his model 'macroeconomic' and uses it to contrast 'trade oriented' 'Japanese type investment' with 'anti trade oriented' 'US type investment.' The economic forces which encouraged Japanese investment arise from a "correspondence principle" discovered by Kojima which states that a country's "comparative profitability" (the ratio of profit rates in two industries) is higher in an industry in which it has comparative advantage. As capital is then said to move out of the industry with a low relative profit rate in one country to the industry with a high relative profit rate in the other, international capital movement under the specific form of FDI is from the industry in which one country has a comparative disadvantage to the industry in which the other country has a comparative advantage. In other words, FDI will follow the direction indicated by comparative profit rates which in turn are a reflection of comparative advantage under competitive conditions. As noted by Kojima (1977b, p. 103) "trade-oriented FDI works only in a competitive world in which standardised commodities are produced and traded and competitiveness is determined by traditional comparative advantage theory à la Ricardian theory or the Heckscher-Ohlin theory". However, he studied only the case of Heckscher-Ohlin theory.

Ricardo in his trade theory assumes international immobility of capital. He introduces preference in location and risk premium in international investment and implicitly informational and socio-psychological costs of transactions, in order to explain the difficulty for the capital to move from one country to another "Experience, however, shows that the fancied or real insecurity of capital, when not under the immediate control of its owner, together with the natural disinclination which every man has to quit the country of his birth and connections and entrust himself, with all his habits fixed, in a strange government and new laws, check the emigration of capital. These feeling, which I should be sorry to see weakened, induce most men of property to be satisfied with a low rate of profits in their own country, rather than to seek a more advantageous employment for their wealth in foreign nations (Ricardo [1817] 1951, p. 83)<sup>81</sup>

In this respect, Ozawa (1992, 2005) argued that Ricardo was perhaps the very first economist who recognized what is now popularly known as the transaction costs of FDI. FDI was impractical for Ricardo and meant insurmountable difficulties, since he saw a prohibitively high transaction cost of doing so because of the lack of efficient communications and transport services in his day. Ricardo failed to see the possibility that Portuguese entrepreneurs with superior technology and prospects for a high profit rate transplanted their cloth manufacturing in England, so long as the Portuguese technological advantages were sufficiently large to overcome the costs of doing business in England. Ozawa thinks that Ricardo failed to understand the logic of pro-trade FDI which is an extended application of the comparative advantage doctrine to investment flows in addition to trade flows.

Ricardo explicitly introduced a technology (knowledge) gap into his trade theory, as reflected in the assumption of different levels of labour productivity between England and Portugal and the assumption of no cross-border knowledge transfer. Ricardo considered that knowledge transfers (international factor movements) would destroy the basis for trade and cause a hollowing out in an absolutely disadvantaged country (England in his illustration).

"It would undoubtedly be advantageous to the capitalists of England, and to the consumers of both countries, that under such circumstances, the wine and the cloth should both be made in Portugal, and therefore that the capital and labour of England employed in making cloth, should be removed to Portugal for that purpose". (Ricardo [1817] 1951, p. 77)

According to Ricardo, there will be no basis for trade once cross-border knowledge transfers are admitted: Portugal flourishes, whereas England is hollowed out and languishes. Ricardo considered that international factor movement (including technology) would destroy

<sup>&</sup>lt;sup>81</sup> Given the psychology of capitalists, cultural and social backgrounds, Ricardo was sorry to see the risk aversion of capitalists weakened.

the basis for trade (i.e., productivity differentials) between countries. Surprisingly, Ricardo "did not envisage that if, instead of moving to Portugal 'the capital and labour of England employed in making cloth', the Portuguese secrets (superior knowledge) of higher productivity in cloth are transferred to England, say, through FDI or licensing, not only is England spared the hollowing out but both countries can also prosper even more, since England's comparative advantage in cloth is enhanced by such technology transfer" (Ozawa, 2005, p.154).. Ricardo failed to recognize this possibility and did not apply to FDI flows the same logic of comparative advantage he used for trade flows. He deprived himself of a chance to study an appropriate pattern of knowledge transfers<sup>82</sup> by excluding the issue of cross-border factor movements, since he thought that foreign investment involved high psychological costs<sup>83</sup> (Ozawa, 1992, 2005, 2007).

According to Hosseini (2005,p. 530), FDI is unexplainable by comparative advantage doctrine, namely the Ricardian version. "*The assumptions of this model are too unreal to allow such an explanation*". "*Such a simple model would not allow the possibility of FDI, or any other form of international production, particularly since it assumed labour time as the only relevant factor of production*". However, Negishi (1982, 1985) notes that capital movements are implicitly considered by Ricardo through consideration of exporters and importers. Capital can move between countries through the activities of exporters and importers to replace the capital of producers. International trade enables capital to move from a country where the rate of profit was lower before trade, to other country, where the rate of profit was higher. The relation between profit rates depends on the possibility of capital movement between countries. It is impossible, however, that profit rates are completely equalized, in view of factors that, Ricardo emphasized, induce most men of property to be satisfied with low rate of profits in their own country rather than to seek a higher rate in foreign countries. Sasaki's (1998) and Negishi's (1982, 1985) analysis show that the case of

<sup>&</sup>lt;sup>82</sup>Based on comparative advantage.

<sup>&</sup>lt;sup>83</sup> Ozawa (1992, 2005) argued that Ricardo was perhaps the very first economist who recognized what is now popularly known as the transaction costs of FDI. FDI was impractical for Ricardo and meant insurmountable difficulties, since he saw a prohibitively high transaction cost of doing so because of the lack of efficient communications and transport services in his day. Ricardo failed to see the possibility that Portuguese entrepreneurs with superior technology and prospects for a high profit rate transplanted their cloth manufacturing in England, so long as the Portuguese technological advantages were sufficiently large to overcome the costs of doing business in England. Ozawa speaks about Ricardo's error when he (Ricardo) neglected pro-trade FDI. He thinks that Ricardo, the originator of the notion of comparative advantage, failed to understand the logic of pro trade FDI which is an extended application of the comparative advantage doctrine to investment flows in addition to trade flows.

classical economics in which capital movement occurs only from an industry to another industry within a country requires extremely strict conditions. "*If the profits on capital were higher, and labour more productive in other countries, it could not be doubted that capital would be transferred to those countries: no proposition in Euclid was clearer than this*". (Ricardo, [1817]1951,p.38). For Ricardo "*no proposition in Euclid*" was clearer than capital transfers depending on profit rates. This reference means that Ricardo did not endogenously exclude the possibility of international capital movements. Ricardo excluded the possibility of capital exports not endogenously for simplicity of his model, but exogenously for the simple reason of insecurity<sup>84</sup>. This means that a Ricardian model can be examined on the assumption of the existence of capital exports.

Following Kojima and Ozawa (1984) as far as cross-border knowledge transfer is concerned, Ricardo's analysis was clearly incomplete. Contrary to Ricardo's belief, they state that, within the FG model of economic development, the basis for trade will not necessarily be destroyed through knowledge transfers; on the contrary, it will be enhanced when superior knowledge is transplanted from a comparatively disadvantaged (hence contracting) industry in a lead-goose economy to a comparatively advantaged (hence expanding) industry in a follower goose economy. In this process, there is an expanded basis for trade. The maximum growth inducing effect of trade is based on two key propositions (i)Countries gain from trade and maximize their economic welfare when they export comparatively advantaged goods and imports comparatively disadvantaged goods (Ricardian comparative advantage), (ii) Countries gain even more from expanded trade when superior entrepreneurial assets are transferred via FDI from the home countries' comparatively disadvantaged industries in such a way to improve the efficiency of comparatively advantaged (existing as well as potential) industries in the host countries. This important second proposition is lacking in Ricardo's trade model, since he assumed international factor immobility. Ozawa (1992,p.43) states that Ricardian trade static model "can be transformed into a dynamic structural upgrading model once the role of multinational firms as a facilitator of industrial transformation is explicitly brought into analysis as causative factors". The pro-trade FDI is a powerful promoter of comparative advantage. The basic hypothesis is that FDI should originate in the source country's comparatively disadvantaged industries so that it can complement comparative advantage patterns. On the other hand, anti-trade FDI (replacements of exports ) is most likely

<sup>&</sup>lt;sup>84</sup> risk premium in international investment and informational and socio-psychological costs

to occur, for example when the host countries pursue import substituting development policies, or when innovating firms decide to specialize in R&D rather than production and exporting by transplanting manufacturing abroad, especially in rapidly growing foreign markets(Ozawa and Castello, 2001).

Oiu (2003) inspired by the stylized facts on North-South FDI and trade (between USA and China), builds a North-South trade-cum-FDI model with two goods 1 (textile) and 2 (auto), two countries (developed and developing countries) and makes a cross-sector comparison for FDI. The developing country has comparative advantage in the production of good 1, and the developed country has comparative advantage in the production of good 2. Following the direction indicted by comparative advantages, the developing country exports (imports) good 1 (good 2) and developed country exports (imports) good 2 (good 1). Qiu examines the implications of Ricardian comparative advantage for FDI incentives under oligopolistic conditions. He defines FDI incentives as the firm's profit difference between investing abroad and not. He is mainly concerned with industries in which firms from the developed country have stronger FDI incentives. The firms producing good 1 and good 2 in the developed country have the opportunity to make FDI in developing country. When it invest abroad, a firm sets up a subsidiary in a developing country and the subsidiary hires country local labour but uses its own technology for production. When the firm originating from the developed country has the opportunity to invest in the developing country, it will make such investment if and only, if by doing so, it can rise its global profit, which is the sum of the profits derived from all markets, domestic and foreign. The firm chooses between FDI and non-FDI. Comparative advantage leads to different market opportunities opened for FDI in different sectors, which results in divergence in cross-sector FDI incentives. On comparison between the FDI incentives in both industries, Qiu found that the first industry (textile) is more attractive to FDI because the host developing country has comparative advantage in this industry. The developed country's firms operating in the comparatively advantaged industry (auto) have weaker FDI incentives than firms operating in the comparatively disadvantaged industry. Qiu concludes that in the developing country the comparative advantage industry is more attractive for inward FDI than the comparative disadvantage industry<sup>85</sup>.

<sup>&</sup>lt;sup>85</sup>According to Qiu (2003) who sets up the link of FDI incentives to comparative advantage, the question becomes why comparative advantage matters. The author argues that comparative advantage determines the pattern of trade, which in turn distinguishes good 1 and good 2 industries in their market opportunity and export opportunity for FDI. A better market and

## 2.4.1.2 Some empirical results

Nachum *et al.* (2000) explore the link between the *comparative advantage* and industrial structure of the UK's OFDI. The authors show that the UK direct investment is concentrated in the industries in which the country is comparatively disadvantaged. Maskus and Webster (1995) examine the connection of the location of FDI to its comparative advantage by comparing OFDI from United Kingdom and South Korea. Using the factor proportions (Heckscher-Ohlin-Vanek or H-O-V) hypothesis, they show that the host country's comparative advantage (of the factor proportions type) is an important determinant of inward FDI. Specifically, sectors using the host country's abundant factors more intensively attract relatively more inward FDI. In addition, the authors measured the revealed factor abundance based on net FDI flows in the U.K. and South Korea and found it to be correlated with the revealed factor content of their net exports.

Lipsey (1999) provides interesting descriptive analysis on whether U.S and Japanese multinationals follow comparative advantage in their investments in developing countries of East Asia. He found that Japanese firms invested heavily in sectors of host-country comparative advantage, such as textiles and electrical apparel. In contrast, U.S. firms made early investments in electronics and computer-related machinery, which were sectors of American comparative advantage at the time. The author suggests that comparative advantages of both source and host countries are involved in investment decisions.

Some papers showed that Japan has invested relatively more heavily in industries in which it has comparative disadvantages. Lee (1990) and Lee and Ogawa (1995) examine the relationship between returns on capital in some of the industries in which Japan was losing its comparative advantage and its OFDI from these industries. In fact, some of the FDI, from Japan and the Asian NIEs are from declining labour-intensive industries. Firms in these industries experience falling profits and thus have an incentive to invest in another country that is gaining a comparative advantage in the same industries. Urata (1991) estimated pooled regressions for eight manufacturing industries for 1977–1986 and found that Japanese OFDI

export opportunity in the first industry in the developing country makes this industry more attractive to inward FDI compared to the second industry.

are strongly positively correlated with imports. Urata argues that, in large measure, Japanese FDI has been directed abroad to industries in which Japan has comparative disadvantages.

## 2.4.2 Reformulating Kojima's "correspondence principle": Ricardian setting

Kojima builds a model of comparative investment profitabilities for trade oriented FDI. This type of FDI works only in competitive world in which standardized commodities are produced and traded and competitiveness is determined by traditional comparative advantage *à la* Ricardian theory or H- O theory. This points out *"low-wage trade"* in the product cycle. Unlike Kojima, we focus on absolute profit rates to explain the direction of FDI and we use the Ricardian trade model that allows international differences in technologies rather than the H-O trade model that takes into account international difference in factor endowments in order to study trade oriented FDI. In addition, our theoretical framework allows us to examine issues that are different from most of the present research on international trade and FDI. Instead of explaining two-way trade and FDI among developed countries (North-North trade and FDI), our model is intended to complement the existing literature by explaining FDI from technologically advanced economies in technologically backward economies (North-South trade and FDI).

North-South FDI has become increasingly important in recent years. Developed countries are the major source of FDI. While a large percentage of FDI moves among developed countries, developing countries' share of the world FDI inflows increased from less than 18 % in 2000, to 28 % in 2008 of global inward FDI (UNCTAD, 2009). On the trade side, due to differences in technologies and endowment between developed and developing countries, North-South trade is dominated by interindustry trade, as opposed to intraindustry trade. In the light of these facts, our model and its results are more applicable to North-South trade and FDI <sup>86</sup>.

<sup>&</sup>lt;sup>86</sup> Some facts summarized in Markusen (1995) only fit North-North FDI and so do not apply here.

We consider North–South FDI in competitive industries<sup>87</sup>. We show that due to both technological differences between countries that lead to divergence in absolute profit rates and industry specificity of capital, FDI originating from comparatively disadvantaged industry in developed country and going to comparatively advantaged industry in developing country can occur even in the absence of imperfect competition. In addition, we find that the investing developed country's welfare improves with FDI due to an improvement in its terms of trade.

Existing theoretical studies in the literature of FDI focus on the case where multinational firms arise from imperfectly competitive markets because of increasing returns to scale or product differentiation<sup>88</sup>. Like Cheng *et al.* (2005) and Batra and Ramachandran (1980) our model is based on perfect competition in the products market without transportation costs and trade barriers. We incorporate some features of FDI (industry-specific capital and technology transfer) in a classical Ricardian trade model and retain the assumptions of perfect competition in the products market.

In the literature of development economics and international trade, North stands for developed country and South for developing country. In our Ricardian trade model, there are two countries, developed country (North designed by (\*)) and a developing country (the South). Each country produces two goods 1 and 2 in autarky. In both countries, the investors engage their capital to create capacities of production according to their knowledge and skills. Wage rates are equalized within each country, and determined exogenously. Profit is the economics surplus after deducting wages. Our model is based on perfect competition in the product markets.

<sup>&</sup>lt;sup>87</sup> For example, textiles, clothing, electronics, watches and clocks industries were some of the key industries in Hong Kong. Hong Kong has advanced technologies but lost its comparative advantage in these industries and local firms were pushed to relocate their production base to others Asian developing countries, particularly China (Cheng *et al.*, 2005; Thompson, 2002, 2003).

<sup>&</sup>lt;sup>88</sup> Cheng *et al.* (2005, p.480) focused on FDI in competitive industries where there are small multinational firms. "While large multinational firms with proprietary technology tend to exploit host countries' domestic markets, small multinational firms tend to exploit host countries' low cost production of relatively standardized products".

The price of good 1 (traditional labour intensive good) and good 2 (capital and technology intensive good) are given by the classical price system (Sasaki, 1998; Negishi, 1982, 1985).

For the developing country

$$p_1 = a_1 w(1+r)$$
 (1)

$$p_2 = a_2 w(1+r)$$
 (2)

where  $\langle p_1 \rangle$  and  $\langle p_2 \rangle$  represent the price of the good 1 and good 2 respectively, the production technology for good 1 and good 2 is described by two unit labour requirements  $\langle a_1 \rangle$  and  $\langle a_2 \rangle$ ,  $\langle w \rangle$  is wage rate,  $\langle r \rangle$  denotes profit rate. For the developed country

$$p_1^* = a_1^* w^* (1 + r^*) \tag{1*}$$

$$p_2^* = a_2^* w^* (1 + r^*) \tag{2*}$$

If we consider the price of the first commodity as numéraire, (i.e.  $P_1 = P_1^* = 1$ ), the prices of the each commodity in each country, in autarky, are given by

For the developing country

$$p_1 = a_1 w(1+r) = 1 \tag{3}$$

$$p_2 = a_2 w(1+r) = \frac{a_2}{a_1} \tag{4}$$

For the developed country

$$p_1^* = a_1^* w^* (1 + r^*) = 1$$
(3\*)

$$p_2^* = a_2^* w^* (1+r^*) = \frac{a_2^*}{a_1^*}$$
(4\*)

Without loss of generality, we suppose that the developing (developed) country has a comparative advantage in producing the good 1 (good 2). The direction of comparative advantage is given by

$$\frac{a_1}{a_2} < \frac{a_1^*}{a_2^*} \tag{5}$$

Three cases of technological differences are consistent with the direction of comparative advantage as described by inequality (5), specifically,

(a)  $a_1 < a_1^*$  and  $a_2 > a_2^*$  (6a)

(b) 
$$a_1 > a_1^*$$
 and  $a_2 > a_2^*$  (6b)

(c)  $a_1 < a_1^*$  and  $a_2 < a_2^*$  (6c)

The inequalities in (6a)-(6c) describe the two countries' absolute advantages or disadvantages in production technology. Given our interest in analyzing FDI from an from a technologically advanced country to a technologically backward country, we shall focus on the case (6b) alone, i.e., the case in which the developed country (North) has an absolute advantage in the production technology of both goods<sup>89</sup>.

The developed country has an absolute advantage in the production technology of both goods because of higher quality of both labour and capital, but has a comparative advantage in the production of good 2, which it exports to the developing country in exchange for good 1. Under the free trade regime without the international capital movement under FDI, if each country is small, the price (p = 0) of the second commodity in the world market is given

$$p_2^*$$

Following Ruffin (2002), we add the condition below

$$\frac{a_1}{a_1^*} < \frac{w^*}{w} < \frac{a_2}{a_2^*}$$
(8)

The later inequality reveals the condition for both countries to have international competitiveness according to comparative advantage. That is the developing (developed) country has an international competitiveness in good 1 (good 2).

The emergence of world market prices fundamentally influences price system based on labour coefficients and affects profit rates in various. Specifically, it causes a divergence in the profit rates between industries in both countries because prices become independent

<sup>&</sup>lt;sup>89</sup> See Beladi et al. (1997), Ruffin and Jones (2007) and Samuelson (2004).

variables in the profit rate in each industry for each country (Sasaki, 1998). The relation between the profit rate and the change in world market price after free trade is given by

For the developing country

$$r_1 = \frac{1}{a_1 w} - 1 \tag{9}$$

$$r_2 = \frac{p}{a_2 w} - 1$$
 (10)

For the developed country

$$r_1^* = \frac{1}{a_1^* w^*} - 1 \tag{9*}$$

$$r_2^* = \frac{p}{a_2^* w^*} - 1 \tag{10*}$$

From (7), (9), (10), (9\*) and (10\*), we compare the profit rates in each country and in each industry. We obtain

$$r_1 > r_2 \qquad ; \qquad r_2^* > r_1^*$$
 (11)

The comparison of the international  $(intra \ industry )$  profit rates suggests an interesting result: from (8), (9), (10), (9\*) and (10\*), we obtain

$$r_1 > r_1^*$$
;  $r_2^* > r_2$  (12)

The result (12) shows that, under the free trade regime, there is a correspondence between absolute profit rate and comparative advantages: The direction of absolute profit rates reflects the direction of comparative advantages. This result is our core argument for trade oriented FDI (or pro-trade FDI). It is based on the fact that FDI should follow the direction indicated by absolute profit rates, which in turn is a reflection of comparative advantages. By focusing on absolute profit rates, our result differs from Kojima (1978). What matters to firm's investment decision are the absolute and not the comparative profit rates? The key point in Kojima's theory is that Japanese FDI is complementary to Japan comparative advantage position. To set up this relationship, Kojima proposes a "correspondence principle" which states that a country's comparative profitability (comparative profit rates) is higher in its comparatively advantaged industry. Kojima's correspondence principle is as follows. Denote  $r_1$  and  $r_1^*$  as the profit rates in the industry 1 in the developing country and the developed country, respectively,  $r_2$  and  $r_2^*$  as the rate of profit in industry 2 in the developing country and the developed country, respectively. Then according to the Kojima's correspondence principle,  $\frac{r_1}{r_2} > \frac{r_1^*}{r_2^*}$  if the developed country has a comparative advantage in the industry 2. Therefore, firms from the developed country producing in industry 2 will invest at home while those in industry 1 will invest in the same industry in the host developing country. Lee (1984, 1990) in his conceptual papers without theoretical framework, casts doubt on Kojima's correspondence principle and argues that it suffers from major conceptual problems.

The first problem with the Kojima's correspondence principle is that firm's investment is not guided by comparative profit rates as defined above but by a comparison of absolute profit rates. To see this point, suppose  $r_1 = 12\%$ ,  $r_2 = 5\%$  and  $r_1^* = r_2^* = 10\%$ , as in Kojima's example. According to Kojima's correspondence principle, Northern firms in industry 2 will invest at home and those in industry 1 will invest in the same industry in the developing country. The fallacy of this argument can be, however, demonstrated if we assume  $r_1 = 8\%$ ,  $r_2 = 6\%$ ,  $r_1^* = 5\%$  and  $r_2^* = 10\%$ . Here, we have the same comparative profitability  $\frac{r_1}{r_2} > \frac{r_1^*}{r_2^*}$  as in Kojima's example. However, there are here a number of directions for capital movement. For instance, it may move from developed country comparatively disadvantaged industry (industry-1) to both industry-1 and industry-2 in the developing country. On the other hand, it may move from both industry-1 and industry-2 in the developing country to industry-2 in the developed country. Here, using the industry specificity of capital argument for the international intra-industry investment, we consider that investment moves from an industry in the investing country to the same industry in the host country- intraindustry movement<sup>90</sup>.

The second problem with Kojima's correspondence principle is that it is a symmetric relationship between developed and developing countries. Given that the relationship between developed and developing countries within Kojima's theory is specified only in terms of comparative advantage and comparative profit rates (comparative profitability) with no reference to absolute profit rates, it follows that FDI is bilateral. One country's comparatively disadvantaged industry with a comparatively low profit rate is the other country's comparatively advantaged industry with a comparatively high profit rate, and conversely. Accordingly, if one country's OFDI is originating from its comparatively disadvantaged industry, it receives FDI in its comparatively advantaged industry from the other country's comparatively disadvantaged industry.

Here, like Lee (1984, 1990), Lee and Ogawa (1995), we assume that firm's investment decision will depend on absolute profit rates. Thus, in the numerical example given by Kojima ( $r_1 = 12\%$ ,  $r_2 = 5\%$  and  $r_1^* = r_2^* = 10\%$ ), firms producing in industry 1 (comparative disadvantage) in the developed country, will invest in industry 1 (comparative advantage) in the developing country earning 12% instead of 10%, while firms in industry 2 (comparative disadvantage) in the developing country would invest in industry 2 (comparative advantage) in the developed country would invest in industry 2 (comparative advantage) in the developed country earning 10% instead of 5%. However, according to the stylized facts on FDI, this was not the case for Japan that invested in developing Asian countries but did not receive FDI from them in its knowledge-intensive industries in return. Here, we point out that the technological superiority of the developed country leads to one direction of FDI: North-South FDI from the developed country, which possesses absolute advantage in the production technology of all goods, to the developing country.

We argue that FDI originating from the developed country comparatively disadvantaged industry and going to the developing country comparatively advantaged industry should follow the direction of absolute profit rate which reflects the direction of comparative advantages. We consider that firms make international intra-industry investment.

<sup>&</sup>lt;sup>90</sup> See Caves (1971, 1996), Mussa (1974), Mayer(1974), Amano(1977), Batra and Ramachandran (1980), Falvey (1979), Qiu (2003) and Ozawa (1979a).

Each industry in both regions entails specific tangible and intangible capital. We assume also, there is no cross-industry investment (see Schweinberger, 2002; Qui, 2003; Gilbert and Oladi, 2009), i.e., the developed country's firms producing in industry 1 never invest in industry 2. Then, going back to Kojima example, firms in the industry 1 in the developed country should invest in the same industry in the developing country to earn 12% instead of 10% and firms in industry 2 should invest at home to earn 10% instead of 5% in the developing country. Lee (1984) argues that there is no inter-industry investment because of high cost of learning about production and management in an unfamiliar (de novo) industry. That is to say, the firms lack intangible capital that can be transferred to the other industry. So the firms cannot move to a different industry without incurring high initial costs. There are, therefore, barriers to entry even in a competitive economy like that described by Kojima. We consider in the following section that both technological superiority and specificity of capital conditions explain this unique direction of North-South FDI in a competitive world. The set of absolute profit rates found in (12) leads to a one direction FDI. The industry specificity of capital, technology and managerial skills explains why firms in industry 1 in the developed country would invest in industry 1 in the developing country instead of moving into domestic industry 2 in which the developed country has comparative advantage and where there is a high or rising profit rate.

### 2.4.2.1 Conditions for North-South FDI

We focus now on the conditions for North-South FDI originating from the comparatively disadvantaged industry in the developed country and going to the comparatively advantaged industry (the same industry) in the host developing country in a competitive world. We explain this direction of FDI by the competitive advantage of firms from the developed country which is characterized by superior technology and by the industry- specificity of capital.

### 2.4.2.1.1 Technological superiority

Kojima and Ozawa use the term FDI in a very broad sense to describe the transfer of intangible assets under whole or majority equity ownership, minority ownership, and a variety of non equity contractual arrangements, such as subcontracting, licensing, managerial contracts and turnkey operations and others through which technology and knowledge can be transferred (as meant by Kojima's notion of "capital" movement).

FDI is an important vehicle of TT from developed countries to developing countries. Theoretically, TT by competitive multinationals firms is less studied. Empirically, it has support from FDI in China and other developing countries. Evidence of FDI in industries characterized by "*perfect competition in product markets*" can be easily found. For instance, a large percentage of Hong Kong's FDI in Mainland China's manufacturing sector in the early 1990s was in "*the textile and clothing industries, which can be regarded as industries with perfect competition*" (Cheng *et al.*, 2005, p. 3)<sup>91</sup>.

The existing literature on FDI points out that firms involved in foreign investments abroad have some competitive advantages. A basic tenet of the theory of the MNFs is that such firms rely heavily on intangible assets, such as superior technology and brand names to offset the disadvantages of operating abroad as well as to successfully compete with local firms that are better familiar with the host country environment (see Saggi, 2002). Superior technology is identified as typical advantage of a MNF. The notion that FDI entails the transfer of not only physical capital but also firm/industry specific technologies and knowhow is exemplified in a number of recent articles (Takarada, 2006; Egger and Pfaffermayr, 2001; Gilbert and Oladi, 2009; Thompson, 1997). Possession of competitive advantages, which take form of technological superiority, is the condition sine qua non for a firm to be engaged in activities abroad<sup>92</sup>. Firms are typically assumed to possess superior technology (technical advantage and blueprint) that allows them to overcome the operational advantages of host country firms. (Liu and Wang, 2002; Dunning, 1988).

A firm becomes multinational if it has competitive advantage. In fact, to offset some obvious disadvantages of production abroad and to compete successfully in the developed country market, a firm originating from the developing country should have a competitive advantage over its northern competitors. Given that the developed country in our model has absolute advantage in the production technology of both goods, developing country's backward technology cannot be transferred to the developed country. In addition, the

<sup>&</sup>lt;sup>91</sup> See also Thompson (2002, 2003).

<sup>&</sup>lt;sup>92</sup> The reason for Ricardo's failure was probably because he had no chance to study overseas investments in his day (which did not exist much) and that this investment would entail high psychological and transactional costs. Hence, capital remains at home. In any event, Ricardo failed to see the possibility that Portuguese entrepreneurs with superior technology and prospects for a higher profit would transplant their cloth manufacturing (comparatively disadvantaged) onto England--so long as the Portuguese technological advantage was sufficiently large enough to overcome the transactional costs of overseas investment., In this case, "the capital and labour of England" does not need to be removed to Portugal (Ozawa, 1992, 2008).

production of good 2 in the developed country using southern backward technology will be costly which does not allow access to good 2 market. Since they lack this competitive advantage (technological superiority), Southern firms cannot invest in the developed country<sup>93</sup>. We consider that there is no South-North FDI originating from industry 2 (comparative disadvantage) in the developing country and going to the same industry (comparative advantage) in the host developed country despite the attractiveness of absolute profit rate.

International organisations consider FDI as the best channel for TT across national boundaries (UNCTAD, 2003). FDI has been recognized as vehicle of transferring not only physical capital<sup>94</sup>, but also intangible assets as advanced technology or better management skills and expertise (see Caves, 1971, 1996; Egger and Pfaffermayr, 2001; Markusen, 1995). When firms from developed country invest in host developing countries, they bring with them advanced technology which makes up their competitive advantage. The main role of FDI is to transfer superior production technology from the advanced industrial country to lesser-developed countries, or in brief, it is the transfer of superior production functions, which replace inferior ones in the host country. The FDI is to be a starter and a tutor of industrialization in less developed countries (Kojima, 1973). Markusen and Venables (1999) argue that FDI is a "*catalyst of industrial development*" in the developing countries. Technology and management used in the developed country are assumed to be superior to those in the developing country before FDI takes place<sup>95</sup>. FDI makes it possible for the host developing country to use superior technology and management (see Lispey, 2004 for a survey). Following the above arguments, we can add the condition below

$$a_1^* \le a_1' \le a_1 \tag{13}$$

<sup>&</sup>lt;sup>93</sup> Lack of technical advantage will remain a long-term factor restricting southern country's development of MNFs.

<sup>&</sup>lt;sup>94</sup> The international movement of money capital is not the main concern in FDI. Some part of the necessary money capital can be borrowed in the host country and a large part of capital is transferred from the developed country in the form of capital goods such as technical knowledge, machines and equipment, which embody technology. Following Kojima (1977b), it is assumed that endowment of capital is not affected significantly because the amount of capital involved is marginal compared to total capital stock both in the investing and in the receiving country. Thus, both a decreased money capital in the investing country and an increased one in the host country can be regarded as marginal and neglected in our theoretical model.

<sup>&</sup>lt;sup>95</sup> Kojima (1978) insists on the success of the transplantation of an industry in which the investor country is comparatively disadvantaged, but in which the host developing country, if it were assisted, can develop and strengthen a comparative advantage.

where «  $a_1'$  » is the advanced technology in producing good 1 transferred to the developing country<sup>96</sup>. Since the foreign investors have the opportunity to invest in the developing country according to profit rate differential, they employ a local labour force, but they use their own technology in producing good 1.

## 2.4.2.1.2 Industry-specificity of capital

Thompson (1997) and Goldberg and Klein (2001) argue that domestic and foreign capitals are completely industry specific. The industry-specificity of foreign capital reflects the prevalent view that direct investment typically involves some active management of an asset<sup>97</sup>. The direct management of foreign investment requires some industry-specific knowledge and particular expertise. Some capital employed in a particular industry is difficult to use in other industries because its properties are specific to that industry (Takarada, 2006; Onaran and Stockhammer, 2008; Choi, 2001; Gilbert and Oladi, 2009).

The theories of FDI emphasize the importance of technology as a firm-industry or country-specific advantage that is exploited abroad (Dunning, 1988). We draw on the idea of that capital is mobile internationally but sector specific given its specialised form. "The question 'Does capital move more easily between industries within a country or between countries within an industry?' is important for the field of international trade theory"<sup>98</sup>. It has been recognized that the multinational capital, while industry- specific within each nation, is nevertheless mobile between the same sectors in different nations. Caves (1971, 1996) pointed out that foreign investment involves the transfer of a bundle of sector- specific assets, technology and equipment, managerial know-how, marketing techniques from one production facility to another abroad. He argues that direct investment is associated with firm-specific capital and thus investment moved from an industry in the investing country to the same industry in the host country. Capital should be seen as a composite factor embodying managerial and technical skills as well as more tangible factors of production. Caves points out that this composite factor is not easily transferable between different sectors within a given country, but may be much easier between countries within the same sector. Mussa (1974), Mayer (1974), Amano (1977), Batra and Ramachnaran (1980) and Falvey (1979) give

<sup>&</sup>lt;sup>96</sup> We can speak about industry-specific technology as used, for example, for labour intensive activities.

<sup>&</sup>lt;sup>97</sup> Xing (2007) argues that Intra-firm trade between parent firms and their foreign affiliates usually fall into same industry categories because of specific capital and technology available in both parent firms and their foreign affiliates.

<sup>&</sup>lt;sup>98</sup> Reitzes and Rousslang (1988, p.312).

support to Caves's argument and tackle the specificity of some factors and technology. They consider this specificity one of the main characteristics of international investments by multinational firms and view FDI as inter country flows of industry specific capital<sup>99</sup>.

We draw on the core argument that the northern firms in the comparatively disadvantaged industry, by investing in the same industry (comparative advantage) in the developing country, avoids the loss of intangible capital. In fact, if the firm were to enter an other industry, its industry-specific intangible capital would have completely depreciated with the consequent loss of the rent from this capital. This loss is the cost that the firm can avoid by investing abroad in the same industry. By investing in the same industry, "the firm was internalizing the market and avoiding the loss of wealth" (Lee, 1984, p. 719). Lee and Ogawa (1995) in their empirical paper argued that the industry-specificity of some of the capital that the firm possesses in the developed country explains the direct investment in the developing country's comparatively advantaged industry instead of moving to the developed country's comparatively advantaged industry. If a firm in a comparatively disadvantaged industry decides to invest abroad, it can produce and market the same product using its present industry-and firm-specific intangible capital and some industry-specific tangible capital transferred from the home country. The industry-specificity of capital explains why firms in the comparatively disadvantaged industry choose investing abroad (the inter-country intraindustry movement of intangible as well as tangible capital) rather than moving into another domestic industry (the intra-country inter-industry movement). Lee and Ogawa (1995) test their predictions on Japan and find that OFDI from comparatively disadvantaged industry is explained by industry-specificity of capital.

Kojima (1973) argues that FDI is undertaken by a firm originating from a specific industry in the investing country and strengthens that specific activity in the host country. Which industry is affected in the investing and host countries is specific and definite<sup>100</sup>. Ozawa (1979a) argues that when an internal structural adjustment is required to exploit comparative advantage in the developed country (the case of Japan), essentially two types of economic resources are released from the comparatively disadvantaged industry: one is non-sector specific, and the other is specific to the comparatively disadvantaged industry. Most

<sup>&</sup>lt;sup>99</sup> See Thompson (1992, 1993, 1997) for more details on the industry-specificity of capital and management.

<sup>&</sup>lt;sup>100</sup> In this point, FDI differs from international money capital movement in which money capital as general, homogenous factor of production is reallocated in a general equilibrium fashion, instead of a specific way.

resources of the first type (such as labour and industrial sites) are, however, non-transferable to the developing country because of institutional or physical constraints. On the other hand, the second type of resources released would be unemployed in the developed country. When they are transferred to a developing country, such resources are used to reinforce comparatively advantaged industries. As Ozawa expressed it, the "push" for OFDI from developed country (Japan) has come from "industry cycles" rather than product cycles. It is easier for firms originating from the comparatively disadvantaged industries to relocate in the developing countries than to go into new product lines.

The general notion that capital is immobile between sectors but increasingly mobile between economies has considerable empirical support (see Caves, 1971; Magee, 1980; Grossman and Levisohn, 1989; Reitzes and Rousslang, 1988)<sup>101</sup>. In our Ricardian setting, we consider that specific capital does not move across sectors. We advance the argument of intercountry intra-industry mobility of industry-specific capital coupled with technological superiority to explain the direction of FDI from industry 1 in the developed country (comparative disadvantage) to industry 1 in the developing country (comparative advantage).

## 2.4.2.2 The reformulated correspondence principle and the technology-trade-welfare link

Following, our theoretical framework, the divergence in absolute profit rates generates north –South FDI from the developed country's comparatively disadvantaged industry to the developing country's comparatively advantaged industry. Specific technology and capital transmitted via FDI enlarge production capacities of host developing countries. According to Kojima (2000), the most important characteristic of trade oriented (pro-trade) FDI is that this investment is undertaken from an investing country's comparatively disadvantaged industry. Thus, foreign production in the developing country increases its stronger comparative advantage because of appropriate capital goods and TT. FDI thus augments comparative advantage which results in an expanded basis for trade.

<sup>&</sup>lt;sup>101</sup> Reitzes and Rousslang (1988) developed and applied an empirical test to determine whether capital of US multinational corporations is more domestically or internationally mobile. The test was applied using cross –section data on rate of return to capital of US multinational corporations in 1966. They found that international capital mobility within industries was greater than domestic capital mobility across industries.

### 2.4.2.2.1 Closing the model

In order to investigate the consequences of FDI on the North-South welfare, we use a simple demand structure (see Ruffin and Jones, 2007). We assume that the preferences of all consumers in each country are described by a simple Cobb-Douglas utility function, identical between both countries, with identical expenditure shares on each good

$$U(c_1, c_2) = c_1 c_2 \tag{14}$$

Where  $c_1$  and  $c_2$  are the consumption of good 1 and good 2, respectively.

We consider "y" as a country's gross national product measured in good 1 and p is the relative price of good 2. The country's welfare "B" (indirect utility) is given by

$$B = \frac{y^2}{4p} \tag{15}$$

We consider the price structure  $p_2^* . The developing country exports the good 1 and$ the developed country exports the good 2. For simplicity, we consider the case of completespecialisation. We compare the case of complete specialisation without FDI and the case ofcomplete specialisation with FDI. Capital in the first industry may be considered as marginalcompared to capital in the second industry in the developed country. It is assumed that eventhe capital released from the first industry is wasted during the process of the specialisationand internal adjustment, capital endowment in the developed country is not affectedsignificantly.

## 2.4.2.2.2 The Reformulated correspondence principle and the welfare analysis

We recall that the developed country has an absolute advantage in the production technology of both goods, but has a comparative advantage in the production of good 2, which it exports to the developing country in exchange for good 1. We focus now on the comparison of free trade equilibrium with the equilibrium in which the developed country invests in the first industry in the developing country.

The technology transfer via FDI reduces the developing country's labour input coefficient in good 1 production. Thus, FDI strengthens comparative advantage and allows greater production of good 1- the export good of the developing country.

$$y' = \frac{L}{a_1'}$$

where "y'" is the developing country's output after receiving FDI. In this point, concerns over the impact of the introduction of new technology with new machinery on the demand for labour in developing country are expressed<sup>102</sup>. Ricardo ([1817] 1951) argues that a temporal decline and subsequent recovery of the demand for labour after the introduction of machinery will occur<sup>103</sup>. Ricardo states that the introduction of machinery will temporarily decrease the demand for labour. However, as capital accumulates, the demand for labour will recover to its previous level and the working population will not be redundant in the long run. Ricardo therefore assumed complementarity between machinery and labour under the new technology. Uchiyama (2000) shows that Ricardo's above argument can hold.

We recall that differences in unit labour requirements induce comparative advantages between countries in the Ricardian model of international trade. Within this classical model, an increase in labour productivity will cause export expansion (Beladi et al., 1997; Samuelson, 2004). The exports of the developing country in the case of complete specialisation and without FDI are given by  $x = L/2.a_1$ . After the reception of the advanced technology " $a_1$ ' », the developing country's exports of good 1 become

$$x' = \frac{L}{2a_1'} \tag{16}$$

For the developed country, the exports of good 2 in the case of complete specialisation with and without FDI remain unchanged

$$x^* = x^{*'} = \frac{L^*}{2a_2^*} \tag{16*}$$

The developed country is dependant on foreign supply of the good 2 so that the direct investment encourages more production in the developing country which must improve the terms of trade for the developed country. Increased income in developing country spills over in part to greater demand for the developed country exportable. The international relative

<sup>&</sup>lt;sup>102</sup>Here, like Lee (1984), we note that new machinery in point of view of the developing country is, in fact, second-hand machinery. <sup>103</sup> See chapter 31 "On Machinery" in the third edition of Ricardo's *Principles* ([1817] 1951).

price of good 2 increases and therefore the terms of trade and the welfare of the developed country improve. Even if the developed country receives no revenue from this investment, it benefits from the improvement in its terms of trade.

If we consider the case of complete specialisation without FDI, the developed country's income measured in terms of good 1 and welfare are given respectively by

$$y^{*} = \frac{L^{*}}{a_{2}^{*}}p$$
$$B^{*} = \frac{y^{*2}}{4p} = \frac{1}{4}\left(\frac{L^{*}}{a_{2}^{*}}\right)^{2}p$$

After outward direct investment from its comparatively disadvantaged industry, the developed country's income (without receiving quasi-rents) and welfare become

$$y^{*} = \frac{L^{*}}{a_{2}^{*}} p'$$

$$B^{*'} = \frac{y^{*'2}}{4p'} = \frac{1}{4} \left(\frac{L^{*}}{a_{2}^{*}}\right)^{2} p'$$
(17)

with p' > p, we obtain  $B^{*'} > B^*$ . Clearly, the developed country gains from its direct investment in the developing country's comparatively advantaged industry. On the other hand, the developing country will gain if  $B' = \frac{y'}{4p'} > B = \frac{y^2}{4p}$ . Otherwise, if we consider the transfer of profit to foreigners in the trade balance, FDI may hurt the welfare of the developing country.

## 2.5 Conclusion

In section 1 of this chapter, we review the Ricardian trade approaches to capital mobility, FDI and MNF. The Ricardian trade model which highlights international differences in technologies as a basis of international trade provides a relevant framework to explain the role of technology in international trade, capital mobility, FDI and the activities of MNFs. Several studies show that complementary relationship between FDI and trade follows a Ricardian form by including allowances for differences in technologies across countries. This complementarity between trade and capital mobility explains the enormous expansion of both international trade and capital mobility and FDI. Because it takes cross-country technology differences as the basis of trade, the Ricardian trade thinking is well suited to study the effects of technology changes. We provide a synthesis which states that Ricardian trade approach is appropriate for these issues and once again reveals its usefulness.

In our next step, we develop a theoretical model to determine the relationships between a country's comparative advantage and its OFDI and the international division of labour between investing developed and host developing countries in a competitive world. Using a two-country, two-good Ricardian trade model, we reformulate Kojima's correspondence principle and we explain the emergence of North-South FDI. We consider the case in which the developed country has an absolute advantage in the production technology of each good. It has comparative advantage in producing one good, which it exports to the developing country and imports the good in which it has comparative disadvantage. The analysis indicates that the emergence of world market prices generates differences in the absolute profit rates between industries having a comparative advantage and disadvantage. This divergence in absolute profit rates entails a direct investment from the developed country's disadvantaged industry to the developing country's comparatively advantaged industry. Thus, following our reformulated version of Kojima's correspondence principle, FDI originating from the comparatively disadvantaged industry in the developed country and going to the comparatively advantaged industry in the developing country should follow the direction of absolute profit rate which is a reflection of the comparative advantage.

## Second part

## THE EFFECT OF TECHNOLOGICAL INFLOWS ON WELFARE, TERMS OF TRADE AND EXPORT SOPHISTICATION OF THE DEVELOPING COUNTRIES:

NEW RICARDIAN PREDICTIONS AND EVIDENCE

The second part of our thesis points out the effects of the technological inflows via FDI on the receiving developing countries. In this part, we develop new Ricardian approaches with an empirical follow-up on the predictions. In chapter 3, we focus on the welfare effect of the North-South TT and the mode of transfer. We build a two-good, two-country Ricardian trade model in which the developed country transfers its superior technology to the developing country's comparatively advantaged industry. We study the welfare effect of such TT. We single out the respective role of the relative size of both countries, the efficiency of the technology transferred and the elasticity of substitution between the goods which are produced.

To discuss the effect of the mode of TT, we reconsider the technology transfer à *la* Kojima –Ozawa from a developed country's comparatively disadvantaged industry and going to a developing country's comparatively advantaged industry. We explore the consequences of free TT, licensing and FDI on the North-South welfare in a two-good, two-country Ricardian model. We also provide an econometric application on the effects of FDI and licensing on the terms of trade of the developing and emerging countries.

In chapter 4, we put back Ricardian technological intensity of export at the forefront of the analysis and study the determinants of the evolution of the sophistication level of a country's exports by extending HHR (2007)'s work. We adapt HHR's measure used in an economic growth framework to an international trade and FDI framework. Using data from developing and emerging countries, we test the core theoretical prediction that foreign involvement facilitates technological progress and upgrades the export sophistication. In our next step, we provide a new empirical analysis on the effect of the export sophistication on the terms of trade of the developing and emerging countries.

## **Chapter 3**

## **Technology transfer and North-South trade:** A theoretical and empirical assessment <sup>104</sup>

#### 3.1 Introduction

The objective of this chapter is to provide an understanding of technology and its transfer and to give new predictions on the welfare effect of such transfer. The forms which technology takes vary from the disembodied (patents, licenses) to those embodied in machines or persons (tacit knowledge) (see Enos, 1989, Enos et al., 1997). Forms of TT also vary as different forms of technology can be transferred via different channels (such as FDI, licensing)<sup>105</sup>.

Our understanding of technology and technological change defines how we view the TT process. We can define technological change in many ways. Products, processes and managerial methods embody technology, but how we understand this technology remains an important problem for economic theory. Embodied in a product or process, technology makes up a blueprint, or collection of information, that is easily available to the producer and consumer. This view of technology is readily apparent in the growth model developed by Solow (1957). In this model, technology is information and technique that are easily reproducible and transferable. Nevertheless, technology can also include knowledge about specific applications that is not easily reproducible or transferable. Mowery and Rosenberg (1989) and Pavitt (1985) point out that technical "knowledge" is tacit and cumulative within individual firms. In this context, technology is part of an individual firm's intangibles specific assets.

<sup>&</sup>lt;sup>104</sup> The first section of this chapter is based on a paper entitled "International technology transfer to developing countries: when is it immiserizing?" (in revision in Revue d'économie politique, according to positive comments from the referees) cowritten with Dominique Redor. I thank Dominique Redor for his substantial contribution and help in this section. <sup>105</sup> This multiplicity of forms in which technology is embodied and transferred causes limitations for quantifying it and for

studying its effects.

Technology can be considered as patentable blueprints, plans, mechanisms, formulae that can improve economic efficiency (Enos, 1989; Enos *et al.*, 1997). It includes possibly patentable aspects of production<sup>106</sup>, and other less tangible factors, such as organizational, marketing and other managerial knowledge and skills that potentially can spill over not just into a specific sector but more broadly as positive externalities into an economy as a whole (Thompson, 2002).

The remainder of this chapter is as follows. In section 3.2, we build a two-good, twocountry Ricardian trade model in which the developed country transfers its superior technology to the developing country's comparatively advantaged industry. We study the welfare effect of such TT. We single out the respective role of the relative size of both countries, the efficiency of the technology transferred and the elasticity of substitution between the goods which are produced. In section 3.3, we examine the consequences of free TT, licensing and FDI on the North-South welfare using a Ricardian setting. In our next step, we provide an empirical application on the effect of FDI and licensing on the terms of trade of the developing countries.

# 3.2 Technology transfer, consumer preferences and welfare in a Ricardian model

Can technology transferred from a developed to a developing country deteriorate the terms of trade, and furthermore the welfare of the latter? To answer this question we build a two-good, two-country Ricardian model in which the developed country transfers its superior technology to the industry where the developing country has a comparative advantage.

## **3.2.1** The structure of consumer preferences and the terms of trade in the Ricardian model

The effects of trade and TT from developed to developing countries have been at the center of the debates about globalization. The theoretical approach to this question has commonly used the Ricardian setting to formalize trade, technological change and its impact on the welfare of the trading countries, even if it is characterized "*by a huge simplification*"

<sup>&</sup>lt;sup>106</sup> Like the specifications of goods and the mechanistic details of their manufacture.

(Jones, 2008a). Our objective is to study the role of consumer preferences in the welfare effect of TT in a Ricardian trade model.

## 3.2.1.1 Immiserizing specialization of developing countries

Beladi et al. (1997) refer to Bhagwati's (1958) seminal research<sup>107</sup>, to analyze the situation, where the developed country transfers the technology of an industry where it has a comparative disadvantage into the same industry where the developing country has a comparative advantage. They conclude that in this case "immiserizing growth" may hurt the developing country's welfare. Ruffin and Jones (2007, p. 212) also study geometrically the same case of immiserizing growth and conclude that "sufficiently low elasticities coupled with a large value for the developing country import propensity could result in a drop of its real income". In a somewhat different context, since technological progress is not imported but is "exogenously" introduced in the comparatively advantaged industry of the less developed country (namely China), Samuelson (2004, p.140) states that: "self-immiseration is a wellknown phenomenon in the economic literature, and it does crop up in the debate over globalization". The case where a developed country transfers the technology of the industry where it has a comparative advantage to a less developed country has been formalized and analyzed in depth by Ruffin and Jones (2007) and Jones and Ruffin (2008). The two authors disclose a "technology transfer paradox". They show, in a two-country Ricardian model, that even in the situation where the specialization of the developed country is reversed, its welfare may increase following the TT to the developing country.

Strangely enough, immiserizing growth which originates in the technology that a developing country receives in its comparatively advantaged industry has never been modelled in depth. However, to our opinion, there are important arguments in favour of carrying out such research. From an empirical point of view, developed countries transfer more easily and voluntarily the technology of an industry for which they have a comparative disadvantage than the opposite. In addition, the reversal of comparative advantages which is formalized by Jones and Ruffin (2008) is of a great theoretical interest, but the conditions of such a transfer seem to be hardly met in practice. We can think for example of an advanced

<sup>&</sup>lt;sup>107</sup> Bhagwati (1958) studies the impact of an increase in the output of the comparatively advantaged industry in the developing country with no reference to international TT.

country which would give up its aeronautic industry transferred to a less developed country and would restart its textile or clothing industry.

## **3.2.1.2** Introducing technology transfer in the Ricardian model with CES utility function

We distinguish a developed country (noted by \*) and a developing country, two goods 1 and 2. Labour is the only factor of production in each country. The supply of labor in the developed country and the developing country is fixed at L\* and L, respectively. Labour is fully employed in each country, and is internationally immobile. Goods are freely traded in the absence of any transportation costs. The developing country's production technology for good 1 and good 2 is described by two unit labour requirements  $a_1$  and  $a_2$ , respectively. Similarly, the developed country's unit labor requirements are given by  $a_1^*$  and  $a_2^*$ .

Given our interest in analyzing TT from a technologically advanced country to a technologically backward country, we shall focus on the case in which the developed country has an absolute advantage in the production technology of both goods (thus, we consider the case  $a_1 > a_1^*$  and  $a_2 > a_2^*$ )<sup>108</sup>. We focus on the case considered by Beladi, Jones and Marjit (1997) (without theoretical model), in which the technologically advanced country passes on its superior technology for producing what at home would be an import-competing good (produced in the developed country only in autarky). The developed country was entirely dependent on the developing country supply of the import good in the initial trading equilibrium, so that TT increases the developing country's production, which must improve the terms of trade for the developed country.

Sharing the view of Kojima and Ozawa (1984) and Kojima (1977a), we consider that the developing country's absorptive (or learning) capacity is not high enough to enable the technology transfer to the industry producing good 2. Here it is assumed that the smaller the technological difference (gap) between the source (North) and the receiving country (South) industries is, the easier it is to transfer and improve the technology in the latter. This justifies that technology is transferred from the developed country to the developing country in industry 1 and not in industry 2. The technology transferred to the developing country'

<sup>&</sup>lt;sup>108</sup> See Beladi et al. (1997), Ruffin and Jones (2007) and Samuelson (2004)

comparatively advantaged industry is superior to the one prevailing in the host industry, though it may be a standardized knowledge in the technologically advanced country. (Kojima, 2000; Ozawa, 2007; Benvignati, 1983; Thompson, 2000, 2002).

Kojima (1977a, p.5, 9-10), by focusing on Japanese TT to the developing countries, stated that:

"technology transfer to developing countries can be theoretically described as an orderly transfer of technology which begins in those industries where the technological gap between providing and receiving countries or firms is smallest and, accordingly, the transfer of technology is easier and its spread effects larger.

"When the transfer of technology in which the technological gap is smallest among all other industries between the two countries, this is called the "orderly transfer of technology".

It is expected that the orderly transfer of technology is much easier than the other type, resulting in faster improvement in productivity and greater spill over effects. That the technological gap is smallest means that there exists already in the recipient, developing economy some, though inefficient, competitive firms and some, though inferior, technological foundation. The transferred technology is easily learned, absorbed, diffused and even improved so as to suit better local conditions; labourers and managers are trained and local competitive firms are established. To realize these spread effects is the essence of the transfer of technology".

Ozawa (2005, p.9) added that "the smaller the technological gap, the greater a catching-up nation's capability of absorbing technology and skills (both technical and organizational)". Keller and Yeaple (2009), Keller (2010) and Lu (2005) add that the technology for complex goods (good 2, in our model) is difficult to transfer (via MNF) to the receiving developing countries.

We suppose that the developing country has a comparative advantage in the production of good 1 and the developed country in the production of good 2. The price of each good is respectively  $p_1$  and  $p_2$ . We consider good 1 as numeraire. So the terms of trade are:  $p = p_2 / p_1$ .

It is necessary to take a particular form for consumer utility in order to evaluate the welfare changes.In order to investigate the consequences of free trade and TT on both countries' welfare, we use a CES utility function which represents the consumers' preferences. The condition of equilibrium of the trade balance gives (Appendix A.I) the terms of trade between the two goods in the case of full specialization of each country:

$$p = \left(\frac{L}{a_1} \frac{a_2^*}{L^*}\right)^{1+\rho} \qquad \qquad \rho > -1 \tag{1}$$

where  $\rho$  is the parameter of the CES utility function, and  $: \sigma = \frac{1}{1+\rho}$ , is the elasticity of substitution  $\sigma$  between the two goods.

If the developing country is relatively big compared with the developed  $\operatorname{country}(L > L^* a_1 / a_2^*)$ , for a given level of the labour coefficients, p increases with  $\rho$ , that is when the elasticity of substitution between the two goods diminishes. This is an adverse evolution for the developing country.

In the Ricardian trade model, technology is captured by the set of labour coefficients per unit of output of each commodity (Beladi *et al.*, 1997; Ruffin and Jones, 2007). So, following the TT, the labour coefficient in the industry 1 of the developing country is reduced  $(a_1^*$  replaces  $a_1$ ). In the rest of our paper, a prime (') refers to the variables after TT.

Taking into account (1), we obtain:

$$\frac{p'}{p} = \left(\frac{a_1}{a_1^*}\right)^{1+\rho} > 1 \quad \text{with} \qquad \rho > -1 \tag{2}$$

These relative terms are an exponential function of  $\rho$ , they increase when the elasticity of substitution between the two goods decreases. Indeed, in that case, good 1, whose production increases, does not compete with good 2 on the international market. Thus, the deterioration of the terms of trade for the developing country increases with the efficiency of the technology which is transferred, and when the elasticity of substitution between the two goods diminishes.

Each country's welfare is modeled by the consumers' utility function (Samuelson, 2004, p 138-140). Thus to study the evolution of the welfare of each country we must formalize U as a function of y and p (Appendix A.I). Taking into account, under free trade, the welfare before ( $B^*$ ) and after ( $B^{**}$ ) the TT, the developed country always gains (equation 8A in Appendix A.I). Indeed, this result is straightforward since the developed country has the same production as before the transfer, and the terms of trade of good 2 improve unambiguously.

The situation of the developing country is more complex to study. Indeed, compared with free trade before the TT, its production of good 1 increases with labour productivity, but its terms of trade deteriorate. Equation (3) applies to full as well as to partial specialization of the developing country. For  $\rho > 0$ , the first factor is higher than 1, and the second lower than 1.

$$\frac{B'}{B} = \frac{a_1}{a_1^*} \left( \frac{1+p^{\frac{\rho}{1+\rho}}}{1+p^{\frac{\rho}{1+\rho}}} \right)^{\frac{\rho+1}{\rho}}$$
(3)

Our objective is to study the evolution of the different effects on the developing country's welfare: the increase in the production due to TT (first factor in equation 3), the deterioration of the terms of trade for the developing country (second factor) when the elasticity of substitution varies. But we must also take into account that, following the TT, this deterioration may be limited by the possible partial specialization of the developing country in commodity 2.

## **3.2.2** Technology transfer, specialization and developing country's welfare

## 3.2.2.1 A two-good setting

If the developing country's welfare is formalized by a Cobb Douglas function ( $\sigma = 1$ ), it always gains from the TT regardless of its relative size and its specialization pattern. When the elasticity of substitution is higher than 1, and when  $\rho$  decreases (between 0 and -1), the developing country's welfare (equation 3) increases compared with free trade on this interval of variation of  $\rho$ . For example, when it tends to -1 (the elasticity of substitution tends to infinity), the terms of trade do not change compared with free trade (equation 2) and the developing country reaps all the benefits of the transfer.

From now on we must study the evolution of the developing country's welfare when the elasticity of substitution between the two commodities is low (with  $\sigma$  varying between 1 to 0, that is to say with  $\rho$  varying between 0 and infinity), which is supposed to correspond to immiserizing growth.

If we start the analysis considering that the elasticity of substitution between the two goods is very low ( $\sigma$  tends to 0), our model shows that the developing country is not completely specialized in the production of commodity 1 and that when the terms of trade deteriorate, then it shifts to partial specialization (the production of commodity 2). Thus, it can be proved that when the elasticity of substitution between the two goods is very low, the developing country's welfare never decreases whatever its size (see Appendix A.II).

Does this mean that the developing country can never lose from the TT? The answer is no, since, when the elasticity of substitution varies between 1 and 0, there are certain conditions where the shift to partial specialization does not prevent the fall in the developing country's welfare.

We call the critical point<sup>109</sup>, the point where the developing country shifts from complete specialization to partial specialization which also corresponds to its minimum welfare (compared with free trade before TT) and to the 'critical relative size' of the two countries. For a given value of  $\rho > 0$ , that is to say an elasticity of substitution inferior to 1, the developing country's welfare is a decreasing function of its relative size if it is completely specialized in the production of good  $1^{110}$ . However, when L/L\* increases above the critical size, the developing country shifts to partial specialization and the terms of trade no longer deteriorate for the developing country after TT. Before TT, it continues to deteriorate since under free trade the shift to partial specialization takes place for a superior relative size of the developing country. So, for a given value of the elasticity of substitution (inferior to 1), there is one critical point (an empirical example is studied hereafter for  $\sigma = 0.5$ ).

The above definition of the critical point yields the following expression (4): this is the point where the price, which corresponds to complete specialization of the developing country on the one hand, and the price corresponding to partial specialization of this country on the other hand are equal after the TT:

$$p' = \frac{a_2}{a_1^*} = \left(\frac{L}{a_1^*} \frac{a_2^*}{L^*}\right)^{1+\rho}$$
(4)

 <sup>&</sup>lt;sup>109</sup> This corresponds to the « turning point », according to Jones and Ruffin's (2008) terminology.
 <sup>110</sup> See equation A10 in Appendix A.I.

So the critical relative size is :

$$\left(\frac{L}{L^*}\right) = \frac{a_1^*}{a_2^*} \left(\frac{a_2}{a_1}\right)^{\frac{1}{1+\rho}} = \frac{\left(a_1^*\right)^{\frac{\rho}{1+\rho}}}{a_2^*} (a_2)^{\frac{1}{1+\rho}}$$
(5)

For a given  $\rho > 0$ , L/L\* is an increasing function of  $\frac{(a_2)^{\frac{1}{1+\rho}}}{a_2^*}$  that is to say, of the ratio

of the relative efficiency of the technology in industry 2. If this ratio is high (the developing country uses an inefficient technology in industry 2 compared to the developed country), it will shift to partial specialization only if it is big enough, relative to the developed country (equation 5). That is to say, it may lose from the TT if it is inferior to the critical size (see hereafter the case where  $\sigma = 0.5$ ).

The critical point and hence the developing country's welfare depends fundamentally on the relative efficiency of its technology in the industry where it has a comparative disadvantage. So it is interesting to single out at what value of this parameter this welfare may decrease.

Taking into account (3), (4) and (5), with  $\rho > 0$ , the developing country's welfare decreases if :

$$\begin{pmatrix} a_{2}^{\frac{\rho}{1+\rho}} \end{pmatrix} > \frac{1 - \left[\frac{a_{1}^{*}}{a_{1}}\right]^{\frac{\rho}{\rho+1}}}{\left[\frac{1}{a_{1}}\right]^{\frac{\rho}{\rho+1}} - \left[\frac{a_{1}^{*\frac{\rho}{1+\rho}}}{a_{1}}\right]^{\rho}}$$
(6)

If (6) is satisfied, the technology in the industry where the developing country has a comparative disadvantage is backward. When it shifts to partial specialization, it is already in a situation of decreasing welfare due to the TT in the industry where it has a comparative advantage.
To discuss the possibility of immiserizing specialization more empirically, we introduce hereafter numerical examples. For that purpose, we use some of the parameters drawn from Samuelson's (2004) well-known article on globalization, namely  $a_1 = 5$   $a_2 = 20$ ,  $a_1^* = 2$ ,  $a_2^* = 0.5$ . For this first simulation we consider that  $a_2$  is not fixed, we compute its value at the critical point and for B'/B=1.

Using equations (5) and (6) the results of our simulations are given in Table 3.1. This table confirms that if the elasticity of substitution between both goods is close to 1 or to zero, the developing country's welfare never decreases. For intermediate values of the elasticity of substitution this welfare may only decrease after TT if the ratio of the labour coefficient  $a_2$  is more than ten times higher in the developing countries than in the developed country if  $\sigma = 0.5$ , and 5.3 times higher than the developing country if  $\sigma = 0.09$ .

ρ	Elasticity of substitution between goods ( $\sigma$ )	Value of $a_2$ which corresponds to the critical point and for which B'/B=1	Critical relative size of the developing country (L/L*) for B'/B=1
0.1	0.9	Tends to infinity	
1	0.5	$a_2 = 5$ $\frac{a_2}{a_2^*} = 10$	L/L*=6.3
10	0.09	$a_2 = 2.65$ $\frac{a_2}{a_2^*} = 5.3$	L/L*=4.1
Tends to infinity	Tends to zero	Impossible, B'/B always higher than 1.	

Table 3.1. Critical points for different values of the elasticity of substitution between goods

So it is remarkable that immizerizing growth following the TT is limited to a small (but not too small) elasticity of substitution between the two goods, and where the technology used by the developing country in its comparatively disadvantage industry is very inefficient compared with the developed country.

But a last question arises : if the relative size of the developing country is superior to its critical value, does the developing country's welfare (compared with free trade without TT) inescapably declines? The answer is no. We are going to show that the shift to partial specialization is a buffer that, under certain conditions, may protect the developing country against immiserizing growth.

Here again we shall use Samuelson's numerical example. First, we hypothesize a "realistically inelastic rate of substitution" between the two goods (Samuelson, 2004, p.140) that is to say  $\sigma = 0.5$ . In addition, following Samuelson we suppose that:  $\frac{a_2}{a_2^*} = 40$ , that is to say that the developed country's technology is forty times more efficient than in the developing country.

In Figure 3.1 we have represented the evolution of the developing country's welfare before and after TT, when its relative size varies (using equations 3,4,5,6, the demonstration is given in Appendix A-II). On the segment AC the developed country is big compared to the developing country. This is the most favorable situation for the latter since the former is partially specialized before and after the TT, thus the terms of trade do not change. On the segment CD (2<L/L\*<5), the developed country is partially specialized under free trade before the TT, but both countries are completely specialized after the TT. The developing country still gains from the TT compared with free trade before the transfer. Between D and F, both countries are completely specialized before and after the TT. When the relative size of the developing country increases, its terms of trade deteriorate (see Appendix A-II). For  $L/L^*=6.3$  (point E), its welfare does not change after the TT (B/B'=1). Then it declines between E and F. F is the critical point, where  $L/L^*=12.6$ , and its welfare is minimum (B'/B=0.74).

Figure 3.1: Evolution of the developing country's welfare (B'/B) after and before the TT when its relative size compared to the developed country ( $L/L^*$ ) varies (and with a elasticity of substitution between goods of 0.5).



Indeed, for a bigger size, the developing country is partially specialized after the TT and begins to produce commodity 2. Thus, it allocates a part of its labour from industry 1 to industry 2, and the terms of trade do not deteriorate any longer. Its welfare improves compared with free trade before TT since in the latter case, this country is still fully specialized in the production of good 1 and its terms of trade continue to deteriorate (segment FH). Then (on segment HI with  $L/L^*>20$ ) when the developing country is partially specialized before and after the TT, its welfare gain is constant (B'/B=1.29).

In this example, with a realistically inelastic consumer utility function, if the ratio of the population of the developing country divided by the developed country's is smaller than 6.3, or bigger than 16.3 the developing country's welfare increases instead of its very poor efficiency in industry 2.

In Figure 3.1, the breaks in the relation between the evolution of the developing country's welfare and its relative size come from the changes in its specialization which are linked with the TT. This is another illustration of a general principle which is summed up by Jones (2008a, p.561) "Although relatively small shocks can harm some countries, larger shocks that serve to alter production pattern may in the end benefit countries who would be harmed if the pattern of production were not disturbed".

#### **3.2.2.1** Extension of the model to n commodities.

We have shown in the previous section, the conditions under which the developing country' specialization after TT is immiserizing. The possibility for the developing country to shift its specialization towards the industry where it has a comparative disadvantage is crucial. This possibility is hampered, and hence the developing country risks losing from the TT if three conditions are simultaneously met (see equations 4, 5, 6).

a. The elasticity of substitution between the two goods is low, but not too low, otherwise the developing country shifts to partial specialization and its welfare never decreases (see Table 3.1).

b. The relative size of the developing country compared to the developed country must not be too big (otherwise, the developing country shifts to partial specialization thus reducing the fall in the terms of trade, equation 5 and Figure 3.1).

c. The technology which is used by the developing country in its comparatively disadvantaged industry is very backward compared with the developed country (equation 6, and Figure 3.1, the ratio between the two labour coefficients is 1 to 40).

How can these conclusions be extended to a model with n goods (n finite)?

The set of comparative advantages can be written as:

$$\frac{a_1}{a_1^*} < \frac{a_2}{a_2^*} < \frac{a_3}{a_3^*} < \dots < \frac{a_k}{a_k^*} < \frac{a_{k+1}}{a_{k+1}^*} \dots < \frac{a_n}{a_n^*}$$
(7)

The developing country has the highest comparative advantage in the production of commodity 1, and the developed country in the production of commodity n. We also suppose that the developed country has an absolute advantage in the production of the n commodities.

Following our previous results (equation 3), the impact of the TT on the developing country's welfare depends on two opposite factors.

a. The increase in production in the industries whose efficiency is improved by the TT.b. The fall in prices in these industries.

To analyse this impact we first consider that before TT, the developing country is completely specialized in the production of the k first goods (and therefore the developed country in the production of commodities k+1 to n) and that the TT concerns all the k commodities produced by the developing country. If there is no change in the specialization of both countries after TT, it means that all the relative prices of the k first goods will drop. This is an adverse evolution which may occur if the substitution between the goods which are produced by both countries is low (Jones, 1979, p. 284-285). However, the above analysis has shown that if the developing country is big enough or (and) its technology to produce commodity k+1 is efficient enough, it will shift to the production of this commodity.

Let's now turn to this case. Then the developed country may still be partially specialized in the production of k+1 or gives it up. In both cases, the developing country transfers a part of its labour force to industry k+1, and the developed country withdraws a part of its labour force from this industry to industries k+2....n. These two opposite movements of factors and hence of the supplies of goods will result in a moderation of the fall of the developing country's prices and in a decrease in the developed country's prices. Like in the two-good model, the transfer of labour force by the developing country to new industries is a buffer which protects it against the adverse evolution of prices.

Let's study a particular situation where the developing country is partially specialized in commodity k before TT, and moves to partial specialization in the production of k+1 after the TT. Before the TT, we have

$$p_k = wa_k = w^* a_k^* \tag{8}$$

and after the TT:

$$p_{k+1} = w' a_{k+1} = w'^* a_{k+1}^*$$

$$\frac{w}{w^*} = \frac{a_k^*}{a_k}$$
(9)

$$\frac{w'}{w'^*} = \frac{a_{k+1}^*}{a_{k+1}} \quad \text{, with } \frac{a_{k+1}^*}{a_k + 1} < \frac{a_k^*}{a_k} \tag{10}$$

where  $w, w^*, w', w'^*$  are respectively the nominal wage in the developing and in the developed country before and after the TT. Thus in this particular case, the developing country's relative wage inevitably decreases, but this decrease is small if  $a_{k+1}$  is close to  $a_{k+1}^*$ , a condition which corresponds to that already obtained above (equation 6, see also Jones and Ruffin, 2008, pp. 325-326).

We consider now another case where the TT concerns only industry 1. This hypothesis is favourable to the thesis of immiserizing growth<sup>111</sup>. Again, the important point is to find out if the developing country will shift from production k to production k+1 (possibly k+2...) following the TT. This will depend on the importance of the reallocation of workers from industry 1 to industry 2..... k+1 and hence of the possibility of substitution between commodity 1 and the goods which are produced by the developing country on the one hand, and also of the possibility of substitution between these goods and those which are produced by the developed country.

If the goods which are produced by the developing country have a low elasticity of substitution with those which are produced by the developed country (but not "too low" see the two-good model) and the comparative advantage of the developed country for the industry k+1 is much higher than for industry k, the developing country may lose from the TT. We find here again the fundamental argument concerning the efficiency of the technology of the developing country in the neighbourhood of the critical point.

<sup>&</sup>lt;sup>111</sup> Indeed if the TT concerns industry k which is close to the critical point, the relative wage decline of the developing country is then very limited, see equations 9 and 10, and Jones and Ruffin (2008, p 325).

## 3.3 Mode of technology transfer and North-South trade and welfare: Revisiting Kojima – Ozawa propositions<sup>112</sup>

Most definitions of the TT do not consider the modes of transfer. Fransman (1986, p.7) defines the international TT as a process "whereby knowledge relating to the transformation of inputs into outputs is acquired by entities within a country (for example, firms, research institutes, etc.) from sources outside that country". UNCTAD (1990) implied the existence of different modes of TT by defining it as "the transfer of systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service and does not extend to the transactions involving the mere sale or lease of goods". Most attention has been devoted to the examination of formal channels of TT, that is, FDI and licensing. These are called formal channels as technology is an explicit object of exchange.

We reconsider the TT à *la Kojima– Ozawa* from a developed (North) country's comparatively disadvantaged industry and going to developing (South) country's comparatively advantaged industry. We study the effects of free TT, TT via licensing and FDI on the North-South welfare in a two-good, two-country Ricardian model. We show that the developed country, which has an absolute advantage based on technologies in both goods, gains by transferring its advanced technology to the developing country's export sector. The developed country benefits from TT regardless of the modes of transfer due to an improvement in its terms of trade. Licensing or FDI allows the North to further extract surplus from the South. However, we cast doubt on Kojima-Ozawa propositions about the mutual welfare gain and we show that while the TT allows the South to improve its comparative advantage and production efficiency, its welfare gain depends on how much it has to pay to the North via licensing or FDI. Our empirical follow-up on the theoretical assessment shows a worsening terms of trade effect of FDI and licensing for the developing countries.

<sup>&</sup>lt;sup>112</sup> We thank Henry Thompson for his helpful comments and suggestions on an earlier version of this section without empirical application presented at the European Economic Finance Society (EEFS) conference in Sofia in June 2007. We thank participants at the Association Française des Sciences Economiques Congres in September 2007. We thank Lionel Fontagné and Thierry Mayer for valuable comments and suggestions and participants at the VII doctoral Meetings in International Trade and International Finance organized by the network "Research in International Economics and Finance – RIEF" at Rennes 1 University. A paper based on this section is submitted.

#### 3.3.1 Kojima and Ozawa macroeconomic approach to FDI and technology transfer

We focus on Kojima–Ozawa macroeconomic approach to FDI called the Japanese school. The authors provide a fundamental criticism of the internalization theory, the eclectic theory and all "other theoretic analyses of FDI is provided by Kojima and Ozawa. In fact they castigate such work for "*its myopic neglect of the macro-global welfare considerations of overseas business operations by individual firms*" (Kojima and Ozawa, 1985, p.135). Their macroeconomic approach to FDI is presented in terms of the Heckscher-Ohlin (H-O) traditional theory of comparative costs. They focus on the comparative advantage augmenting type of FDI- trade oriented or pro trade FDI. The authors use the term FDI in a very broad sense to describe the transfer of intangible assets under whole or majority equity ownership, minority ownership and a variety of non equity contractual arrangements, such as subcontracting, licensing, managerial contracts and turnkey operations and others through which technology and knowledge can be transferred (as meant by Kojima's notion of "capital" movement).

#### 3.3.1.1 Kojima – Ozawa propositions on technology transfer

The model was originally advanced in 1973 and has been modified and extended in a number of subsequent publications. Here, the notion of pro-trade FDI (and that of anti-trade) introduced by Kojima (1975) is quite relevant. Ozawa (1992) and Ozawa and Castello (2001) give a Ricardian conceptual approach to the Kojima-Ozawa macroeconomic model. In its lasted formulation, the Kojima Ozawa position is expressed by two key propositions. One is the classical Ricardian theory of comparative advantage; the second concerns the TT. This analysis is built on - and is an extension of -well-established economics, a position that can be summarized in the following tandem statements:

- Proposition I: countries gain from trade and maximize economic welfare when they export comparatively advantaged goods and import comparatively disadvantaged goods.
- Proposition II: countries gain even more from an expanded basis for trade when technology is transferred through FDI or licensing from the home countries' comparatively disadvantaged industries to the host countries' comparatively advantaged ones (both current and potential) in such a way to improve the efficiency of comparatively advantaged industries in the host countries and to contract comparatively disadvantaged industries. The second proposition indicates an additional mutually

beneficial TT that parallels the mutually gainful type of trade posited in the first proposition.

The Ricardian model assumed different industry specific technologies (i.e., different labour productivities) between the trading countries involved, but again no international transfer of such technology. The second proposition which is based on TT indicates a mutually beneficial type of FDI that parallels the mutually gainful type of trade posited in the first proposition.

Kojima and Ozawa see the Ricardian models of trade as "*incomplete*" in the sense that depending on the nature of knowledge transfers, the benefit of trade can either be enhanced – that is, in model the effect of knowledge transfer on the basis or trade is left unexplored. In the spirit of proposition (II), Ozawa (1992, 2001, 2005, 2007) speaks about Ricardo's error when he (Ricardo) neglected pro-trade FDI<sup>113</sup>. He thinks that Ricardo failed to understand the logic of pro-trade FDI. This investment is an extended application of the comparative advantage theory to investment flows in addition to trade flows.

One implication of Kojima and Ozawa propositions is that pro-trade FDI can be considered as an extended application of the comparative advantage theory to investment flows. The basis for trade will not necessarily be destroyed via knowledge transfers. On the contrary, it will be improved when superior knowledge is transferred from a comparatively disadvantaged industry in a developed country to a comparatively advantaged industry in a developing country. The role of TT via FDI in this model is to change the industrial structures in both home and host countries in a way complementary with trade to maximize the benefits of trade.

<sup>&</sup>lt;sup>113</sup> As is well known to trade theorist, Ricardo explicitly introduced a technology (knowledge) gap into his trade theory, as reflected in the assumption of different levels of labour productivity between England and Portugal and the assumption of no cross-border knowledge transfer. Ricardo considered that knowledge transfers (international factor movements) would destroy the basis for trade and cause a hollowing out in an absolutely disadvantaged country (England in his illustration). According to Ricardo, there will be no basis for trade once cross-border knowledge transfers are admitted: Portugal flourishes, whereas England is hollowed out and languishes. Ricardo considered that international factor movement (including technology) would destroy the basis for trade between countries. Surprisingly therefore, Ricardo failed to think that if, instead of moving to Portugal "*the capital and labour of England employed in making cloth*", the Portuguese secrets (superior knowledge) of higher productivity in cloth were transferred to England [say via FDI or licensing] not only would England be spared the hollowing out but both nations could also prosper even more, since England's comparative advantage in cloth would be improved by such TT. Ricardo failed to recognize this possibility and did not apply to FDI flows the same logic of comparative advantage he used for trade flows (Ozawa, 1992, 2007).

The income growth effect envisaged in the static Ricardian model of trade (which allows no transfer of factors and no structural change) can be summarized as follows:



Growth in income

According to the Ricardian theory, as specialization and reallocation of resources in the comparatively advantaged industries lead to gains from trade, national income rises. However, the country's production possibility schedule remains unchanged because there is neither factor expansion nor technological progress.

Ozawa (1992) states that the latter static model can be transferred into a dynamic structural upgrading model once the role of MNFs as a facilitator of industrial transformation and TT is involved. As outward-looking, export oriented (OL-EO) regime is likely to achieve faster growth and structural upgrading. Ozawa (1992) argues that an OL-EO regime is a necessary condition for FDI facilitated development.

Outward orientation



Comparative augmenting advantage



 $\checkmark$ 

Natural progress of structuring



Super-growth

Trade expansion via FDI

Ozawa points out the role of trade as an engine for economic growth. The basis for trade is expanded by comparative advantage-augmenting FDI which leads to a greater expansion of growth.

*"The Kojima-Ozawa analysis is concerned with global economic welfare. The criterion of welfare maximization is increased volume of trade"* (Strange, 1993, pp. 18). The role of FDI in the model is to transform the industrial structures in both investing and host countries in a way complementary with trade so as to maximize the benefits of trade. This analysis has been criticized by a number of economists as being normative rather than positive - a charge rejected by Kojima and Ozawa. These authors provide a positive theory, but a positive theory of welfare maximization via FDI. They argue that global welfare is

increased where international production helps to restructure industries in line with dynamic comparative advantage (Strange, 1993, pp. 17-19; Kojima and Ozawa, 1985). However, we cast doubt on Koijma-Ozawa's "criterion of welfare maximization" which is an "increased volume of trade" and we think that analysis must take into account that an increase in growth and trade does not necessarily imply an increase in welfare.

In this section, we question whether welfare maximization goes along with an increased volume of trade. We reconsider TT à la Kojima-Ozawa from a developed (North) country's comparatively disadvantaged industry going to a developing (South) country's comparatively advantaged industry<sup>114</sup>. We study if there are "*mutual gains*" from this type of TT compared with free trade without TT. We develop a two-good, North-South Ricardian model to study the welfare effects of various types of TT. Three different modes of TT are considered, which are (1) free TT, (2) TT via licensing and (3) TT via FDI. We argue that the developing country always gains from TT regardless of the modes of TT, even if it receives no royalties and quasi rents, due to an improvement in its terms of trade. The developing country's welfare depends on the mode of TT: The developing country gains in mode  $(1)^{115}$ but may suffer from TT if it takes the mode (2) or (3). Thus, the welfare of the developing country depends on the mode of TT, the specter of welfare loss is present and the "mutual gains" à la Kojima-Ozawa is not evident.

#### 3.3.1.2 Free technology transfer

In specifying the various mechanisms of TT, we include reverse engineering, imitation and different spillovers. Their existence suggests that it is possible to acquire technology freely. Since this mode of TT does not require compensating technology owners, it can be an attractive option for developing economies.

<sup>&</sup>lt;sup>114</sup> Sharing Kojima and Ozawa's view, we consider that the developing country absorptive (or learning) capacity is not high enough to enable the technology transfer to the industry producing good 2.<sup>115</sup>This case depends on the hypothesis, which is made about the demand structure in both countries and relies on the

assumption of the Cobb-Douglas utility function.

We use here a very simple structure that allows us to obtain analytical solutions. The purpose is to focus on the traditional mode of technological transfer through imitation or, more generally, free TT<sup>116</sup>. Technology here is like a public good in that the giver still has its resources and technology. Without loss of generality, we suppose that the developing country has a comparative advantage in producing the good 1

$$a_1 / a_2 < a_1^* / a_2^* \tag{1}$$

We consider the case in which the developed country has an absolute advantage in the production technology of both goods

$$a_1 > a_1^*$$
 and  $a_2 > a_2^*$  (2)

We assume that the preferences of all consumers in each country are described by a simple Cobb-Douglas utility function<sup>117</sup>, identical in both countries

$$U(c_1, c_2) = c_1 c_2$$
(3)

where  $c_1$  and  $c_2$  are the consumptions of good 1 and good 2, respectively. We consider "y" as gross national product measured in term of good 1. We note p the relative price of good 2.

The welfare is given by  $B = \frac{y^2}{4p}$ .

First, we focus on free-trade-in-goods without TT. Each country is completely specialized in the production of its comparatively advantaged good. Our world economy consists of two specialized regions or countries, the North and the South (see Figure 3.2). The output of each good in the free trade regime without international TT is given by:

$$Q_1 = \frac{L}{a_1}$$
,  $Q_2^* = \frac{L^*}{a_2^*}$  (4)

<sup>117</sup> DFS (1977) continuum analysis was carried out under the assumption that uniform homothetic tastes are of the Millian or Cobb-Douglas form: regardless of prices and incomes, every country spends a fixed function of its income in its respective good. Ruffin and Jones(2007) and Jones and Ruffin (2008) use the Cobb-Douglas utility  $U = c_1^{1/2} c_2^{1/2}$  in order to explore the consequences of the TT originating from the comparatively advantaged industry in the home country and going to the comparatively disadvantaged industry (the same industry) in the foreign country.

<sup>&</sup>lt;sup>116</sup> Grünfeld (2006) considers free TT as "*manna from heaven*". However, we follow Ruffin and Jones (2007) and we consider technology like a public good in that the giver still has its resources and technology.

Subsequent analyses by Samuelson (2004), Laussel *et al*, (2004), Cheng *et al*, (2005), simplified by retaining the assumption that demand in both countries exhibited constant and equal expenditure shares on all commodities, as in Cobb–Douglas.

Figure 3.2: Initial trade regime



Using the trade balance condition, we obtain the equilibrium relative price of good 2

$$p = \frac{a_2^* L}{a_1 L^*}$$
(5)

For a complete specialization of each country<sup>118</sup>, this equilibrium relative price of good 2 satisfies the condition:

$$\frac{a_2}{a_1} (6)$$

We focus now on the comparison of the initial free trade equilibrium with the equilibrium in which the developed country transfers its own technology for producing the good 1 (not counting any payment for the TT or free transfer) to the same sector in the developing country. The developing country's labour input coefficient for good 1,  $a_1$  is reduced by the TT. Thus, the developing country strengthens its comparative advantage in the same industry (Kojima, 2000). The world output of good 1 is increased by the improvement

<sup>&</sup>lt;sup>118</sup> Here, we follow the North-South perspective and the complete regional specialization in Burgstaller (1985).

of the developing country's productivity. The transfer of technology allows greater production of good 1, the export good of the developing country. The new output of good 1 produced by the developing country is equal to  $Q_1' = L/a_1^*$ . In the rest of our paper, all (') refer to the variables after TT. After the reception of the advanced technology (see Figure 3.3), the national output of the developing country becomes  $L/a_1^*$ , (initially  $L/a_1$ ). The new world production possibilities curve is above the old curve. World output is clearly increased by this improvement in the developing country's productivity. After the reception of the advanced technology  $a_1^*$ , the developing country's exports of good 1 increase. For the developed country, the production of good 2 remains unchanged.

Figure 3.3: Free trade regime with international TT



Within this classical model, an increase in labour productivity will cause export expansion. Figure 3.4 illustrates by

- *i.* the solid broken line, the world production possibilities curve without international TT
- *ii.* The dashed broken line, the world production possibilities curve after the transfer of the advanced technology of production of good 1 in the developed country to the developing country.

Figure 3.4: Free trade regime with international TT



As we know, differences in unit labour requirements induce comparative advantages between countries in the Ricardian model of international trade. Within this classical model, an increase in labour productivity will cause export expansion (Nesset, 2004, p.147). The initial exports of the developing country are given by  $X = \frac{L}{2a_1}$ . After the reception of the advanced technology  $a_1^*$ , the developing country's exports of good 1 become

$$X' = \frac{L}{2a_1^*}$$

For the developed country, the exports of good 2 remain unchanged

$$X^* = X^{*'} = \frac{L^*}{2a_2^*}$$

After TT, using the balanced trade condition  $\left(\frac{L}{2a_1^*} = \frac{L^*}{2a_2^*}p'\right)$ , the equilibrium relative

price of good 2 becomes

$$p' = \frac{a_2^* L}{a_1^* L^*} \tag{7}$$

The relative price of good 2 goes up. The developed country experiences a terms of trade improvement. That is, any payment which the developed country would receive for transfer of its superior technology for producing good 1 (its import good or comparatively disadvantaged good) is added to the gain coming from the improvement of its terms of trade.

### Figure 3.5: International TT and terms of trade



Figure 3.5 displays the relative price change of good 1 by illustrating relative demand and supply schedules for  $Q_1/Q_2$ . Each country is completely specialized in its comparatively advantaged good and the TT lowers the international relative price of good 1 (from A to B in Figure 3.5).

The developing country's GNP and the developed country's GNP measured in good 1 are respectively  $\frac{L}{a_1^*}$  and  $\frac{L^*}{a_2^*}p$ . The developing country's welfare with TT is higher than without TT. Indeed, its gains in productivity are large enough to overtake the deterioration of its terms of trade. The welfare of both countries is improved by this mode of TT.

$$\frac{B'}{B} = \frac{a}{a_1^*} > 1$$
(8)

$$\frac{B^{*'}}{B^{*}} = \frac{a}{a_{1}^{*}} > 1$$
 (8 bis)

Thus with the same Cobb-Douglas utility function in both countries and complete specialization, both developing and developed countries gain in welfare from the free TT ( or imitation) in comparison with the initial case of free trade without TT. Free TT will improve global welfare. Here, we agree with the Kojima-Ozawa propositions. Even if the developed country allows the technology of production of its importing good to be imitated, it must benefit due to the improvement of its terms of trade.

Note however that this proposition depends heavily on the hypothesis which is made about the demand structure in both countries. The above result relies on the assumption of the Cobb-Douglas utility function. If the demand is less elastic, as noted by both Samuelson (2004), Ruffin and Jones (2007), immiserizing growth may occur. Indeed, if the developing country has an important import propensity for good 2 produced by the developed country, or if the elasticity of substitution between the two goods is low, the specter of immiserizing growth for the developing country cannot be ruled out. Sufficiently low elasticity of substitution between good 1 and good 2 could result in the decline of the welfare of the developing country and in a drop in its real incomes (Ruffin and Jones, 2007). The developing country could thus lose in the receipt of a more efficient technology in its comparatively advantaged sector (exportable), even if the developed country does not charge anything for such  $TT^{119}$ . So, it must be kept in mind that our model, which supposes an elasticity of substitution between good 1 and good 2 which equals 1, gives a result which is relatively favorable to the developing country's welfare.

# 3.3.2 Northern exploitation of its technological superiority through licensing and FDI: are Kojima and Ozawa right?

Now we model the positive productivity effect of TT via FDI and licensing. This strengthens the findings of those who defend openness to FDI and technology trade. However, we will show that FDI and licensing may decrease the developing country's welfare due to the transfer of income to foreigners.

It has been recognized that TT via FDI and licensing increases growth for receiving developing countries. Recent literature in growth theory points to research and innovation as the engine of growth. A policy implication for developing economies that has been drawn from this theory is that foreign investment increases growth via the access to more efficient technologies. Romer (1993) puts emphasis on the point and recommends the openness to foreign investment for the developing countries. Several empirical studies support the argument. Blomstrom *et al.* (1994), Balasubramanyam *et al.* (1996) and Borensztein *et al.* (1998) present evidence that inward direct investment has raised the growth rate of many developing countries. Barrel and Pain (1997) and Borensztein *et al.* (1998) suggest that the transfer of technology is an important channel to spur economic growth.

Reis (2001, 2006) notes that the strength of the empirical result that FDI increases growth may overshadow the fact that FDI does not necessarily increase welfare. Welfare assessments must recognize that investment returns and royalties may be repatriated. Caves (1971), Cheng (1984), Brander and Spencer (1983), Blomstrom and Wang (1992) and Cheng *et al.*(2005) addressed the question of how MNFs exploit their technological superiority in foreign countries. Other authors also raise the question of the welfare effect of the TT and of the international payments which are linked to this transfer (see Reis, 2006). We cast doubt on

<sup>&</sup>lt;sup>119</sup> For more details, see the first section of chapter 3.

Koijma-Ozawa's "*criterion of welfare maximization*». We think that is often forgotten that an increase in growth and trade does not necessarily imply an increase in welfare. We will show that modes TT via FDI and licensing may decrease the developing country's welfare because of the transfers of income to foreigners.

We consider now that the developed country transfers its advanced technology in producing its importing good via licensing and second we consider that Northern MNFs invest in the Southern country's comparatively advantaged industry. In both cases, MNFs are able to extract income from their technological superiority. Thus, the commonly held view that MNFs have a competitive or technological advantage that they exploit in foreign markets is adopted in this contribution. We integrate not only the technological effect, which increases productivity but also the drain effect, i.e. the negative impact originating from the repatriation of the income generated by FDI and licensing. The total effect on the developing country's welfare depends upon the relative weights of these two components. We show that TT via FDI and licensing to the developing country exportable may decrease its welfare, through the income distribution effects of quasi-rents and royalties repatriated which are extracted by developed investing countries. Many developing economies spend valuable resources and efforts on attracting foreign investors. However, our research raises the possibility that there may be welfare loss from receiving FDI. Therefore, more care should be given to welfare analysis before such resources are spent.

## **3.3.2.1** Technology transfer via licensing

### 3.3.2.1.1 Licensing

In this section, we raise the question of the welfare effect of the TT and of the international payments which are linked to this transfer. We explain how the developed country, which has an absolute advantage, based on technology in both goods, gains by selling its modern technology to developing country's export sector.

Pugel (1982, p. 325) states that "the royalty is based upon the marginal value of new technology, but it can also be equal to a constant fraction of output, a standard feature of many current technology contracts". According to Kopits (1976), a licensing agreement stipulates that the licensee pays a royalty or license fee, for the patent and know-how received from the licensor. Most international licensing agreements provide a royalty rate as a percentage of the licensee's net sales of the licensed product over the life of the contract. The great majority of American companies with foreign licensing agreements receive percentage or per unit royalties from their licensees. Following Kopits (1976, p 792), the aggregate royalty payment during any given period may be stated as

$$R = bS \tag{9}$$

Where *R* is the royalties and "*b*" (0 < b < 1) is the royalty as a percentage of net sales "*S*". The royalty is determined simply by equation (9) where the values *b* are governed by the efficiency of the technology transferred, the licensor's degree of monopoly concerning the technology over time. The real sales of the developing country measured in terms of good 1 are  $S = L/a_1^*$ 

$$R = \frac{bL}{a_1^*} \tag{10}$$

The trade balance condition must now take into account that the royalty must be paid to the developed country. Thus we have the developing country's exports of good 1 and services (royalties)  $\left(\frac{L}{2a_1^*} + b\frac{L}{a_1^*}\right)$  are equal to its imports  $\left(\frac{L^*}{2a_2^*}p^*\right)$ . The international relative price of good 2 becomes

$$p' = \frac{(1+2b)a_2^*L}{a_1^*L^*} \tag{11}$$

Thus, the developed country's terms of trade (TOT) improve (p' > p). As revealed in expression (11), the developed country's terms of trade improve due to three reasons: (*i*) the unit cost of producing good 1 in the developing country decreases, (*ii*) the increased royalties' payment from the developing country spills over to greater demand for the good 2 (the developed country exportable) and to an improvement in the trade balance and (*iii*) the increased developing country's income spills over in part to greater demand for the good 2.

The developing country' terms of trade deteriorate. The exports associated with royalties & license fees payment represent trade in services and spillover to higher demand for imports, which accentuate the deterioration of the developing countries' TOT. The developing country may gain or lose depending on the relative importance of productivity increases brought about by TT via licensing and the deterioration of the developing country's terms of trade.

#### **3.3.2.1.2** Welfare effect of technology transfer via licensing

After TT via licensing, the developed country's GNP measured in good 1 becomes  $\frac{L^*}{a_2^*}p'+b\frac{L}{a_1^*}$ On comparison of its welfare with TT via licensing and its welfare without TT,
we obtain (see Appendix B-I of this chapter)

$$\frac{B^{*'}}{B^*} = \left( \begin{array}{c} \frac{(1+3b)^2}{(1+2b)} \\ \end{array} \right) \left( \frac{a_1}{a_1^*} \right) > 1$$
 (12 a)

Clearly, the developed country gains in welfare regardless of the value of the royalties that it receives from the developing country (regardless of the value of 'b' coefficient). It gains from the improvement of the terms of trade and from the payment of royalties.

The developing country's GNP measured in good 1 becomes  $y = \frac{L}{a_1^*}$ . On comparison

of its welfare with TT via licensing and its welfare without TT, we obtain

$$\frac{B'}{B} = \left(\frac{1}{1+2b}\right) \left(\frac{a_1}{a_1^*}\right) \ge <1$$
(12 b)

The developing country may be immiserized through this mode of TT. When b is sufficiently larger, the TT and the payment of royalties may hurt the welfare of the developing country.

#### 3.3.2.2. Technology transfer via FDI

Existing theoretical studies in the literature of MNFs focus on the case where MNFs arise from imperfectly competitive markets. This work differs from other research in the literature in two important ways. First, we explain that technological inflow and FDI arise due to technological differences between two regions. Second, we consider perfect competition in the product markets with neither transportation costs nor trade barriers.

#### 3.3.2.2.1 FDI and quasi rents

Bhagwati (1973), Bhagwati *et al.* (1978) and Brecher and Diaz-Alejandro (1977) argue that inward FDI may deteriorate the developing countries' terms of trade and welfare. Their research concludes that the effect FDI in developing countries depends on the country's trading mode. Under the export promotion strategy, inward FDI leads to a biased growth in exports thus may deteriorate the country's terms of trade. Cardoso and Dornbusch (1989) Helleiner (1989), Young and Miyagiwa (1986) and Reis (2001, 2006) argued that FDI might reduce the welfare of developing countries<sup>120</sup>. Reis (2006, p.412) states that"*with foreign investment creative destruction may imply redistribution from nationals to foreigners decreasing national income*".

 $<sup>^{120}</sup>$  Cardoso and Dornbusch (1989, p 1415 ) state that  $\,:\,$ 

<sup>•</sup> If capital is paid at its marginal product, a discrete inflow of capital increases national income, as the ouput increase is larger than the returns to foreign capital.

<sup>•</sup> If some distortion implies that capital is paid more than its marginal product, foreign investment may imply a decrease in welfare.

Technology and managerial talent have become the key ingredients of FDI (Campos and Kinoshita, 2002; Cheng *et al.*, 2005; Root 1994). Following Lu (2007) and Antràs (2005), FDI refers to the process of TT and takes the form of building up production sites in the South and modifying operating procedures to suit Southern conditions that require Southern labour input. MNFs hire Southern workers, retain full control over production, and remit all profits back to the North.

We want to isolate the effect of FDI on national welfare. We consider a two-good version of Cheng et al.'s (2000, 2005) continuum Ricardian model. MNFs transfer technology and this transfer requires the use of human resources such as expatriate employees (Teece, 1977). There is a continuum of MNFs with decreasing efficiency in TT, and each MNF can manage an increasing volume of foreign production only at increasing cost. Under these assumptions, the resource requirements of the marginal MNF increase as the total amount of MNF production increases. The "supply curve of TT" is upward sloping. For every unit of good 1 produced by a marginal MNF, it uses  $a_1^*$  unit of developing country's labour for production, and a certain amount of developing country's labour in the process of TT. The latter amount is industry-specific and depends on the total amount of technology transferred by the MNFs. The amount of the developing country's labour required for TT per unit of good 1 produced by an MNF is given by " $cka_1^*$ " where "k "is fixed and captures the characteristics of TT specific to good 1, whereas c depends on the total amount of TT by all MNFs. The unit production cost measured in terms of developing country's labour, our numeraire, incurred by the marginal MNF in the production of good 1 is  $a_1^*(1+ck)$ . The unit cost of production of good 1 using the backward technology is  $a_1$ . FDI will emerge if the cost of TT is small relative to the technology gap. Thus, FDI takes place in good 1's industry if in equilibrium:

$$a_1^*(1+ck) \le a_1 \tag{13}$$

Thus, the commonly held view that MNFs have a competitive or technological advantage that they exploit in foreign markets is adopted in this paper. We consider FDI (from the Northern country) that crowds-out domestic (Southern) investment. With this type of creative destruction, property incomes (originating from South) are transferred to

(Northern) foreigners. This transfer of income will be crucial in the evaluation of the welfare effect of FDI.

To operationalize the assumption that "c" depends on the amount of technology transfer, let T, the amount of TT is given by

$$T = a_1^* k Q_{1FDI}$$

where  $Q_{1FDI} = \frac{L}{a_1^*(1+ck)}$  is the output of good 1 produced by the marginal MNF in

the developing country.

The relationship between "T "and "c " is given by

$$c = c_0 + \lambda T \tag{14}$$

where both  $c_0$  and  $\lambda$  are positive coefficients.  $c_0$  is the value of c of the MNF that is most efficient at TT. This upward supply curve of TT is assumed linear. From (14), the "supply curve" of, "T" <sup>121</sup> is given by

$$T = \frac{c - c_0}{\lambda} \tag{14'}$$

The resource cost of TT is captured by "k". The variable "c" can analytically be thought of as the unit cost of "T" for the marginal MNF. The unit cost of TT varies from " $c_0$ " to "c". The unit cost of TT varies from " $c_0$ " to "c". The marginal unit labor cost of TT is  $cka_1^*$ . Thus, the total labour cost (CT) of this transfer is :

$$CT = \int_{c_0}^{c} cka_1^* dc = \left[\frac{1}{2}(c^2ka_1^* - c_0^2ka_1^*)\right]$$

The average unit cost is :

$$\frac{CT}{\lambda T} = \frac{\left[\frac{1}{2}(c^2ka_1^* - c_0^2ka_1^*)\right]}{c - c_0} = \frac{ka_1^*(c + c_0)}{2}$$
(15)

Thus, with  $c_0 < c$ , the marginal unit labour cost of TT,  $cka_1^*$ , exceeds the average unit labour

<sup>&</sup>lt;sup>121</sup> An upward sloping supply curve of "T" captures the probable phenomenon that when MNFs expand their operations in foreign countries they may have to tap marginal resources that are increasingly less efficient at technology transfer.

 $cost(c+c_0)k a_1^*/2$ , where both costs are measured in terms of the developing country's labour.

The labour force of the MNFs in the developing country is employed<sup>122</sup> to produce good 1 with Northern technology.

$$L_{FDI} = a_1^* \left( 1 + \frac{c + c_0}{2} k \right) Q_{1FDI}$$
(16)

Using (15), the expression of  $L_{FDI}$  becomes<sup>123</sup>

$$L_{FDI} = \left(\frac{1}{k} + \frac{c+c_0}{2}\right)T \tag{17}$$

It is widely recognized that part of the national income of the advanced countries is derived from the temporary monopoly of their superior technology. Krugman (1979) emphasized the importance of the quasi-rents associated with technological leadership in the national income of the advanced countries. Focusing on benefits of technological leadership, Blomstrom and Kokko (1992) and Cheng (1984) give an interesting definition of the quasi-rents. By quasi rents, they mean the maximum total rents that a firm (or a country) can extract through FDI (joint venture or full ownership). Naturally, a country's quasi rents depend on its own technology level and that of its competitors. Following Cheng *et al.*(2000), the MNFs' quasi-rents are equal to the difference between their total output of good 1 and the cost of  $L_{FDI}$  in terms of good 1 <sup>124</sup>. Therefore, the MNFs extract the surplus of the production and bring back this surplus to their country of origin.

$$\frac{L_{FDI}}{a_1^*(1+\frac{c+c_0}{2}k)} - \frac{L_{FDI}}{a_1^*(1+ck)} = \frac{L_{FDI}}{a_1^*(1+ck)} \times \frac{(\frac{c-c_0}{2})}{(\frac{1}{k}+\frac{c+c_0}{2})} = \frac{\pi_{FDI}}{a_1^*(1+ck)}$$
(18)  
where  $\pi_{FDI} = \frac{(c-c_0)T}{2} = \frac{(c-c_0)^2}{2\lambda} = \frac{\lambda T^2}{2}$ 

<sup>&</sup>lt;sup>122</sup> Here we consider the case of complete specialization, with  $a_1^*(1+ck) < a_1$  (FDI crowd out the total investment of the developing country and transfer costs c do not increase rapidly with *T*).

<sup>&</sup>lt;sup>123</sup> Equation (17) shows that  $L_{FDI}$  is an increasing and convex function of "T" and "c", where convexity is explained by the positive relationship between "c" and "T" in (14). <sup>124</sup> Here we consider that that inequality (13) is strict. FDI crowds out domestic investment. That is to say, the technological

<sup>&</sup>lt;sup>124</sup> Here we consider that that inequality (13) is strict. FDI crowds out domestic investment. That is to say, the technological gap is large between both countries and transfer costs c do not increase rapidly with T.

In the case  $a_1^*(1+ck) = a_1$ , MNFs and domestic firms coexist in the developing country to produce good 1.  $a_1^*(1+ck)$  can be replaced by  $a_1$ . The developed country takes profit of the quasi-rents, but the developing country unambiguously loses in welfare if these quasi-rents are entirely captured by MNFs.

#### 3.3.2.2.2 Welfare effect of technology transfer via FDI

We consider that FDI crowds-out domestic investment. The lower costs of foreign technology makes domestic production units unprofitable. With this type of creative destruction, FDI involves transfer of quasi rents to the developed country. This transfer of profits is the second effect of FDI in addition to productivity increase and will be crucial in the evaluation of the welfare effect of FDI. The trade balance condition must now take into account quasi-rents associated to export of services from the developing country. The developing country's exports of good 1 and services ( $\frac{L}{2a_i^{-}(1+ck)} + \frac{\pi_{FDI}}{a_i^{-}(1+ck)}$ ) are equal to its imports ( $\frac{L}{2a_2^{-}}p^{-}$ ). Using the balance trade condition<sup>125</sup>, the international relative price of good 2 becomes

$$p' = \frac{a_2^{*}(L + 2\pi_{FDI})}{a_1^{*}L^{*}(1 + c.k)}$$
(19)

Thus, it is clear that the developed country's terms of trade improve (p' > p). As revealed in expression (19), the developed country's terms of trade improve due to three reasons: (*i*) the unit cost of producing good 1 in the developing country decreases, (*ii*) an increase in demand for good 2 (the developed country's exportable) arising from the MNF profits and (*iii*) the increased developing country's income spills over in part to greater demand for the good 2.

The developing country' terms of trade deteriorate. The exports associated with quasirents (MNFs' quasi-rents are spent in the home countries) represent trade in services (see Cheng *et al*, 2005), and spill over to higher demand for imports (see Ruffin and Jones, 2007) which accentuate the deterioration of the developing countries' terms of trade. The developing country may gain or lose depending on the relative importance of productivity increases brought about by TT via FDI and the deterioration of the developing country's terms of trade.

<sup>&</sup>lt;sup>125</sup> Under complete specialization, and with  $a_1^*(1+ck) < a_1$  (FDI crowd out the total investment of the developing country).

The developed country's GNP measured in good 1 becomes  $\frac{L}{a_2} p' + \frac{\pi_{FDI}}{a_1'(1+ck)}$ . On comparison of its welfare with TT via FDI and its welfare without TT, we obtain (see Appendix B-II)

$$\frac{B^{*'}}{B^{*}} = \left(\frac{(L+3\pi_{FDI})^2}{(L^2+2L\pi_{FDI})}\right) \left(\frac{a_1}{a_1^{*}(1+ck)}\right) > 1$$
(20)

The developed country gains in welfare from this mode of TT.

For the developing country, it is shown that welfare may decrease and thus the specter of immiserizing growth is present. Its welfare with TT may be higher or lower than without TT because it gains from an increase in its productivity, but loses due to the deterioration in the terms of trade<sup>126</sup>.

$$\frac{B'}{B} = \left(\frac{L}{L + 2\pi_{FDI}}\right) \left(\frac{a_1}{a_1^*(1 + ck)}\right) \ge <1$$
(21)

The worsening terms of trade and the specter of the welfare loss should be an alert to those developing economies making great efforts to attract FDI.

# 3.3.3 The effect of inward FDI and licensing on the developing country terms of trade: an empirical analysis

Inspired by the works of Reis (2001, 2006), Bhagwati *et al.* (1978), Li *et al*, (2007) and Cheng *et al.*(2000), we challenge, the view that inward FDI improves the Southern host country's terms of trade.

In their theory of the effects of international income transfers on the terms of trade of a country, Krugman and Obstfeld (2005) state that an international transfer of income deteriorates the donor (developed) country's terms of trade and improves the recipient (developing) country's terms of trade if the donor (developed country) has a higher marginal propensity to spend on its export good than the recipient (developing country). In fact, due to

<sup>&</sup>lt;sup>126</sup> FDI increases welfare only if the increase in productivity is great enough to compensate for the loss of profits.

trade barrier, each country usually consumes more goods produced by its own than by foreign countries. Therefore, home country transfer payments to other countries tend to reduce demand for domestic goods, thus deteriorating the home country's terms of trade.

Because FDI affects both countries' international income, there have always been controversies on the effect of inward FDI on a country's terms of trade (see Li *et al.*, 2007). . According to Krugman and Obstfeld' theory, inward FDI should improve a country's terms of trade. However, Bhagwati *et al.* (1978) find that inward FDI might deteriorate the host country's terms of trade by leading to a biased growth in exports. Li *et al.*(2007) note that, when the donor's comparatively disadvantaged industries correspond to the recipient's comparatively advantaged industries, while stimulating exports growth, transfers of income may deteriorate the recipient's terms of trade because of possible downward pressure on export price. For example, the deterioration of China's terms of trade is explained by the fact that its export growth largely depends on inward FDI and labour-intensive products. FDI into Chinese export sectors has contributed to an adverse evolution of terms of trade (see Li *et al.*, 2007; Lemoine and Ünal-Kesenci, 2008).

The above Ricardian setting on the relations between inward FDI, royalties & licensee fees payments and a country's terms of trade are mostly a theoretical conjecture that lacks empirical proof. The broad challenge posed by the theoretical arguments developed above can be resolved through careful empirical study. We put the argument that technical progress via FDI and licensing deteriorates the developing countries' terms of trade to the empirical test. Our empirical methodology follows Goldberg and Klein (2001), Andrés, Hernando and Kriiger (1996), Golub, Jones and Kierzkowski (2007) and Uzagalieva and Cukrowski (2006) by using a two good Ricardian trade model to motivate a general empirical analysis<sup>127</sup>. Following Grossman and Helpman (1995), we consider that good 1 comprises the bulk of the developing country's export basket and good 2 comprises the bulk of its import basket.

<sup>&</sup>lt;sup>127</sup> Bitzer *et al.* (2008) use a three good Ricardian model to motivate their general (multisectoral) empirical follow-up on Samuelson's controversial paper.

#### Measure of the terms of trade 3.3.3.1

One of the most important views in the post-war development policy debate has been the Prebisch Singer hypothesis<sup>128</sup> concerning a structural tendency for the net barter terms of trade (NBTT) of developing countries to deteriorate in their dealing with the industrialized countries. Sarkar and Singer (1991) argue that the terms of trade of manufactured exports from developing countries, like that of their primary commodity exports, have manifested a long-term trend favouring the importing developed countries.

The negative long-run trend of commodity prices has been well documented in the literature. Much empirical research has been carried out to test the validity of these views (Ram, 2004; Maizels, 2000; UNCTAD, 2001, Kaplinsky et al., 2002; Maizels et al., 2002, Sarkar, 2001, 2004; Sarkar and Sarkar, 2008). Macroeconomic statistical studies show that during the 80s and 90s the deterioration of developing countries' manufacturing commodities terms of trade was higher than the decline in their primary commodity terms of trade. These results concern the trade between developing countries and the United States (Maizels, 2000), as well as the European Union (UNCTAD, 2001).

Applied to a country's external trade, the concept most widely used since the beginning of the terms of trade (hereafter, TOT<sup>129</sup>) debate in the 1950s has been NBTT (Mansfield and Reinhardt, 2008; Sarkar and Sarkar; 2008; World Bank, 2009) defined as the ratio between the unit value index of the export basket and that of the import basket (of individual countries)<sup>130</sup>.

<sup>&</sup>lt;sup>128</sup> The seminal contribution of Prebisch (1950) and Singer (1950) focused on the tendency of the deterioration in the long run of the terms of trade of developing countries with developed countries. Firstly, they compared the relative movements in the price of primary non-oil commodities exported by developing countries and the unit value of commodities exported by developed countries.

<sup>&</sup>lt;sup>129</sup> There are different concepts of terms of trade – commodity terms of trade (CTT) or net barter terms of trade (NBTT), income terms of trade (ITT), double factorial terms of trade (DFTT). Of all these concepts, the CTT or NBTT is widely used - unless otherwise specified, the phrase, 'terms of trade' is used to mean CTT or NBTT (Sarkar and Sarkar, 2008). <sup>130</sup>The NBTT indexes are calculated as the ratio of the relative change in the price of the exported goods and services basket

to that of the corresponding import basket (of individual countries).

<sup>&</sup>quot;The terms of trade measure the relative prices of a country's exports and imports. There are a number of ways to calculate terms of trade. The most common is the net barter (or commodity) terms of trade index constructed as the ratio of the export price index to the import price index. When a country's NBTT index increases, its exports become more valuable or its imports cheaper" (World Bank, 2009, p.335).

### **3.3.3.2** Estimations and results from short balanced panel

Although the main contribution of the chapter is theoretical, it is nonetheless attractive to assess empirically the mechanism it proposes. This is done in this sub-section, which is an attempt at testing the predictions of the theoretical model presented in the previous section which shows the negative effect of TT via FDI and licensing on the developing countries' terms of trade.

A broader conception of TT is more useful and common when considering MNFs as its agent (Wu, 2000). In this section, we test this hypothesis by using panel data from a sample of developing countries. We investigate whether FDI, royalties & licensee fees payment and imports affect the terms of trade of developing countries.

We use the NBTT (for individual countries) index to characterize the evolution of the developing countries' TOT and the role of licensing and inward FDI in this process. The theoretical framework developed above is an illustration of how TT (via FDI and licensing) may lead to a deterioration of the developing countries' TOT. The combined predictions of equations (11) and (19) will be tested on the basis of a sample of developing countries for the 1997-2003 period and 1990-2007 period using panel (balanced and incomplete) data techniques (with a number of countries higher than time dimension).

Our empirical specification which we initially estimate using a within-groups estimator, takes the following form:

 $\log TOT_{it} = \gamma + \alpha_i + \alpha_t + \alpha_1 \log Roy_{it} + \alpha_2 \log FDI_{it} + \alpha_3 \log pop_{it} + \alpha_4 \log imp_{it} + \alpha_5 inst_{it} + u_{it} (22)$ 

where "TOT" is the terms of trade of a developing country measured by NBTT for country *j* in year *t* (see Ram, 2004). We use inward FDI in stocks divided by exports taken from WDI. This measure could capture the share of foreign firms in the country's exports (foreign involvement in exports). FDI in stock/exports could serve as proxy for the relative importance of international integration by means of inward FDI<sup>131</sup> as compared with exports from the domestic developing economy.

<sup>&</sup>lt;sup>131</sup> In recent years, FDI growth has far outpaced growth in either world production or trade. While merchandise trade grew about 85 percent, and world production grew 27 percent, world FDI flows increased by 535 percent during the 1990s.

Following Fernandez-Arias and Hausmann (2001), Van Hoesel (1999) and UNCTAD (2009), we can use either FDI stock/export or FDI stock/GDP to normalize for the size of an economy. Here, in order to capture at the same time the size of an economy and its outward orientation we use FDI stock/export. Fernandez-Arias and Hausmann (2001, p. 47) use FDI/ export and argue that "*openness is controlled, by using FDI divided by exports*". Our objective is to control outward –oriented development strategy. In addition, FDI may capture quasi rents, and consequently FDI/exports measure may capture the relative importance of quasi-rents (i.e., services exports) as compared with overall exports from the host developing country.

The "Roy" regressor is real royalties & license fees payment. We use royalties and license fees divided by consumer price index (CPI). "Imp" are imports divided by GDP. Pop is population used to control the effect of country size. "Inst" is institutional quality measured by the economic freedom index. The variables "TOT", Roy, FDI and Pop are expressed in natural logarithm<sup>132</sup>."i" is country and "t" is year. From our theoretical model developed above, especially the combined predictions of equations (11) and (19), we expect that FDI and licensing may decrease a developing country's TOT, thus  $\alpha_1 < 0$  and  $\alpha_2 < 0$ .  $\alpha_i$  and  $\alpha_t$  are respectively country specific effects and time effects in panel data.

Equation (22) is estimated using a within-groups estimator, which controls for country specific heterogeneity. We introduce year fixed effects to capture the unobserved effects of economy-wide changes over time. We will furthermore verify, relying on instrumental variables (IV), that our results are not biased by simultaneity, reverse causality or circularity issues.

Remarkably, developing countries benefitted disproportionately, raising their share of the world inward stock of FDI from 20.6 percent in 1990 to over 28 percent in 2008 (UNCTAD, various years).

<sup>&</sup>lt;sup>132</sup> The existing empirical literature on the terms of trade uses the natural logarithm of NBTT (see Ram, 2004; Athukorala, 1993, 2000 for a survey).

Variable name	Definition	Source
log ( TOT)	Natural logarithm of terms of trade (NBTT) "The terms of trade measure the relative prices of a country's exports and imports. There are several ways to calculate it. The most common is the net barter (or commodity) terms of trade index, or the ratio of the export price index to the import price index. When a country's net barter terms of trade index increases, its exports become more valuable or its imports cheaper. Net barter terms of trade index is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes" (World Bank, 2009, p. 335)	<ul> <li>UN-COMTRADE</li> <li>UNCTAD Handbook of statistics</li> <li>World Bank's World Development Indicators (WDI) database</li> </ul>
log(Roy)	Natural logarithm of real royalties and license fees Real royalties & license fees = $\left[\frac{Royalties \& fees payments}{consumer price index}\right]$ (Author calculation)	Data on royalties and license fees payments from WDI. Data on world consumer price are taken from WDI CD-ROM (2005) and WDI (2009)
log(FDI)	Inward FDI in stocks/exports (see Fernandez-Arias and Hausmann, 2001) Real inward FDI (in stock) = $\left[\frac{inward FDI stock}{consumer price index}\right]$ (see Bénassy-Quéré, Fontagné and Lahreche-Revil,2001)	UNCTAD database
log(Pop)	Natural logarithm of population	World Bank' s WDI database
log(100*Imp/GDP) Imp/GDP	log(100*Imports of goods and services/ GDP) Imports of goods and services/ GDP (decimal equivalent)	World Bank' s WDI database
Inst	Institutional quality We use the Heritage Foundation's index of economic freedom as a proxy for the institutional quality. The Heritage Foundation's index of economic freedom measures ten specific factors, including freedom in the business environment, trade, fiscal policy, government, monetary policy, investment, property rights, and corruption. The lower scores on a factor the higher the level of government interference in the economy and the lower the economic freedom.	World Bank and Heritage foundation
	List of countries in panel 1 ( balanced ): China, Philippines, Brazil, Uruguay, Costa Rica, Argentina, Hungary, Poland, Turkey, Morocco, Mexico, Malaysia, India, Oman, Colombia, Venezuela, Paraguay, Peru, Chile, El Salvador, Panama, Ecuador, South Korea, Nicaragua, Jordan, Mauritius, Indonesia, Guatemala, Niger, Nigeria, Senegal, Kenya, Ethiopia, Sudan, Egypt and Thailand. These countries report regular data on royalties and TOT over the period 1997-2003 and are taken from our balanced panel in chapter 4. List of countries in panel 2 (incomplete) Algeria, Angola, Argentina, Bangladesh, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Central African Republic, Chile, China, Colombia, Congo Dem. rep., Congo Rep., Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Gabon, Ghana, Guatemala, Guinea, Haiti, Honduras, Hong Kong, Hungary, India, Indonesia, Jordan, Kenya, South Korea, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nicaragua, Niger, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Rwanda, Senegal, Seychelles, South Africa, Sri Lanka, Tanzania, Thailand, Togo, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Turkie, and Zinkiekura	World Bank's classification of countries into low and middle income groups according per capita income levels.

We consider the econometric estimation with a fixed effects model, controlling for country specific effects. We have to take into account heteroscedasticity and serial correlation potential problems in the residuals. Since a modified Wald test for groupwise heteroskedasticity rejects the null hypothesis of homoscedasticity, we rely on robust standard errors. We test our models for autocorrelation of residuals with Wooldridge's (2002) test for serial correlation; the statistics obtained indicate that there is autocorrelation in the residuals. Therefore, we use an estimator, which is robust with respect to heteroscedasticity and autocorrelation in the residuals.

As recommended by Peterson (2009), Egger and Raff (2010), Baltagi *et al.*(2008), and Hericourt & Poncet (2009), we apply various estimation techniques to our data in order to assess robustness of the key variables' significance to multiple corrections on standard errors. We run our fixed effects regressions using Newey-West correction on standard errors<sup>133</sup> and heteroscedasticity and autocorrelation consistent (HAC) kernel estimator. We also re-run each regression using Rogers or clustered standard errors<sup>134</sup> and Driscoll-Kraay correction on standard errors.

Such a simple econometric estimation does not take into account potential problems of endogeneity. This could lead to some of our variables being insignificant or having the wrong sign. Therefore, we additionally estimate our model with instrumental variables (IV), which are lags of our explanatory variables. In order to test the validity of our instruments with the Hansen test of over-identifying restrictions<sup>135</sup>, we have included some extra instruments (see the econometric methodology of Havrylchyk and Poncet, 2007; Hering and Poncet, 2009).

<sup>&</sup>lt;sup>133</sup> The adjusted the standard errors are obtained using the Newey-West procedure (Newey and West, 1987) modified for use in a panel data set. Newey produces Newey–West standard errors for coefficients estimated by OLS regression. The error structure is assumed to be heteroscedastic and possibly autocorrelated up to some lag. The problem of choosing a lag length is simplified in a panel data set, since the maximum lag length is one less than the maximum number of years per country. We therefore choose Newey-West standard errors that allow for an AR (1) process in the error term. The error structure is assumed to be heteroskedastic and possibly autocorrelated up to one lag.

<sup>&</sup>lt;sup>134</sup> The problem of autocorrelation in the residuals is addressed by Rogers' heteroskedasticity- and autocorrelation-corrected (robust) standard errors. Note that if the panel identifier (e.g. individuals, firms, or countries) is the cluster () variable, then Rogers standard errors are heteroscedasticity and autocorrelation consistent (HAC) (Hoechle, 2007, p.3). In the cluster approach, the within-group autocorrelation can be completely arbitrary. The Cluster approach gives us standard errors that are robust to arbitrary autocorrelation.

<sup>&</sup>lt;sup>135</sup> The first essential property of an instrument is statistical independence from the disturbance process. Although we cannot test the validity of that assumption directly, we can assess the adequacy of instruments in an overidentified context with a test of overidentifiying restrictions.

Tables 3.6 and 3.7 report results of IV estimation. We use the Arellano-Bond (1991) test for serial correlation implemented by Rodman (2009) for the static IV context. The Arellano and Bond (1991) test reveals that serial correlation is also present in our regressions<sup>136</sup>. We systematically check the validity of our instruments via the Hansen's J-test of overidentifying restrictions. Insignificant Hansen J-test statistics indicate that the orthogonality of the instruments and the error terms cannot be rejected, and thus that our choice of instruments is appropriate. The test statistics reported in Tables 3.6 and 3.7 do not reject the orthogonality of the instruments and the error terms, and thus we can conclude that our choice of instruments was appropriate. We complement this test by the Partial R<sup>2</sup> of excluded instruments and the first-stage F-test. Partial R<sup>2</sup> are systematically higher than 10% which provides satisfactory explanatory power of instruments for each instrumented regressor. We also report the robust F-stat form of the Cragg-Donald statistic (Kleibergen-Paap F statistic); this statistic has been suggested by Stock and Yogo (2005) as a global test for the presence of weak instruments (i.e. it tests the null hypothesis that a given set of instruments is weak against the alternative that it is strong). This statistic is also reported together with the critical values as tabulated by Stock and Yogo (2005)<sup>137</sup>. The test rejects the null hypothesis if the computed statistic exceeds the critical value. The results with respect to the quality of the instruments are overall quite satisfactory.

In order to test the appropriateness of relying on the IV estimator, we perform the Durbin-Wu-Hausman test statistic, which tests the endogeneity in a regression estimated with IV. The rejection of the null hypothesis means that the endogeneity of the regressors has a significant effect on the estimated coefficients and we have to rely on the IV estimation. Since these test statistics do not reject the null hypothesis of exogeneity of the regressors tested (at the 10% confidence level), the IV estimates are not appropriate.

 <sup>&</sup>lt;sup>136</sup> See Bascle (2008) for more details on Arellano and Bond test for AR (1) to test for the presence of serial correlation in static IV context.
 <sup>137</sup> Kleibergen-Paap F statistic is reported together with critical value Stock-Yogo weak identification test for 10% and 15%

<sup>&</sup>lt;sup>137</sup> Kleibergen-Paap F statistic is reported together with critical value Stock-Yogo weak identification test for 10% and 15% maximal IV size distortion as tabulated by Stock and Yogo (2005). If there are three or more instruments (thus, there are two or more overidentifying restrictions), the relative-bias criterion can be used (Cameron and Trivedi, 2009; p. 194). Thus, we report critical values based on a 5% and 10% maximum bias of the IV estimator relative to the OLS at the 5% confidence level, as tabulated by Stock and Yogo (2005).
We report results from TOT regressions using a balanced panel on developing countries over the period 1997-2003 in Tables (3.3), (3.4), (3.5), (3.8), (3.9) and (3.10). It is interesting to note that the estimated coefficients on FDI and licensing are negative and statistically significant in all fixed effect regressions. To assess robustness, we use royalties & license fees payment divided by (a) export value index, (b) unit value index of exports, (c) export of goods and services and (d) merchandise exports. Our finding remains robust to this additional test. Thus, there is strong conclusive evidence supporting our theoretical model on the worsening TOT effect of international TT via FDI and licensing.

The TOT deteriorate because of possible decrease in the price of the export goods. FDI and licensing resulted in the excess supply of exports, which has deteriorated TOT through competition in the global market. Our results are in line with Li *et al.* (2007) who conclude that the primary cause of the deterioration of China's TOT is that its export growth largely depends on FDI. The increase in FDI in technologically less advanced industries lowers the export prices of the host developing economies and leads to a deterioration of their TOT.

We find that the institutional quality index has no statistically significant effects on the TOT in all regressions. The increase in population and imports deteriorates the terms of trade of the developing countries. In Tables 3.3 and 3.4, according to the fixed effect regressions with Newey-West HAC standard errors, the estimated coefficient on imports/GDP, which captures the excess of demand, and the estimated coefficient on population, are negative and significant.

The exports associated with quasi-rents (MNFs' quasi-rents are spent in the home countries), royalties & license fees payment represent trade in services (see Cheng *et al.*, 2005), and spill over to higher demand for imports, which accentuates the deterioration of the developing countries' TOT. We think that FDI generates quasi-rents for investors, which in turn are repatriated, spill over to demand of foreign goods and deteriorate the developing country's TOT. Based on our empirical work, we have come to the conclusion that the theoretical debate on TOT is justified. Technological inflows via FDI and licensing have contributed to an adverse evolution of the developing countries' TOT by strengthening

competition in world markets for final goods. The hypothesis of secular decline in the developing countries' TOT is "*not a myth but a reality*"<sup>138</sup>.

It is essential for the developing countries to understand the relationship between technological inflows (via FDI & licensing) and TOT. The deterioration of TOT serves to offset the gains from receiving better technology in their comparatively advantaged industries. Indeed, the possibility of immiserising growth would be present if the deterioration of TOT has not been absorbed by rapid productivity gains (Beladi *et al.*, 1997; Lemoine and Ünal-Kesenci, 2008).

<sup>&</sup>lt;sup>138</sup> Sarkar (2001, p. 323)

		Regression with Newey-West standard errors							Fixed effec clustered standard err	t (within) regr (at the cou rors	ression with intry level)	ith el)   Regression with Driscoll –Kraay standard errors			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(1)	(2)	(3)	(4)
log(real royalties )		-0.022 (1.98)**	- 0.0178 (1.72)*	-0.0186 (1.76)*	-0.023 (2.01)**	-0.0186 (1.76)*	-0.02 (1.80)*	-0.021 (1.82)*		-0.022 (1.70)*	-0.023 (1.75)*			-0.0186 (2.43)**	-0.02 (2.61)***
log (100*FDI/exports)	-0.098 (3.72)***	-0.067 (2.93)***		-0.064 (2.82)***	-0.066 (2.74)***	-0.0656 (2.71)***	-0.064 (2.65)***	-0.065 (2.93)***	-0.098 (2.99)***	-0.067 (2.63)***	-0.066 (2.48)**	-0.098 (8.49)***	-0.09 (7.45)***	-0.064 (10.51)***	-0.064 (7.08)***
log (FDI/unit value index of exports )			- 0.087 (3.08)***												
log(population)	-0.5176 (1.98)**	-0.7534 (3.11)***	- 0.8455 (1.70)*	-0.62 (2.52)***	-0.8 (1.75)*	-0.79 (1.82)*	-0.81 (1.73)*	-0.768 (3.25)***	-0.5176 (1.32)	-0.7534 (2.16)**	-0.8 (1.25)	-0.5176 (3.63)***	-0.393 (3.06)***	-0.62 (4.17)***	-0.81 (2.55)***
log(100*Imp/GDP)			- 0.322 (3.53)***	-0.3 (3.62)***		-0.345 (3.62)***							-0.285 (6.51)***	-0.3 (5.61)***	-0.64 (5.76)***
Imp/GDP	- 0.626 (3.40)***	-0.624 (3.68)***			-0.68 (3.41)***		-0.64 (3.31)***	-0.596 (3.72)***	- 0.625 (2.58)**	- 0.624 (2.53)**	- 0.684 (2.29)**	- 0.625 (7.59)***			
Institutional quality	-0.0001 (0.05)	0.0017 (0.66)	0.0024 (0.95)	0.0017 (0.66)	0.0024 (0.94)	0.0023 (0.90)			-0.0001 (0.04)	0.0017 (0.51)	0.0023 (0.71)	-0.0001 (0.07)	0.00006 (0.03)	0.0017 (1.29)	
Constant	16.047 (2.94)***	21.13 (4.10)***	23.609 (2.26)**	19.077 (3.73)***	22.11 (2.27)**	18.84 (2.05)**	22.397 (2.25)**	21.48 (4.29)***	14.125 (2.12)**	18.3 (3.00)***	19.084 (1.69)*	14.12544 (6.00)***	12.7 (6.00)***	19.077 (6.35)***	19.367 (3.47)***
Year dummies	No	No	Yes	No	Yes	Yes	Yes	No	No	No	Yes	No	No	No	Yes
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.5461	0.5532	0.6292	0.5780	0.5664	0.5958	0.5638	0.5518							
Adj R <sup>2</sup>	0.4469	0.4654	0.5358	0.4951	0.4615	0.4980	0.4617	0.4671							
R <sup>2</sup> within									0.2346	0.2557	0.2778	0.2346	0.2346	0.2970	0.2735
Cross sectional independence test															
Pesaran's test (p.value) Friedman's test (p.value)			0.1319 1.0000	0.1213 0.9798		0.2980 1.0000	0.3062 1.0000	0.2232 0.9919							
Number of countries	36	28	28	28	28	28	28	28	36	28	28	36	36	28	28
Number of observations	252	196	190	196	196	196	196	196	252	196	196	252	252	196	196

#### Table 3.3. Dependant variable: log (TOT) over the period 1997-2003

*Notes*: Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. In columns 4, 5 and 6, the Wald test of joint significance rejects the inclusion of time specific effect.

• The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag. In order to test whether or not the residuals from fixed effects estimation are spatially independent, we perform Pesaran's (2004) and Friedman cross-sectional dependence (CD) tests using "xtcsd" Stata command. The null hypothesis of the CD test states that the residuals are cross-sectionally (spatially) uncorrelated. Correspondingly, the test's alternative hypothesis presumes that spatial dependence is present. The Pesaran's CD and Friedman's CD tests do not reject the null hypothesis of spatial independence.

• Fixed effect regression with Rogers or clustered (at the country level) standard errors: Robust t-student, based on clustered (at the country level) standard errors, are reported in parentheses. Statistics are robust to heteroskedasticity and clustering on country (robust to arbitrary within-group correlation). While correcting for clustered errors resulted in the reduced t-statistics reported in the above table, the results remain significant.

• The problem of autocorrelation in the residuals is addressed by Rogers' heteroskedasticity- and autocorrelation-corrected (robust) standard errors. Note that if the panel identifier (e.g. individuals, firms, or countries) is the cluster () variable, the Rogers standard errors are heteroscedasticity and autocorrelation consistent (HAC) (Hoechle, 2007, p.3). In the cluster approach, the within-group autocorrelation can be completely arbitrary. -Cluster- gives us standard errors that are robust to arbitrary autocorrelation.

List of countries: China, Philippines, Brazil, Uruguay, Costa Rica, Argentina, Hungary, Poland, Turkey, Morocco, Mexico, Malaysia, India, Oman, Colombia, Venezuela, Paraguay, Peru, Chile, El Salvador, Panama, Ecuador, South Korea, Nicaragua, Jordan, Mauritius, Indonesia, Guatemala, Niger, Nigeria, Senegal, Kenya, Ethiopia, Sudan, Egypt and Thailand. These countries report regular data on royalties and TOT over the period 1997-2003 and are taken from our balanced panel in chapter 4.

Variables	log (Real royalties )	log(population)	log(100*imports/GDP)	log(100*FDI/exports)	Institutional quality	
VIF	1.33	1.82	1.46	1.09		Mean VIF= 1.43
VIF	2.19	3.12	1.46	1.09	2.22	Mean VIF= 2.02

	Regression West star	with Newey- ndard errors	Fixed effe regression w clustered ( a level) stat	ect (within) vith Rogers or at the country ndard errors	r Regression with Newey-West standard errors					Fixed effect (within) regression with Rogers or clustered (at the country level) standard errors				
log(nool novalting non	(1)	(2)	(1)	(2)	Deel Dev neu conite	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
capita )	-0.022 (1.98)**	-0.025 (2.01)**	-0.022 (1.70)*	-0.023 (1.75)*	Keai Koy per capita	-0.4806 (2.92)***	-0.5091 (3.08)***	-0.4164 (2.51)**	-0.4548 (2.63)***	- 0.4806 (2.37)**	-0.5091 (2.41)**	-0.4164 (1.97)*	-0.4548 (2.05)*	
log ( 100*FDI/exports )	-0.067 (2.93)***	-0.066 (2.74)***	-0.067 (2.63)**	-0.066 (2.48)**	FDI/exports			-0.0684 (3.74)***	-0.0662 (3.53)***			-0.0684 (3.54)***	-0.0662 (3.40)***	
log(population)	-0.776 (3.16)***	-0.82 (1.78)*	-0.776 (2.20)**	-0.82 (1.27)	log(population)	-0.8149 (3.16)***	-0.5816 (1.14)	-0.6533 (2.73)***	-0.6449 (1.55)	-0.8149 (2.05)**	-0.5816 (0.73)	-0.6533 (1.83)*	-0.6449 (1.07)	
Imp/GDP	-0.624 (3.68)***	-0.684 (3.41)***	-0.624 (2.53)**	-0.684 (2.29)**	Imp/GDP	-0.6683 (3.60)***	-0.6983 (3.23)***	-0.7422 (4.33)***	-0.7922 (4.11)***	-0.6683 (2.52)**	-0.6983 (2.22)**	-0.7422 (3.19)***	-0.7922 (2.88)***	
Institutional quality	0.0017 (0.66)	0.0024 (0.94)	0.0017 (0.51)	0.0024 (0.71)	Institutional quality	0.0006 (0.22)	0.0016 (0.22)	0.0019 (0.76)	0.0027 (1.08)	0.0006 (0.17)	0.0016 (0.47)	0.0019 (0.57)	0.0027 (0.79)	
Constant	21.13 (4.10)***	22.11 (2.27)**	18.3 (3.00)***	19.08 (1.69)	Constant	21.833 (4.00)***	16.88 (1.57)	18.44 (3.65)***	18.225 (2.08)**	18.8885 (2.71)**	14.8079 (1.07)	16.1359 (2.59)**	15.9852 (1.52)	
Time specific effect	No	Yes	No	Yes	Year dummies Joint significance F stat of time specific effect (p.value)	No	Yes 0.1191	No	Yes 0.0167	No	Yes 0.0011	No	Yes 0.0004	
Within R <sup>2</sup>			0.2557	0.2778	Within R <sup>2</sup>					0.2020	0.2365	0.2824	0.3067	
R <sup>2</sup>	0.5532	0.5664	0.5532	0.5664	R <sup>2</sup>	0.5209	0.5417	0.5692	0.5838					
Country Fixed effect	Yes	Yes	Yes	Yes	Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Number of country units	28	28	28	28	Number of country units	28	28	28	28	28	28	28	28	
Number of observations	196	196	196	196	Observations	196	196	196	196	196	196	196	196	

#### Table 3.4: Robustness checks: log (TOT) over the period 1997-2003

Notes:

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level

Dependant variable: log (TOT) over the period 1997-2003	Regres	sion with Newe	y-West standar	d errors	Fixed effect (within) regression with Rogers or clustered (at the country level) standard errors			
	(1)	(2)	(3)	(4)	(1)	(2)		
Real royalties per capita	-0.407	-0.351	-0.456	-0.396	-0.456	-0.396		
	(2.24)***	(2.03)**	(2.78)***	(2.28)**	(2.10)**	(1.71)*		
FDI/exports		-0.079		-0.065		-0.065		
-		(4.48)***		(3.38)***		(2.92)***		
Imp/GDP	-0.623	-0.712	-0.606	-0.69	-0.606	-0.69		
-	(2.84)***	(4.06)***	(2.80)**	(3.52)***	(1.97)*	(2.48)**		
Rpop	-2.718	-2.378	-1.623	-1.66	-1.623	-1.66		
	(4.03)***	(4.13)***	(3.54)***	(3.79)***	(3.38)***	(3.66)***		
Institutional quality	0.0022	0.0033	0.0021	0.0032	0.0021	0.0032		
	(0.94)	(1.51)	(0.86)	(1.19)	(0.65)	(0.97)		
Constant	10.313	9.623	8.034	8.122	5.041	5.096		
	(7.33)***	(7.98)***	(8.55)***	(8.94)***	(25.59)***	(26.50)***		
Year dummies	No	No	Yes	Yes	Yes	Yes		
Within R <sup>2</sup>					0.2422	0.3103		
R <sup>2</sup> ( from LSDV and newey )	0.4849	0.5527	0.5450	0.5859				
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes		
Number of country units	28	28	28	28	28	28		
Number of observations	196	196	196	196	196	196		

Table 3.5. Robustness checks: Real royalties per capita and FDI/exports as RHS variables

Notes:

• Rpop is the population of a developing country divided by the population of the G5 (USA, UK, Japan, Germany and France).

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.

Dependant variable: log (TOT)	Static FE- IV	Static FE- IV				
	(1)	(2)	(3)	(4)	(5)	(6)
log(real royalties)	-0.016	-0.016	-0.016	-0.016	-0.016	-0.016
	(1.24)	(1.24)	(1.35)	(1.31)	(1.35)	(1.24)
log (100*FDI/exports )	-0.125	-0.135	-0.125	-0.135	-0.1246	-0.1246
	(2.31)**	(2.71)***	(2.30)**	(2.64)***	(2.27)**	(2.23)**
log(population)	-0.499	-0.915	-0.499	-0.915	-0.499	-0.499
	(1.15)	(1.47)	-1.39	(1.76)	(1.39)	(1.15)
log(100*Imp/GDP)	-0.343	-0.405	-0.343	-0.405	-0.34	-0.34
	(2.67)***	(2.74)***	-3.18	(3.35)***	(3.18)***	(2.67)***
Inst	0.001	0.002	0.001	0.002	0.0014	0.0014
	(0.44)	(0.76)	0.48	( 0.86)	(0.48)	(0.48)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes	No	No
first-stage F-stat	54.29***	44.93***	20.71***	22.06 ***	13.60***	31.882***
Partial R <sup>2</sup> for excluded instruments	0.3699	0.3602	0.3699	0.3602	0.3761	0.3761
Hansen J statistic of overidentifying	Equation exactly identified	equation exactly identified	equation exactly identified	equation exactly identified	0.019	0.017
restrictions					Chi-sq(1) P-val = 0.8891	Chi-sq(1) P-val = 0.8978
Kleibergen-Paap rk Wald F statistic	54.287	44.934	20.714	22.064	13.605	31.882
Stock-Yogo weak ID test critical values:						
10% maximal IV size	16.38	16.38	16.38	16.38	19.93	19.93
15% maximal IV size	8.96	8.96	8.96	8.96	11.59	11.59
Durbin-Wu-Hausman endogeneity test	0.684	1.114	0.807	1.159	0.790	0.670
	Chi-sq(1) P-val = 0.4082	Chi-sq(1) P-val = 0.2913	Chi-sq(1) P-val = 0.3691	Chi-sq(1) P-val = 0.2818	Chi-sq(1) P-val = 0.3742	Chi-sq(1) P-val = 0.4132
	Instrumented:	Instrumented:	Instrumented:	Instrumented:	Instrumented:	Instrumented:
	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)
	Instrument for IV regression:	Instruments for IV regression:	Instruments for IV regression:			
	First lag of	First lag of				
	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)	log(100*FDI/exports)
					and log( telecommunication	and log(telecommunication
					infrastructure)	infrastructure)
	Statistics robust to	Statistics robust to				
	heteroskedasticity and	heteroskedasticity and				
	clustering on country(robust	clustering on country (robust	autocorrelation (HAC kernel	autocorrelation (HAC kernel	autocorrelation (HAC kernel	clustering on country (robust
	to arbitrary within-group	to arbitrary within-group	estimator/Newey-West)	estimator/Newey-West)	estimator/Newey-West )	to arbitrary within-group
	correlation)	correlation)				correlation)
Number of observations	168	168	168	168	168	168

#### Table 3.6. IV regressions: checking the exogeneity of the independent variables

Notes: Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.

• In an influential paper, Arellano and Bond (1991) proposed a test for serial correlation, where rejection of the null hypothesis means that disturbance terms are autocorrelated (other tests exist, but this test is more general in its applicability than other tests). In Stata, the Arellano–Bond test for autocorrelation is obtained through the 'abar' command. Arellano–Bond test for autocorrelation (to run after each regression): abar

To obtain estimates robust to serial correlation, 'abar' is not an official Stata command. Roodman (2009) created it.

• See Bascle (2008) for more details on Arellano and Bond test for AR (1) to test for the presence of serial correlation in static IV context.. The Arellano-Bond test for AR (1) reveals that serial correlation is also present in IV regressions. The above Hansen J test of overidentication restrictions does not reject the null hypothesis that the instruments are uncorrelated with the error term and suggests that we should be satisfied with this specification of the equation.

• Telecommunication infrastructure is measured by telephone lines density.

	Static FE- IV	Static FE- IV	Static FE- IV	Static FE- IV	Static FE- IV
	(1)	(2)	(3)	(4)	(5)
Real ROYpc	-0.4963	-0.565	-0.5688	-1.218	-1.1598
-	(2.18)**	(2.79)***	(2.80)***	(2.14)**	(1.96)*
FDI/exports	-0.115	-0.069	-0.0695	-0.0639	-0.064
	(3.98)***	(2.54)**	(2.55)**	(2.35)**	(2.37)**
Imp/GDP	-0.88	-0.9398	-0.962	-0.991	-0.9375
	(3.10)***	(2.07)**	(2.07)**	(2.09)**	(2.60)**
log (population)	-0.506	-0.555	-0.563	-0.775	-0.74
	(0.80)	(0.75)	(0.77)	(1.02)	(1.02)
Institutional quality	0.0028	0.002	0.002	0.003	0.0027
	(0.92)	(0.69)	( 0.70)	(0.87)	(0.82)
Country fixed effect	Yes	Yes	Yes	Yes	Yes
Fixed effect by year	Yes	Yes	Yes	Yes	Yes
First-stage F-stat cluster-robust	14.87***	60.41***	34.44 ***	29.96 *** (for imp)	23.81***
				12.98 *** (for real ROY pc)	
Partial R <sup>2</sup> for excluded instruments	0.3254	0.3789	0.3825	Shea Partial R <sup>2</sup>	0.2401
				0.3722	
				0.2708	
Hansen J statistic of overidentifying restrictions	Equation exactly identified	equation exactly identified	0.272	0.130	equation exactly identified
			Chi-sq(1) P-val = 0.6019	Chi-sq(1) P-val = 0.7179	
Kleibergen-Paap rk Wald F statistic	14.865	60.405	34.441	13.824	23.812
Stock-Yogo weak ID test critical values:					
10% maximal IV size	16.38	16.38	19.93	13.43	16.38
15% maximal IV size	8.96	8.96	11.59	8.18	8.96
Durbin-Wu-Hausman endogeneity test	2.419	0.192	0.294	2.366	1.988
	Chi-sq(1) P-val = 0.1199	Chi-sq(1) P-val = 0.6617	Chi-sq(1) P-val = 0.5878	Chi-sq(2) P-val = 0.3064	Chi-sq(1) P-val = 0.1585
	Instrumented: FDI/exports	Instrumented: Imports	Instrumented: Imports	Instrumented: Imports, real	Instrumented: real ROY pc
	Instrument for IV regression:	Instrument for IV regression :	Instruments for IV regression :	ROY pc	Instruments for IV regression: :real
	FDI/exports lagged (one year)	Imports lagged (one year)	Imports lagged (one year) and	Instruments for IV regression :	ROY pc lagged (one year)
			log (telecommunications	Imports lagged (one year), real	
			infrastructure)	ROY pc(one year) and	
				telecommunications	
	~	~	~ · · ·	infrastructure	~ · · ·
	Statistics robust to	Statistics robust to	Statistics robust to	Statistics robust to	Statistics robust to
	neteroskedasticity and	neteroskedasticity and	neteroskedasticity and	neteroskedasticity and clustering	neteroskedasticity and clustering on
	clustering on country (robust to	clustering on country (robust	clustering on country (robust	on country (robust to arbitrary	country (robust to arbitrary within-
	arourary within-group	io aronary within-group	contrainery within-group	wium-group correlation)	group correlation)
Number of the metions				1/0	160
Number of observations	168	108	108	168	108

Table 3.7. IV regressions: checking exogeneity of the explanatory variables

Notes:

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.

• The Arellano-Bond test for AR (1) reveals that serial correlation is also present. The above Hansen J test of overidentication restrictions does not reject the null hypothesis that the instruments are uncorrelated with the error term and suggests that we should be satisfied with this specification of the equation.

#### 3.3.3.3 Robustness checks: alternative measures of real royalties

We run robustness tests using an alternative measure of real royalties (author conception and calculation). We divide the royalties & license fees (in US dollars) by export value index in order to capture the outward orientation of the economy and the influence of royalties as export of services and to get a real value.

• Measure 1

$$\log(Roy) = \log\left[\frac{Royalties \& license fees payments}{export value index}\right]$$

• Measure 2

$$\log(Roy) = \log\left[\frac{Royalties \& license fees payments}{unit value index of exports}\right]$$

 $\log TOT_{it} = \gamma + \alpha_i + \alpha_t + \alpha_1 \log Roy_{it} + \alpha_2 \log FDI_{it} + \alpha_3 \log pop_{it} + \alpha_4 imp_{it} + \alpha_5 inst_{it} + u_{it}$ 

This equation is estimated using a within-groups estimator, which controls for country specific heterogeneity. We provide regressions with Newey–West standard errors. We also cluster standard errors at the country level and we report Driscoll-Kraay correction to assess robustness to estimation technique. Tables 3.8 to 3.10 report TOT regressions using different measures of royalties. In regressions using Newey-West standard errors correction, the findings show negative and statistically significant estimated coefficients on FDI, Royalties, imports and population.

		R	Regression wit	h Newey-Wes	st standard erro	ors		Fixed effect (within) regression with Rogers or clustered ( at the count level) standard errors						Fixed effect (within) regression with Driscoll –Kraay standard errors		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	
log (Roy/export value index )	-0.025 (1.83)*	-0.025 (1.85)*	-0.023 (1.69)*	-0.023 (1.69)*	-0.024 (1.76)*	-0.024 (1.77)*	-0.025 (1.84)*	-0.025 (1.95)*	-0.025 (2.01)*	-0.023 (1.74)*	-0.023 (1.74)*	-0.024 (1.83)*	-0.024 (1.87)*	-0.024 (2.05)**	-0.024 (2.02)*	
log(100*FDI/exports )	-0.063 (2.73)***	-0.07 (3.04)***	-0.063 (2.61)***	-0.063 (2.61)***	-0.062 (2.76)***	-0.069 (3.05)***	-0.066 (2.23)**	-0.063 (2.53)**	-0.07 (2.89)***	-0.063 (2.45)**	-0.063 (2.45)**	-0.062 (2.55)**	-0.069 (2.89)***	-0.062 (9.51)***	-0.069 (9.87)***	
log(pop)	-0.723 (5.02)***		-0.768 (1.69)*		-0.735 (3.16)***			-0.723 (2.05)*		-0.768 (1.21)		-0.735 (2.15)**		-0.735 (5.08)***		
log (Rpop)		-1.007 (2.90)***		-0.768 (1.69)*		-1.017 (3.03)***	-1.1801 (2.77)***		-1.007 (2.02)*		-0.768 (1.21)		-1.017 (2.10)**		-1.017 (4.49)***	
Imp/GDP	-0.626 (6.90)***	-0.67 (3.92)***	-0.676 (3.31)***	-0.67 (3.31)***	-0.606 (3.75)***	-0.6486 (3.95)***		-0.6226 (2.49)**	-0.67 (2.68)**	-0.67 (2.22)**	-0.676 (2.22)**	-0.606 (2.57)**	-0.6486 (2.71)***	-0.606 (6.58)***	-0.6486 (6.73)***	
log (Imports, constant 2000 US \$)							-0.0918 (2.41)**									
Institutional quality	0.0012 (0.48)	0.0014 (0.55)	0.0017 (0.69)	0.0017 (0.69)			-0.0011 (0.45)	0.0012 (0.37)	0.0014 (0.44)	0.0017 (0.51)	0.0017 (0.51)					
Constant	20.528 (3.99)***	0.408 (0.23)	21.46 (2.21)**	1.596 (0.70)	20.83 (4.23)***	6.214 (16.31)***	1.253 (0.48)	17.823 (2.88)***	2.422 (1.73)*	18.56 (1.66)	3.025 (1.77)*	18.09 (3.06)***	2.428 (1.73)***	18.09 (7.07)***	2.428 (3.98)***	
Year dummies	No	No	Yes	Yes	No	No	No	No	No	Yes	Yes	No	No	No	No	
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Within R <sup>2</sup>								0.2547	0.2516	0.2732	0.2732	0.2534	0.2494	0.2534	0.2494	
R <sup>2</sup> (newey)	0.5525	0.5636	0.5503	0.5636	0.5518	0.5494	0.5638									
Number of country units	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	
Number of observations	196	196	196	196	196	196	190	196	196	196	196	196	196	196	196	

#### Table 3.8. Dependant variable: log (TOT) over the period 1997-2003

Notes:

• Rpop is the population of a developing country divided by the population of the G5 (USA, UK, Japan, Germany and France). Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag.

• We obtain clustered standard errors by using the Stata command xtreg, fe cluster (country).

• In columns 3 and 4, the Wald test of joint significance rejects the inclusion of year dummies.

		Regression with Newey-West standard errors						Fixed effect (within) regression with Driscoll –Kraay standard errors				Fixed effect (within) regression with Rogers or clustered (at the country level) standard errors			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	.5 (4)	(1)	(2)	(3)	(4)
log (Roy/exports , BOP )	(1)	-0.0219 (1.68)*	-0.02 (1.69)*	(1)	(5)	(0)	(7)	-0.02 (2.13)**	(2)	(3)	(1)	-0.02 (1.75)*	(2)	(3)	(1)
log (Roy/unit value index of exports )				-0.032 (2.32)**	-0.03 (2.17)**	-0.032 (2.33)**	-0.03 (2.20)**		-0.032 (2.67)**	-0.032 (2.68)**	-0.03 (2.39)**		-0.032 (2.59)**	-0.032 (2.62)**	-0.03 (2.23)**
log(100*FDI/exports )	-0.0875 (2.96)***	-0.062 (1.99)**	-0.062 (2.72)***	-0.06 (2.71)***	-0.0587 (2.46)**	-0.06 (2.66)***	-0.061 (2.48)**	-0.062 (8.63)***	-0.06 (7.61)***	-0.06 (7.77)***	-0.061 (6.17)***	-0.062 (2.48)**	-0.06 (2.52)**	-0.06 (2.49)**	-0.061 (2.31)**
log(pop)	-0.932 (3.56)***	-0.806 (2.58)***	-0.583 (2.41)**	-0.5087 (2.21)**	-0.576 (1.10)	-0.4999 (2.07)**	-0.611 (1.21)	-0.583 (4.37)***	-0.5087 (3.98)***	-0.4999 (4.11)***	-0.611 (2.56)**	-0.583 (1.67)	-0.5087 (1.55)	-0.4999 (1.46)	-0.611 (0.90)
log (100*Imp/GDP)			-0.309 (3.68)***	-0.304 (3.63)***	-0.3367 (3.62)***	-0.306 (3.52)***	-0.3449 (3.49)***	-0.309 (5.69)***	-0.304 (5.91)***	-0.306 (5.69)***	-0.3449 (5.54)***	-0.309 (2.55)***	-0.304 (2.54)**	-0.306 (2.47)**	-0.3449 (2.40)**
log (Imports, constant 2000 US \$)	-0.03 (0.65)	-0.0826 (2.12)**													
Institutional quality	-0.002 (0.67)	-0.001 (0.45)	0.001 (0.40)			0.0007 (0.28)	0.0017 (0.62)	0.001 (0.94)		0.0007 (0.91)	0.0017 (1.71)*	0.001 (0.32)		0.0007 (0.23)	0.0017 (0.49)
Constant	19.9 (5.53)***	23.9 (3.89)***	17.898 (3.61)***	17 (3.62)***	18.478 (1.67)*	16.79 (3.38)***	19.146 (1.78)*	15.819 (6.83)***	15.119 (6.63)***	14.936 (6.94)***	16.904 (3.88)***	15.819 (2.71)**	15.119 (2.78)***	14.936 (2.60)**	16.904 (1.41)
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	No	No	No	Yes	No	Yes	No	No	No	Yes	No	No	No	Yes
Within R <sup>2</sup>								0.2964	0.3270	0.3275	0.3544	0.2964	0.3270	0.3275	0.3544
R <sup>2</sup> ( newey )	0.5591	0.5613	0.5776	0.5962	0.6114	0.5965	0.6127								
Number of country units	34	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Number of observations	238	190	196	190	190	190	190	196	190	190	190	196	190	190	190

#### Table 3.9. (Continued) Dependant variable: log (TOT) over the period 1997-2003

Notes:

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level ; \*\*Significant at 5% level, \*Significant at 10% level.

• In the regression with Newey-West standard errors, Wald test of joint significance reject the inclusion of year dummies.

• The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag.

	Regress	ion with News	ey-West stand	ard errors	RHS variables lagged (one year)       Regression with Newey-West standard errors       (1)     (2)     (3)     (4)				RHS variables lagged (one year) FE regression with clustered (at the country level) standard errors			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
log(real FDI)	-0.045 (2.36)**	-0.0466 (2.43)**	-0.0456 (2.36)**	-0.043 (2.24)**	-0.062 (2.89)***	-0.0627 (2.94)***	-0.062 (2.89)***	-0.0599 (2.72)***	-0.062 (2.46)**	-0.0627 (2.50)**	-0.062 (2.46)**	-0.0599 (2.35)**
log (Roy/merchandise exports )	-0.0217 (1.67)*				-0.0238 (1.78)*				-0.0238 (1.92)*			
log (Roy/exports , BOP )		-0.0207 (1.70)*				-0.024 (1.97)*				-0.024 (2.23)**		
log (Roy/export value index )			-0.0217 (1.67)*				-0.0239 (1.79)*				-0.0239 (1.93)*	
log (Roy/unit value index of exports)				-0.0317 (2.25)**				-0.0296 (2.20)**				-0.0296 (2.56)**
log(pop)	-0.673 (2.85)***	-0.6633 (2.84)***	-0.673 (2.85)***	-0.578 (2.51)**	-0.53 (1.97)*	-0.5167 (1.92)*	-0.53 (1.97)*	-0.433 (1.63)	-0.53 (1.61)	-0.5167 (1.58)	-0.53 (1.61)	-0.433 (1.39)
log (100*Imp/GDP)	-0.3089 (3.66)***	-0.31 (3.72)***	-0.3089 (3.66)***	-0.309 (3.53)***	-0.385 (3.65)***	-0.39 (3.70)***	-0.385 (3.65)***	-0.382 (3.56)***	-0.385 (2.94)***	-0.39 (2.98)***	-0.385 (2.94)***	-0.382 (2.86)***
Institutional quality		0.0017 (0.62)	0.0018 (0.64)	0.0013 (0.46)	0.006 (1.71)*	0.006 (1.70)*	0.006 (1.71)*	0.0057 (1.53)	0.006 (1.44)	0.006 (1.44)	0.006 (1.44)	0.0057 (1.31)
Constant	19.813 (4.09)***	19.624 (4.10)***	19.896 (4.06)***	18.089 (3.83)***	16.92 (3.05)***	16.247 (2.94)***	17.027 (3.04)***	12.825 (3.01)***	14.857 (2.69)**	14.606 (2.66)***	15.298 (2.71)***	13.674 (2.58)**
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R <sup>2</sup>									0.3119	0.3132	0.3121	0.3261
$R^2$ (newey)	0.5691	0.5686	0.5691	0.5851	0.5691	0.5699	0.5692	0.5773				
Number of country units	28	28	28	28	28	28	28	28	28	28	28	28
Number of observations	196	196	196	196	168	168	168	162	168	168	168	162

#### Table 3.10. (Continued) Dependant variable: log (TOT) over the period 1997-2003

Notes:

• Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses. \*\*\*Significant at 1% level ; \*\*Significant at 5% level, \*Significant at 10% level.

• The Newey-West estimates of the standard errors use one time lag.

#### **3.3.3.4** Estimations and results from a large incomplete panel

In this section, we run new regressions using a large incomplete (highly unbalanced) panel over the period 1990-2007 in order to check robustness of our results. Following Xu and Lu (2009) econometric method, we use two regression specifications: level and difference regression equations.

First, we use a level regression equation specified as follows:

$$\log TOT_{it} = \gamma + \alpha_i + \alpha_t + \alpha_1 \log Roy_{it} + \alpha_2 \log FDI_{it} + \alpha_3 \log pop_{it} + \alpha_4 imp_{it} + u_{it}$$
(22)

Second, following Mansfield & Reinhardt (2008) and Broda (2004), we use the concept of TOT volatility and we consider year-on-year change in TOT. The terms of trade often fluctuate widely across time, although the extent to which this occurs varies by country. Given the variations in TOT across time, we use a difference (time-difference) regression equation specified as follows:

$$\Delta \log TOT_{it} = \eta + \theta_i + \theta_t + \beta_1 \Delta \log Roy_{it} + \beta_2 \Delta \log FDI_{it} + \beta_3 \Delta \log pop_{it} + \beta_4 \Delta imp_{it} + v_{it}$$
(23)

The difference regression equation estimates the link between changes in TOT (in log) and changes in RHS variables. The dependent variable is  $\Delta \log$  (TOT), where  $\Delta$  denotes yearly difference (see Broda, 2004; Mansfield and Reinhardt, 2008). This is useful as the evolution of TOT is pronounced in the time dimension. This equation contains country-specific and year specific fixed effects. Note that the time-differencing level equation (22) would yield a difference equation without country fixed effects, while the difference equation (23) includes country dummies ( $\theta_i$ ) to control for the effects of unobserved country features on changes in the TOT. In this sense, equation (23) is more general than equation (22) in estimating the effects of FDI and royalties' variables on the TOT changes.

We run our regressions using the new advanced techniques for incomplete panel data, which correct heteroskedasticity and autocorrelation. We report Newey-West, HAC kernel and Driscoll-Kraay estimations. To check robustness to technique choice, we also report the results from regressions with Rogers or clustered standard errors (at the country level). Our findings are robust to the technique choice.

Tables (3.11)-(3.13), report the results of TOT level regressions with a set of robustness checks by including different measures of FDI and royalties' payment. Tables 3.14 to 3.16 report the results of TOT differences regressions. The results from difference regressions are consistent with the ones obtained from level regressions. Interestingly, the key regressors - FDI and licensing - appear to significantly affect the directional change in TOT. An improvement (increase from one year to the next) in FDI and licensing measures results in a TOT deterioration. Thus, there seems to be a robust negative association between change in a country's TOT and changes in inward FDI and royalties' payment of the country. In other words, larger drops in TOT occurred in countries with faster growth of FDI and licensing are the ones with more competition in the global market, and hence TOT tend to decrease by a larger amount in such countries. In addition, Southern TOT deterioration results from faster population growth which is a Ricardian prediction in Matsuyama (2000) extended DFS (1977) model.

This gives credence to our results obtained from the balanced panel case. In addition, we follow Broda (2004) and we exclude oil exporting developing countries -Venezuela, Nigeria and Angola in our case- (Algeria is dropped because of the lack of data on royalties) in Tables 3.13, 3.14 and 3.15. Our findings are robust to this exclusion.

We also report regressions with RHS variables lagged one year. The sign and the significance of the key regressors are robust to this test. Our findings are robust to lagging the key RHS variables -FDI and royalties -by one year (see Tables 3.B.1 and 3.B.2 in the Appendix B of chapter 3 and Table 3.10).

Dependant variable : log(TOT)		Newey-West estimation $(1)$ $(2)$ $(4)$ $(5)$ $(6)$ $(7)$						heteroskeda	FE regressior sticity robust	n with standard erro	ors		Driscol	ll-Kraay estir	mation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(5)
log (real Roy)			-0.02 (2.11)**	-0.034 (3.67)***	-0.035 (3.73)***	-0.021 (2.18)**	-0.036 (3.73)***	-0.02 (2.32)**	-0.034 (4.25)***	-0.035 (4.33)***	-0.021 (2.41)**			-0.02 (3.02)***	-0.034 (4.27)***	-0.035 (4.26)***
log(real FDI)	-0.0196 (3.51)***		-0.037 (2.59)***			-0.0396 (2.74)***		-0.037 (3.16)***			-0.0396 (3.35)***	-0.0196 (4.07)***		-0.037 (2.95)***		
log(100*FDI/exports)		-0.032 (2.31)**		-0.0667 (3.05)***			-0.0648 (2.98)***		-0.0667 (3.69)***				-0.032 (2.68)***		-0.0667 (2.54)**	
log(100 FDI/GDP )					-0.042 (1.82)*					-0.042 (2.18)**						-0.042 (2.22)**
log(pop)	-0.344 (1.79)*	-0.263 (1.35)	-0.3626 (1.39)	-0.453 (1.65)	-0.412 (1.41)	-0.3137 (1.20)	-0.375 (1.37)	-0.3626 (1.67)*	-0.453 (1.99)**	-0.412 (1.69)*	-0.3137 (1.45)	-0.344 (2.01)**	-0.263 (1.44)	-0.3626 (2.26)**	-0.453 (3.15)***	-0.412 (2.46)**
Imp/GDP	-0.405 (3.70)***	-0.403 (3.74)***	-0.412 (3.52)***	-0.443 (3.69)***	-0.412 (3.49)***			-0.412 (4.27)***	-0.443 (4.52)***	-0.412 (4.26)***		-0.405 (2.77)***	-0.403 (2.85)***	-0.412 (3.21)***	-0.443 (3.38)***	-0.412 (3.19)***
log(100* imp/GDP )						-0.1377 (2.15)**	-0.142 (2.20)**				-0.1377 (2.51)**					
Constant	8.7085 (2.17)**	10.406 (2.54)**	9.039 (1.95)*	10.50 (2.14)**	9.816 (1.89)*	12.1 (2.17)**	9.897 (3.07)***									
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.3628	0.3420	0.4607	0.4638	0.4554	0.4529	0.4588									
Adj R <sup>2</sup>	0.3115	0.2903	0.3983	0.4017	0.3923	0.3896	0.3954									
Nb of countries	70	71	60	60	60	60	60	59	59	59	59	70	71	60	60	60
Number of observations	1195	1237	772	772	772	772	772	771	771	771	771	1195	1237	772	772	772

#### Table 3.11. TOT level regressions with different measures of FDI

Notes:

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses in Newey –West and Driscoll-Kraay estimations. The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag.

• We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional independence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced (Not enough common observations across panel to perform Pesaran's test.).

• List of countries used in our study : Algeria , Angola , Argentina , Bangladesh , Benin , Bolivia , Botswana, Brazil , Burkina Faso, Burundi , Cameroon, Central African Republic, Chile, China, Colombia, Congo Dem. Rep, Congo Rep., Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Gabon ,Ghana, Guatemala, Guinea, Haiti, Honduras , Hong Kong, Hungary, India, Indonesia, Jordan, Kenya, South Korea, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nicaragua, Niger, Nigeria, Pakistan, Panama, Paraguay , Peru, Philippines, Poland, Rwanda, Senegal, Seychelles, South Africa , Sri Lanka, Tanzania, Thailand, Togo, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Zambia and Zimbabwe.

• The introduction of royalties' variable strongly dropped the size of our sample because of the lack of data for many countries. One singleton is dropped in the OLS estimation using Stata command "xtivreg2" (without excluded instruments).

Dependant variable : log(TOT)	Newey	y-West	FE regree heteroskedasticity r	ssion with obust standard errors	Drisc/H	Kraay	FE Regression w the country level	vith clustered (at ) standard errors	FE regression correction(Ba (1999)	on with AR(1) altagi and Wu's method )
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
log ( Roy/exports of goods &services)	-0.0285 (2.76)***	- 0.0287 (2.74)***	-0.0285 (3.03)***	- 0.0287 (3.02)***	-0.0285 (3.13)***	- 0.0287 (2.97)***	-0.0285 (2.06)**	- 0.0287 (2.05)**	-0.014 (2.59)***	-0.014 (2.56)***
log(real FDI)	- 0.053 (4.02)***	- 0.0565 (4.15)***	- 0.053 (5.07)***	- 0.0565 (5.25)***	-0.053 (4.20)***	- 0.0565 (4.25)***	-0.053 (2.38)**	- 0.0565 (2.42)**	-0.03 (2.08)**	-0.032 (2.12)**
log(pop)	-0.424 (1.59)	-0.377 (1.41)	-0.424 (1.92)*	-0.377 (1.71)*	-0.424 (2.63)**	-0.377 (2.23)**	-0.424 (0.91)	-0.377 (0.81)	-0.097 (0.68)	-0.104 (0.72)
Imports/GDP	-0.422 (3.61)***		-0.422 (4.40)***		-0.422 (3.35)***		-0.422 (2.17)**		-0.36 (4.10)***	
log(100* imports/GDP)		-0.14 (2.20)**		-0.14 (2.57)***		-0.14 (1.63)		-0.14 (1.43)		-0.143 (3.60)***
Constant	12.8792 (2.60)***	13.011 (2.30)**							0.066 (1.47)	0.045 (1.00)
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.4655	0.4572								
Adj R <sup>2</sup>	0.4036	0.3944								
Within R <sup>2</sup>									0.5197	0.5149
Number of country units	60	60	59	59	60	60	59	59	59	59
Number of observations	772	772	771	771	772	772	771	771	712	712

#### Table 3.12. Robustness checks: log (Roy/exports of goods & services) as RHS variable

Notes:

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag.

• In order to report FE estimation with heteroskedasticity robust standard errors, we use Stata command "xtivreg2" without instruments and with "robust" option.

• For FE regressions, we use the Stata command "xtivreg2" without instruments. One singleton is dropped in the estimation. FE regression with AR(1) correction applied with Baltagi and Wu's (1999) method reports standard errors estimates robust to disturbances being autocorrelated with AR (1). We use "xtregar" Stata command to estimate a fixed-effects panel model with AR1 structure. The command xtregar estimates fixed-effects (difference estimator) when disturbance term is first-order autoregressive. However, this method does not correct heteroskedasticity. Estimation is this case applied with first order autoregressive residuals, according to the method of Baltagi and Wu (1999). We use the Baltagi-Wu locally best invariant (LBI) option because panel is unbalanced.

• We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional independence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced (Not enough common observations across panel to perform Pesaran's test.).

Dependant variable : log(TOT)			Newey-West	FE regress heteroskedast	sion with icity robust	Drisc/Kraay		FE regression with clustered ( at the country		FE regressio correction (B	n with AR(1) altagi and Wu's
				standard	errors			level) sta	indard errors	(1999) method )	)
	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
log ( Roy/export value	-0.025	-0.0256	-0.024	-0.025	-0.0256	-0.025	-0.0256	-0.025	-0.0256	-0.0147	-0.015
index )	(2.52)**	(2.51)**	(2.56)**	(2.77)***	(2.77)***	(2.68)***	(2.60)**	(1.86)*	(1.86)*	(2.68)***	(2.71)***
log(real FDI)	-0.0526	-0.056	-0.03	-0.0526	-0.056	-0.0526	-0.056	-0.0526	-0.056	-0.032	-0.031
	(3.98)***	(4.11)***	(3.46)***	(5.03)***	(5.21)***	(4.16)***	(4.22)***	(2.35)**	(2.40)**	(2.11)**	(2.07)**
log(pop)	-0.42	-0.3717	-0.386	-0.42	-0.3717	-0.42	-0.3717	-0.42	-0.3717	-0.101	-0.095
	(1.57)	(1.39)	(1.47)	(1.90)*	(1.69)*	(2.62)**	(2.23)**	(0.90)	(0.80)	(0.71)	(0.67)
Imports/GDP	-0.416		-0.236	-0.416		-0.416		-0.416			-0.356
	(3.56)***		(2.52)**	(4.34)***		(3.31)***		(2.14)**			(4.07)***
log(100* imports/GDP)		-0.137			-0.137		-0.137		-0.137	-0.142	
		(2.15)**			(2.50)**		(1.60)		(1.40)	(3.57)***	
Constant	9.757	9.474	13.193							0.064	0.085
	(2.05)**	(1.98)**	(2.39)**							(1.41)	(1.88)
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.4637	0.4554	0.4807								
Adj R <sup>2</sup>	0.4016	0.3924	0.4210								
within R <sup>2</sup>										0.5146	0.5194
Number of country units	60	60	57	59	59	60	60	60	60	59	59
Number of observations	772	772	747	771	771	772	772	772	772	712	712
			Angola, Nigeria and Venezuela (as oil exporting								
			countries) are excluded								

#### Table 3.13. Robustness checks: log (Roy/export value index) as RHS variable

Notes :

• The t-stats (absolute value) in parentheses are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag.

- For FE estimations, we use the Stata command "xtivreg2" without instruments. One singleton is dropped in the estimation using Stata command "xtivreg2" (without instruments)
- FE regression with AR(1) correction applied with Baltagi and Wu's (1999) method reports standard errors estimates robust to disturbances being autocorrelated with AR(1) process. We use "xtregar" Stata command to estimate a fixed-effects panel model with AR1 structure. We use the LBI option because panel is unbalanced. However, this method does not correct heteroskedasticity.
- We use Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for crosssectional independence in panel data (see Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced (Not enough common observations across panel to perform Pesaran's test). Stata command "xtcsd" is capable of performing Pesaran's (2004) CD test for slightly unbalanced panels.

	Dependant variable : log(TOT)					Dependant variable : $\Delta$ log(TOT					) (where $\Delta$ denotes yearly difference)				
	(1)	(2)	(3)	(4)	(5)		(1) (2)		(2)	(3)		(	4)		
	FE regression with heteroskedasticity	Newey- West	Drisc/Kraay	FE regression with clustered (at the country level) standard	FE regression with AR(1) correction (Baltagi and Wu's (1999) method)		FE regression H with heteroskedasticity		kernel	Drisc/	Kraay	FE regress clustered ( country lev	ion with at the el) standard		
	errors			errors			errors			lag(1) option	lag(0) option	citors			
log(Roy/merchandise exports )	-0.028 (2.95)***	-0.028 (2.67)***	-0.028 (2.77)***	-0.028 (1.99)**	-0.015 (2.84)***	$\Delta \log(\text{Roy/merchandise} + \text{exports})$	- 0.0118 (1.82)*	- 0.0118 (2.04)**	-0.0098 (1.97)**	- 0.0118 (2.01)**	- 0.0118 (2.15)**	- 0.0118 (2.55)**	-0.0098 (2.18)**		
log(real FDI )	-0.0565 (5.25)***	-0.0565 (4.15)***	-0.0565 (4.27)***	-0.0565 (2.42)**	-0.032 (2.12)**	$\Delta$ log(real FDI )	- 0.0268 (2.29)**	- 0.0268 (2.27)**	-0.021 (2.13)**	- 0.0268 (2.53)**	- 0.0268 (2.33)**	- 0.0268 (2.21)**	-0.021 (2.03)**		
log(pop)	-0.37 (1.69)*	-0.37 (1.39)	-0.37 (2.22)**	-0.37 (0.80)	-0.11 (0.78)	$\Delta \log$ (pop)	-3.53 (2.14)**	-3.53 (2.21)**	- 3.58 (2.37)**	-3.53 (2.10)**	-3.53 (2.28)**	- 3.53 (3.66)***	- 3.58 (3.95)***		
log(imports)	-0.1388 (2.54)**	-0.1388 (2.18)**	-0.1388 (1.61)	-0.1388 (1.42)	-0.143 (3.62)***	$\Delta \log(\mathrm{imports})$	- 0.132 (2.44)**	- 0.132 (2.43)**	- 0.094 (1.82)*	- 0.132 (3.42)***	- 0.132 (2.71)***	- 0.132 (2.45)**	- 0.094 (1.91)*		
Constant		9.229 (1.94)*	11.21 (3.89)***		0.049 (1.09)	Constant				0.094 (2.63)***	0.094 (2.89)***				
Time fixed effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Time fixed effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
R <sup>2</sup> Adj R <sup>2</sup>		0.4570 0.3941													
Within R <sup>2</sup>					0.5157					0.1353	0.1353				
Number of countries	59	60	60	60	59	Number of countries	58	58	55	59	59	58	55		
Number of observations	771	772	772	772	712	Observations	698	698	678 Angola, Nigeria and Venezuela (as oil exporting countries) are excluded	699	699	698	678 Angola, Nigeria and Venezuela (as oil exporting countries) are excluded		

### Table 3.14. TOT level and difference regressions

Notes:.

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. Wooldridge test does not reject serial autocorrelation in TOT difference regressions. However, Arellano-Bond test for AR (1) (z = -0.81 Pr > z = 0.4192) and Baltagi-Wu LBI=statistics (Baltagi-Wu LBI = 2.081189) reject the presence of serial autocorrelation in TOT difference regressions. The Baltagi- Wu LBI-statistic (A value of the statistic around 2 signals the absence of serial correlation in the residuals) is the equivalent of the Durbin-Watson statistic and is the relevant statistic for a test of serial correlation in the case of an unbalanced panel (because the Durbin-Watson-statistic is not appropriate in case of an unbalanced panel). A value of the Baltagi-Wu LBI-statistic far below 2 indicates that correction for serial correlation is clearly necessary.

• FE regression with AR(1) correction applied with Baltagi and Wu's (1999) method reports standard errors estimates robust to disturbances being autocorrelated with AR(1) process. We use "xtregar" Stata command to estimate a fixed-effects panel model with AR1 structure. However, this method does not correct heteroskedasticity. We use the LBI option because panel is unbalanced.

Royalties are royalties & license fees divided by merchandise exports to control for the outward orientation of a developing country. This measure reflects the relative importance of royalties & license fees payment considered as export of services.

	<b>Dependant variable :</b> $\Delta \log(\text{TOT})$ (where $\Delta$ denotes yearly difference)									
		(1)	(2)	(3)		(4)		(5)	(6)	(7)
	Newey –West		Fixed effect regression with	HAC kernel		Drisc/Kraay		FE regression with clustered	FE regression with clustered	HAC kernel
	lag(0) option	lag(1) option	standard errors		lag(0) option	lag(1) option	lag(2) option	level) standard errors	level) standard errors	
$\Delta$ log (Roy/ export value index)	-0.0116 (2.05)**	-0.0116 (2.19)**	- 0.0115 (1.75)*	- 0.0115 (1.87)*	- 0.0115 (2.08)**	- 0.0115 (1.96)*	- 0.0115 (2.05)**	- 0.0115 (2.53)**	-0.009 (2.10)**	-0.009 (1.78)*
$\Delta$ log(real FDI )	-0.037 (2.70)***	-0.037 (2.65)***	-0.0268 (2.30)**	-0.0268 (2.29)**	-0.0268 (2.32)**	-0.0268 (2.52)**	-0.0268 (3.02)***	-0.0268 (2.27)**	-0.021 (2.03)**	-0.021 (2.12)**
$\Delta \log( ext{pop})$	-0.5989 (0.84)	-0.5989 (0.86)	-3.53 (2.14)**	-3.53 (2.16)**	-3.53 (2.28)**	-3.53 (2.10)**	-3.53 (2.08)**	-3.53 (3.73)***	-3.5796 (3.94)***	-3.5796 (2.27)**
$\Delta$ log(imports)	-0.081 (1.42)	-0.081 (1.42)	- 0.131 (2.43)**	- 0.131 (2.47)**	- 0.131 (2.70)***	- 0.131 (3.41)***	- 0.131 (3.67)***	- 0.131 (2.49)**	-0.093 (1.89)*	-0.093 (1.84)*
Constant	0.017 (1.29)	0.017 (1.31)			0.0939 (2.89)***	0.0939 (2.63)***	0.0939 (2.62)***			
Time fixed effect (year dummies)	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed effect	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R <sup>2</sup>					0.1349	0.1349	0.1349			
Number of countries	59	59	58	58	59	59	59	58	55	55
Number of observations	699	699	698	698	699	699	699	698	678 Angola, Nigeria and Venezuela (as oil exporting countries) are excluded	678 Angola, Nigeria and Venezuela (as oil exporting countries) are excluded

#### Table 3.15. TOT difference regressions

Notes:

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.

• Wooldridge test does not reject the presence serial autocorrelation in TOT difference regressions. However, Arellano-Bond test for AR (1) and Baltagi-Wu LBI-statistics (Baltagi-Wu LBI = 2.0806127) reject the presence of serial autocorrelation in TOT difference regressions. This result does not show significant problems of serial correlation in TOT difference regressions.

• The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag to correct autocorrelation.

• One singleton group dropped by "xtivreg2" (without instruments and using OLS estimation) Stata command in columns (2), (3), (5), (6) and (7).

• We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for crosssectional independence in panel data (see Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced: (Not enough common observations across panel to perform Pesaran's test.).

<b>Dependant variable : log(TOT)</b>				<b>Dependant variable:</b> $\Delta \log(TOT)$ (where $\Delta$ denotes yearly difference)									
	Newey-West		y-West Driscoll-Kraay			Fixed effect regression with heteroskedasticity robust standard errors		Newey-West		Driscoll-Kraay		Regression v (at country le errors	with clustered evel) standard
	(1) lag(1) option	(2) lag(2) option	(1) lag(1) option	(2) lag(2) option		(1)	(2)	(1) lag(1) option	(2) lag(1) option	(1) lag(1) option	(2) lag(0) Option	(1)	(2)
log (Roy/merchandise exports )	-0.036 (1.69)*	-0.036 (1.69)*	-0.036 (2.19)**	-0.036 (2.25)**	$\Delta \log$ (Roy/merchandise exports)	-0.018 (2.17)**	-0.017 (2.09)**	-0.018 (2.45)**	-0.017 (2.37)**	-0.018 (3.10)***	-0.018 (2.89)***	-0.018 (3.70)***	-0.017 (3.57)***
log(FDI/exports )	- 0.073 (2.25)**	- 0.073 (2.08)**	- 0.073 (2.44)**	- 0.073 (2.46)**	$\Delta\log({ m FDI/exports}$ )	-0.093 (3.45)***	-0.098 (3.61)***	-0.093 (3.22)***	-0.098 (3.36)***	-0.093 (3.44)***	-0.093 (3.33)***	-0.093 (2.88)***	-0.098 (2.99)***
log(pop)	-0.946 (1.67)*	-0.946 (1.53)	-0.946 (2.43)**	-0.946 (2.48)**	$\Delta \log( ext{pop})$	-0.891 (0.42)	-0.2896 (0.15)	-0.891 (0.46)	-0.2896 (0.16)	-0.891 (0.43)	-0.891 (0.41)	-0.891 (0.68)	-0.2896 (0.25)
Imports/GDP	-0.703 (3.32)***	-0.703 (3.24)***	-0.703 (3.75)***	-0.703 (4.39)***	$\Delta$ (imports/GDP)	-0.40 (2.77)***		-0.40 (2.74)***	, <u>,</u>	-0.40 (4.93)***	-0.40 (4.70)***	-0.40 (2.36)**	· · · · ·
					$\Delta \log(100*imports/GDP)$		-0.204 (3.48)***		-0.204 (3.35)***				-0.204 (3.19)***
Constant	24.588 (2.08)**	24.588 (1.90)*	21.137 (3.22)***	21.137 (3.30)***	Constant	-0.0449 (1.81)*	-0.0488 (2.08)	0.0024 (0.12)	0.002 (0.10)	0.0648 (2.27)	- 0.0648 (2.16)	-0.0014 (0.05)	-0.014 (0.54)
Time fixed effect (year dummies)	Yes	Yes	Yes	Yes	Time fixed effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed effect	Yes	Yes	Yes	Yes	Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	37	37	37	37	Number of countries	37	37	37	37	37	37	37	37
Number of observations	444	444	444	444	Observations	407	407	407	407	407	407	407	407

#### Table 3.16. TOT level and difference regressions- (balanced panel) over the period 1996-2007

Notes :

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• Wooldridge test does not reject the presence serial autocorrelation in TOT difference regressions. However, Arellano-Bond test for AR (1) (p value varies from 0.5761 to 0.6308) and Baltagi-Wu LBI-statistics (take the values 1.925 and 1.935) reject the presence of serial autocorrelation in TOT difference regressions. This result does not show significant problems of serial correlation in TOT difference regressions.

• List of countries: Algeria, Angola, Argentina, Bangladesh, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Central African Republic, Chile, China, Colombia, Congo Dem. Rep. Congo, Costa Rica, Cote d'Ivoire Ecuador, Egypt, El Salvador, Ghana, Guatemala, Haiti, Honduras, Hong Kong, China, Hungary, India, Jordan, Kenya, Korea, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Senegal, Seychelles, South Africa, Thailand, Togo, Tunisia, Turkey, Uganda, Uruguay, Venezuela and Zambia.

#### 3.4 Conclusion

In the first section of this chapter, we have examined, within Ricardian setting with CES utility function, the conditions under which North-South TT is immiserizing for the developing country. We have singled out the respective role of the relative size of both countries, the efficiency of the technology, which is transferred, and the elasticity of substitution between the goods which are produced.

In the second section, we have considered the effect of TT originating from the comparatively disadvantaged sector in the developed country and going to the comparatively advantaged sector (the same sector) in the developing country. On comparison with the free trade case without TT, we show that the developed country gains by transferring its technology abroad regardless of the mode of TT (including free TT). The developing country's welfare decreases (compared to free trade without TT) if the quasi rents and royalties that it must pay to the developed country are large compared to the increase in productivity linked to technology transfer.

Our empirical analysis is based on a balanced and incomplete panel data on the developing countries. We have shown that FDI/export, FDI/GDP and Real FDI variables deteriorate the TOT of the developing countries. From the TOT difference regressions, the negative estimated coefficient on foreign presence implies that a country would see a larger drop in the terms of trade the faster the increase in foreign presence in the country.

We think that FDI generates quasi-rents for investors, which in turn repatriated have a negative effect on the developing country's TOT. The exports associated with quasi-rents represent trade in services and spill over to higher demand for imports, which accentuates the deterioration of the developing countries' TOT. Real royalties & license fees coefficient estimates are negative as expected and significant. Royalties and license fees payments deteriorate the developing countries' TOT because of their export supply enhancing effect via TT and their negative effect on the developing countries' trade balance.

To sum up, inward FDI and roylaties' payment (licensing) deteriorate the developing countries' TOT. The rationale: TT via FDI and licensing encourage more export supply from the developing country, which deteriorates its TOT. The increased developing country income spills over in part to greater demand for the developed country exportable.

#### **3.**A Appendix for chapter 3

### **Appendix A**

#### A.I/ The two-country, two-good Ricardian model under free trade before and after TT, with complete specialization of each country

#### > Determination of the terms of trade under free trade, and before and after TT.

We consider that the consumers preferences can be formalized by :

$$U = A \left[ \frac{1}{2} c_1^{-\rho} + \frac{1}{2} c_2^{-\rho} \right]^{-\rho}$$
(A1)

"y" is a country's gross national product measured in terms of good 1. If  $p_a$  is the relative price of good 2 in terms of good 1, in a closed economy (autarky), we have:

$$y = c_1 + p_a c_2 \tag{A2}$$

The maximization of the utility function (A1) under the constraint (A2) gives, in a closed economy, the demand for each good.

$$c_1 = \frac{y}{1 + p_a^{\frac{\rho}{1 + \rho}}}$$
(A3a)

and

 $c_2 = \frac{y}{p_a + p_a^{\frac{1}{1+\rho}}}$ (A3b) A developed country noted \*, and a developing country which were in autarky decide to open their

economies. We consider that the consumers have the same utility function in both countries. Under free trade they exchange their 2 goods according to their comparative advantage. If they are completely specialized, the terms of trade is determined by the condition of equilibrium of their trade.

$$p = \frac{c_1^*}{c_2} = \frac{y^*}{y} \frac{p + p^{1+\rho}}{1 + p^{1+\rho}}$$
(A4)

Under free trade with complete specialization, the real income of each country is :

$$\frac{y}{p} = \frac{L^{*}}{a_{2}^{*}}$$
 (A5a) and  $y = \frac{L}{a_{1}}$  (A5b)

We introduce these expressions in (A4) and obtain the terms of trade before and after the TT (TT), and in the case of complete specialization of both countries:

$$p = \left[\frac{La_2^*}{L^*a_1}\right]^{1+\rho} \tag{A6}$$

$$p' = \left[\frac{La_2^*}{L^*a_1^*}\right]^{1+\rho} \tag{A6b}$$

#### > Welfare of each country after the TT: hypothesis of complete specialization of both countries.

We formalize U (A1) as a function of y and p (using A3a, A3b, A5a, A5b) and get the expressions :

$$B = U = A \left(\frac{1}{2}\right)^{\frac{-1}{\rho}} \frac{y}{\left(1 + p^{\frac{\rho}{1+\rho}}\right)^{\frac{1+\rho}{\rho}}}$$
(A7)

$$\frac{B^{*'}}{B^{*}} = \frac{\frac{y^{*'}}{\left(1+p^{\frac{\rho}{1+\rho}}\right)^{\frac{1+\rho}{\rho}}}}{\frac{y^{*}}{\left(1+p^{\frac{\rho}{1+\rho}}\right)^{\frac{1+\rho}{\rho}}}} = \frac{p'}{p} \frac{\left(1+p^{\frac{\rho}{1+\rho}}\right)^{\frac{1+\rho}{\rho}}}{\left(1+p^{\frac{\rho}{1+\rho}}\right)^{\frac{1+\rho}{\rho}}} = \left[\frac{1+p^{-\frac{\rho}{1+\rho}}}{1+p^{-\frac{\rho}{1+\rho}}}\right]^{\frac{1+\rho}{\rho}}$$
(A8)

1.....

The same demonstration gives the evolution of the developing country's welfare before and after the TT.

$$\frac{B'}{B} = \frac{a_1}{a_1^*} \frac{\left(1 + p^{\frac{\rho}{1+\rho}}\right)^{\frac{1+\rho}{\rho}}}{\left(1 + p^{\frac{\rho}{1+\rho}}\right)^{\frac{1+\rho}{\rho}}}$$
(A9)

## > Developing country's welfare for different values of the elasticity of substitution between goods, and complete specialization of both countries.

In A9, we replace p and p' using (A6) and (A6b)

$$\frac{B'}{B} = \frac{a_1}{a_1^*} \left( \frac{1 + \left(\frac{L}{a_1} \frac{a_2^*}{L^*}\right)^{\rho}}{1 + \left(\frac{L}{a_1} \frac{a_2^*}{L^*}\right)^{\rho}} \right)^{\rho} = \frac{a_1}{a_1^*} \left( \frac{1 + \left(\frac{L}{a_1} \frac{a_2^*}{L^*}\right)^{-\rho}}{\left(\frac{L}{a_1} \frac{a_2^*}{L^*}\right)^{-\rho} + \left(\frac{a_1}{a_1^*}\right)^{\rho}} \right)^{1 + \frac{1}{\rho}}$$
(A10)

Case 1.  $\rho \to \infty \Rightarrow \sigma \to 0$ 

- If 
$$\frac{L}{L^*} \frac{a_2^*}{a_1} \ge 1$$
 that is  $\frac{L}{L^*} \ge \frac{a_1}{a_2^*}$ , since  $a_1 > a_1^*, B'/B \to 0$   
- If  $\frac{L}{L^*} \frac{a_2^*}{a_1} < 1$ , two different cases must be taken into account

Considering the first part of equality (A10), if :  $a_1^* < \frac{L}{L^*} a_2^* \le a_1$ ,  $B'/B \to 0$ 

and if: 
$$\frac{L}{L^*}a_2^* < a_1^*$$
,  $B'/B \to a_1/a_1^* > 1$ 

**Case 2.**  $\rho = 1$  (harmonic utility function), using (A8), we obtain the following condition for a decrease in the developing country's welfare :

$$\frac{B'}{B} = \frac{a_1}{a_1^*} \left( \frac{1 + \left(\frac{L}{a_1} \frac{a_2^*}{L^*}\right)}{1 + \left(\frac{L}{a_1} \frac{a_2^*}{L^*}\right)} \right)^2 < 1$$
(A11)  
$$\left[ \frac{a_1^{1/2} + \left(La_1^{\frac{-1}{2}}\right)\left(a_2^*/L^*\right)}{a_1^{1/2} + \left(La_1^{\frac{*-1}{2}}\right)\left(a_2^*/L^*\right)} \right]^2 < 1$$
$$a_1^{1/2} - a_1^{\frac{*-1}{2}} < \frac{La_2^*}{L^*} \left(\frac{1}{a_1^{\frac{+1}{2}}} - \frac{1}{a_1^{\frac{1}{2}}}\right)$$
$$\frac{L}{L^*} > \frac{a_1^{\frac{1}{2}}a_1^{\frac{*-1}{2}}}{a_2^*}$$
(A12)

#### A.II/ Study of the developing country's welfare when it may be partially specialized

#### > Case where the elasticity of substitution tends to zero.

if the elasticity of substitution between the two goods tends to zero, the developing country's welfare never decreases. We present here the demonstration in the case of full specialization of both countries. The conditions of complete specialization of both countries before TT are :

$$p = \left[\frac{La_2^*}{L^*a_1}\right]^{1+\rho} < \frac{a_2}{a_1} \text{ and } p = \left[\frac{La_2^*}{L^*a_1}\right]^{1+\rho} > \frac{a_2^*}{a_1^*}$$

The condition of complete specialization of both countries after TT is :

$$p' = \left[\frac{La_2^*}{L^*a_1^*}\right]^{1+\rho} < \frac{a_2}{a_1^*}; \quad \text{with } \rho \to \infty \Longrightarrow \sigma \to 0$$

This last necessary condition yields:

$$\left[\frac{La_2^*}{L^*a_1^*}\right] < 1 \Longrightarrow \frac{L}{L^*} < \frac{a_1^*}{a_2^*};$$
(A13)

On the other hand, the developing country's welfare decreases, if:  $\frac{L}{L^*}a_2^* > a_1^*$ 

This condition is in contradiction with (A13); thus if the developing country is completely specialized, its welfare cannot decrease if the elasticity of substitution between the two goods tends to zero. Indeed, in that case it shifts to partial specialization (production of good 2)<sup>139</sup>.

## A.III/ Partial specialization and developing country's welfare with an elasticity of substitution between both goods of 0.5

First, we give the general expressions of the conditions of complete specialization of both countries under free trade before TT. Then the conditions of complete specialization of both countries after TT and the condition for a decline in the developing country's welfare are also presented. Then we derive the mathematical conditions for a decline in the developing country's welfare. We present the detailed mathematical demonstrations for the cases corresponding to segment DF and FH and HI on Figure 3.1 in the text.

Numerical results use Samuelson's (2004) labor coefficients, namely:  $a_2^* = 0.5$ ,  $a_1^* = 2$ ,  $a_2 = 20$ ,  $a_1 = 5$ .

The conditions of complete specialization of both countries under free trade and before TT are:

$$p = \left(\frac{La_2^*}{L^*a_1}\right)^2 < \frac{a_2}{a_1}; \ \frac{L}{L^*} < \frac{a_1^{\frac{1}{2}}a_2^{\frac{1}{2}}}{a_2^*}; \qquad \frac{L}{L^*} < 20$$
(A14)

$$p = \left(\frac{La_2^*}{L^*a_1}\right)^2 > \frac{a_2^*}{a_1^*}; \frac{L}{L^*} > \frac{a_1}{a_2^{\frac{1}{2}}a_1^{\frac{1}{2}}}; \frac{L}{L^*} > 5$$
(A15)

The conditions of complete specialization of both countries after TT are:

$$p' = \left(\frac{La_2^*}{L^*a_1^*}\right)^2 < \frac{a_2}{a_1^*}; \frac{L}{L^*} < \frac{a_1^{\frac{1}{2}}a_2^{\frac{1}{2}}}{a_2^*}; \frac{L}{L^*} < 12.6$$
(A16)

1 1

The developing country's welfare decreases if :

$$\frac{B'}{B} = \frac{a_1}{a_1^*} \left( \frac{1 + (p)^{\frac{1}{2}}}{1 + (p')^{\frac{1}{2}}} \right)^2 < 1$$
(A17)

<sup>&</sup>lt;sup>139</sup> More detailed demonstrations can be obtained on request from the additional Appendix not included in Redor and Saadi (2010)

#### > Study of the segment DF on Figure 3.1 in the text.

The condition for a decrease in the developing country's welfare are given by .

$$\frac{L}{L^*} > \frac{a_1^{\frac{1}{2}} a_2^{\frac{1}{2}}}{a_2^*};$$

 $\frac{L}{L^*} > 6.3$ 

With Samuelson's coefficients :

The conditions for the complete specialization of both countries is given by (A16). The conditions for a complete specialization of both countries before TT (A14 and A15) must also be taken into account , finally :

$$6.3 < \frac{L}{L^*} < 12.6$$

#### Study segment FG on Figure 3.1 in the text. Full specialization of both countries before TT, and partial specialization of the Southern country after TT

This case is a little more complex since we have to calculate the conditions for a developing country's welfare decrease.

The Southern country's welfare decreases if A17 is verified, that is :

$$(p)^{\frac{1}{2}} < \frac{a_1^{*\frac{1}{2}}}{a_1^{\frac{1}{2}}} \left(1 + (p')^{\frac{1}{2}}\right) - 1$$

with :

$$p' = \frac{a_2}{a_1^*} < \left(\frac{La_2^*}{L^*a_1^*}\right)^2; \frac{L}{L^*} > \frac{a_1^{*\frac{1}{2}}a_2^{\frac{1}{2}}}{a_2^*}; \frac{L}{L^*} > 12.6$$

. .

$$p = \left(\frac{La_2^*}{L^*a_1}\right)^2$$

Finally the developing country's welfare decreases in this case if :

$$\left(\frac{L}{L^*}\right) < \left[\frac{a_1^{*\frac{1}{2}}a_1^{\frac{1}{2}}}{a_2^*} + \frac{a_2^{\frac{1}{2}}a_1^{*\frac{1}{2}}}{a_2^*} - \frac{a_1}{a_2^*}\right] \Rightarrow \frac{L}{L^*} < 16.3 \qquad ^{140}$$

<sup>&</sup>lt;sup>140</sup> More detailed demonstrations can be obtained on request from an additional Appendix not included in Redor and Saadi's (2010) paper.

Different Specialization cases	Hypothesis and conditions on economic variables	Developing country's welfare in function of its relative size
Case 1. Complete specialization of both countries before and after TT	The conditions of complete specialization after TT is : $p' = \left(\frac{La_2^*}{r^*}\right)^2 < \frac{a_2}{r^*}; \frac{L}{r^*} < 12.6 ;$	The developing country's welfare decreases if:
Complete specialization of both countries before and after TT	$L a_1 = a_1 = L$ Condition for a decrease in the developing country's welfare :	$6.3 < \frac{L}{L^*} \le 12.6$
(segment DF on Figure 3.1)	$\frac{L}{L^*} > 6.3$	
	For $L/L^* = 0.5$ , $B/B = 1$ , for $L/L^* = 12.6$ , $B'/B = 0.74$	
Case 2. Complete specialization of both countries before TT and partial specialization of developing country after TT	Partial specialization of the developing country after TT: $p' = \frac{a_2}{a_1^*} \le \left(\frac{La_2^*}{L_1^*a_1^*}\right)^2; \frac{L}{L_1^*} \ge 12.6$	The developing country's welfare decreases if: $12.6 \le \frac{L}{L^*} < 16.3$
Complete specialization of both countries before TT and partial specialization of developing country after TT (segment EG and GH on Figure 3.1)	Condition for a decrease in the developing country's welfare : $\frac{L}{L^*} < 16.3$	(segment FG) For $16.3 \le \frac{L}{L^*} < 20$
(segment i G and Gir on Tigure 5.1)	for $L/L^* = 16.3$ , $B'/B = 1$ in G	$1 \le \frac{B'}{B} < 1.29$ (segment GH)
Case 3.Partial specialization of the developed country before TT and complete specialization of both countries after TT	Partial specialization of the developed country before TT $p = \frac{a_2^*}{a_1^*} > \left(\frac{La_2^*}{L^*a_1}\right)^2; \frac{L}{L^*} < 5$ $p' = \left(\frac{La_2^*}{L^*a_1^*}\right)^2 < \frac{a_2}{a_1^*}; \frac{L}{L^*} < 12.6$ Condition for a decrease in the developing country's welfare : $\frac{L}{L^*} > 5.4$	In this case, with the Samuelson's (2004) numerical coefficients, the developing country's welfare does not decrease.
Case 4.Partial specialization of developed country before TT and partial specialization of the developing country after TT	Partial specialization of the developed country before TT $p = \left(\frac{La_2^*}{L^*a_1}\right)^2 < \frac{a_2^*}{a_1^*}; \frac{L}{L^*} < 5$	With Samuelson's (2004) numerical coefficients, this case of specialization is impossible

	* ~ ~ *	· • •	<b>3</b> 0 <b>5</b>	
Table 3.A.1. The developing country's welfare with partial specialization, an elasticity of substitution of 0.5 and Samuelson's (2004) labour coefficients: a	$a_{a} = 0.5, a_{a}$	$= 2, a_2 = 2$	$20.a_1 = 5$	
the second provide the second provide the provide the provide the second provide the seco	),	_,, _		

	Partial specialization of the developing country after TT	
	$p' = \frac{a_2}{a_1^*} < \left(\frac{La_2^*}{L^*a_1^*}\right)^2; \frac{L}{L^*} > 12.6$	
Case 5.Partial specialization of developing country before TT and complete specialization of both countries after TT	$p = \frac{a_2}{a_1} < \left(\frac{La_2^*}{L^*a_1}\right)^2; \frac{L}{L^*} > 20$	This case of specialization is impossible
	The conditions of complete specialization of both countries after TT is :	
	$p' = (\frac{La_2^*}{L^*a_1^*})^2 < \frac{a_2}{a_1^*}; \frac{L}{L^*} < 12.6$ .	
	This case of specialization is impossible	
Case 6.Partial specialization of Southern country before and after TT	$p' = \frac{a_2}{a_1^*} < \left(\frac{La_2^*}{L^*a_1^*}\right)^2; \frac{L}{L^*} > 12.6$	The developing country's welfare never decreases whatever the value of technical coefficients
	$p = \frac{a_2}{a_1} < \left(\frac{La_2^*}{L^*a_1}\right)^2; \frac{L}{L^*} > 20$	
	Thus: $\frac{L}{L^*} > 20$ , with $B'/B = 1.29$	

• The demonstrations for cases 3, 4, 5,6 in table 3.A.1 can be obtained from the authors on request

#### **Appendix B**

#### **B-I** Welfare effect of TT via licensing

$$B^{*} = \frac{y^{*2}}{4p} \text{ and } B^{*} = \frac{y^{*2}}{4p'}, \quad y^{*} = \frac{L^{*}}{a_{2}^{*}}p \text{ and } y^{*} = \frac{L^{*}}{a_{2}^{*}}p' + b\frac{L}{a_{1}^{*}}$$
$$B = \frac{y^{2}}{4p}; \quad B' = \frac{y'^{2}}{4p'}; \quad y = \frac{L}{a_{1}} \text{ and } y' = \frac{L}{a_{1}^{*}}.$$
$$p = \frac{a_{2}^{*}L}{a_{1}L^{*}} \text{ and } p' = \frac{(1+2b)a_{2}^{*}L}{a_{1}^{*}L^{*}}$$

The change of the developed country's welfare is given by  $\frac{B^2}{B}$ 

$$\frac{p^{*}}{p^{*}} = \frac{\frac{(\frac{L^{*}}{a_{2}}p' + b\frac{L}{a_{1}})}{4p'}}{\frac{(\frac{L^{*}}{a_{2}}p)^{2}}{\frac{(\frac{L^{*}}{a_{2}}p)^{2}}{4p}}}$$

By replacing  $p = \frac{a_2^* L}{a_1 L^*}$ ,  $p' = \frac{(1+2b)a_2^* L}{a_1^* L^*}$  and by simplifying, we obtain

$$\frac{B^{*'}}{B^{*}} = \left(\begin{array}{c} \frac{(1+3b)^2}{(1+2b)} \end{array}\right) \left(\frac{a_1}{a_1^*}\right) > 1$$

$$B'$$

The change of the developing country's welfare is given by

$$\frac{B'}{B} = \frac{\frac{(\frac{L}{a_1^*})^2}{\frac{4p'}{(\frac{L}{a_1})^2}}}{\frac{(\frac{L}{a_1})^2}{\frac{4p}{4p}}}$$

By replacing  $p = \frac{a_2^* L}{a_1 L^*}$ ,  $p' = \frac{(1+2b)a_2^* L}{a_1^* L^*}$  and by simplifying, we obtain

$$\frac{B'}{B} = \left(\frac{1}{1+2b}\right) \left(\frac{a_1}{a_1^*}\right) \ge <1$$

#### **B-II** Welfare effect of TT via FDI

$$B^{*} = \frac{y^{*2}}{4p} ; B^{*} = \frac{y^{*'2}}{4p'} ; y^{*} = \frac{L^{*}}{a_{2}^{*}}p \text{ and } y^{*} = \frac{L^{*}}{a_{2}^{*}}p' + \frac{\pi_{FDI}}{a_{1}^{*}(1+ck)}.$$

$$B = \frac{y^{2}}{4p} ; B' = \frac{y'^{2}}{4p'} ; y = \frac{L}{a_{1}} \text{ and } y' = \frac{L}{a_{1}^{*}(1+ck)}.$$

$$p = \frac{a_{2}^{*}L}{a_{1}L^{*}} \text{ and } p' = \frac{a_{2}^{*}(L+2\pi_{FDI})}{a_{1}^{*}L^{*}(1+ck)}.$$

The change of the developed country's welfare is given by

$$\frac{B^{*'}}{B^{*}} = \frac{\frac{\left(\frac{L^{*}}{a_{2}^{*}}p' + \frac{\pi_{FDI}}{a_{1}^{*}(1+ck)}\right)^{2}}{4p'}}{\frac{\left(\frac{L^{*}}{a_{2}^{*}}p\right)^{2}}{4p}}$$

By replacing  $p = \frac{a_2^* L}{a_1 L^*}$ ,  $p' = \frac{a_2^* (L + 2\pi_{FDI})}{a_1^* L^* (1 + ck)}$  and by simplifying, we obtain  $\frac{B^{*'}}{B^*} = \left(\frac{(L + 3\pi_{FDI})^2}{(L^2 + 2L\pi_{FDI})}\right) \left(\frac{a_1}{a_1^* (1 + ck)}\right) > 1$ 

The change of the developing country's welfare is given by

$$\frac{B'}{B} = \frac{\frac{\left(\frac{L}{a_1^*(1+ck)}\right)^2}{4p'}}{\frac{\left(\frac{L}{a_1}\right)^2}{4p}}$$

By replacing  $p = \frac{a_2^* L}{a_1 L^*}$ ,  $p' = \frac{a_2^* (L + 2\pi_{FDI})}{a_1^* L^* (1 + ck)}$  and by simplifying, we obtain

$$\frac{B'}{B} = \left(\frac{L}{L+2\pi}\right) \left(\frac{a_1}{a_1^*(1+ck)}\right) \ge <1$$

		Newey-West estimation						FE (within) regression with clustered(at the country level) standard errors				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)			
log (real Roy) lagged	-0.027** (2.14)					-0.027** (2.09)						
log (Roy/ exports, BOP ) lagged		-0.026** (2.32)	-0.023** (2.05)					-0.023** (2.22)	-0.026*** (2.72)			
log ( Roy/export value index ) lagged				-0.022* (1.80)	-0.0248** (2.10)		-0.022* (1.84)					
log(real FDI ) lagged			-0.056*** (2.61)	-0.056** (2.56)			-0.056** (2.16)	-0.056** (2.20)				
log(100*FDI/exports ) lagged	-0.058*** (2.62)	-0.058** (2.58)			-0.0568** (2.53)	-0.058** (2.40)			-0.058** (2.33)			
log(pop) lagged	-0.8317* (1.67)	-0.808 (1.65)	-0.859* (1.70)	-0.85* (1.70)	-0.7957 (1.64)	-0.8317 (1.39)	-0.85 (1.35)	-0.859 (1.36)	-0.808 (1.37)			
log(100* imp/GDP ) lagged	-0.36*** (3.43)	-0.366*** (3.45)	-0.37*** (3.54)	-0.363*** (3.48)	-0.358*** (3.39)	-0.36*** (2.77)	-0.363*** (2.79)	-0.37*** (2.86)	-0.366*** (2.80)			
Constant	23.817** (2.25)	22.787** (2.20)	24.84** (2.29)	25.08** (2.32)	23.012** (2.23)	20.767* (1.99)	21.807* (1.96)	21.566* (1.95)	19.864* (1.95)			
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
$R^2$ Adj $R^2$	0.5665 0.4473	0.5603 0.4395	0.5689 0.4504	0.5677 0.4489	0.5590 0.4378							
R <sup>2</sup> within						0.3077	0.3097	0.3116	0.2979			
Nb of countries	28	28	28	28	28	28	28	28	28			
Number of observations	168	168	168	168	168	168	168	168	168			

#### Table 3.B.1. Balanced panel - Robustness checks: RHS variables lagged (one year)

• The t-stats (in parentheses) are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses.

	Newey-West estimation						Driscoll-Kraay estimation					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)		
log (real Roy) lagged	-0.016*			-0.03***	-0.015*	-0.0285***	-0.016**	-0.03***				
	(1.81)			(3.43)	(1.70)	(3.30)	(2.21)	(4.20)				
log (Roy/merchandise exports ) lagged		-0.0188**							-0.0188**			
		(1.99)							(2.52)			
log ( Roy/export value index ) lagged			-0.0174*							-0.0174**		
			(1.89)							(2.36)		
log(real FDI ) lagged	-0.036**	-0.0495**	-0.049***		-0.035**		-0.036**		-0.0495**	-0.049***		
	(2.28)	(3.35)	(3.31)		(2.18)		(2.09)		(3.29)	(3.24)		
log(100*FDI/exports ) lagged				-0.044**		-0.046**		-0.044**				
				(2.21)		(2.31)		(2.19)				
log(pop) lagged	-0.1936	-0.24	-0.2419	-0.1988	-0.215	-0.244	-0.1936	-0.1988	-0.24	-0.2419		
	(0.74)	(0.91)	(0.91)	(0.72)	(0.84)	(0.89)	(0.99)	(1.17)	(1.29)	(1.31)		
Imp/GDP lagged					-0.314***	-0.343***						
					(2.95)	(3.06)						
log(100* imp/GDP ) lagged	-0.114**	-0.115**	-0.115**	-0.1187**			-0.114**	-0.1187**	-0.115**	-0.115**		
	(2.14)	(2.16)	(2.14)	(2.18)			(1.97)	(1.90)	(2.00)	(1.97)		
Constant	9.4778*	10.17*	7.935**	9.63*	9.43*	10.08*	8.558***	8.873***	9.014***	9.57***		
	(1.71)	(1.82)	(2.57)	(1.65)	(1.95)	(1.96)	(2.67)	(3.14)	(2.90)	(3.13)		
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
R <sup>2</sup>	0.4592	0.4604	0.4598	0.4551	0.4623	0.4595						
Adj R <sup>2</sup>	0.3936	0.3949	0.3941	0.3890	0.3970	0.3939						
Nb of countries	60	60	60	60	60	60	60	60	60	60		
Number of observations	731	731	730	730	731	731	731	731	731	730		

#### Table 3.B.2- Incomplete panel - Robustness checks: RHS variables lagged (one year)

• The t-stats (in parentheses) are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. Heteroskedasticity and autocorrelation robust t-statistics (absolute values) are reported in parentheses.

# **Chapter 4**

## **Export sophistication of developing countries:**

An empirical follow-up on an extended DFS (1977) framework <sup>141</sup>

#### **4.1 Introduction**

Raising the productivity content of export is an issue of great importance to the lowand middle-income countries that constitute the "South". We use Hausmann, Hwang and Rodrik's (2007) paper (hereafter HHR for short) and Rodrik's (2006) sophistication index (EXPY<sup>142</sup>) which measures the productivity level associated with a country's export basket (productivity content of the country's overall exports). According to HHR (2007) and Rodrik, "*it is not how much but what you export that matters*". The authors find that the type of goods in which a country specializes has major implications for economic growth. "*The idea is that producing high-productivity goods has greater growth benefits than producing other goods computer chips are better than potato chips*"(Amiti and Freund, 2007, p.39).

According to HHR (2007), the export sophistication measure affects economic growth positively and significantly. In other words, countries that produce high-productivity goods enjoy faster growth than countries with lower-productivity goods. Thus, structural transformation, e.g., the change in the specialization pattern towards goods with higher implied productivity, should be part of the agenda for economic growth. The increase in the average sophistication of the developing country's export basket was achieved through a reallocation of resources from goods with low productivity content to goods with higher productivity content. HHR (2007) develop a model based on the cost-discovery process that supports their empirical findings.

<sup>&</sup>lt;sup>141</sup>We are indebted to Dani Rodrik and Bailey Klinger for providing us with the data on export sophistication. We wish to thank Usha Nair-Reichert, Dominique Redor, Alain Desdoights and Fabian Gouret for their helpful suggestions and comments. We thank participants at the European and Economic Financial Society (EEFS) conference in Warsaw in June 2009.

<sup>&</sup>lt;sup>142</sup> Rodrik's (2006) notation.

This chapter relies on data on the export sophistication of the developing and emerging countries to contribute to the literature, especially to HHR (2007) and Rodrik (2006) in two different ways:

- The first new contribution is to combine an extended DFS (1977) continuum Ricardian trade setting which ranks sophistication of exports by their technology intensity with HHR contribution on export sophistication (a measure of technological contents of a country's exports). We provide both a theoretical and empirical analysis on the relationship between trade, foreign involvement and technological upgrading via technological absorptive effort. We put back Ricardian technological intensity of export at the forefront of the analysis and study the determinants of the evolution of the level of sophistication of a country's exports by extending HHR's (2007) paper. Using data from developing and emerging countries, we provide an empirical follow-up on an extended DFS (1977) framework<sup>143</sup>. We test the core theoretical prediction that the technological absorptive effort via foreign involvement and export penetration facilitates technological progress and upgrades the export sophistication (technological upgrading of exports) of a country by leading it to expand the range of goods that it produces toward sectors with rising productivity. Our findings indicate that export sophistication (technological upgrading) is mainly fostered by foreign presence, export penetration and labour productivity.
- The second new contribution of this chapter is to investigate whether the increase in export sophistication (export productivity index or whole technological content index) is terms of trade worsening or improving. The question of the effect of export sophistication on the terms of trade has not yet been studied by the new empirical literature on the export sophistication which focuses only on its effect on the economic growth. We provide a new empirical analysis on the effect of export sophistication on the terms of trade of the developing countries. Importantly, we show that despite the increase in their export

<sup>&</sup>lt;sup>143</sup>The Ricardian trade model has long been perceived as a useful pedagogical tool with, ultimately, little empirical content. However, the Ricardian model is widely used as a "*building block*" in the literature on technology and trade. It has had a strong influence on how the relationship between technology and trade has been studied (see Costinot and Komunjer, 2008, Grossman and Helpman, 1995). The contribution of this chapter is not to offer a new stylized fact on the determinants of international trade within Ricardian trade approach. Previous tests of the Ricardian trade model such as MacDougall (1951), Stern (1962), Balassa (1963, 1965) and more recently Golub and Hsieh (2000) were remarkably successful.

productivity and the implied export sophistication, many developing countries have experienced a terms of trade deterioration.

Following Santos-Paulino (2008), Guariglia & Santos-Paulino (2008), Yang and Yao (2007), Yang *et al.* (2009) and Minondo (2009), we use interchangeably export sophistication index; export productivity index and technological content index. An increase in export productivity content shows that exporters are able to move towards goods which are technologically sophisticated and have a high value added. It is therefore a measure of performance related to the process of technological upgrading. Higher labour productivity corresponds to higher technological contents (Krugman, 1986; Yang and Yao, 2007). In this chapter, we focus on the hypothesis that openness and foreign involvement facilitate the transfer of technology. We explore the role of a few different channels for importing and absorbing technologies and their impact on the export performance as measured by technological content of a country's overall export.

The remainder of this chapter is as follows. Section 4.2 develops the mechanism of TT and absorption through openness and foreign presence. Section 4.3 sets up the model and derives the core results on North-South technological gap, Southern catch-up and overall Southern export sophistication. This section uses an extended continuum Ricardian model<sup>144</sup> to link technological inflows, spillovers and technological absorptive effort to the technological content of goods exported by the developing countries. Section 4.4 tightly links the theory and its predictions to estimating equations, describes the data and presents the estimates. By using country-year panel data, we are going to check the relationship between openness, foreign involvement and export sophistication from an international perspective. We test the principal prediction that foreign involvement and export penetration enhance the sophistication of the developing country's exports. In our next step, we provide a new empirical analysis on the effect of export sophistication on the terms of trade of the developing countries. Section 4.5 concludes.

<sup>&</sup>lt;sup>144</sup>The simplicity of DFS model is helpful in itself, but the main advantage of the Ricardian continuum model is that it facilitates the analysis of the range of goods that a country will export and import, something that the two-good model could not usefully address. One finds, for example, that an expansion of the labour endowment of one country relative to the other will expand its exports, not just by exporting more of what it already exported (though that happens too), but by exporting goods that it previously imported.

#### 4.2 The link between openness and technological progress

Recent advances in the endogenous growth theory point out the crucial importance of R&D and human capital for economic growth (Romer, 1990; Grossman and Helpman, 1995; Lucas 1988). In the spirit of this view, international trade and FDI are considered as conduits of the diffusion of technical progress. Trade in goods and factors of production provides new sources of technological progress (Keller, 2010; Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991; Coe and Helpman, 1995)<sup>145</sup>.

How do technologies move from one country to another? International trade and FDI facilitate technology diffusion across countries. Technological inputs could be purchased (new machines, foreign investments and skilled personnel) and others could be obtained via spillovers, by trading with more technologically advanced countries and by learning from sophisticated imported goods (Rivera-Batiz and Romer 1991; Grossman and Helpman 1991; Eaton and Kortum, 2002; Navaretti *et al.*, 2004; Keller and Acharya, 2009).

#### 4.2.1 Foreign presence, productivity and technological progress

FDI and MNFs could contribute to TT by seeking the exploitation of dynamic comparative advantages via integration within higher value added activities and by transmitting new production methods that would be more efficient and more knowledge-intensive. FDI is, just like trade flows, an integral part of the process of opening up a country's economy. FDI is often considered as the strongest conduit for international TT and diffusion (Quinn, 1969; Root, 1994; Cheng *et al.*, 2005; Glass and Saggi, 2008; Keller, 2010; Blomström and Kokko, 1998; Aitken and Harrison, 1999; Carr *et al.*, 2001). With rapid expansion of FDI in the global economy, the role of MNFs in TT and spillovers and the effect of foreign involvement on the host economy, particularly on technological upgrading, have received increasing attention.

<sup>&</sup>lt;sup>145</sup> Empirical studies of the extent to which a country's productivity level depends on the foreign stock of general knowledge suggest the existence of international knowledge spillovers. Coe and Helpman (1995) find that the stock of foreign knowledge proxied by cumulative R&D expenditure, benefits domestic productivity because of the transfer of technological know-how via trade among developed countries. This result is confirmed by Keller (1998) and Lumenga-Neso, Olarreaga and Schiff (2005). Coe *et al.* found substantial R&D spillovers from developed countries to developing countries.

It has been recognized that inward FDI is an important source of efficiency gains during economic development in the host country (see Lipsey, 2004; Blomström and Kokko, 1997). According to Cecchini and Tong (2008), the growth effect of FDI stems from technology transfer. Inward FDI fosters the use of new intermediary goods, increases the overall knowledge stock<sup>146</sup> of the host country and allows the adoption of new management and organization concepts. The authors suggest that tacit knowledge diffusion is more easily with FDI than with imports. According to Findlay (1978), FDI improves technical progress in the host country by means of a contagion effect from more advanced technologies and better management practices in set up firms. FDI also stimulates competition and therefore leads to a better resource allocation<sup>147</sup>.

The impact of FDI on a host country's productivity is often composed into two types of effects: direct and indirect effects. The direct effect of inward FDI refers to its impact on the productivity of FDI-recipient firms, while the indirect effect refers to the impact of foreign firms' presence on the productivity of domestic (indigenous) firms i.e., productivity spillovers from foreign to domestic (indigenous) firms (Zhang and Song, 2000; Buckley *et al.*, 2007). Two approaches give theoretical explanations: industrial organisation and endogenous growth theories (see Liu and Wang, 2003).

• The industrial organisation approach

This approach focuses on the indirect effect or externality of FDI on the host countries. It explains the role of FDI in the technology transfer, the diffusion of knowledge, the market structure and the competition in the host countries (Dunning, 1993; Caves, 1996). MNFs possess specific advantages in order to overcome the difficulties of doing business in the host countries and to compete successfully with local firms who have superior information of local markets, consumer preferences and local business practices. By investing abroad, MNFs transfer their superior technology - specific advantage- which improves the efficiency of domestic firms. First domestic firms are forced to be more efficient in using existing technology and resources. Second, domestic firms can become more productive by imitating MNFs affiliates operating in the local market. These effects on domestic firms lead to an

<sup>&</sup>lt;sup>146</sup>Inward FDI increases the overall knowledge stock thanks to local staff training, skill acquisition by the active population and technical assistance to local suppliers.

<sup>&</sup>lt;sup>147</sup> Findlay focuses also on the role of reverse engineering in accelerating TT. Wang (1990) integrates this idea in a model in which applied knowledge in production is a function of FDI.
increase in productivity. Since MNFs possess intangible assets and can transfer them to their subsidiaries located abroad and subsequently to domestic firms (via technology spillover effects), then technology spillover is expected to improve productivity and efficiency at industry level in the host countries (see Blomstrom and Kokko, 1997,1998, 2001; Saggi, 2002,2009 for surveys on international TT and spillovers)<sup>148</sup>.

• The endogenous growth model

This approach considers FDI as an important source of technology change and is expected to boost economic growth. Wang and Blomstrom (1992) consider TT via FDI as an equilibrium which results from strategic interaction between foreign firms and domestic firms. They argue that the magnitude of spillovers depends on the domestic firms' reaction to the technology gap with subsidiaries of MNF. Grossman and Helpman (1991) show that knowledge spillovers can be increased via international trade which has the ability to introduce a technology in a country that may not exist within its own borders. The presence of MNFs should allow for technology to be transferred between countries through a process of learning by watching. Active participation by employees in the production process will accelerate the rate of diffusion and increase the rate of growth (Saggi, 2002).

The international trade theories with imperfect competition mainly examine why FDI occurs and how firms choose between exporting, FDI and licensing as an entry mode (see the detailed surveys of Saggi, 2002, Lipsey 2004, Markusen and Maskus, 2003). However, how does FDI affect industrial upgrading has not been discussed explicitly (Liu and Wang, 2003).

The first econometric test for productivity spillovers from FDI was carried out by Caves (1974). Using an extended production function that includes capital intensity, labour quality and FDI, Caves tested econometric models for productivity spillovers using cross-sectional Australian manufacturing data for 1966, and he found that the presence of foreign firms had a positive effect on labour productivity in the industries studied. Following his pioneering work, a number of empirical studies on the impact of FDI have been published. Subsequent similar single-country studies by Globerman (1979) for Canada, by Blomstrom

<sup>&</sup>lt;sup>148</sup> Gorg and Strobl (2001) review the literature on MNFs and productivity spillovers. They argue that the empirical methods used, and whether cross section or panel analysis is employed, may have an effect on the empirical results.

and Persson (1983), Kokko (1994) and Blomstrom and Wolf (1994) for Mexico, by Kokko *et al.*(1996) for the Uruguayan manufacturing sector and by Liu *et al.*(2000) for UK manufacturing, find positive productivity spillovers from FDI and then give support to Caves' findings.

More recent studies regarding both developed and developing countries have found a positive link between FDI or foreign ownership and productivity in host countries' industries. Liu and Wang (2003) study the effect of FDI on total factor productivity (TFP) for a cross sectional sample of Chinese industrial sectors. They found that foreign presence, the level of R&D and the firm size chiefly enhance TFP in Chinese industries. These findings support the argument that "*attracting FDI is an effective way of introducing advanced technology to host countries*"<sup>149</sup>. The authors view the positive effect of FDI on TFP as evidence which indicates that the FDI inflow is a channel for TT. Human capital is found to benefit TFP only when the interactions between this variable, the foreign presence and R&D are taken into account, implying that the higher the level of FDI presence and R&D, the more productive human capital becomes. They conclude that it is imperative for China to enhance TFP via spillovers from FDI as it is an effective way of improving technological progress.

Liu *et al.* (2001) focus on the impact of FDI on the labour productivity using a dataset from the Chinese electronics industry for 1996 and 1997. The authors examine the overall effects of inward FDI on the Chinese electronics industry. They confirm that foreign presence reflected in FDI was associated with higher labour productivity. Borenstein *et al.* (1998) examine the role of FDI in promoting economic growth using an endogenous growth model. They analyzed FDI flows from industrial countries over the period 1970-1989. They show that FDI is an important vehicle of TT, contributing more to economic growth than domestic investment. They make a case for a minimum threshold human capital stock to absorb foreign technologies efficiently. The stock of human capital in a host country is essential for absorbing foreign knowledge and an important determinant of whether potential spillovers will be realized.

<sup>149</sup> Liu and Wang (2003, p.945)

According to Chung (2001, p 212), productivity increases as marginal, inefficient firms are forced to exit and remaining firms improve their efficiency to ensure their survival. Baldwin *et al.* (2005) examine productivity growth in general, rather than only spillovers to domestic firms, and conduct a cross-country, cross-industry study on nine OECD countries from 1979 to 1991 in seven broad industries. Without distinction between productivity in foreign- owned firms and that in domestically- owned ones, the authors measure the total impact on an industry and report that higher FDI penetration levels led to more rapid growth in industry's labour productivity. Many studies<sup>150</sup> on the developing countries suggest that a higher presence of foreign firms raises aggregate industrial productivity, even if the effect on domestic firms is not significant or negative.

### 4.2.2 Openness and technology diffusion

The international economics literature has had interest in the relationship between trade and technology transfer (see Keller 2004 for a review of literature). Caselli and Coleman (2001) and Comin and Hobijn (2004) show a positive correlation between trade openness and technology adoption. There are several mechanisms through which an increase in international trade could facilitate technology transfer.

- Increased contact with foreign agents could boost the transmission of foreign technological knowledge.
- greater exposure to foreign products may facilitate imitation.

Following the above mechanism, technology transfer in a sector would depend largely on trade within the sector. Moreover, trade in one sector may improve productivity in another via input-output relations. For example, larger imports of intermediate goods could enhance the access to foreign technological improvements embodied in such goods and facilitate production of final goods (Keller, 2000; Saggi, 2002; Choudhri and Hakura, 2002).

A popular view is that international trade represents an important channel for the TT and trade liberalization would thus allow the developing countries to achieve faster productivity growth. A number of studies have found a positive association between

<sup>&</sup>lt;sup>150</sup>Okamoto and Sjoholm (2005) for Indonesia, Zukowska – Gagelmann (2002) for Poland; Djenkov and Hoekman (2000) for the Czech enterprises and Aitken and Harrison (1999) for Venezuela.

international trade and productivity growth in the developing countries and a strong relationship between growth of GDP or per capita GDP and various aggregate measures of openness (Baldwin, 2004; Sachs and Warner, 1995; Edwards, 1993; Rodriguez and Rodrik, 2001; Choudhri and Hakura, 2002)<sup>151</sup>. Edwards (1998) tests the robustness of the opennessgrowth relationship, associates total factor productivity growth with nine different openness measures and concludes that more open countries had higher rates of growth. His results are robust to openness measures, estimation techniques and time periods. Coe et al. (1997) show that increased trade with industrial countries boosts productivity growth of developing countries via R&D spillovers. Sachs and Warner (1995) found evidence that openness had a significant and positive influence on growth (open economies grow faster).

### 4.2.2.1 Technology diffusion through imports

Identifying imports as an important source of technological inflow adds a critical third component, along with exports and FDI, to the argument that trade promotes economic growth. Employing a foreign intermediate good in final output production involves the implicit use of embodied technology. Imports are crucial in acquiring embodied foreign technology and would play a more important role in imitation (Rivera-Batiz and Romer, 1991; Grossman and Helpman, 1991; Eaton and Kortum, 2002; Keller, 2010; Keller and Acharya, 2009).

There is evidence on the importance of imports that comes from international R&D spillovers. Coe and Helpman (1995), the pioneering empirical analysis relating imported technologies to growth, and subsequently Coe et al. (1997) and Keller (1998, 2000), look at R&D spillovers transmitted via general imports of machinery<sup>152</sup>. The larger the share of imports from countries with large R&D investments the larger the expected productivity gains in the importing countries. These authors, using country-level data, suggest that international technology spillovers are substantial and that trade plays an important role in these spillovers. Connolly (2003) identifies imports in high technology sectors as a major source of productivity and economic growth.

<sup>&</sup>lt;sup>151</sup> Choudhri and Hakura (2002) relying on the 'technological gap' model of Krugman (1986), conduct an empirical analysis on 33 developing countries and find that strengthened competition via higher imports enhances growth and global productivity only when this competition takes place in medium-growth industries. In traditional industries (characterized by slower growth), as well as in high-tech sectors, an increase in imports has no impact on global productivity growth. <sup>152</sup> Coe and Helpman (1995) relate TFP to domestic and foreign R&D.

Keller (2010) and Acharya and Keller (2009) point out that imports represent a channel for TT. Domestic firms exploit foreign R&D by importing the intermediate goods. The trade linkages with R&D intensive economies are supposed to be an important source of knowledge and technology.

### 4.2.2.2 Technology diffusion through export

Exports could provide greater contact with foreign agents than imports. Firms can learn about foreign technology via the export experience, the interaction with more knowledgeable foreign buyers and the exposure to more competitive markets (Almeida and Fernandes, 2007; Bernard and Jensen, 1999; Bernard et al., 2003; Clerides et al., 1998, Pavcnik, 2002). Case studies of the export performance of a number of East Asian countries focus on learning-by-exporting effects (Rhee et al., 1984). The argument of learning-byexporting points out that export firms productivity can be improved over time, either because of FDI transfers technology to firms that introduce new export products, or sales in export markets may improve firms' technological capabilities (Westphal, 2002). Keller (2010) states that a firm through its exporting activity is exposed to foreign technology which raises its technological capacity. Hobday (1995) and Gereffi (1999) point out the importance of exports in technology acquisition and find that exports related technology transfers played a crucial role in a number of export industries in developing countries. Clerides el al., (1998) study manufacturing plants in Columbia, Morocco, and Mexico during the 1980s and find evidence on learning-by-exporting effects. Using data on U.S. firms, Bernard and Jensen (1999) study learning-by-exporting and find that labour productivity growth is about 0.8% higher among exporters than non-exporters. Falvey et al. (2004) show that exporting has a substantial impact on industry productivity growth. For developing countries, exports are a channel to new technologies and knowledge spillovers (Lall, 2000; Santos-Paulino, 2002).

Foreign markets are a source of demand as well as a source of learning through close relationships to foreign buyers. Following Westphal *et al.*, (1985), the experience of the East Asian countries shows export spillovers. The authors argue that information and knowledge transfers via trade are very valuable sources for the exporters. According to Egan and Mody (1992), the information acquired from the importers may improve the production capability of the exporters.

# 4.3 An extended continuum Ricardian setting

The aim of this section is to present a model in which FDI-led sophistication is driven by Southern catch-up. To this end, we use a Ricardian trade model that allows us to discuss international technology differences and Southern catch-up<sup>153</sup>. We consider a general form of Southern catch-up that goes beyond FDI considered as synonymous to TT (Cheng *et al.*, 2005; Root, 1994; Bitzer *et al.*, 2008; Glass and Saggi, 2008).

The economic implications of importing superior technology through trade and foreign presence for the developing country can be developed in terms of the continuum Ricardian trade (DFS, 1977; Dornbusch and Park, 1987) model of export of technology (as shown in Figure 4.2). To illustrate the effects of importing superior technology on the developing economy, we present a conceptual framework, focusing on the role of openness and foreign involvement in enhancing technological contents of a country overall export through a North-South Ricardian trade model which rank sophistication of exports by their technology intensity (Cheng *et al.*, 2005; Grossman and Helpman, 1995; Krugman,1986; Xu and Lu, 2009) to motivate our empirical analysis. In this chapter, we put back Ricardian technological intensity of export at the forefront of the analysis. The theoretical model is adapted from papers on continuum Ricardian trade and technology gap. Using the predictions of this model, we have estimated the impact of technological inflows on the pattern of trade across countries by relying on measures of export sophistication. In order to testify the above argument, we employ the index of the total technological contents of a country's overall exports developed by HHR (2007).

Some developing and newly industrialized countries have experienced a continuous upgrading of their export basket towards more sophisticated goods (HHR, 2007). We argue that this can be explained by technological catch-up. This point can be developed in terms of a

<sup>&</sup>lt;sup>153</sup> Within our framework, continuum Ricardian trade model is a powerful tool for analyzing the role of technology in international trade. Countries specialize on the basis of the differences in labour productivity arising from technological asymmetries within industries. Countries that are closer to the technological frontier show much higher productivity in sophisticated and complex industries than laggard countries. At the same time, productivity differences will be lower in industries in which technology is standardized and, consequently, the technological frontier moves slowly. These considerations structure a setting where technology diffusion in the international economy determines a country's specialisation pattern. The Ricardian model of trade is a natural starting point for such an investigation, because it focuses on technology as the primary source of comparative advantage and has been frequently used to study the transmission of technological progress among countries (Krugman, 1979; Cheng *et al.*, 2005; Bond, 2007). The Ricardian approach provides a convenient way to analyse technological progress because there is just one factor of production, and technological progress can be specified in a neutral way without committing to labour or capital-saving technological progress (Spilimbergo, 1998).

Ricardian model of technology export<sup>154</sup>. In this model, Southern catch-up causes production of the least sophisticated Northern goods to migrate to South (where they become the most sophisticated Southern goods). We focus on the effect of openness and indirectly on technological inflows in technological upgrading measured by export sophistication.

The purpose of this section is to focus on the influence of the technology gap and TT on the pattern of specialization and the process of export sophistication in the South within the context of a continuum Ricardian approach. The theoretical basis of this analysis derives from many papers on technology export within Ricardian continuum model (Krugman, 1986; Cheng *et al.*, 2005; Dornbusch and Park, 1987). We presented a model to describe the trade and technology effort strategy by which a country exports products that have higher technological contents.

In what follows, we present a simple model based on Ricardian technology gap trade model to illustrate the effect of technological absorptive effort on the sophistication of export baskets from the developing and emerging countries. We begin this section with a review of the familiar Ricardian model, including extensions that allow for a continuum of goods. Goods and countries are indexed and ordered according to the technology level.

### 4.3.1 Goods and technology

This framework incorporates a continuum of goods and technologies in which the Northern country's historically derived technological experience exceeds that of the Southern country. The international economy is formed by two countries, North (N) and South (S), which differ in terms of their technological development, the North being the more advanced country. Both countries compete in the production of a very large number of goods. Goods are produced with only one factor of production, labour. There is a continuum of goods which are indexed on the interval [0, 1] and are ordered by their technological contents from the lowest to the highest. Each good is identified by a certain productivity level. Goods are aligned on a continuum such that higher-ranked goods entail higher productivity. *'Technology'* is an amalgam of all those characteristics that help to determine the quantity of labour that is required to produce one unit output of each good.

<sup>&</sup>lt;sup>154</sup> We employ the continuum Ricardian trade model developed by DFS (1977) and Dornbusch and Park (1987), which highlights international differences in technologies as a basis of international trade.

A good "z" is associated with each point on the interval. Given this indexing convention, "z"may be interpreted as a measure of the level of technological intensity or export sophistication level (Cheng et *al.*, 2005; Chuang, 1998; Young, 1991, Porcile *et al.*, 2006). "*Let z be the index of the products as well as their technological contents*" (Yang and Yao, 2007, p.158). Costinot (2009a) interprets z as the complexity level of goods or tasks. In these papers, goods are ordered by technological contents (*z*). "A larger z represents a product with a higher level of technological contents" (Yang and Yao, 2007, p.158). In our empirical work, we shall proxy z with a measure calculated from export statistics. We deal with the issue by adopting the method developed by HHR (2007) and Rodrik (2006) to propose a quantitative compounded index of the technological contents of a country's exports. This measure aims to capture the productivity level associated with a country's exports.

The widening of the productivity gap for goods with a higher index z implies that technological complexity increases with "z". Naturally, goods with higher technological contents, i.e., z in our model, have higher labour productivity. The North has higher labour productivity than the South in producing every good, especially in producing the high technological contents and value added goods (Dornbusch and Park, 1987).

What the two countries or regions will produce depends on their Ricardian comparative advantage determined by the relative cost. According to Ricardian trade theory, relative cost is the ratio of wage to labour productivity, i.e. unit labour cost. Different goods have different relative cost, and even for the same good, different country may have different relative costs for it. Thus, the technology leader country has lower relative cost on high technological contents products and the technology follower country has lower relative cost on low technological content products. The technologically advanced country will produce goods with high technological content products, while the technologically backward country will produce goods with low technological contents. As " z "represents the frontier of good range produced by the two countries in our framework, thus, the advanced country produces goods with technological contents higher than " z", while the follower produces products with technological contents lower than "z".

Like the standard DFS (1977) Ricardian continuum model, the theoretical setting is presented as follows. The unit labour requirement to produce a good z is a(z) in the developing country and  $a^*(z)$  in the developed country<sup>155</sup>. Our neglect of an explicit role for capital in production reflects a desire to focus on medium – term dynamics. A useful tool for understanding the pattern is the relative developed country productivity labour schedule A(z), which gives ratios of developed country to developing country required unit labour inputs. Without loss of generality, the relative unit labour requirement –function of technology- is given by

$$A(z) = a^*(z)/a(z) \tag{1}$$

On the assumption that goods have been ordered along [0,1], so that the relative developed country labour requirement falls as "z" rises. The relative unit labour requirement function in (1) is by construction decreasing in "z"; as shown in Figure 4.1. This means that for any two goods z' and z'', if z' < z'' the developing country has the greater relative technological advantage in producing z'. The function A(z) is shown in Figure 4.1 as the downward sloping schedule (A'(z) < 0). The downward sloping function  $A(z) = a^*(z)/a(z)$  is the ratio of the two countries' unit labour requirements, ordered so that developing country comparative advantage declines with rising "z".

To find the pattern of specialization it is necessary to combine the curve of relative labour requirements with the curve of relative wages. Consider now the range of goods produced in the developing country and those produced in the developed country, as well as the relative price structure associated with given wages. The wage rates (in terms of a common unit) in the developing country and the developed country are w and  $w^*$ . The developing country will efficiently produce all those goods for which domestic unit labour costs are less than or equal to unit labour costs in the developed country. The A(z) schedule helps to determine international specialisation. Good z will be produced and exported by the developing country if  $a(z)w \le a^*(z)w^*$ . The developed country has a cost advantage over the developing country for any good satisfying the reverse inequality. Consequently, any good such that

<sup>&</sup>lt;sup>155</sup> In the developing country a unit of good z can be made out of a(z) units of labour, while in the developed country a unit of good z can be made out of  $a^*(z)$  units of labour.

$$\omega = \frac{w}{w^*} < A(z) = \frac{a^*(z)}{a(z)}$$
(2)

is produced in the developing country, while goods for which  $\omega > A(z)$  are produced in the developed country. In Figure 4.1, the relative wage  $\omega = w/w^*$  and the relative unit labour requirements  $A(z) = a^*(z)/a(z)$  are measured along the vertical axis. Following Obstfeld and Rogoff (1996, p 239), we allocate the production of the marginal "cut -off" good  $\tilde{z}$  to the developing country. This marginal "cut -off" good  $\tilde{z}$  is defined by:

$$\omega = A(\widetilde{z})$$

Irrespective of the relative wage  $\omega$  in equilibrium, there must be a complexity level z > 0 such that  $\omega = A(\tilde{z})$ . For a given  $\omega = \frac{w}{w^*}$ , the range of goods  $0 \le z \le \tilde{z}(w)$  will be produced in the developing country and the range of goods  $\tilde{z}(w) \le z < 1$  will be produced in the developed country, where the borderline good  $\tilde{z}$  is determined by:

$$\widetilde{z} = A^{-1}(\omega) \tag{3}$$

 $A^{-1}()$  being the inverse function of A(). Figure 4.1 is graphic depiction of the determination of  $\tilde{z}$ . In this model, diversification is represented by the ability of the South to competitively produce a higher number of goods.

#### • Demand

To determine the equilibrium value of  $\omega$ , one needs assumptions about demand, which are reflected in the upward sloping curve  $B(z, L^*/L)$ . Demand for goods depends on consumer preferences. Preferences of all consumers are identical and are represented by the continuum version Cobb-Douglas utility function. Expenditures shares "b(z)" are constant for each good "z" and across countries implying uniform homothetic demand.

$$b(z) = \frac{P(z)C(z)}{Y} > 0$$

$$b(z) = b^{*}(z)$$

$$\int_{0}^{1} b(z)dz = 1$$
(4)

Where Y denotes world income, C demand for commodity z and P the price of good z. If the developing country produces all the goods less than z, the share of world income devoted to its (aggregate) output is

$$\begin{aligned} \vartheta(\widetilde{z}) &= \int_0^{\overline{z}} b(z) dz > 0 \\ \vartheta'(\widetilde{z}) &= b(\widetilde{z}) > 0 \end{aligned}$$
(5)

With  $(0,\tilde{z})$  is the range of goods for which the developing country possesses a comparative advantage. With a fraction  $\mathcal{G}$  of each country's income, and therefore of world income, spent on goods produced in the developing country, it follows that the fraction of income spent on goods produced in the developed country is

$$1 - \vartheta(\tilde{z}) \equiv \int_{\bar{z}}^{1} b(z) dz$$

$$0 \le \vartheta(z) \le 1$$
(6)

### • Equilibrium relative wages and specialization

Consider the developing country's labour market or equivalently the market for domestically produced goods. Equilibrium in the market for developing country produced goods requires that developing income (labour income wL) equals world spending on developing country produced goods:

$$wL = \vartheta(\tilde{z})(wL + w^*L^*)$$
(7)

With  $\tilde{z}$  denotes the hypothetical dividing line between goods produced in the developing country and goods produced in the developed country.

Similarly, we obtain

$$w^{*}L^{*} = (1 - \vartheta(\tilde{z}))(wL + w^{*}L^{*})$$
(7')

Equation (7) associates with each  $\tilde{z}$  a value of the relative wage  $(\psi_{w^*})$  such that market equilibrium obtains. This schedule is drawn in Figure 4.1 as the upward sloping locus and is obtained from (7) and (7')

$$\omega = \frac{w}{w^*} = \frac{\mathcal{G}(\tilde{z})}{1 - \mathcal{G}(\tilde{z})} (L^* / L) = B(\tilde{z}, L^* / L)$$
(8)

Following (8), the schedule starts at zero and move towards infinity as  $\tilde{z}$  approaches unity. The right hand side of (8) is plotted in Figure 4.1 which is depicted by the B() curve and finds the equilibrium wage at the intersection with the A(z) curve. The B() curve represents the demand side. This curve measures the relative wage at which demands for each country's range of goods produced would equal their supplies (or, equivalently, the relative wage at which values of a country's exports and imports will be equal). This entails that the ratio of expenditures on the two sets of goods equal the ratio of the incomes of those who produce them. As the definition of this market-clearing relative wage shown in Figure 4.1 indicates, it depends positively on  $\vartheta(z)$ , the fraction of income spent on the goods produced by developing country, which in turn rises with the fraction of goods that the developing country produces. Substituting the condition of efficient specialization as represented in equation (3), which

substituting the condition of efficient specialization as represented in equation (3), which specifies the competitive margin as a function of the relative wage in (8) yields as a solution the unique relative wage  $\overline{w}$ , at which the world is efficiently specialized, is in balanced trade, and is at full employment with all markets clearing.

$$\overline{\omega} = A(\overline{z}) = B(\overline{z}; L^* / L) \tag{9}$$

The equilibrium relative wage defined in (9) is represented in Figure 4.1 at the intersection of the A() and B() schedules. In Figure 4.1, the range of goods z is aligned along the horizontal axis. Commodity  $\tilde{z}$  denotes the equilibrium borderline of comparative advantage between commodities produced and exported by the developing country ( $0 \le z \le \tilde{z}$ ) (technologically least sophisticated goods) and those commodities produced and exported by the developed country ( $\tilde{z} < z \le 1$ ).





Products ordered by technological contents (z)

Source: DFS (1977)

#### **Proposition 1**:

The equilibrium features a "chain" of comparative advantage, with the developed country producing all those goods for which its relative technological advantage is the greatest. In free trade equilibrium, the developed country produces and exports the more sophisticated and complex goods; the developing country produces and exports the less sophisticated ones.

In what follows, we draw the main conclusions of the DFS (1977) continuum Ricardian model. In Figure 4.1, the wage of the developing country relative to the developed country is given by  $(\frac{w}{z})$ , and  $A(z) = a^*(z)/a(z)$  is the relative unit labour requirement of the good (z) in the developed country relative to the developing country (both are measured along the vertical axis in Figure 4.1. The range of goods (z) is ranked along the horizontal axis so that the developing country is more efficient in the production of goods near to the origin. Relative wage costs then determine the pattern of trade. The developed country will specialise in producing those goods for which the unit labour costs are lower than the unit labour costs of their production abroad. Any good z will be produced in the developing country if  $wa(z) < w^*a^*(z)$ . A given relative wage  $(w/_*)$  therefore determines the competitiveness of the developing country. The relative wage itself is determined by demand and the level of spending: demand conditions are shown by the schedule OB along which the demand for developing country produced goods is equal to the full-employment supply. If the range of goods produced by the developing country increases (i.e. moving along the horizontal axis to the right) then an excess demand for labour is created and the equilibrium relative wage increases. Point E represents the general equilibrium where goods markets clear and production occurs in the lowest-cost location. The developing country produces goods in the range  $O\tilde{z}$ , and the developed country, the range of goods to the right of  $\tilde{z}$ . If the developing country becomes more productive (its a(z) shifts down, shifting the A curve up), it produces more goods but its relative wage increases.

Following the Figure above, as a country's labour force rises relative to the other country (shifting the B curve up or down), its share of goods produced increases as well, while in addition its relative wage falls.

# 4.3.2 Importing superior technology, technological inflow and diffusion

Since differing levels of technological sophistication separate developed from less developed countries, FDI which attempts to bridge the technology gap seems desirable. FDI is growing in importance as a means of TT. Technology and managerial talent have become the key ingredients of FDI (Cheng *et al.*, 2000, Root, 1994). Considering FDI as synonymous to technology and managerial skill transfer (see Cheng *et al.*, 2005), policies try to attract FDI to push industries into ranges of increasing value added activities.

International technology diffusion in our chapter refers to both technology spillovers as well as non- spillovers. As will be discussed below, the two are often difficult to separate. Following Dornbusch and Park (1987), we now show what happens when a superior technology is transferred (via FDI) from the developed country to the developing country<sup>156</sup>. Such transfers reduce the discrepancies in relative unit labour requirements-by lowering them for each "z" in the developing country -and therefore flatten the A(z) schedule in Figure 4.1. In Figure 4.2, we have  $(\gamma'_w) < 1$  by construction. The developed country has the superior technology for the goods that the developing country is producing. Because of TT, the developing country's relative unit labour requirements will fall. The A(z) schedule rotates (shifts) upward. The new equilibrium is at E'. The country has now expanded the range of goods it can produce. Hence, the developing country produces up the new borderline  $\tilde{z}$ " on the right of  $\tilde{z}$ . Finally, we consider the industries that the developed country loses to the developing country. These more sophisticated goods within  $[\tilde{z}, \tilde{z}^{*}]$ , can be produced more cheaply in the developing country than in the developed country.

<sup>&</sup>lt;sup>156</sup> Gholami *et al.* (2006) and Addison and Heshmati (2004) focus on the economic role of information and communication technology in determining FDI inflows and its effect on the host country's economy. They show that this role can be explained by a conceptual framework of the continuum Ricardian two-country model of trade developed by Dornbusch and Park (1987) which deals with the effects of technology on relative wages and the decision to (re) locate production to developing countries. They argue that information and communication technology needs to be considered in explaining FDI flows. They examined the determinants of FDI, using a large sample of countries. Their findings suggest that information and communication technology increases inflows of FDI to developing countries mainly because information and communication technology lowers the transaction and production costs of foreign investors.







Source: Dornbusch and Park (1987), Addison and Heshmati (2004), Obstfeld and Rogoff (1996)





Products ordered by technological contents (z)

Source: DFS (1977)

Following DFS(1977), the specification of the curve A(z) in Figure 4.3 implies that technical change affects relative labour productivity in the production of the different goods in exactly the same proportion.

The terms of trade (TOT) of the developing country are given by :

$$\frac{P(z)}{P^{*}(z^{*})} = \frac{w \ a(z)}{w^{*} \ a^{*}(z^{*})} = \omega \left[\frac{a(z)}{a^{*}(z)}\right]$$

Remember that  $A(z) = a^*(z) / a(z)$ is monotonically decreasing and in Z  $\omega = \frac{w}{w^*} = \frac{\mathcal{G}(\tilde{z})}{1 - \mathcal{G}(\tilde{z})} (L^*/L) = B(\tilde{z}, L^*/L)$  is monotonically increasing in z. Following DFS(1977) and Obstfeld and Rogoff (1996), when a(z) decreases after uniform technological progress such as  $a'(z) = \frac{a(z)}{v}$  with v > 1, it becomes cheaper to produce in the developing country and the North-South cut off good  $\tilde{z}$  shifts to the right leading to a diversification of developing countries' exports toward high productivity goods. This is accompanied by an increase in labour demand in the developing country which leads to an increase in relative wage  $\omega = \frac{w}{w^*}$ . The terms of trade (for goods) of the developing country  $\frac{P(z)}{P^{*}(z^{*})} = \frac{wa(z)}{w^{*}a^{*}(z^{*})}$  decrease because of the increase in  $\omega = \frac{w}{w^*}$  is less than proportionate to the increase in  $A(z) = \frac{a^*(z)}{a(z)}$ [because the wage curve  $B(z, \frac{L^*}{L})$  has a finite positive slope in the original DFS model]<sup>157</sup>. The change in the factor terms of trade ( $\omega = \frac{w}{w^*}$ ) is less than proportional than the productivity gains in the developing countries (Matsuyama, 2000). Thus, the developing country's terms of trade (for goods) deteriorate (Obstfeld and Rogoff, 1996, p. 242-243). This idea seems clearer when we consider  $\omega = d$  is constant in the model.

The above model could be relevant for a country at any stage of economic development, but it is designed especially for the developing countries where openness is a source of TT. In order to specify how openness and foreign involvement influence the technology gap which in turn affects the export sophistication of the developing country, we describe an extension of the DFS (1977) and Dornbusch and Park (1987) models which underlies our empirical analysis. The empirical segment has two objectives. The first is to establish on a prior basis the reasonableness of our use of the Ricardian model as a framework to analyze the effect of technological inflows via FDI and trade on export sophistication. The

<sup>&</sup>lt;sup>157</sup> Suppose that a(z) decrease by a factor  $\alpha$ . Then  $A(z) = \frac{a^*(z)}{a(z)}$  increases by the same proportionality factor  $\alpha$ . As a result, the relative wage  $\omega = \frac{w}{w^*}$  and the threshold  $\tilde{z}$  both increase. But note that  $\omega = \frac{w}{w^*}$  increases by a factor lower than  $\alpha$ . To sum up, the terms of trade (for goods) of the developing country  $\frac{P(z)}{P^*(z^*)} = \frac{wa(z)}{w^*a^*(z^*)}$  decrease because  $\Delta \omega < -\Delta a(z)$ .

second is then to use this framework to calculate the impact of these flows on the developing countries' exports. Our work tries to test the applicability of the continuum Ricardian model that integrates import of superior technology through FDI and openness. The key empirical implication of this Ricardian approach is that TT via FDI leads to an increase in the export sophistication from developing countries.

### 4.3.3 Technology gap within a comparative advantage framework

The Ricardian continuum model was proposed originally by DFS (1977) and subsequently revisited by Cimoli (1988), Dosi *et al.* (1990), Holland & Porcile (2005) and Porcile & Cimoli (2007) from a Keynesian-Schumpeterian perspective. We present a multisector framework based on the Krugman (1986)<sup>158</sup>, Porcile *et al.*(2006), Cimoli, Porcile & Holland (2006) and Cimoli & Porcile (2010) technology gap model of trade and the subsequent Neo-Schumpeterian revisions of Cimoli (1988) and Dosi *et al.*(1990), we consider that the position of the A(z) schedule depends on the North-South technological gap defined as G = (Tn/Ts) > 1, where Tn and Ts are the technological levels of North and South, respectively. The evolution of the technology gap depends on the relative rates of innovation in the North and technology diffusion towards the South. North-South technological spillovers  $[\lambda - (\lambda/G)]$  are assumed to be a linear function of the inverse of the technological gap and the technological absorption in the South

$$\hat{G} = \rho - \left[\lambda - \lambda \left(\frac{Ts}{Tn}\right)\right] = \rho - \left[\lambda - \lambda \left(\frac{1}{G}\right)\right]$$
(10)

where  $\hat{G} = (\dot{G}/G)$  is the proportional rate of growth of the technology gap,  $\rho$  is the exogenous rate of growth of knowledge in the North and  $\lambda$  is the Southern technological

<sup>&</sup>lt;sup>158</sup> Krugman (1986) uses DFS (1977) model with a given technology gap to study the changes in production pattern, wage rates and welfare as a result of a technology gap widening as well as technology gap narrowing. Yet North-South models that emphasize the product cycle nature of trade have been particularly useful for understanding international technology transfer. These models capture technology driven trade and have been generalized to consider technology transfer more explicitly (Cheng *et al.*, 2005; Coe and Helpman, 1995). Like Cheng *et al.* (2005), we complement Krugman's analysis and we explain the effect of technology transfer made possible by the existence of given technology gaps. This is in the spirit of a model geared to Southern technology catch-up.

absorptive effort  $\lambda > \rho > 0$ . The parameters  $\rho$  and  $\lambda$  reflect the amount of resources allocated to technological learning in both countries. In the above model, this is not explicitly modelled, but we suggest, inspired by the huge literature, that the technological absorption  $\lambda$  is related to foreign involvement, country technical level, country size (population) and openness.

The stability of the technology gap entails

$$\frac{\dot{G}}{G} = 0 \Longrightarrow G^* = \frac{\lambda}{\lambda - \rho} \tag{11}$$

Equation (11) gives the equilibrium value of the technology gap ( $G^*$ ) as a function of  $\lambda$  and  $\rho$ . In equilibrium, the gap will not be fully closed. While South gains additional technological experience by attracting FDI, market forces are such that the North's historic technological advantage blocks full convergence. The North will keep a technological superiority advantage with respect to the South. In other words, we consider that TT and diffusion to the South narrows the gap but we exclude the possibility that the South could eventually reach the technological frontier. Following Yang and Yao (2007), we speak about limited catch-up.

We examine the model's prediction of specialization characterized by a cut off  $\tilde{z}$ . Our interest is centred on the model's theoretical implications for export sophistication increase in the South. In order to address the role of technological gap or Southern technology lag in determining the range of goods produced in the South, we consider that the North-South technology gap may affect the position of the A(z) curve as in the following equation ( see Cimoli and Porcile, 2010; Porcile *et al.*, 2006; Porcile and Cimoli, 2007; Cimoli, Porcile & Holland, 2006; Holland & Porcile, 2005):

$$A(z) = \frac{a^*(z)}{a(z)} = \alpha - \beta \ G - bz \tag{12}$$

where  $\alpha$ ,  $\beta$  and *b* are positive parameters and  $\alpha > \beta + b$ . The evolution of the North-South technological gap , which affects specialization, depends negatively on the technology diffusion towards the South. Narrowing the North-South technological gap, an improvement in the Southern catch-up thus shifts the A(z) schedule to the right, increasing the relative labour requirements of the North for all goods *z* produced in the international economy.

A reduction in the technology gap G shifts A(z) to the right, increasing the relative labour requirements of the North relative to that in the South for all goods produced in the international economy. We follow Porcile & Cimoli (2007) and Porcile et al.(2006), in choosing this specification of the curve A(z) which implies that technical change affects relative labour productivity in the production of the different goods in exactly the same proportion.

To complete the model it is necessary to make assumptions about how the B(z) curve behaves. In order to keep the model analytically tractable and for notational simplicity, Porcile et al. (2006), Cimoli, Porcile & Holland (2006) and Porcile & Cimoli (2007) consider the simplest assumption that nominal wages are constant and therefore the B(z) is horizontal. However, this simplification does not compromise the validity of the exercise.

In other words, the relative nominal wage remains constant<sup>159</sup> as z increases. Although this assumption is not essential to our framework, it helps to keep the analysis tractable and allows us to focus on the export sophistication and the terms of trade for goods.

$$\frac{w}{w^*} = d \tag{13}$$

where  $0 < d \le \alpha - \beta$ .

Porcile et al. (2006), Cimoli, Porcile & Holland (2006), Cimoli et al. (2004), Holland & Porcile (2005) and Cimoli & Porcile (2010) explained the assumption of constant nominal wages (this assumption will be abandoned later) by the fact that the labour market in the North is resistant to changes in the Southern exports and competitiveness, while the supply of labour in the South enables the increase in employment rather than nominal wages when the economy grows<sup>160</sup>. This is consistent with the idea that nominal wages are rigid and hence quantities adjust. As the North is a big country whose levels of employment and nominal wages are little affected by changes in the Southern exports, this simplification does not compromise the validity of the exercise. "A high technology gap implies that the Southern

<sup>&</sup>lt;sup>159</sup>Despite nominal rigidity, real wages may be increasing because of the rise of productivity in both the Northern and Southern countries. See also Cimoli, Holland, Porcile, Primi and Vergara (2006).

economy faces a disadvantage as regards productivity levels, which constraints labour demands for higher wages. Unions will realize that jobs are at risk if the relative wage increases in this context and will therefore curb their demands" (Cimoli and Porcile, 2010, p.7). Under these assumptions, it is the level of employment in the South that adjusts to completely absorb the impact of changes in international competitiveness. Nominal wages are constant in both countries and therefore they do not affect prices; consumers spend their nominal income on the same goods and in exactly the same proportions; perfect competition assures that productivity growth fully translates into lower prices.

This assumption of constant relative nominal wage implies that the labour market of the developing country functions  $\dot{a} \, la$  Lewis (1954)<sup>161</sup>, that is to say, the surplus of labour in the rural sector or in the informal sector can be quicly incorporated to the production without changes in the nominal wage. This simple wage formula  $\dot{a} \, la$  Lewis is useful as way to maintain the attention centered in the technological dimension of the international specialisation (see Poricle *et al.*, 2006; Cimoli *et al.*, 2004).

### • Export sophistication and terms of trade (for goods)

Using (13) assumption, we add the expression of the developed country relative prices –its terms of trade (for goods).

$$\frac{P^*(z)}{P(z)} = \frac{1}{d} \left[ \frac{a^*(z)}{a(z)} \right]$$
(14)

For given  $a^*(z)$ , technology progress in the developing country leads to a reduction in a(z) which in turn deteriorates its terms of trade ( for goods)  $\frac{P(z)}{P^*(z)} = d \left(\frac{a(z)}{a^*(z)}\right)$ . "In

*its process of growth and its attempt to catch up with the North, the South faces a terms of trade decline in a product cycle scenario*" (Sarkar, 1997,p.117). The terms of trade (falls in commodity export price) turn against the South as result a of its catch up effort. Thus, the developing countries' terms of trade deteriorate. This interesting prediction from the Ricardian continuum trade model will be tested empirically (in addition to export sophistication determinants).

<sup>&</sup>lt;sup>161</sup> See Ros (2000) for detailed discussion on of the implications of Lewis' model for growth theory.

The assumption of uniform technical change combined with constant relative wages makes the model more tractable and allow us to focus on the export sophistication. With A(z)=d in equilibrium (see Figure 4.5), we obtain the specialization pattern (the set of goods produced in) of the South and the North as a function of the North-South technological gap:

$$\widetilde{z} = \frac{\eta - \beta G}{b} \tag{15}$$

where  $\eta = \alpha - d$  and the borderline good  $\tilde{z}$  is the level of technological intensity or the level of complexity of goods exported. The production of the trade cut-off good ( $\tilde{z}$ ) is allocated to the South. The South produces goods in  $[0, \tilde{z}]$  while the North produces goods in  $[\tilde{z}, 1]$ . Our focus is on the effects of Southern catch-up on  $\tilde{z}$ . The above equation relates export sophistication level shifts to Southern catch-up. The change in  $\tilde{z}$  depends on the change in the Southern catch-up process.

From (11) and (15), we obtain

$$\widetilde{z} = \frac{\eta(\lambda - \rho) - \lambda\beta}{(\lambda - \rho)b}$$
(16)

Following Yang and Yao (2007), the developing country exports a wide range of products with an overall level of technological content given by  $\tilde{z}$  in our framework. An increase in z means export diversification towards more sophisticated product. FDI and the related technology absorption affect the composition of the export bundle and may make it more diverse (see Harding and Javorcik, 2006). In our empirical work, we proxy  $\tilde{z}$  with export sophistication (EXPY) and relative export sophistication (REXPY) - measures calculated from export statistics. Focusing on exports is a sensible strategy since  $\tilde{z}$  refers to the most productive goods that a developing country produces and we can expect a country to export those goods in which it is the most productive. Following Li (2007), z itself is a function of technology spillover and diffusion (via foreign investment and trade) which requires an absorptive effort captured by  $\lambda$  in our model.

Unambiguously, the partial derivative of (16) with respect to  $\lambda$  is positive and the partial derivative of (15) with respect to G is negative. These implications can be summarized as:

$$\frac{\partial \widetilde{z}}{\partial \lambda} = \frac{\beta \rho}{\left(\lambda - \rho\right)^2 b} > 0 \qquad ; \qquad \frac{\partial \widetilde{z}}{\partial G} = \frac{-\beta}{b} < 0 \tag{17}$$

The pattern of specialization responds to changes in the technology gap. Now it is of interest to discuss how changes in the technology gap and technology diffusion affect the Southern export sophistication. Following the negative derivative of (15) with respect to G,  $\tilde{z}$  increases when the catch-up or Southern technological capabilities increase. Therefore  $\tilde{z}$  increases when G decreases. Southern catch-up leads to a shift in a country's export shares towards more sophisticated goods. The Southern economy can expand and diversify its range of exports towards of more sophisticated products by heightening its investments in catching-up. Southern catch-up leads to a fall in the a(z) schedule relative to the  $a^*(z)$  schedule. This raises  $\tilde{z}$  and leads to more goods diversification in the Southern economy towards more sophisticated products. The partial derivative of (16) with respect to  $\lambda$  is unambiguously positive, suggesting that the Southern economy can diversify the economy by intensifying its technological absorptive effort. Using foreign involvement or presence (FP) as a proxy for  $\lambda$  (thus,  $\frac{\partial \tilde{z}}{\partial FP} = \frac{\beta \rho}{(FP - \rho)^2 b} > 0$ ), we provide the basic prediction to motivate our empirical

analysis on the determinants of the export sophistication. Because of its strong linkage to technology, Chung (2001), Cheng *et al.*(2001), Borensztein *et al.* (1998), Djankov and Hoekman (2000) and Navaretti *et al.* (2004) equate FDI (or foreign presence) to technology transferred and use this measure as proxy for technological inflows.

Figure 4.5 shows the co-evolution of G and  $\tilde{z}$  after an increase in Southern technological efforts or absorptive capacity (from  $\lambda_1$  to  $\lambda_2$ ). The rise in  $\lambda$  shifts the technology spillover curve  $\hat{T}_{spillover}$  to the right, thereby starting a gradual process of reduction of G as it moves towards its new (lower) equilibrium level. In Figure 4.4, this is represented by an increase in the inverse of the equilibrium technological gap (1/G), from(1/G<sub>1</sub>) to(1/G<sub>2</sub>) where  $G_2 < G_1$ . As "G" decreases, the specialization pattern changes and new activities are taken over by the South which enlarge the range of products: this is represented by an increase in the borderline good  $\tilde{z}$ , from  $\tilde{z}_1$  to  $\tilde{z}_2$  (which correspond, respectively, to the

equilibrium levels of the technological gap  $G_1$  and  $G_2$ ). The proposition implies that as  $\lambda$  increases, the ranges of goods produced by the Southern country and its export sophistication expand.

To test equation (17), measures of export sophistication level, technological absorptive effort (captured by foreign presence, export penetration and self-discovery process) have been collected for a panel of countries in the empirical part of this chapter.





(See Porcile et al., 2006 and Cimoli, Porcile & Holland, 2006 )

Figure (4.4) describes the impact of an increase in the technological absorptive capacity  $\lambda$  (+ $\Delta\lambda$ ) on the equilibrium technological gap (given the technical progress in the North).





Products ordered by technological contents (z)

(See Porcile et al., 2006 and Cimoli, Porcile & Holland, 2006)

Figure 4.5 shows how narrowing the North-South technological gap (- $\Delta G$ ) affects the specialization pattern, leading to the expansion of the scope of the products in the South (from  $\tilde{z}_1$  to  $\tilde{z}_2$ ).

In this framework, technological improvement is represented by a shift of the function  $A(z)^{162}$ . In the spirit of modelling the Southern technology catch-up, we define it as technology spillover from developed to developing countries. The South is catching up if Southern productivity rises relative to Northern productivity. Referring to Figure 4.4, Southern catch-up leads to a shift of A(z) schedule to the right which leads to a rise in  $\tilde{z}$  and therefore an expansion in the scope of exports. Southern specialization pattern shifts towards goods with a higher productivity content. With a catch-up strategy via FDI and export penetration, the developing country will expand the scope of its exports towards products with a higher technological content.

### **Proposition 2:**

By identifying larger z with greater technological intensity (sophistication or productivity content), the basic logic of our theoretical framework can be sketched as follows. By improving its catch-up through foreign presence and exporting penetration, the Southern country expands the range of goods it produces which leads to an increase in the sophistication of its export basket and to an upgrading in its overall export structure. Southern technology catch- up induces the North to transfer production of its least complex goods to the South. With a catch up strategy through FDI and export penetration, the developing country will expand the scope of its exports towards products with higher technological contents. Here we hypothesize that improvements in export sophistication through openness, either to trade or to FDI, result from technology transfers.

Narrowing the technology-gap is generally seen as an outcome or an impact of increased competitiveness of an industry caused by FDI inflow. Nevertheless, the impact on technology-gap may be marginal, if the source country firms are not on a higher technological trajectory. FDI originating from the developed countries may affect the kind of technology transferred there by spurring advanced technology, technical knowledge and blueprints leading to a narrowing of the North-South technology gap. Though simple, the model developed above allows us to generate new predictions on the determinants of the evolution of export sophistication. Our core insight is that narrowing the North-South technology gap and improving the Southern catch- up due to mainly TT through exports of high productive goods and foreign presence (and other mechanisms of technology diffusion), expands the scope of exports and raises the sophistication (productivity content) level of the Southern country's export basket. Proposition 2 is helpful for empirical work because it suggests a relation between improvement in technology diffusion and the patterns of specialisation. We test the principal prediction that openness to trade and foreign involvement facilitate

<sup>&</sup>lt;sup>162</sup> For an increase of productivity uniform and proportional in all goods see DFS(1977)

technological progress and upgrade export sophistication by leading the South to expand the range (the scope) of goods that it produces toward sectors with rising productivity.

## • Flexible relative nominal wages

In the previous section, we derive the level of sophistication (z) under the assumption that nominal wages were constant and changes in nominal income reflected adjustments in employment in the South. Now we turn to the case in which the relative nominal wages is flexible. Based on Cimoli, Porcile & Holland (2006, p.13), a similar analysis is presented by abandoning the assumption of constant nominal wage. This does not compromise the validity of the relationships between the North-South gap (G), Southern catch-up and Southern export sophistication (z). In the case of flexible nominal wages, full employment is assumed both in the North and in the South and the relative nominal wage adjusts to respond to changes in international competitiveness.

The equilibrium in the international economy requires the current account of the two countries to be balanced. Following the assumption that consumers spend exactly the same percentage of their nominal income on each type of goods z,

- If the South produces goods for which 0 < z ≤ ž (and hence the North produces goods for which ž < z ≤ 1), then ž will be the percentage of the nominal income consumers in both North and South spend on goods produced in the South.</li>
- If the exchange rate is fixed and equal to the unit, then Southern exports will equal the Northern nominal income  $(y^*)$  times  $\tilde{z}$  (Obstfeld and Rogoff, 1996, p.240).  $(y\tilde{z})$  will be the nominal income of the South spent on domestically produced goods.

Symmetrically, Southern imports will equal the Southern nominal income (y) times  $(1-\tilde{z})$  (the latter being the share of the nominal income of the South that goes to buy Northern goods).

To have current account equilibrium it is necessary that

$$(1 - \widetilde{z})y = \widetilde{z}y^*$$

This allows writing the equilibrium condition in the international economy as follows:

$$y = \frac{\tilde{z}}{1 - \tilde{z}} y^* \tag{18}$$

Equation (18) presents the Southern nominal income (consistent with external equilibrium) as a function of the Northern nominal income and the degree of diversification of the Southern economy. This equation (18) gives a Ricardian version of Thirlwall's Law<sup>163</sup> in which the elasticity parameters of the demand functions for exports and imports have been replaced by parameters that reflect the production diversification towards higher productivity goods and its implied export sophistication in the South (Cimoli, Porcile & Holland , 2006, p.9; Cimoli, Holland, Porcile, Primi and Vergara , 2006, p.9 ).

Since labour is the only factor of production, whose amount is constant, it is true that

$$y = wL$$
 and  $y^* = w^*L^*$ 

Therefore, the current account equilibrium condition defined by equation (18) can be written as follows:

$$wL = \left[ \frac{\widetilde{z}}{1-\widetilde{z}} \right] w^* L^*$$
(19)

Using the equilibrium condition  $A = \omega$  (given L and L\*) with  $\omega = \frac{w}{w^*}$  and the equations (12) & (19), the trade cut-off ( $\tilde{z}$ ) as a function of G can be expressed as:

$$\widetilde{z} = \frac{f(G) - \sqrt{[f(G)]^2 - 4b(\alpha - \beta G)}}{2b}$$
(20)

where  $f(G) = \alpha - \beta G + b + c > 0$ , and  $c = \frac{L^*}{L}$  (see Cimoli, Porcile and Holland, 2006, p.9; Cimoli, Holland, Porcile, Primi and Vergara, 2006, p. 11). Figure 4.6 describes how the export sophistication responds to changes in the technology gap in the case of flexible nominal wages.

<sup>&</sup>lt;sup>163</sup> McCombie and Thirlwall (1994, chapter 3)

Figure 4.6: Export sophistication and changes in the technology gap: the case of flexible nominal wages



Source: Cimoli, Porcile and Holland (2006, p.24)

Figure 4.6 shows the relationship between export sophistication and changes in the technology gap in the case of flexible nominal wages. The decrease in the North-South gap (G) or Southern catch-up will lead to an increase in the Southern export sophistication level (ie, an increase in z).

The common prediction that then arise from the constant nominal wage case and the flexible nominal wage case is that the decrease in the North-South technological gap (G) through a Southern catch-up facilitated by its technological absorptive effort, leads to an increase in the Southern export sophistication (z). This prediction will be empirically tested on the basis of a sample of developing and emerging countries.

Our focus is on the effects of Southern catch-up. The core insight of the model presented above is that the technology diffusion and the technological absorptive effort in the South (through foreign presence or involvement and Southern export penetration) raise Southern export sophistication (z). To examine this empirically, we need to link the theory as tightly as possible to an estimating equation.

# 4.4 Linking theory to empirics

The Ricardian model is an important reminder that technological differences can be a source of comparative advantage. We observe a growing awareness that technological differences play a role in the integration process following an economic liberalization as well as a growing direct empirical support for the simple two-good Ricardian model (see Golub and Edwards, 2005; Golub and Hsieh, 2000; Mbaye and Golub, 2002; Harrigan, 1997, 2003; Castinot, 2009a).

The main qualitative insight of the Ricardian framework with a continuum of goods developed above can be summarized as follows: the developing country, by opening to trade and foreign involvement and by absorbing technological inflows, will upgrade its export structure and increase its exports in the more complex industries. By reducing the technological gap, the Southern country enlarges the range or the scope of goods towards goods with of higher technological sophistication. An increase in  $\tilde{z}$  shifts the South's export shares towards more sophisticated goods. Such shifts in the export sophistication level are observable<sup>164</sup>. Our contribution is to examine predictions involving observable export sophistication shifts as opposed to unobservable shifts in  $\tilde{z}$ .

<sup>&</sup>lt;sup>164</sup> see the new advanced literature in export sophistication such Lall *et al.*(2006), Schott (2008), HHR (2007), Rodrik (2006), Kumakura (2007), Yao(2009), Wang and Wei(2010), Xu(2010) Xu and Lu (2009) and Di Maio and Tamagni (2008).Unlike Schott (2008), we do not distinguish between "*within-product sophistication*" and sophistication of export structure-"*across-product sophistication*".

The continuum Ricardian model, developed above, gives rise to two testable predictions.

- Technological absorptive effort (via FDI and openness) and spillover lead to an increase in the sophistication of the developing country's overall export basket (equation 17)
- The increase in the export sophistication of the developing country's overall export basket is accompanied by a deterioration of its terms of trade (equation 14).

These predictions are consistent with evidence from a panel of developing and emerging countries observed in the years 1997–2003.

## 4.4.1 Measure of export sophistication

# **4.4.4.1** The North – South trade cut-off ( $\tilde{z}$ )

Moenius (2007) argued that the continuum Ricardian model can be extended to model trade with commodities grouped into industries. In the real world, goods are produced by industries, each of which may produce more than one good. The DFS model should be amended, keeping the basic assumption of a continuum of goods, but regrouping goods into industries. For later empirical implementation, one may think of all international transactions being sorted according to some industry classification like the Standard International Trade Classification (SITC). Moenius considers the industry-specific borderline points  $\tilde{z}_k$ , with "k" represents industry. There will be intra-industry (see Davis, 1995) trade, as in each industry, the good to the left of  $\tilde{z}_k$  will be produced in the developing country and those to the right in the developed country. According to Krugman (1986) and Spilimbergo (1998), the rate of progress of best practice technique say the labour productivity for good (z) can be regarded as an index of z's technology intensity. This particular form of technological progress followed a definite sectoral pattern. The rate of technological progress (i.e. the fall in labour requirement) called also technology intensity differed between sectors.

We focus here on the Southern exports. Following Cheng *et al.* (2005), we recall that "z" could be considered as the sophistication level of export. According to Zhu and Trefler (2005), product data aggregation bias prevents us from directly observing  $\tilde{z}$ . The problem is that at the disaggregated level of the World Trade Database, most countries export most goods. In many cases, there is thus no cut-off good  $\tilde{z}$  beyond which the Southern countries

cease exporting. Following Feenstra and Hanson (1996) and Schott (2003), this lack of specialization is probably an artifact of aggregation bias. The key to the implementation of an empirical test is to measure technological content of exports, i.e.,  $\tilde{z}$  in the model. Unlike what we have assumed in the simple theoretical model, in reality each country exports a wide range of products instead of those below a certain level of technological contents, i.e.,  $\tilde{z}$  in the model (Yang and Yao, 2007; Krugman, 1986). "*Fortunately, the inability to observe*  $\tilde{z}$  *is not an insurmountable obstacle to empirical work*" (Zhu and Trefler, 2005, p. 13).

As international trade expanded, studies began to focus on the technological improvements in exports rather than simply the growth of export values. Existing studies do not give direct measures of technology sophistication of export structure, which is often indirectly expressed by ranking of export shares. Sakakibora and Porter (2001) use world export share to rank Japanese industries and find that world export share is positively related to industry R&D. Banga (2006) uses world export share to classify Indian industries into traditional and non-traditional industries. The author defines traditional (non - traditional) industry as the one whose world export share is high (low) in a developing country.

Ranking of export shares, however, does not provide a satisfactory measure of sophistication of exports. Recently a number of researchers have constructed a measure of export sophistication that does not require the use of product-level R&D data (Lall *et al.*, 2006; Rodrik, 2006; HHR, 2007; Schott, 2008). We combine this new literature on measuring export structure with export sophistication levels (see Table 4.1) and prediction of the Ricardian continuum setting with TT.

Zhu and Trefler (2005) consider an increase in export share (Revealed comparative advantage) toward skill intensive goods as a proxy for an increase in  $\tilde{z}$ . Here, we think that the authors failed to give the best proxy for sophistication of a country's export basket. In our framework, an increase in  $\tilde{z}$  upgrades the Southern country export basket and improves its sophistication level. Such export sophistication is observable. We deal with this issue by adopting the method developed by HHR (2007) to obtain a compounded index of the technological contents of a country's exports<sup>165</sup>. We will therefore examine predictions

<sup>&</sup>lt;sup>165</sup>The definition is based on a method developed by HHR (2007) to measure the technological contents of a country's exports. The key element of the HHR method is what we call the technological sophistication index for each exported product. It is the average per-capita GDP of countries that export the product, weighted by each country's relative weight of the product in world trade. Then, the technological content index of a country's exports is defined as the weighted average of

involving observable export sophistication from HHR's EXPY index data (as opposed to unobservable shifts in  $\tilde{z}$ ). A high EXPY index corresponds to a high z.

Following the Krugman's (1986) technology gap model of Ricardian trade, each good produced by the technologically advanced country has higher technological content than each good produced by the follower. However, in reality, countries might well not follow this direction exactly and there is always overlap between their scopes of exporting goods. Fortunately, the export productivity (or sophistication) index reflects the technological contents of a country's exports well.

# 4.4.1.2 Construction of the HHR export sophistication measure

As explained above, the index " $\tilde{z}$ " may be interpreted as measure of the technological intensity or the level of exports sophistication (see Yang and Yao, 2007, Porcile *et al.*, 2006). It is therefore, of interest to establish whether there is a positive link between importing superior technology via FDI and export sophistication. We extend the well-known papers of HHR (2007) and Rodrik (2006) to explore the effect of TT via openness and foreign involvement on the sophistication of developing countries.

In order to document the estimation of the export sophistication index (productivity level associated with a country's exports) developed by HHR (2007), a quantitative indicator which sorts traded goods in terms of their implied productivity, we proceed as follows. We use subscript *j* to index countries, and *l* to index products. Then, let  $Y_j$  stand for the per-capita GDP of country *j*, and  $x_{jl}$  stand for the export value of product *l* in country *j*. The total export value of country *j* is  $X_j$ . The income level associated with each exported of product *l* in year *t* is computed. This indicator, denominated PRODY, is calculated as follows:

$$PRODY_{l} = \sum_{j} \frac{x_{jl} / X_{j}}{\sum_{j} (x_{jl} / X_{j})} Y_{j}$$

the technological sophistication index of the country's exported products. It is usually the case that higher labor productivity corresponds to higher technological contents.

It is the weighted average of per-capita income of countries exporting product *l* using the modified revealed comparative advantage index as the weight<sup>166</sup>.Each good *l* that a country can potentially produce and export has an intrinsic level of productivity associated to it, *PRODY*<sub>*l*</sub> that is the weighted average of the income levels of this good *l*'s exporters, where the weights correspond to the revealed comparative advantage (RCA) of each country j in product *l*.

Other studies, such as that by Lall et *al.* (2006), use the share of country j's exports of product l in total world exports of product l as weight in the PRODY calculation. However, as noted by HHR (2007), if this weight is used, the PRODY indicator over-weights large countries. It will be biased towards large countries' GDP per capita, because large countries export more than small countries. In order to overcome this limitation, HHR suggest the use of RCA as a weight.

PRODY index ranks traded goods in terms of their implied productivity. The construction of PRODY follows the idea of Ricardian comparative advantage: that is, countries with higher per capita income export products with higher technological contents, while countries with lower per capita income export products with lower technological contents (see Yang *et al.*, 2009, p.60)

The export sophistication (EXPY) of country *j*'s export bundle is the overall level of productivity of its export basket. EXPY is our measure of the productivity level associated with a country's specialization pattern. It is the weighted sum of the productivity levels associated to each exported good l, *PRODY*<sub>1</sub>, with the weights being the share of each good in the country's total exports. The productivity level associated with country j's export basket EXPYj, is

$$EXPY_{j} = \sum_{l} \frac{X_{jl}}{X_{j}} PRODY_{l}$$

<sup>&</sup>lt;sup>166</sup> The numerator of the weight,  $\frac{x_{jl}}{X_j}$ , is the value-share of the commodity in the country j's overall export basket while the denominator of the weight,  $\sum_j (\frac{x_{jl}}{X_j})$  aggregates the value-shares across all countries exporting the good.

In other words, the technological content index of country *j*'s exports, i.e., the overall level of productivity of country's export basket (EXPY), is the weighted average of the PRODY for that country, where the weights are the shares of each product in the country's total exports. EXPY is our measure of the productivity level associated with a country's specialisation pattern (see HHR, 2007, p.3; Yang *et al.*, 2009).

As a robustness test, we will rely on a relative sophistication exports (REXY) of a developing country. Inspired by the empirical works of Xu and Lu (2009), we calculate REXY of a developing country and regress it in our econometric model to check robustness of the sophistication measure.

$$REXPY_{j} = \frac{EXPY_{j}}{EXPY_{developed}}$$

where  $EXPY_d$  is the mean export sophistication (productivity) of the 5 major (G5) countries-USA, UK , Japan, Germany and France. This mean export sophistication<sup>167</sup> is a reference to the developing countries. Northern countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom and the United States. According to Zhu and Trefler (2005, p. 14), "*it does not matter exactly which countries are included in the North provided that the major destinations for Southern exports are included, i.e., the United States, Japan, Germany, France, and the United Kingdom*". We use two relative sophistication measures

$$(REXPY_{j})_{1} = \frac{EXPY_{j}}{mean \ EXPY5_{developed}}$$

which is based on the mean EXPY of the G5 : USA, UK , Japan, Germany and France.

$$(REXPY_j)_2 = \frac{EXPY_j}{mean \ EXPY \ 15_{developed}}$$

which is based on the mean EXPY of 15 developed countries: Australia, Austria, Canada, Denmark, Finland, France, Germany, Iceland, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom, and United States (this list is from Zhu and Trefler (2005)). All the data on relative export sophistication are less than one.

 $<sup>^{167}\,\</sup>mathrm{EXPY}\,$  is measured at current US  $\$  .
Paper	Data and source	Period	Methodology	Main results
Rodrik, D. (2006), What is so special about China's Exports?	6-digit HS (Comtrade)	1992-2003	Indicator (EXPY)that measure the productivity level associated with a country's export basket	Since 1992 the quality of Chinese exports has increased. The indicator adopted (EXPY) shows that Chinese export bundle is similar to countries up to three times the level of income of China
Hausman, R., Hwang, J. and Rodrik, D. (2007), What you Export Matters	6-digit HS (Comtrade)	1992-2003	Index of productivity level associated to a country's export basket (PRODY and EXPY). Theoretical model and empirical analysis	Regressions on a sample of 160 countries show high correlation between EXPY and GDP per capita. Regressions show that countries exporting goods with higher EXPY grow more rapidly.
Schott, P. K. (2008) Chinese Exports, Economic Policy, January 2008	US Imports 7 to 10- digit HS (US Customs)	1972-2005	Export similarity of Chinese exports with OECD (Finger- Kreinin index). Analysis of the unit value of exports	Export-similarity with OECD countries is raising. China is catching-up at an earlier stage of economic development compared to other countries.
Xu, B. (2007), Measuring China's Export Sophistication	10 digit HS (US Custom statistics)	1992-2005	EXPY adjusted by a region- weighted measure of Chinese GDP per capita and a relative price (unit values) index	Critics the works of Rodrik and Schott on the methodology adopted; Adjusting China's income for the income level of exporting regions downsize Rodrik's results; Introducing relative unit values of China's exports show that Chinese exports are still at the quality ladder; Confirms that across-products, China is an outlier among developing countries
Wang, Z. and Wei, S.J. (2008), The Rising Sophistication of China's Exports: Assessing the Role of Processing Trade, Foreign Invest Firms, Human Capital and Government Policies	6-digit HS (Comtrade) and 8-digit HS (China Customs)	1995-2005	Empirical estimation of the determinants (at the city level) of China's export sophistication (measured by the dissimilarity index of Chinese exports with US, EU and Japan) and of the unit values of Chinese exports	The authors , using city-level data, show that processing trade and foreign investment lead to the export of more sophisticated varieties within a given product category Exports from 'policy zones' (EPZs and high-tech zones) and human capital (measured either by the number of enrolled students in colleges and by per capita GDP) have a positive effect on the sophistication of export structure at the city level; processing trade and FIEs (both WOEs and JVs) have a positive effect on quality (unit values) of Chinese exports

### Table 4.1. Some papers on export sophistication

Jarreau and Poncet (2009), Export Sophistication and Economic Performance: Evidence from Chinese Provinces <u>Paper online in 31 december 2009</u>	6-digit HS (Comtrade)	1997-2007	The determinants of Chinese export sophistication	The authors used a database of China's exports over the period 1997-2007 to investigate the upgrading of China's exports and to identify the determinants of Chinese export sophistication. They use different measures of sophistication They distinguish between exporters by type of firm and between processing and ordinary trade to identify their respective contributions to the overall sophistication: they find that the processing sector in China is significantly more sophisticated; however, the ordinary sector has also upgraded importantly over the recent years. The authors test the hypothesis of spillovers from foreign invested firms to domestic exporters in China. They find evidence of a positive impact of foreign firms' export structure on that of domestic firms. The increase in the level of sophistication of foreign entities is the main contributor to the global upgrading of China's exports.
Minondo, A (2009) " Exports' productivity and growth across Spanish regions"	8-digit extension of HS (Comtrade)	1994-2004	Exports' Productivity and Growth across Spanish Regions	Using a highly disaggregated, regional trade database, the productivity level associated with Spanish provinces' exports is calculated and whether provinces that latch on more productive exports have achieved higher rates of growth is analysed. The results show that there is a positive link between exports' productivity and growth at a regional level.
Xu, B. and Lu, J. (2009)" Foreign Direct Investment, Processing Trade, and China's Export Sophistication	10 digit HS (US Customs) 4-digit ISIC for the industry-level analysis and processing trade (China customs)	2000-2005	Empirical estimation of the determinants of across-product and within-product export sophistication of China	The authors find that FDI by wholly foreign owned firms (no by joint ventures) from advanced countries and processing trade (for foreign-invested firms, no for domestic firms) have positive effect on both across- and within-product export sophistication Foreign firms have contributed significantly to the increase of the sophistication of China's exports.

The basic descriptive statistics on *EXPY* are summarized in Tables 4.2 to 4.4.

	China	Indonesia	India	Malaysia	Brazil	Turkey	Mexico	
1997	12569.36035	10094.99609	10308.38477	12862.11621	11470.62793	10845.54297	14041.7832	
1998	12818.10059	10672.71191	10307.07813	13004.8877	11658.04688	11083.60254	14456.29102	
1999	12967.72363	10011.88867	10578.94141	13638	11688.79199	11414.90918	14617.18945	
2000	13200.90918	10462.71289	10631.42871	14110.98633	12182.18262	11638.85352	14669.1582	
2001	13502.76758	10312.5752	10825.96777	14392.53906	11855.89648	11734.15527	14990.37012	
2002	13806.85645	10320.93652	10927.0498	14383.96387	11671.5332	11846.2998	14972.46973	
2003	14127.39551	10278.94727	11138.50879	14398.88281	11685.8291	12107.1709	14679.43945	

Table 4.2. EXPY over time

Table 4.5. EAT I summary statistics (by year	Table 4.3.	EXPY	summary	statistics	(by y	ear)
--	------------	------	---------	------------	-------	------

			Mean	Std. Dev.	Min	Max	Observations
EXPY (PPP)	1997	overall	9562.768	2879.25	2369.991	14905.53	N = 58
		between		2879.25	2369.991	14905.53	n = 58
		Within		-	9562.768	9562.768	T = 1
EXPY (PPP)	1998	overall	9684.354	2945.666	2182.941	15226.42	N = 58
		between		2945.666	2182.941	15226.42	n = 58
		Within		-	9684.354	9684.354	T = 1
EXPY (PPP)	1999	overall	9823.002	3038.036	2137.314	15592.78	N = 58
		between		3038.036	2137.314	15592.78	n = 58
		Within		-	9823.002	9823.002	T = 1
EXPY (PPP)	2000	overall	9948.923	3004.381	2295.552	15693.77	N = 58
		between		3004.381	2295.552	15693.77	n = 58
		Within		-	9948.923	9948.923	T = 1
EXPY (PPP)	2001	overall	10138.83	3060.43	2424.323	15582.11	N = 58
		between		3060.43	2424.323	15582.11	n = 58
		Within		-	10138.83	10138.83	T = 1
EXPY (PPP)	2002	overall	10222.05	2958.692	3086.431	15842.45	N = 58
		between		2958.692	3086.431	15842.45	n = 58
		Within		-	10222.05	10222.05	T = 1
EXPY (PPP)	2003	overall	10065.17	3106.066	2793.385	16041.74	N = 58
		between		3106.066	2793.385	16041.74	n = 58
		Within		-	10065.17	10065.17	T = 1

### Table 4.4.EXPY summary statistics

	Percentiles	Smallest	
1%	2424.323	2137.314	
5%	5367.3	2182.941	
10%	6100.377	2295.552	
25%	7910.766	2369.991	
			Obs 406
50%	9741.398		
75%	11828.7	15842.45	
90%	14215.64	15854.49	
95%	15024.74	15954.4	
99%	15826.24	16041.74	

In what follows, we provide a first attempt at assessing the empirical plausibility of the mechanism proposed in this chapter. This is done in two parts. The first is a test of the model's prediction whereby FDI leads to an increase in the sophistication of the developing country's overall export basket using panel data. The second part is an attempt to test whether the increase in the export sophistication of the developing country's overall export basket corresponds to deterioration of its terms of trade using panel data

### 4.4.2 Export sophistication: Testable estimation, data and econometric analysis

### 4.4.2.1 Model 1

In this section, we use HHR's methodology and their export sophistication measure to characterize the evolution of the exports' basket towards goods with a higher implied productivity and the role FDI synonymous to TT in this process. The theoretical framework developed above is an illustration of how TT (via FDI) leads to an increase in the country's export sophistication. This stimulates an empirical study to test the influence of technology import via FDI on the sophistication of the developing country's export basket. We try to test the prediction that importing superior technology leads to an increase in the range of goods and an upgrading in export sophistication of developing countries. This prediction will be tested on the basis of a sample of developing and emerging countries for the 1997-2003 period using panel data techniques.

We seek to understand the patterns of export sophistication. We estimate a timevarying export sophistication measure and we analyse its determinants. By combining propositions 1 and 2 from the Ricardian setting, the prediction is unambiguous: Factors that promote Southern catch-up or that narrow North-South technological gap and that facilitate the TT and diffusion to the Southern country lead to an upgrading in the developing country's export structure. In what follows, we try to bring the Ricardian predictions to the data and to check whether the econometric estimations confirm the predictions of the Ricardian model previously presented. The key empirical implication of our theoretical framework is that technological inflows and spillovers lead to an upgrading in export structure and an increase in the export sophistication of the developing country. Our core argument is that inward FDI in developing countries, by reducing the North – South technological gap and improving its catch-up, upgrades the export structure of the Southern country. It is of interest to study the effect of openness to trade and FDI on export productivity. To examine this empirically, we need to link the theory as tightly as possible to an estimating equation. Our empirical model builds on:

- a huge literature on North-South technological gap and Southern technological catch-up (see Zhu and Trefler, 2005; Krugman, 1979, 1986; Glass and Saggi, 1998)
- papers that investigate the link between technology transfers and outward orientation, through international trade for and through FDI and
- the new literature on export sophistication (Rodrik, 2006; HHR, 2007; Xu and Lu, 2009; Xu, 2010).

Table 4.5.	Variables used	in analysis:	Measurement	and Data Sources
------------	----------------	--------------	-------------	------------------

Variable name	Definition	Source
log ( EXPY ) REXPY log(REXY)	Natural logarithm of export sophistication measured in parity purchasing power (EXPY (\$ PPP)) Relative export sophistication ( using EXPY measured in current US \$) Natural logarithm of relative export sophistication	Rodrik database World Bank & PRMED database PRMED: The Economic Policy and Debt Department (PRMED) is responsible for the World Bank's operational and policy work in the areas of growth, fiscal policy, and strategic debt issues, as well as integrative policy analysis and tools for economic analysis
log(real FDI)	$\log(\text{real FDI}) = \log[\frac{inward FDI \ stock}{consumer \ price \ index}]$	Author calculation from World Bank' World Development Indicators and UNCTAD databases
FDI in stock / world FDI	In level and in log	UNCTAD database
FDI in stock / GDP	In level and in log	UNCTAD database
FDI in stock / exports	Foreign presence (in level and in log)	UNCTAD database
log(GDP per capita)	Natural logarithm of GDP per capita measured in PPP, constant 2000 international \$	World Bank's WDI (CD-ROM 2005)
log (Pop) log (labour)	Natural logarithm of population Natural logarithm of labour force	World Bank's WDI database
Rpop	Relative population	
Rlabour	Relative labour force	
EP (export penetration)	Southern export penetration or exporting measured by high-tech exports/manufactured exports The high-technology exports comprise exports from sectors that are intensive en R&D, namely aerospace, computers, pharmaceuticals, scientific instruments and electrical machinery. In level and in log	World Bank's WDI database
Imp/GDP log(100*imp/GDP)	Imports of goods and services/ GDP	World Bank's WDI database

Following Zhu and Trefler's (2005) methodology, we consider that developing and emerging (the South) countries are countries whose 1997 real GDP per capita is below US \$ 15,000 (Southern GDP per capita cut-off). We select only those developing and emerging countries (transitional economies are included) for which there are substantial data over the 1997-2003 period. We also use the World Bank' classification of countries into low and middle income groups.

Navaretti et al. (2004) consider some EU neighbouring developing countries: Hungary, Czech Republic, Slovak Republic, Poland, Slovenia, Croatia, Morocco, Turkey, Egypt, Cyprus, Morocco, Malta, Tunisia and Syria.

#### List of developing and emerging countries used (transitional economies are included) in our data:

China, Philippines, Brazil, Uruguay, Costa Rica, Argentina, Czech Republic, Hungary, Slovenia, Slovak Republic, Poland, Croatia, Turkey, Romania, Bulgaria, Morocco, Albania, Macedonia, Lebanon, Estonia, Latvia, Moldova, Mexico, Malaysia, India, Indonesia, Colombia, Venezuela, Mauritius, Nigeria, Paraguay, Peru, Chile, El Salvador, Oman, Jordan, Panama, Guatemala, Nicaragua, Ecuador, South Korea, Belize, Barbados, Niger, Georgia, Senegal, Azerbaijan, Bolivia, Kenya, Uganda, Sudan, Mongolia, Ethiopia, Iran, Egypt, Thailand, Lithuania and Trinidad and Tobago

World Bank' classification of countries into low and middle income groups.

Trade data from United Nations Commodity Trade Statistics Database (COMTRADE) cover over 5,000 products at the Harmonized System 6-digit level for the years 1992–2003. The value of exports is converted to 2000 dollars for comparison with real GDP per capita series. PRODY measure was constructed for a consistent sample of countries that reported trade data in each of the years 1999-2001.PRODY is calculated with PPP-adjusted GDP. The average PRODY from 1999-2001 is then used to construct an EXPY index for all countries reporting trade data during the period from 1992 to 2003. The PRODY that go into the construction of EXPY themselves do not vary over the years (HHR, 2007)

The details on EXPY calculation are taken from Dani Rodrik and the same database is used in

- Hausman, Hwang and Rodrik (2007), "What you export matters", Journal of economic growth"
- Rodrik (2006), "What's so special about China's Exports?", China and World economy •
- Hausman and Bailey (2008), "South Africa's Export predicament", Economics of transition •
- Klinger Bailey (2009) database

PRODY is available here: http://www.nd.edu/~networks/productspace/data.htm

We mainly focus on the effect of FDI on the technological intensity of the developing and emerging countries' export basket using a panel data. Following the econometric methodology from HHR (2007, p.21), Zhu and Trefler (2005), Schott (2008), Xu and Lu (2009), we start our econometric estimation with fixed effects model, controlling for country and time-specific effects. We use four estimators: OLS with country fixed effects (or Least Square dummies variables), OLS with country fixed effects and year dummies, static (country) fixed effect –instrumental variable, fixed effect –instrumental variable with year dummies. We use HHR (2007) index to assess how well the developing country moves towards goods with higher income content through openness to trade and foreign involvement.

The theoretical model developed above provides the prediction that the technological absorptive effort (TAE) and the related technology diffusion in the developing country boost the sophistication of its exports. This relationship is given by the following general equation<sup>168</sup>:

$$EXPY_{it} = a + b TAE_{it} + v_{it}$$
(21)

Where *TAE* is the vector of variables used as proxies for the dynamism of the technological absorptive effort: Foreign presence or involvement, export (or market) penetration and self-discovery process (proxied by country size and measured by population or labour force) (see Porcile *et al.*, 2006; Cimoli, Porcile & Holland, 2006; Cimoli, Holland, Porcile, Primi and Vergara, 2006 for methodology). "*j*" is country and "t" is year.  $v_{it}$  is the error term.

Goldberg *et al.* (2008) give an interesting approach to the role of FDI and trade in the technological absorptive effort. They point out that the openness to trade and the participation in global supply networks enhance knowledge and technology absorption. They argue that FDI stimulates the acquisition of managerial and technical skills. They find evidence of learning by exporting, underscoring the importance of trade as a driver of technology absorption. *"The channels of technology absorption- trade, FDI, R&D- need a stable and conducive policy framework and a business-friendly investment climate"*<sup>169</sup>. Inspired by

<sup>&</sup>lt;sup>168</sup> see Gancia and Bonfigliol (2008), Goldberg and Klein (2001), Gholami *et al.* (2006) and Yang et Yao (2007) for methodology.

<sup>&</sup>lt;sup>169</sup> Goldberg *et al.*(2008, p.3)

Goldberg *et al.* (2008), we expect that inward FDI and trade, and the related technology absorption, will upgrade the export sophistication of the developing countries.

In order to test the theoretical model, we regress the sophistication level of the export basket of a sample of developing and emerging countries for the 1997-2003 period using panel data techniques. The cross-section dimension of the sample is much more important than its time-series dimension. Our empirical specification which we initially estimate, takes the following form:

$$EXPY_{it} = \gamma + \alpha_i + \alpha_1 FDI_{it} + \alpha_2 Pop_{it} + \alpha_3 EP_{it} + \alpha_4 imp_{it} + u_{it}$$
(23)

where "EXPY", the dependant variable, is an index of the technological content of the exports -the level sophistication of a country's entire export basket (or package). EXPY is the original notation of Rodrik (2006) and HHR (2007) for overall export sophistication level of a country. FDI, Pop, EP and imp are respectively real FDI, population, export (or market) penetration and imports. The variables EXPY, Pop and FDI (real) are expressed in natural logarithm; Southern export (or market) penetration (EP) and imports (Imp) are expressed in ratios. "j" is country and "t" is year.  $\alpha_i$  are country specific effects in panel data that capture unobserved country heterogeneity. We add country specific dummies (country fixed effect) and imports/GDP to control for potential omitted factors. We expect  $\alpha_1 > 0; \alpha_2 > 0; \alpha_3 > 0; \alpha_4 > 0$ . We will furthermore verify, relying on instrumental variables (IV), that our results are not biased by simultaneity or circularity issues.

Some authors have considered the role of FDI in the technology sophistication of China's total trade. For example, Amiti and Freund (2010) show that once excluding processing export from China's total export, there is no evidence of significant skill upgrade. Xu and Lu (2009) find that foreign firms originating from advanced countries have contributed significantly to the increase of Chinese export sophistication. The authors use China's industry-level data to find that an industry's level of export sophistication is positively related to the share of wholly foreign owned enterprises from OECD countries and the share of processing exports of foreign-invested enterprises. The key role of foreign presence in the development of export sophistication in the developing and emerging countries is consistent with our estimations' results in this chapter.

In order to focus on the effect of FDI measured in absolute terms, we use Bénassy-Quéré *et al.*'s (2001) measure of real FDI.

$$\log (\text{Real FDI}) = \log[\frac{inward FDI \ stock}{consumer \ price \ index}]$$

We consider that this variable represents technology spillover. FDI in stock is likely to better capture the overall presence of foreign firms (Guariglia and Poncet, 2008; Cheng *et al.*, 2005). We consider a stock measure of FDI, less influenced by shorter term variability than FDI flows. We prefer FDI stocks to FDI flows because of export sophistication enhancing spillovers should not only emerge from recent FDI inflows but also from FDI established much earlier (see Nunnenkamp and Spatz, 2004; p.60).

We mainly focus on FDI due to its direct influence on the industry structure and product. FDI often brings in new technology, advanced managerial practices, efficient processes and skills which lead to an improvement in the competitiveness of the industries. Cheng *et al.* (2005) consider FDI as synonymous to advanced technologies and management experiences. We expect that FDI leads to technology absorption and therefore to an increase in the export sophistication. We will report a series of regressions with the left- hand- side variable being the export sophistication.

How does EXPY vary across countries? Figure 4.7 shows a scatter plot of EXPY against real FDI. There is a strong correlation between these two variables which is robust to the year choice over the 1997-2003 period.



Figure 4.7: Relationship between real FDI and EXPY (in logs), 2003

### • Checking robustness to outliers

In order to check the robustness of our results to outliers, we provide the estimation using the new advanced econometric methods in Bramati & Croux (2007) and Veradi & Croux (2009). We report the robust regression estimates using Maronna-Yohai Median Squares method.

Data sources: Dani Rodrik (for EXPY), World Bank' WDI (for consumer price index) and UNCTAD (for inward FDI in stock)

## Dependant variable: log (EXPY)

	Coef.	Std. Err.	t	P> t			
log (real FDI)	0.06	0.012	5.28	0.000			
Country dummies	Yes						

Let's try robust regression and check to see if the results change. The results are nearly identical to the original results.

Robust regression estimates - Maronna - Yohai Median Squares (MS) - estimator robust to outliers							
	Coef.	Std. Err.	t	P> t			
log (real FDI)	0.05	0.01	6.79	0.000			
Country dummies	Yes						
The total number of p-subsets to check for each iteration is 20							
"Msregress" produces M-S estimator which is robust to outliers							
We use this estimator in the fixed effects panel data models, as suggested by Bramati and Croux (2007) and Verardi							
and Croux (2009)							

### Dependant variable: log (EXPY)

Depend	lant var	iable: l	log (	(EXPY)	)
OLS regression	on with W	/hite roł	nist	standard	errors

	Coef.	Robust Std. Err.	t	P> t		
log (real FDI)	0.06	0.018	3.39	0.001		
Country dummies	Yes					

On comparison, we show that M-S estimator of log (real FDI) coefficient in the above regression is nearer (the difference is 0,01) to the OLS- fixed effect estimator. The standard errors from robust regression estimates are nearer to the standard error from OLS regression with fixed effect. We conclude that there is no serious problem from potential outliers. The results are almost identical to the original results.

In order to assess robustness, we also introduce inward FDI as percentage of total World FDI as a measure of the foreign penetration. Figure 4.8 shows a scatter plot of EXPY against FDI/total World FDI. There is a strong correlation between these two variables, which is robust to the year choice over the 1997-2003 period.

Figure 4.8: Relationship between  $\frac{Inward FDI}{World FDI}$  (%) and EXPY (in logs), 2003



Data sources:

EXPY from Rodrik database.

FDI in stock and as a percentage of total world are taken from UNCTAD database

### • Population

According to Cheng *et al.* (2005) in their Ricardian trade model with specific factor, an increase in the relative population of the South expands the range of products that it will produce in the absence of technology transfer, thus opening more opportunities for profitable technology transfer. This may enlarge the range of goods produced by the MNFs and by spillover leads to diversification of the whole economy's exports.

Our analysis of the effect of the domestic market size measured by population on a country's export performance should distinguish between the volume and the structure of exports. According to Linder's theory, the range of a country's potential exports is determined by the level of domestic *"representative demand"*, as production for domestic demand precedes production for foreign demand. The introduction of population size may be explained by the fact that a large domestic market (consumer market) stimulates the growth of industries that need large scale and higher productivity to operate efficiently, which is in turn

a precondition for export production (Linnemann, Van Dijck and Verbruggen, 1987, pp. 36 - 48). Rodrik (2006, p.11) gives an interesting explanation of the role of population or country size in the "*self-discovery*" process:

"The original story of how comparative advantage is determined in part by a process of cost discovery by initial entrants in a new industry". High productivity "discoveries" naturally attract more emulation, and the productivity of an economy's tradable sector tends to converge towards the productivity level of the most profitable (most productive) activities discovered to date. Larger economies have more entrepreneurs engaged in discovery, and therefore, everything else being the same, will have maximum levels of productivity in tradable that are higher".

In words, having a larger population improves export sophistication. Larger economies have more entrepreneurs engaged in discovery, and therefore, everything else being the same, will have more productivity. However, the country does not know the exact commodity composition of that range; it has to 'discover' it. If entrepreneurs 'discover' the high-productivity products within that range, economic growth will occur as resources are transferred to more productive activities.

Recent models of international trade point out consumers' interest for variety and the impact of countries' size on their ability to supply that variety. In these models, larger economies produce and export broader ranges of goods (Schott, 2008, p.9). Hence, we expect that country size or population, proxy for the absorption of high productive discoveries, upgrades the overall export basket. In addition, in order to assess robustness, we use labour force variable. DFS model shows that as a country's labour force rises relative to the other country (shifting the *B* curve up or down), its share of goods produced increases as well (see Deardorff, 2007).

### • Export ( or market ) penetration

The developing countries learn through exporting activities and the exposure to global best practice technology and management techniques. The concept of Southern export penetration may be interpreted as a process by which exporting increases productivity by exposing producers to new technologies, or through upgrading productivity level of goods. Exporting is a channel through which firms based in open economies can acquire foreign knowledge about technologies and goods. This can be interpreted as learning by exporting (see Kraay, 1997; Girma *et al.*, 2003). We measure Southern export ( or market) penetration

by the ratio of high tech exports to manufactured exports (we use the decimal equivalent), which captures the compositional shift of exports from manufactured goods associated with low productivity to manufactured goods associated with high productivity. Southern export penetration, which leads to the "*discovery*" of a number of high productivity exportables, sets off a powerful technology spillover from demonstration effect. This is strongly indicative of a process of technology spillover associated with producing a set of high productivity exportables and spread around the economy as labour moves across industries to the higher productivity exportable activities. This reinforces the technological absorptive capacity of the exporting countries.

We consider high-tech manufactured exports divided by overall manufactured goods as good proxy for Southern export penetration. High-tech product export causes more technology spillover compared with traditionally primary manufactured goods export (see Bao et *al.*, 2010). High-tech exports measure is different from the participation of high tech exports in total exports and different from the measure of country overall export productivity. Overall export productivity is composed of poor productivity goods (raw materials, natural resources, food) middle and high productivity goods (for example products of electronic cluster). We suppose that high-tech exports represent dynamic items in international trade, while agricultural exports tend to generate fewer technological externalities. We consider Southern export penetration as a mechanism of technology absorption.

### • Imports

In addition, we consider the knowledge absorbed from imported goods and services. We interpret the notion that imports contain knowledge in the broadest sense, ranging from actual backward engineering of goods to the wider information contained in the fact that import activities can establish the existence of domestic demand for certain goods. We estimate the effects of imports of goods and services divided by GDP.

### 4.4.4.2 Estimation and results

We start our econometric estimation with a fixed effect model, controlling for country and time-specific effects. Since a modified Wald test for groupwise heteroscedasticity rejects the null hypothesis of homoscedasticity, we rely on robust standard errors to infer about the significance of our results. We also test our models for autocorrelation of residuals with Wooldridge's (2002) test for serial correlation of order one in the residuals.

Such a simple econometric estimation does not take into account potential problems of endogeneity. This could lead to some of our variables being insignificant or having the wrong sign. Therefore, we additionally estimate our model with instrumental variables (IV), which are lags of our explanatory variables. In order to test the validity of our instruments with the Hansen test of over-identifying restrictions, we have included some extra instruments (see the econometric methodology of Havrylchyk and Poncet, 2007; Hering and Poncet, 2009).

Table 4.9 gives the results of IV estimation. We test the validity of our instruments with the Hansen test of overidentifying restrictions. The test statistics obtained do not reject the orthogonality of the instruments and the error terms, and thus we can conclude that our choice of instruments was appropriate. We complement this test by the Partial R<sup>2</sup> of excluded instruments and the first-stage F-test<sup>170</sup>. Partial R<sup>2</sup> are systematically higher than 10% which provides satisfactory explanatory power of instruments for the regressor instrumented. We also report the robust F-stat form of the Cragg-Donald statistic (Kleibergen-Paap F statistic); initially suggested by Stock and Yogo (2005) as a global test for the presence of weak instruments. (i.e., it tests the null hypothesis that a given set of instruments is weak against the alternative that it is strong). This statistic is also reported together with the critical values, as tabulated by Stock and Yogo (2005). The test rejects the null hypothesis if the computed statistic exceeds the critical value. The results with respect to the quality of the instruments are overall quite satisfactory. Our instruments pass the Cragg–Donald test comfortably in all cases. We obtain a Kleibergen-Paap Wald F-statistic above the informal threshold of 10 suggested by Staiger and Stock (1997) to assess the validity of instruments. All Kleibergen-

<sup>&</sup>lt;sup>170</sup> The first stage *F*-statistic is developed by Stock and his colleagues (Staiger and Stock, 1997; Stock *et al.*, 2002; Stock and Yogo, 2005)

Paap Wald F statistics shown in Table 1.5 are greater than the Stock and Yogo 10 or 15 percent critical values<sup>171</sup>.

In order to test the appropriateness of relying on the IV estimator, we perform the robust Durbin-Wu-Hausman test statistic, which tests the endogeneity in a regression estimated with IV. The rejection of the null hypothesis means that the endogeneity of the regressors has a significant effect on the estimated coefficients and we have to rely on the IV estimation. Since these test statistics do not reject the null hypothesis of exogeneity of regressors tested (at the 10% confidence level), IV estimates are not appropriate.

Tables 4.6 and 4.7 report the results of the export sophistication level log(*EXPY*) regressions. The fixed effect's results are particularly telling, since these explicitly control for time invariant country characteristics and identify the impact of EXPY off the variation *within* countries. It is interesting to note that the estimated coefficients on FDI and export penetration are positive and statistically significant at 1% and 5% level in all regressions. This provides strong support for our proposition 2 in the theoretical model (see the third section of this chapter). These regressions show highly significant positive effects of FDI and EP (southern export penetration) on overall export sophistication of our countries sample.

The FDI variable enters with a positive coefficient that is statistically significant at 1% in all of these specifications. The estimated coefficient varies from 0.04 to 0.05. Taking the midpoint of this range, the results imply that a 10% increase in the FDI variable boosts country overall export sophistication by half a percentage points. The developing countries appear to have benefited from the transfer of sophisticated production techniques and backward linkages.

The EP variable enters with a positive coefficient that is statistically significant at 1% in all of these specifications. The results imply that an increase in exporting of high-tech manufactured good as a percentage of manufactured exports improves country overall export sophistication. We find evidence of export (market) penetration, underscoring the importance

<sup>&</sup>lt;sup>171</sup> Kleibergen-Paap F statistic is reported together with critical value Stock-Yogo weak identification test for 10% and 15% maximal IV size distortion as tabulated by Stock and Yogo (2005). If there are three or more instruments (thus, there are two or more overidentifying restrictions), the relative-bias criterion can be used (Cameron and Trivedi, 2009; p. 194).

of trade as a driver of technology absorption. The exposure to international best practices through exports affects absorption outcomes.

Our results show that by absorbing technology via FDI and exporting, a developing country can produce goods of higher productivity ("sophistication"). In other words, Southern catch-up expands the Southern range of exports towards more sophisticated goods. Exporting and FDI are crucial to the process of technological absorption and diffusion. The developing countries could rely on FDI when attempting to catch up in technologically advanced industries.

The estimated coefficient on population is positive and statistically significant at 1 % level in the one-way FE regression. The increase in population in a developing country that benefit from FDI and export penetration leads to the production of high-productivity goods. In line with HHR (2007), we confirm that population plays a strong effect on the export sophistication. In Table 4.10, we use labour force instead of population as a proxy for country size. The estimated coefficient on labour force is positive and statistically significant at 1 % and 5%.

The estimated coefficient on imports of goods and services (in level) is positive which the expected sign is but its significance is not robust to various specifications. Technology absorption through global imports is much lower than exporting. Imports of goods and services do not enter in a robustly significantly way in all regressions, and their presence does not affect much the significance of FDI, export penetration, labour productivity and population (or more generally country size).

We conduct a number of robustness checks to examine the sensitivity of our main results to alternative specifications of the main estimating equation from Model 1. We estimate the baseline specification using the relative export sophistication (in level and in logarithmic form) as a dependent variable. The results of a number of robustness checks are reported in Tables 4.11 to 4.15. The significance of key variables remains robust which gives credence to our results on the determinants of export sophistication. We also report regressions with RHS variables lagged one year in Table 4.8. The significance of the key regressors are robust to this test. Our findings are robust to lagging the key RHS variable -FDI -by one year.

1 3(	
	One-way fixed effect
log(real FDI )	0.0577***
	(3.17)
EP	0.286***
	(2.87)
log(pop)	0.584***
	(2.82)
Imports/GDP	0.075
	(1.00)
Constant	3.34*
	(1.70)
Country fixed effect	Yes
Wooldridge test for autocorrelation	F(1, 54) = 1.152
	Prob > F = 0.2879
Hausman Test FE vs RE	59.26
	Prob>chi2 = 0.0000
Breusch and Pagan Lagrangian multiplier test for random effects	chi2(1) = 815.24
	Prob > chi2 = 0.0000
Number of countries	55
Number of observations	385

### Table 4.6. Dependant variable: log (EXPY) over the period 1997-2003

• Robustified significance joint test for country fixed effects: F(54, 326) = 370.72, Prob > F = 0.0000 (default test significance F(54, 326) = 56.56 Prob > F = 0.0000)

• In our model, Breusch and Pagan Lagrangian multiplier test reject strongly the presence of random effects.

• The Fisher test following the fixed effect regressions with standard errors indicates that are significant individual (country level) effects implying that pooled OLS would be inappropriate. Following the Hausman test, the hypothesis of no fixed-effects is rejected at the 1 % level of significance. Therefore, the Hausman test leads to the conclusion that pooled OLS estimation is likely to produce inconsistent coefficient estimates for the regression model in (23). As a result, the regression model in (23) should be estimated by fixed effects regression.

Least square dummy variable (LSDV) model fitted using "areg" command from Stata (see Cameron and Trivedi, 2009, p. 253).

• Heteroscedasticity robust t-statistics are given in parentheses. \*\*\*significant at 1% level, \*\*significant at 5% level, \* significant at 10% level

• There is evidence of the multicollinearity problem if the mean VIF is greater than 6 and the largest individual VIF is greater than 10 (Gujariti, 2004; Enders, 2004; Baum, 2006; Kennedy, 2003, Chatterjee and Price, 1991). We are comfortable with our data. No variables in our regressions presented here reached this criterion.

		One-way fixed effect		Two-way fixed effect			
	(1) (2)		(3)	(4)	(5)	(6)	
log (real FDI)	0.0595***	0.059***	0.0577***	0.057***	0.058***	0.057***	
	(3.22)	(3.31)	(3.17)	(2.73)	(2.83)	(2.77)	
log (Pop)	0.596***	0.5917***	0.584***	0.462	0.5*	0.506*	
	(2.84)	(2.84)	(2.82)	(1.74)*	(1.88)	(1.90)	
EP		0.29***	0.286***		027***	0.266***	
		(2.92)	(2.87)		(2.65)	(2.59)	
Imports/GDP	0.095		0.075	0.0878		0.0645	
	(1.24)		(1.00)	(1.08)		(0.80)	
Constant	3.2387	3.29	3.34	4.51	4.15	4.07	
	(1.63)	(1.68)*	(1.70)*	(1.77)*	(1.63)	(1.59)	
Time specific effects (year dummies)	No	No	No	Yes	Yes	Yes	
Robustified test of joint significance of				F(6, 321) = 1.52	F(6, 321) = 1.25	F(6, 320) = 1.21	
time specific effect (Wald test)				Prob > F = 0.1700	Prob > F = 0.2815	Prob > F = 0.3015	
Wooldridge test for autocorrelation	F(1, 54) = 1.594	F(1, 54) = 1.163	F(1, 54) = 1.152	F(1, 54) = 1.599	F(1, 54) = 1.185	F(1, 54) = 1.183	
-	Prob > F = 0.2121	Prob > F = 0.2856	Prob > F = 0.2879	Prob > F = 0.2114	Prob > F = 0.2811	Prob > F = 0.2816	
R <sup>2</sup>	0.9545	0.9558	0.9559	0.9557	0.9568	0.9568	
Adj R <sup>2</sup>	0.9465	0.9481	0.9480	0.9470	0.9483	0.9482	
Number of countries	55	55	55	55	55	55	
Number of observations	385	385	385	385	385	385	

### Table 4.7. Dependant variable: log(EXPY) over the period 1997-2003

• Heteroscedasticity robust standard errors have been used, and robust t-statistics are given in parentheses. \*\*\*significant at 1% level, \*\*significant at 5% level, \* significant at 10% level.

• All regressions include country fixed effects.

• There is evidence of the multicollinearity problem if the mean VIF is greater than 6 and the largest individual VIF is greater than 10. We are comfortable with our data. No variables in our regressions presented here reached this criterion.

Variables	log (real FDI)	log(pop )	EP	
VIF	1.83	1.74	1.08	Mean VIF=1.55

		1110 11110100				
	(1)	(2)	(3)	(4)	(5)	(6)
log (real FDI) lagged (one year)	0.0556	0.054	0.0536	0.052	0.052	0.051
	(2.50)**	(2.46)**	(2.36)**	(2.32)**	(2.28)**	(2.23)**
log (Pop) lagged (one year)	0.5725		0.549		0.541	
	(2.39)**		(2.31)**		(2.29)**	
log(labour) lagged (one year)		0.3536		0.3336		0.329
		(2.67)***		(2.52)**		(2.52)**
EP lagged (one year)			0.167	0.1598	0.16	0.153
			(1.81)*	(1.73)*	(1.75)*	(1.67)*
Imports/GDP lagged (one year)					0.098	0.1038
					(0.95)	(0.98)
Constant	3.53	3.463	3.74	3.76	3.78	3.798
	(1.57)	(1.70)*	(1.67)*	(1.84)*	(1.70)*	(1.87)*
R <sup>2</sup>	0.9599	0.9597	0.9604	0.9602	0.9605	0.9603
Adj R <sup>2</sup>	0.9516	0.9514	0.9521	0.9518	0.9521	0.9518
Number of countries	55	55	55	55	55	55
Number of observations	330	330	330	330	330	330

# Table 4.8. Dependant variable: log (EXPY) over the period 1997-2003RHS variables lagged one year

• Heteroscedasticity robust standard errors have been used, and robust t-statistics are given in parentheses. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.

• All regressions include country fixed effects.

• There is evidence of the multicollinearity problem if the mean VIF is greater than 6 and the largest individual VIF is greater than 10. We are comfortable with our data. No variables in our regressions presented here reached this criterion.

Dependant variable: log(EXPY)	Static IV-FE				
	(1)	(2)	(3)	(4)	(5)
	Instrumented:	Instrumented:	Instrumented:	Instrumented:	Instrumented:
	log(real FDI)	log(real FDI)	Imports/GDP, log (real FDI)	Imports/GDP, log (real FDI)	EP
log(real FDI)	0.0767	0.083	0.0812	0.0823	0.0378
	(2.27)**	(2.09)**	(2.20)**	(1.97)**	(2.16)**
EP	0.3626	0.3706	0.3578	0.3434	0.4987
	(3.23)***	(3.28)***	(2.96)***	(2.87)***	(6.71)***
log(pop)	0.64	0.924	0.652	0.727	0.3845
	(2.63)***	(3.04)***	(2.79)***	(2.17)**	(1.73)*
Imports/GDP	0.0367	0.034	0.103	0.1343	0.0322
	(0.34)	(0.35)	(0.38)	(0.53)	(0.41)
Country fixed effect	Yes	Yes	Yes	Yes	Yes
Time specific effects (year dummies)	No	Yes	No	Yes	No
Arellano-Bond test for autocorrelation in IV context	z = 0.30	z = 0.33	z = 0.27	z = 0.29	z = 0.79
	Pr > z = 0.7606	Pr > z = 0.7431	Pr > z = 0.7897	Pr > z = 0.7725	Pr > z = 0.4290
First-stage F-test	96.68***	88.31***	68.68*** (for FDI)	61.08*** (for FDI)	109.39***
			14.61***(for imp)	16.66*** ( for imp)	
Partial R <sup>2</sup> for excluded instruments	0.6238	0.5999	0.6249 (for FDI)	0.6035 (for FDI)	0.2974
			0.2482 (for imp)	0.2700 (for imp)	
Hansen J statistic of overidentifying restrictions	equation exactly	equation exactly	1.221	0.000	2.031
	identified	identified	Chi-sq(1) P-val = 0.2692	Chi-sq(1) P-val = 0.9979	Chi-sq(1) P-val = 0.1541
Kleibergen-Paap rk Wald F statistic	96.677	88.306	12.750	15.627	109.394
Stock-Yogo weak ID test critical values:					
10% maximal IV size	16.38	16.38	13.43	13.43	19.93
15% maximal IV size	8.96	8.96	8.18	8.18	11.59
Instruments(excluded) for IV regressions	First lag of log (real FDI)	First lag of log (real FDI)	Imports/GDP lagged (one	Imports/GDP lagged (one	ICT exports and
			institutional quality	institutional quality	terecommunications intrastructure
Durbin-Wu-Hausman endogeneity test	1.803	1.360	1.448	1.500	1.568
	Chi-sq(1) P-val = 0.1793	Chi-sq(1) P-val =0.2436	Chi-sq(2) P-val = 0.4849	Chi-sq(2) P-val = 0.4723	Chi-sq(1) P-val = 0.2105
Number of countries	55	55	55	55	48
Number of observations	385	385	318	318	336

 Table 4.9.
 IV regressions and exogeneity checks

• ICT: information and communication technology.

Heteroscedasticity robust t-statistics are given in parentheses \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.

• We use the Arellano-Bond (1991) test for autocorrelation implemented by Rodman (2009) for the static IV context.. In an influential paper, Arellano and Bond (1991) proposed a test for serial correlation, where rejection of the null hypothesis means that disturbance terms are autocorrelated (other tests exist, but this test is more general in its applicability than other tests). In Stata, the Arellano-Bond test for autocorrelation is obtained through the 'abar' command. Arellano-Bond test for autocorrelation (to run after each regression); abar

To obtain estimates robust to serial correlation, 'abar' is not an official Stata command. Roodman (2009) created it. See Bascle (2008) for more details on Arellano and Bond test for AR (1) to test for the presence of serial correlation in static IV context.

Hansen J statistic of overidentifying restrictions: under the joint null hypothesis that instruments are valid and that the excluded instruments are correctly excluded from the estimated equation, the test statistic is distributed as 
 <sup>2</sup>
 <sup>2</sup>
 <sup>1</sup>
 <sup>1</sup>

• Wald joint significance test rejects the inclusion of year dummies.

• Following Hering and Poncet (2009), we use the technique of extra-instrument in order to improve Hansen J test of instrument validity. Inspired by Golub *et al.*'s (2007) paper on the role of services links in exports, we added telecommunication infrastructure (services links) as an extra-instrument.

Labour force as a right -hand side va		
	FE	FE
	(1)	(2)
log(Real FDI )	0.0559***	0.0544***
	(3.08)	(2.66)
log(labour)	0.354***	0.2785**
	(3.23)	(2.08)
EP	0.275***	0.2517**
	(2.67)	(2.37)
Imports/GDP	0.0838	0.0666
	(1.04)	(0.81)
Constant	2.6	3.799*
	(1.52)	(1.72)
Time specific effects (year dummies)	No	Yes
Robustified test of joint significance of time specific effect		F(6, 320) = 1.43
		Prob > F = 0.2020
Wooldridge test for autocorrelation	F(1, 54) = 1.153	F(1, 54) = 1.156
	Prob > F = 0.2876	Prob > F = 0.2870
R <sup>2</sup>	0.9556	0.9566
Number of countries	55	55
	205	205
Number of observations	385	385

## Table 4.10. Dependant variable: log (EXPY) over 1997-2003Labour force as a right -hand side variable

• Variance inflation factor VIF: Mean VIF = 2.02, largest VIF=2.91. Heteroscedasticity robust standard errors have been used, and robust t-statistics are given in parentheses. \*\*\*significant at 1% level, \*\*significant at 5% level, \* significant at 10% level.

• All regressions include country fixed effects. The Robustified test of joint significance of time specific effect (Wald test performed by Stata command "testparm") rejects the inclusion of year dummies.

	log(	EXPY)	• •			
log(Real FDI )	0.0559 (3.08)***	0.054 (2.66)***	0.0179 (2.51)**	0.0179 (3.01)***	0.0179 (3.20)***	
log(labour)	0.354 (3.23)***	0.278 ( 2.08)**	0.1878 (3.49)***	0.1878 (3.84)***	0.1878 (3.63)***	
EP	0.275 (2.67)***	0.2517 (2.37)**	0.152 (2.78)***	0.152 (3.46)***	0.152 (3.80)***	
Imports/GDP	0.0838 (1.04)	0.0666 (0.81)	0.047 (0.87)	0.047 (1.00)	0.047 (0.97)	
Constant	2.6 (1.52)	3.799 (1.72)*	-2.766 (-3.36)***	-1.97 (-3.59)***	-2.766 (-3.50)***	
Time specific effects (year dummies)	No	Yes	No	No	No	
Joint significance F stat of time specific effect		F(6, 320) = 1.43 Prob > F = 0.2020				
	No serial correlation	No serial correlation	Corrected (robust) Std.Err. Adjusted for 55 clusters in country	Newey-West Heteroscedasticity and autocorrelation robust standard errors	Heteroscedasticity robust standard errors	
R <sup>2</sup>	0.9556	0.9566	0.9657	0.9657	0.9668	
	log	g(EXPY)	$(REXPY)_1$			
log(real FDI)	0.0577 (3.17)***	0057 (2.77)***	0.019 (2.70)***	0.019 (3.12)***	0.019 (3.31)***	
log(pop)	0.584 (2.82)***	0.506 (1.90)*	0.311 (3.16)***	0.311 (3.63)***	0.311 (3.63)***	
EP	0.286 (2.87)***	0.266 (2.59)***	0.1578 (2.91)***	0.1578 (3.70)***	0.1578 (3.92)***	
Imports/GDP	0.075 (1.00)	0.0645 (0.80)	0.0425 (0.85)	0.0425 (0.95)	0.0425 (0.91)	
Constant	-1.49 (-0.44)	-0.213 (-0.05)	-2.80 (-3.08)***	-1.456 (-2.95)***	-2.805 (-3.37)***	
Time specific effects (year dummies)	No	Yes	No	No	No	
Joint significance F stat of time specific effect		F(6, 320) = 1.21 Prob > F = 0.3015				
	No serial correlation	No serial correlation	Corrected (robust) Std.Err. Adjusted for 55 clusters in country	Newey-West Heteroscedasticity and autocorrelation robust standard errors	Heteroscedasticity robust standard errors	
R <sup>2</sup>	0.9559	0.9568	0.9660	0.9660	0.9670	
Number of countries	55	55	55	55	55	
Number of observations	385	385	385	385	385	

1 able 4.11. Robustness checks- Relative export sophistication as LHS
---

 Number of observations
 385
 385
 385
 385

 • Population is measured in millions. All regressions include country fixed effects. In the case of no serial correlation, heteroscedasticity robust t-statistics are given in parentheses. In the case of serial correlation, clustered (at the country level) and Newey-West standard errors have been used. \*\*\*significant at 1% level, \*significant at 5% level, \* significant at 10% level.

Dependent variable: log (EXPY)	FE	FE	FE	FE	FE	FE
- ·F ··· · · · · · · · · · · · · · · · ·	(1)	(2)	(3)	(4)	(5)	(6)
FDI/GDP	0.2182***	0.2032**	0 .2033***	0.1909**		
	(3.15)	(2.27)	(2.79)	(2.05)		
log(100*FDI/GDP)					0.0593***	0.054***
					(2.81)	(2.85)
EP	0.2849***	0.284***	0.2784***	0.2754***	0.2649***	
	(2.92)	(2.71)	(2.83)	(2.60)	(2.73)	
log(100* high tech/ manufactured exports)						0.0162*
						(1.70)
log(labour)	0.2642**	0.2244*	0.2647**	02294*		0.223*
	(2.20)	(1.77)	(2.21)	(1.82)		(1.88)
log(population)					0.386*	
					(1.87)	
Imports/GDP			0.1106	0.1025	0.072	
			(1.26)	(1.11)	(0.83)	
log(100*Imports/GDP)						0.061*
						(1.76)
Constant	4.98***	5.587***	4.93***	5.47***	5.283***	5.296***
	(2.70)	(2.84)	(2.66)	(2.79)	(2.74)	(2.90)
Country Fixed effect	Yes	Yes	Yes	Yes		
Time fixed effect (year dummies)	No	Yes	No	Yes	No	No
Number of countries	58	58	58	58	58	58
Number of observations	406	406	406	406	406	406

### Table 4.12. Robustness checks – inward FDI/GDP as RHS variable

### Table 4.13. Robustness checks – inward FDI/GDP as RHS variable

	Subtriess encens			
Dependent variable $\log(REXPY)$ .	FE	FE	FE	FE
	(1)	(2)	(3)	(4)
FDI/GDP	0.2446***	0.27***	0.23**	0.26**
	(2.86)	(2.37)	(2.53)	(2.19)
EP	0.347***	0.386***	0.341***	0.379***
	(3.06)	(3.07)	(2.97)	(2.97)
log(labour)	0.335**	0.369**	0.3356**	0.373**
	(2.26)	(2.23)	(2.27)	(2.26)
Imports/GDP			0.104	0.084
			(0.88)	(0.67)
Constant	-6.047***	-6.61***	-6.09***	-6.703***
	(-2.65)	(-2.57)	(-2.66)	(-2.61)
Country Fixed effect	Yes	Yes	Yes	Yes
Time fixed effect (year dummies)	No	Yes	No	Yes
Number of countries	58	58	58	58
Number of observations	406	406	406	406
	408	400	400	400

٠

Robust t-statistics are given in parentheses.\*\*\*significant at 1% level, \*\*significant at 5% level, \* significant at 10% level. Robustified test of joint significance of time specific effect (Wald test performed by Stata command "testparm") rejects the inclusion of year dummies. ٠

Dependant variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
log (100* FDI/world FDI )	0.084 (3.09)***	0.0836 (3.12)***	0.0813 (2.94)***	0.0775 (2.99)***	0.0756 (2.94)***	0.0785 (2.91)***	0.0788 (2.91)***	0.0755 (2.96)***	0.074 (2.92)***	0.0777 (2.63)***	0.0737 (2.73)***	0.0717 (2.70)***	0.0768 (2.51)**
log( pop)	0.759 (3.69)***	0.740 (3.63)***	0.728 (3.58)***	0.671 (3.30)***	0.640 (3.12)***	0.691 (3.42)***	· · · · · ·			0.672 (3.12)***	0.619 (3.09)***		0.66 (3.09)***
log(labour)							0.4699 (4.11)***	0.438 (3.84)***	0.418 (3.61)***			0.404 (3.67)***	
EP		0.294 (2.99)***	0.289 (2.91)***			0.279 (2.79)***	0.276 (2.68)***						
log (100* high tech exports/manufactured exports)				0.017 (1.95)*	0.0168 (1.88)*			0.017 (1.90)*	0.0167 (1.83)*	0.0166 (1.78)*	0.017 (1.92)*	0.017 (1.87)*	0.017 (1.82)*
Imports/GDP			0.081 (0.97)	0.10 (1.31)			0.083 (0.96)	0.1023 (1.27)					
log(100*imports/GDP)					0.0687 (2.16)**	0.07 (2.01)**			0.0678 (2.04)**	0.061 (1.81)*			
log(imports of goods and services )											0.031 (1.71)*	0.0325 (1.71)*	0.0235 (1.41)
Institutional quality										0.0017 (0.76)			0.0017 ( 0.79)
Constant	2.22 (1.16)	2.368 (1.25)	2.438 (1.29)	2.966 (1.57)	3.04 (1.61)	2.56 (1.36)	2.0167 (1.16)	2.494 (1.43)	2.604 (1.49)	2.637	2.774 (1.46)	2.313 (1.32)	2.416 (1.18)
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup> within	0.1308	0.1578	0.1593	0.1677	0.1715	0.1643	0.1570	0.1674	0.1711	0.1593	0.1693	0.1695	0.1781
R <sup>2</sup> Adj R <sup>2</sup>	0.9519 0.9437	0.9534 0.9453	0.9535 0.9452	0.9540 0.9458	0.9542 0.9460	0.9538 0.9456	0.9534 0.9451	0.9539 0.9458	0.9541 0.9460	0.9524 0.9452	0.9540 0.9459	0.9541 0.9459	0.9529 0.9444
Number of countries	58	58	58	58	58	58	58	58	58	56	58	58	56
Number of observations	406	406	406	406	406	406	406	406	406	392	406	406	392

Table	4.14.	Robustness	checks -	. Ing	(100*inward	d FDI/W	/orld FE	D) as RHS	variable
I HOIV		Itobustitos	CHICCHES	106	1100 111,001	A I I/ I/ / /		I WO INTED	, at 10010

• Robust t-statistics are given in parentheses. \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level. Year dummies are excluded because of non-joint significance at 10% level.

			log(EXP)	Y)			$log(REXPY)_1$						
log(real FDI )	0.055 (3.23)***	0.054 (2.78)***	0.062 (3.05)***	0.054 (3.21)***	0.067 (2.89)***	0.051 (2.79)***	0.0598 ( 2.49)**	0.064 (3.06)***	0.06 (3.02)***	0.063 (2.73)***	0.0577 (2.61)***		
log(labour)	0.323 (2.85)***	0.252 (1.91)*	0.416 (2.93)***	0.302 (2.68)***	0.3097 (2.67)***	0.299 (2.79)***	0.3967 (2.35)**	0.3897 (2.34)**	0.398 (2.79)***	0.382	0.39 (2.86)***		
log(EP)	0.0196 (2.10)**	0.019 (2.02)**	0.0216 (1.95)*	0.0189 (2.04)**	0.0212 (2.29)**	0.0194 (2.06)**	0.0218 (1.94)*	0.022 (1.99)**	0.021 (1.89)*	0.022 (1.93)*	0.02 (1.92)*		
Imports/GDP	0.103 (1.40)	0.078 (1.04)	0.094 (0.93)					0.069 0.66					
log(100*imports/GDP)		· · · · ·		0.066 (2.08)**					0.063 (1.48)	0.052 (1.17)			
Import value index					0.0004 (1.51)								
log(imports of goods and services )						0.03 (1.53)	0.0378 (1.35)				0.03 (1.26)		
Constant	3.099 (1.78)*	4.224 (1.96)**	-8.389 (-3.80)***	3.98 (1.83)*	5.59 (4.35)***	2.88 (1.61)	-8.877 (-3.01)***	-8.003 (-2.92)***	-8.287 (-3.74)***	-8.024 (-2.96)***	-8.6048 (-3.83)***		
Year dummies	No	Yes	No	No	No	No	Yes	Yes	No	Yes	No		
Joint significance F stat (Wald test) of year dummies		F(6, 320) = 1.47 Prob > F = 0.1885					F(6, 320) = 1.31 Prob > F = 0.2503	F(6, 320) = 1.36 Prob > F = 0.2310		F(6, 320) = 1.31 Prob > F = 0.2510			
			log(EXP	(Y)			$\log(REXPY)_1$						
log(real FDI)	0.0565 (3.32)***	0.056 (2.89)***	0.064 (3.13)***	0.056 (3.30)***	0.067 (2.88)***	0.0529 (2.90)***	0.062 (2.58)***	0.066 (2.84)***	0.063 (3.10)***	0.065 (2.81)***	0.0599 (2.70)***		
log(pop)	0.525 (2.48)**	0.439 (1.66)	0.641 (2.45)**	0.495 (2.32)**	0.437 (2.03)**	0.491 (2.40)**	0.6207 (1.85)*	0.611 (1.83)*	0.614 (2.33)**	0.598 (1.81)*	0.6029 (2.35)**		
log(EP)	0.0196 (2.13)**	0.019 (2.07)**	0.0217 (2.00)**	0.0189 (2.07)**	0.0213 (2.33)**	0.0193 (2.10)**	0.022 (1.99)**	0.02 (2.05)**	0.021 (1.94)*	0.022 (1.99)**	0.0215 (1.97)**		
Imports/GDP	0.096 (1.39)	0.076 (1.04)	0.088 (0.91)					0.065 (0.62)					
log(100*imports/GDP)				0.064 (2.19)**					0.06 (1.52)	0.051 (1.18)			
Import value index					0.0004 (1.58)								
log(imports of goods and services )						0.0277 (1.51)	0.0366 (1.32)				0.0298 (1.27)		
Constant	3.11	3.94	-8.03 (-3.24)***	3.996 (2.00)**	4.45 (2.12)**	2.904	-8.60 (-2.47)**	-7.77 (-2.36)**	-7.84 (-3.15)***	-7.71 (-2.35)**	-8.245 (-3.29)***		
Year dummies	No	Yes	No	No	No	No	Yes	Yes	No	Yes	No		
Joint significance F stat (Wald test) of year dummies		F(6, 320) = 1.26 Prob > F = 0.2740					F(6, 320) = 1.28 Prob > F = 0.2640	F(6, 320) = 1.27 Prob > F = 0.2707		F(6, 320) = 1.23 Prob > F = 0.2899			
Number of countries	55	55	55	55	55	55	55	55	55	55	55		
									22	22			

 Table
 4.15. Robustness checks - Comparing between log(EXPY) and log(REXPY)

• In order to test whether or not the residuals from a fixed effects estimation are spatially independent, we perform Pesaran (2004) and Friedman cross-sectional dependence (CD) tests using "xtcsd" Stata command. The null hypothesis of the CD test states that the residuals are cross-sectionally uncorrelated. Correspondingly, the test's alternative hypothesis presumes that spatial dependence is present. The Pesaran and Friedman'CD tests do not reject the null hypothesis of spatial independence.

#### 4.4.2.3 Model 2

We want to check whether the use of adjusted measure of FDI which is FDI/exports and lagged GDP per capita support our findings. We therefore carried out additional regressions including these variables .We consider a second model in which we introduce FDI in stock divided by exports. We regress the sophistication level of the export basket of a sample of developing and emerging countries for the 1997-2003 period using panel data techniques. We use OLS with country fixed effects.

$$EXPY_{jt} = \gamma + \alpha_j + \alpha_1 GDPpc_{jt-1} + \alpha_2 Pop_{jt} + \alpha_3 FP_{jt} + \alpha_4 EP_{jt} + \alpha_5 \operatorname{Im} p_{jt} + u_{jt}$$
(23)

where "EXPY", the dependant variable, is an index of the technology content of exports -the level of productivity or sophistication of a country's entire export basket (or package). EXPY is the original notation of Rodrik (2006) and HHR (2007) for overall export sophistication level of a country. Foreign presence (FP) variable is FDI divided by exports. The variables EXPY, GDPpc and Pop are expressed in natural logarithm, FP"EP" and "Imp" "ť" is ratios. "j" is country and are expressed in vear. We expect  $\alpha_1 > 0$ ;  $\alpha_2 > 0$ ;  $\alpha_3 > 0$ ;  $\alpha_4 > 0$ ;  $\alpha_5 > 0$ .  $\alpha_i$  are country specific effects in panel data that capture unobserved country heterogeneity. Following the static panel analysis in Zhu & Trefler (2005) and Hsieh & Golub (2000), we introduce the productivity variable with a lag. We consider that it takes up to a year before the full effects of Southern labour productivity on overall export sophistication are worked through. This corresponds to the Bernard and Jensen (1999) observation that productivity growth precedes export.

### • GDP per capita (GDPpc)

Inspired by HHR (2007) and Yang and Yao (2007), we consider here GDP per capita (PPP, constant 2000 international \$) as a proxy for labour productivity. GDPpc is used to measure the technical (and educational) level of a country. It captures the host country's absorptive capacity or productivity catch-up. Many studies (Boreinstein *et al.*, 1998; Noorbakhsh *et al.*, 2001) consider that the average years of secondary schooling can capture the human capital level in host countries. According to Griliches (1994) and Elmawazini *et al.*(2009), human skills can be acquired not only by education but also by training and work experience. The level GDPpc reflect the level of technological and human capabilities that lead to a shift in the production function in a country. Hence, in our model, labour productivity measured by real GDP per capital can capture the technological and human capabilities that allow host countries to absorb the technology diffusion and spillover. We use productivity as a driver of absorptive capacity.

We recall that the continuum Ricardian model ranks sophistication of exports by their technology intensity and explains a country's export structure by its comparative advantage in technology capability. Based on the works of Yang and Yao (2007) and Krugman (1986), we think that the construction of the export sophistication index follows the idea of Ricardian comparative advantage, that is, countries with higher per-capita income export goods with higher technological content, while countries with lower per-capita income export goods with lower technological content. The basic assumptions are that the sophistication level of an exported product is revealed by the income levels of countries that export the product. *"For example, passenger jets are exported mainly by high-income countries, so they have a high sophistication level; shirts are exported mainly by low income countries so they have a low sophistication level"* (Xu and Lu, 2008, p. 3).

According to the Ricardian comparative advantage theory, the rank of a country's export sophistication (technological intensity) in the world depends on its labour productivity, and a country with higher labour productivity has higher export sophistication or export productivity (Yang and Yao, 2007, Dornbusch and Park, 1987; Krugman, 1994, Golub and Hsieh, 2000). Although it is difficult to obtain data of labour productivity, fortunately, it is possible to use per capita GDP instead since there is quite a close relationship between labour productivity and per capita GDP (Yang and Yao, 2007). We recall that HHR (2007) showed

the positive and significant effect of EXPY on GDPpc growth as dependent variable. In order to avoid simultaneity and reverse causality with EXPY, we run regression using the lagged value of GDPpc variable. We also argue that the GDPpc proxy for labour productivity takes time to absorb technology and knowledge, which allows us to consider lagged value for this regressor.

As would be expected, EXPY is strongly correlated with per-capita income (lagged one year). Figure 4.9 shows the scatter plot of EXPY against per-capita GDP lagged (one year) for 2003. The correlation coefficient is 0.80. Table 4.17 shows that there is no serious problem from outliers.



Figure 4.9: Relationship between GDP per capita (lagged one year) and EXPY (in logs), 2003

Data sources:Dani Rodrik (for EXPY), CD-ROM(2005) of the World Bank' WDI (for GDP per capita, PPP, constant 2000 international \$)

### • Foreign presence (FP)

In our regression, the presence of foreign knowledge in the country is captured by a ratio of FDI in stocks to exports. We use inward FDI in stocks expressed as percentages of exports from WDI as a proxy for engagement in the internationalization process (Outward orientation). This measure could capture the share of foreign firms in the country's exports (foreign involvement). FDI/exports could serve as a proxy for the relative importance of international integration by means of inward FDI as compared with exports from the domestic developing economy. Following Van Hoesel (1999), we can use either FDI stock /export or FDI stock/GDP to normalize for the size of an economy. Here, in order to capture at the same time the size of an economy and its outward orientation, we use FDI stock/export. Fernandez-Arias and Hausmann (2001, p. 47) use FDI stock/export and argue that "openness is controlled, by using FDI divided by exports". Our objective is to control the outward – oriented development strategy.

Our estimation approach of the impact of the FDI divided by exports on export sophistication should alleviate the potential problem of FDI endogeneity, since it is unlikely that an export sophistication shock translates into a change in FDI/exports. Like Hausman and Fernandez-Arias (2001) we think that this new measure mitigates an eventual endogeneity problem coming from FDI and is plausibly exogenous in our model. However, since we want to ensure that our results are free from any estimation bias, we also use instrumental variables' (IV) estimation. By using FDI/ exports instead of real FDI, Model 2 is different from Model 1.

### 4.4.2.4 Estimations and results

Table (4.16) reports the results from the export productivity level log(*EXPY*) regressions. The estimated coefficient on FP, lagged GDPpc, EP are positive and statistically significant at 1% and 5% level in all regressions. This provides strong support for our proposition 2 in the theoretical model (see the third section of this chapter). These regressions show highly significant positive effects of FDI, GDPpc and EP (southern export penetration) on the overall export sophistication of our countries' sample. Exporting, labour productivity and foreign involvement (FDI/exports) are crucial to the process of technological absorption and diffusion that improves the export sophistication of developing countries.

The "Foreign presence" (FP) variable enters with a positive coefficient that is statistically significant at 1% in all of these specifications. The increase in FP variable improves country overall export sophistication. The export (or market) penetration (EP) variable enters with a positive coefficient that is statistically significant at 1% in all of these specifications. The increase in exporting of high-tech manufactured goods as a percentage of manufactured exports improves country overall export sophistication. We find evidence of exporting, underscoring the importance of trade as a driver of technology absorption. The exposure to international best practices through exports affects absorption outcomes. The coefficient of GDPpc proxy for labour productivity or technical (and educational) level is statistically significant at 1% in all of these specifications. The estimated coefficient varies from 0.20 to 0.28. Taking the midpoint from this range, the results imply that a 10% increase in lagged GDP per capita improves country overall export sophistication by a 2,4 percentage point. Higher labour productivity corresponds to higher technological contents (see Krugman, 1986; Yang and Yao, 2007).

Our results show that by absorbing technology via FDI, exporting and labour productivity, a developing country can produce goods of higher productivity (*"sophistication"*). In other words, Southern catch-up expands the Southern range of exports towards more goods with higher implied productivity. In Table 4.A.1 in the Appendix of chapter 4, we conduct IV regressions and exogeneity checks.

The estimated coefficient on population is positive and statistically significant at 10 % level. The increase in population levels in a developing country that benefit from FDI and exporting leads to the production of high-productivity goods. In line with HHR (2007), we confirm that population plays a strong effect on the export productivity. In order to assess robustness, we use labour force (Labour) variable and relative population (Rpop1) as right hand variable in Tables 4.18 to 4.20 instead of population. The results show stronger significance of labour force and relative population as proxy a for country size.

In Table 4.20, we assess more robustness by introducing a new measure on labour productivity, taken from World Bank database. We use labour productivity measured by GDP per person employed (annual growth) instead of real GDP per capita. The estimated coefficient on labour productivity is positive and statistically significant. The increase in

labour productivity in a developing country leads to the production of high-productivity goods and to an increase in the export sophistication.

There is a very weak positive partial correlation between *EXPY* and the imports and virtually no partial correlation with institutional quality. The estimated coefficient on imports of goods and services is positive which is the expected sign but statistically insignificant in all regressions. Technology absorption through global imports is much lower than exporting. Imports of goods and services do not enter significantly, and their presence does not affect much the significance of FDI, export penetration, labour productivity and population (or more generally country size).

Dependant variable : log (EXPY)	FE	FE	FE	FE	FE	FE							
	(1)	(2)	(3)	(4)	(5)	(6)							
FP	0.0538	0.0506	0.0489	0.0508	0.0479	0.0498							
**	(4.12)***	(3.66)***	(3.61)***	(3.72)***	(3.48)***	(3.58)***							
$\log(GDPnc)$ lagged (one year)	0.2524	0.1799	0.2096	0.2552	0.2003	0.250							
105(0D1 pc) lagged (one year)	(3.62)***	(2.19)**	(3.33)***	(2.59)***	(3.06)***	(2.51)**							
EP	0.260	0.2663	0.3007	0.3057	0.2954	0.2984							
	(2.28)**	(2.37)**	(2.77)***	(2.82)***	(2.68)***	(2.71)***							
log(non)			0.441	0.5942	0.4426	0.6116							
$\log(pop)$			(1.88)*	(1.80)*	(1.88)*	(1.84)*							
Imports/GDP					0.0684	0.0746							
					(0.76)	(0.82)							
Constant	6.0527	6.5277	3.1316	1.307	3.1678	1.1563							
	(13.18)***	(11.85)***	(1.36)	(0.36)	(1.38)	(0.32)							
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes							
Time specific effect (year dummies)	No	Yes	No	Yes	No	Yes							
Robustified test of joint significance of time specific effect		F(5,282) = 2.16		F(5, 281) = 1.70		F(5, 280) = 1.78							
(Critical p.value =0.05)		Prob > F = 0.0589		Prob > F = 0.1343		Prob > F = 0.1177							
Wooldridge test for autocorrelation	F(1, 57) = 0.481	F(1, 57) = 0.616	F(1, 57) = 0.398	F(1, 57) = 0.461	F(1, 57) = 0.388	F(1, 57) = 0.455							
	Prob > F = 0.4910	Prob > F = 0.4358	Prob > F = 0.5306	Prob > F = 0.5001	Prob > F = 0.5361	Prob > F = 0.5029							
R <sup>2</sup>	0.9598	0.9610	0.9610	0.9619	0.9610	0.9620							
Adj R <sup>2</sup>	0.9515	0.9521	0.9526	0.9530	0.9525	0.9529							
Number of countries	58	58	58	58	58	58							
Number of observations	348	348	348	348	348	348							

## Table 4.16. Dependant variable: log (EXPY) Population as explanatory variable

• Robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. .

• See Tables 4.A.1 in the Appendix of chapter 4 for more details on exogeneity checks of our explanatory variables.

Multicollinearity is also examined using Variance inflation factors (VIF). The VIFs look fine here. The results confirm that our variables do not suffer from any multicollinearity problem.

Variables	FP	log(GDP pc) lagged one year	EP	
VIF	1.04	1.03	1.05	Mean VIF= 1.04

	Variables	FP	log(GDP pc	)lagged one year	EP	log(pop)		
	VIF	1.05		1.15	1.10	1.16	Mean VIF= 1.12	
Var	riables FP	log(G	DP pc )lagged one year	EP	log(pop)	Import	s/GDP	
, T	VIF 1.06		1.15	1.29	1.89	1.8	33	Mean VIF= 1.45

Dependant variable: log (EXPY)	Regression with default standard errors	Regression with robust standard errors	Robust regression estimates
		(heteroscedasticity robust standard errors)	Maronna - Yohai Median Squares (MS) - estimator robust to outliers (see Verardi and Croux, 2009)
FP	0.05 (4 44)***	0.05 (4.12)***	0.03 (6 62)***
log(GDPpc) lagged (one year)	0.25 (3.65)***	0.25 (3.62)***	0.22 (4.78)***
EP	0.26 (2.55)**	0.26 (2.28)**	0.27 (6.40)***
Constant	6.05 (13.47)***	6.05 (13.18)***	7.54 (17.83)***
Country specific effect	Yes	Yes	Yes

### Table 4.17. Robust regressions

y specific effect Yes Yes Yes Yes Yes Yes Yes Yes Or Wes The new Stata command "Msregress" produces M-S estimator which is robust to outliers. In order to check robustness, we use this estimator in the fixed effects panel data models, as suggested by Bramati and Croux (2007) and Verardi and Croux (2009). On comparison, we show that M-S estimator in the above regression is nearer to the fixed effect estimator. The standard errors from robust regression estimates are nearer to the standard error from OLS regression with fixed effect. We conclude that there is no serious problem from potential outliers. The results are almost identical to the original results.

 Table 4.18. Labour force as explanatory variable

Dependant variable: log (EXPY)	FE						
·F	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FP	0.05	0.0515	0.0505	0.052	0.0496	0.0512	0.062
11	(3.92)***	(3.85)***	(3.88)***	(3.83)***	(3.74)***	(3.70)***	(3.20)***
$\log(GDPnc)$ larged (one year)	0.225	0.2414	0.2018	0.2224	0.1927	0.217	0.36
105(0D1 pc) hagged (one year)	(3.47)***	(2.60)**	(3.18)***	(2.47)**	(2.95)***	(2.38)**	(2.68)***
EP			0.2967	0.2974	0.2915	0.2908	0.41
			(2.72)***	(2.72)***	(2.63)***	(2.62)***	(2.59)***
$\log(Labour)$	0.2345	0.2701	0.272	0.3204	0.2729	0.3274	0.25
109(2000000)	(1.95)*	(1.95)*	(2.30)**	(2.30)**	(2.31)**	(2.38)**	(1.86)*
Imports/GDP					0.0671	0.0645	
					(0.73)	(0.69)	
log (merchandises imports)							0.0005
							(0.01)
Constant	3.55	2.8677	3.136	2.2179	3.174	2.129	1.98
	(1.80)*	(1.11)	(1.61)	0.85	(1.62)	(0.82)	(0.81)
Country fixed effect	Yes						
Time specific effect (year dummies)	No	Yes	No	Yes	No	Yes	No
Test of joint significance of time specific effect		F(5, 282) = 1.38		F(5, 281) = 1.36		F(5, 280) = 1.34	
(Wald test)		Prob > F = 0.2331		Prob > F = 0.2403		Prob > F = 0.2457	
Robustified test of joint significance of time		F(5, 282) = 1.58		F(5, 281) = 1.53		F(5, 280) = 1.56	
specific effect		Prob > F = 0.1656		Prob > F = 0.1801		Prob > F = 0.1728	
Wooldridge test for autocorrelation	F(1, 57) = 0.654	F(1, 57) = 0.797	F(1, 57) = 0.424	F(1, 57) = 0.513	F(1, 57) = 0.412	F(1, 57) = 0.507	F(1, 43) = 0.164
	Prob > F = 0.4222	Prob > F = 0.3758	Prob > F = 0.5176	Prob > F = 0.4767	Prob > F = 0.5234	Prob > F = 0.4791	Prob > F = 0.6875
R <sup>2</sup> (from LSDV)	0.9597	0.9607	0.9609	0.9618	0.9609	0.9618	0.9559
Number of countries	58	58	58	58	58	58	58
Number of observations	348	348	348	348	348	348	348

Robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10 % level. In order to test whether or not the residuals from fixed effects estimation are spatially independent, we perform Pesaran's (2004) and Friedman cross-sectional dependence (CD) tests using "xtcsd" Stata command. The null hypothesis of the CD test states that the residuals are cross-sectionnally uncorrelated. Correspondingly, the test's alternative hypothesis presumes that spatial dependence is present. CD test does not reject the null hypothesis of spatial independence.

٠

Dependant variable: log (EXPY)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	EX at c	KPY and Gl current US d	DP lollar
														(14)	(15)	(16)
FP	0.054 (4.12)***	0.05 (3.76)***				0.054 (4.12)***	0.05 (3.75)***				0.0469 (3.40)***	0.0478 (3.52)***		0.068 (3.77)***		
log(FP)			0.049 (2.00)**	0.054 (2.09)**	0.05 (1.97)**			0.0495 (2.00)**	0.054 (2.08)**	0.0515 (1.97)**			0.0515 (1.97)**		0.098 (2.33)**	0.090 (2.16)**
log(GDP pc, PPP international \$) lagged	0.238 (3.36)***	0.257 (3.73)***	0.216 (2.82)***	0.2325 (3.15)***	0.2136 (2.79)***	0.238 (3.35)***	0.256 (3.74)***	0.2157 (2.82)***	0.231 (3.14)***	0.212 (2.79)***						
log (GDP pc current US \$) lagged											0.1985 (3.31)***	0.2087 (3.65)***	0.214 (2.79) ***	0.2399 (3.21)***	0.368 (2.22)**	0.3937 (2.32)**
EP	0.2599 (2.28)**	0.3195 (2.96)***	0.275 (2.52)**	0.352 (3.55)***	0.336 (3.29)***	0.26 (2.28)**	0.319 (2.96)***	0.274 (2.52)**	0.352 (3.54)***	0.336 (3.29)***	0.298 (2.73)***	0.303 (2.82)***	0.336 (3.29)***		0.393 (3.01)***	0.57 (3.45)***
log(100*high- tech/manufactured exports)																0.021 (1.50)
log (pop)											0.455 (1.93)*	0.4538 (1.93)*		0.60 (2.15)**	0.66 (2.36)**	0.5196 (1.77)*
Rpop1	1.066 (2.16)**		1.22 ( 2.09)**													
log(Rpop1)		0.608 (1.64)		0.76 (2.16)**	0.74 (2.11)**								0.7413 (2.11)**			
Rpop2						1.313 (2.17)**		1.504 (2.10)**								
log(Rpop2)							0.609 (1.66)*		0.76 (2.18)**	0.74 (2.12)**						
log(100*imp/GDP)					0.05 (1.55)					0.0516 (1.55)						
Imp/GDP											0.0695 (0.77)		0.0517 (1.55)	0.0517 (0.43)		
log(import value index)															0.0067 (0.16)	0.028 (0.74)
Constant	6.92 (11.75)***	9.24 (7.09)***	6.94 (11.42)***	9.86 (8.08)***	9.776 (8.00)***	6.92 (11.75)***	9.396 (6.81)***	6.94 (11.43)***	10.049 (7.78)***	9.959 (7.70)***	3.256 (1.43)	3.22 (1.41)	9.776 (8.00)***	-0.23 (-0.07)	-2.515 (-0.70)	-1.029 (-0.28)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.96	0.9610	0.9585	0.9601	0.9609	0.9618	0.9609	0.9585	0.9601	0.9603	0.9609	0.9609	0.9603	0.9602	0.9549	0.9585
Number of observations	348	348	348	348	348	348	348	348	348	348	348	348	348	348	264	264

### Table 4.19. Robustness checks - different measures of GDP as RHS variables

Robust t-statistics are given in parentheses . \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10 % level. For the lagged variables, we use the first lag. ٠

٠

	Dependant variable: log (EXPY)					(PPP, const	ant 2000 inte	ernational \$)	•	• •	Dependant variable: log (EXPY) (current US \$ )				Dependant variable: REXPY
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(1)	(2)	(3)	(4)	
FP	0.0527 (3.95)***		0.053 (3.90)***		0.053 (3.88)***			0.051 (3.58)***							0.0198 (3.30)***
log(FP)		0 .0577 (2.28)**		0.0615 (2.45)**		0.069 (2.38)**	0.062 (2.38)**		0 .0616 (2.39)**	0.0616 (2.45)**	0 .093 (2.63)***	0.095 (2.79)***	0.08 (2.75)***	0.068 (2.17)**	
GDP per person employed (annual growth) lagged (one year)	0.25 (2.01)**	0.277 ( 2.09)**	0.28 ( 2.29)**	0.31 (2.39)**	0.28 (2.27)**	0.318 (2.39)**	0.2647 (2.09)**	0.2356 (1.98)**							0.09 (1.98)**
log (1+ GDP per person employed (growth) ) lagged (one year)									0.2678 (2.09)**	0.313 (2.39)**	0.333 (1.98)**	0.4018 (2.31)**	0.395 (2.33)**		
log (GDP pc Current US \$) lagged														0.208 (2.71)***	
EP			0.3469 (3.20)***	0.37 (3.59)***	0.346 (3.09)***	0.373 (3.50)***	0.373 (3.64)***	0.347 (3.21)***	0.372 (3.63)***	0.369 (3.58)***	0.487 (3.95)***	0.486 (3.94)***	0.482 (4.02)***	0.43 (3.64)***	0.175 (4.42)***
log(labour)	0.342 (2.69)***	0.31 (3.02)***	0.3797 (2.99)***	0.421 (3.39)***	0.396 (2.88)***	0.4428 (3.34)***				0.419 (3.39)***		0.593 (3.62)***	0.5687 (3.67)***		
log(pop)							0.646 (2.81)***	0.557 (2.31)**	0.6455 (2.80)***		0.8785 (2.95)***			0.737 (2.72)***	0.306 (3.04)***
Institutional quality					0.002 (0.89)	0.0012 (0.53)					0.0012 (0.47)	0.0008 (0.36)			
Constant	3.784 (1.92)*	2.993 (1.54)	3.16 (1.61)	2.318 (1.22)	2.77 (1.25)	1.849 (0.87)	2.75 (1.29)	3.797 (1.68)*	2.755 (1.29)	2.333 (1.23)	-0.075 (-0.03)	-0.9588 (-0.37)	-0.443 (-0.19)	-0.0658 (-0.02)	-2.427 (-2.56)**
R <sup>2</sup>	0.9589	0.9581	0.9605	0.9599	0.9594	0.9590	0.9599	0.9603	0.9599	0.9599	0.9578	0.9580	0.9591	0.9589	0.9690
Number of countries	58	58	58	58	56	56	58	58	58	58	56	56	58	58	58
Number of observations	348	348	348	348	336	336	348	348	348	348	336	336	348	348	348

### Table 4.20. Robustness checks: Labour productivity measured by GDP per person employed (annual growth) as RHS variable

• Robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. All regressions include country specific effects.
# 4.4.2.5 Additional tests using relative export sophistication

In addition, we re-run a number of robustness checks. We use two relative sophistication measures:

$$(REXPY_j)_1 = \frac{EXPY_j}{mean EXPY5_{developed}}$$
 which is based on the

mean EXPY (based on GDP at current US dollar) of five developed countries (G5): USA, UK, Japan, Germany and France.

$$(REXPY_j)_2 = \frac{EXPY_j}{mean \ EXPY \ 15_{developed}}$$
 which is based on the mean

EXPY of 15 developed countries: Australia, Austria, Canada, Denmark, Finland, France, Germany, Iceland, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom, and United States (this list is from Zhu and Trefler (2005)). All the data on relative export sophistication are less than one. We provide interesting evidence on the robustness of our results when relative export sophistication is a left hand side variable. FP, lagged GDPpc and EP enter with positive and significant coefficients at 1% and 5% in all regressions.

The results of a number of robustness checks usisng relative export sophistication (in level and log) as dependant variable are reported in Tables 4.21 to 4.25. The significance of key variables remains robust which gives credence to our results on the determinants of export sophistication.

	n	r	r	5		
	FE	FE	FE	FE	FE	FE
	(1)	(2)	(3)	(4)	(5)	(6)
FP	0.0186	0.0183	0.0186	0.0185	0.0182	0.018
11	(3.17)***	(3.02)***	(3.19)***	(3.08)***	(3.04)***	(2.96)***
log(GDPnc) lagged	0.1296	0.1252	0.1182	0.1184	0.1135	0.116
log(ODI pc) lagged	(3.84)***	(2.36)**	(3.65)***	(2.27)***	(3.37)***	(2.22)***
EP			0.1515	0.155	0.1488	0.1518
			(3.66)***	(3.51)***	(3.56)***	(3.39)***
$\log(P_{on})$	0.2123	0.202	0.2438	0.2536	0.2446	0.2619
$\log(1 op)$	(2.27)**	(1.31)	(2.60)**	(1.61)	(2.62)***	(1.67)*
Imports/GDP					0.0349	0.0353
•					(0.63)	(0.62)
Constant	-4.0828	- 3.8749	-4.516	-4.6747	-4.5037	- 4.8
	(-2.49)**	(-1.35)	(-2.75)***	(-1.60)	(-2.74)***	(-1.65)
Time specific effect (year dummies)	No	Yes	No	Yes	No	Yes
Test of joint significance of time specific effect		F(5, 282) = 1.07		F(5, 281) = 1.12		F(5, 280) = 1.12
		Prob > F = 0.3767		Prob > F = 0.3473		Prob > F = 0.3512
Robustified test of joint significance of time specific		F(5, 282) = 0.99		F(5, 281) = 1.17		F(5, 280) = 1.11
effect		Prob > F = 0.4211		Prob > F = 0.3241		Prob > F = 0.3574
Wooldridge test for autocorrelation	F(1, 57) = 2.291	F(1, 57) = 2.095	F(1, 57) = 2.277	F(1, 57) = 1.927	F(1, 57) = 2.181	F(1, 57) = 1.885
	Prob > F = 0.1356	Prob > F = 0.1533	Prob > F = 0.1369	Prob > F = 0.1705	Prob > F = 0.1452	Prob > F = 0.1752
R <sup>2</sup>	0.9690	0.9696	0.9702	0.9708	0.9702	0.9708
Adj R <sup>2</sup>	0.9625	0.9626	0.9638	0.9639	0.9638	0.9638
Number of countries	58	58	58	58	58	58
Number of observations	348	348	348	348	348	348

# **Table 4.21.** Dependant variable: Relative export sophistication $(REXPY_i)_1$

• Heteroscedasticity robust standard errors have been used, and robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• All regressions include country fixed effect.

# **Table 4.22.** (Continued) **Dependant variable: Relative export sophistication** $(REXPY_i)_1$

	FE	FE	FE	FE	FE	FE
		(2)	(3)	(4)	(5)	(6)
	(1)	(2)	(3)	(+)	(3)	(0)
FP	0.0195	0.0187	0.0196	0.019	0.019	0.0185
11	(3.31)***	(3.03)***	(3.36)***	(3.10)***	(3.20)***	(2.99)***
log(GDPnc) lagged	0.1268	0.1125	0.115	0.103	0.1105	0.1004
105(0D1 pc) lagged	(3.79)***	(2.38)**	(3.56)***	(2.23)**	(3.30)***	(2.17)**
EP			0.148	0.1505	0.146	0.147
			(3.59)***	(3.40)***	(3.49)***	(3.28)***
$\log(Labour)$	0.125	0.1003	0.144	0.1257	0.144	0.129
105(Eubour)	(2.42)***	(1.35)	(2.79)***	(1.68)*	(2.82)***	(1.74)*
Imports/GDP					0.034	0.0301
					(0.61)	(0.52)
Constant	-2.53	-2.021	-2.74	-2.35	-2.718	-2.39
	(-2.70)***	(-1.39)	(-2.94)***	(-1.61)	(-2.91)***	(-1.64)
Time specific effect (year dummies)	No	Yes	No	Yes	No	Yes
Test of joint significance of time specific effect		F(5, 282) = 1.17		F(5, 281) = 1.19		F(5, 280) = 1.16
		Prob > F = 0.3257		Prob > F = 0.3153		Prob > F = 0.3296
Robustified test of joint significance of time specific effect		F(5, 282) = 1.16		F(5, 281) = 1.35		F(5, 280) = 1.24
		Prob > F = 0.3286		Prob > F = 0.2450		Prob > F = 0.2914
Wooldridge test for autocorrelation	F(1, 57) = 2.368	F(1, 57) = 2.192	F(1, 57) = 2.337	F(1, 57) = 2.010	F(1, 57) = 2.234	F(1, 57) = 1.968
	Prob > F = 0.1294	Prob > F = 0.1442	Prob > F = 0.1319	Prob > F = 0.1617	Prob > F = 0.1405	Prob > F = 0.1661
Number of observations	348	348	348	348	348	348

Labour force as RHS variable

Notes:

Heteroscedasticity robust standard errors have been used, and robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. All regressions include country fixed effect.

• In order to test whether or not the residuals from the fixed effects estimation are spatially independent, we perform Pesaran (2004) and Friedman cross-sectional dependence (CD) tests using "xtesd" Stata command. The null hypothesis of the CD test states that the residuals are cross-sectionally uncorrelated. Correspondingly, the test's alternative hypothesis presumes that spatial dependence is present. The CD test does not reject the null hypothesis of spatial independence.

	Dependant variable	$(REXPY_j)_1$			Dependant variable	$(REXPY_j)_2$	
	(1)	(2)	(3)		(1)	(2)	(3)
FP	0.0186 (3.17)***	.01866 (3.19)***	0.018 (3.04)***	FP	0.0193 (3.16)***	0.0193 (3.17)***	0.0187 (3.01)***
$\log(GDPpc)$ lagged	0.1296 (3.84)***	0.118 (3.65)***	0.113 (3.37)***	log(GDP pc) lagged	0.154 (4.34)***	0.142 (4.17)***	0.1356 (3.83)***
EP		0.1515 (3.66)***	0.1488 (3.56)***	EP		0.1602 (3.72)***	0.1565 (3.61)***
log(Pop)	0.212 (2.27)**	0.2438 (2.60)**	0.2446 (2.62)***	log(Pop)	0.2625 (2.67)***	0.2958 (3.00)***	0.2969 (3.03)***
Imports/GDP			0.0348 (0.63)	Imp			0.047 (0.82)
Constant	-4.08 (2.49)**	-4.516 (2.75)***	-4.5 (2.74)***	Constant	-5.0927 (2.97)***	-5.551 (-3.23)***	-5.534 (-3.22)***
Wooldridge test for autocorrelation	F(1, 57) = 2.291 Prob > F = 0.1356	F(1, 57) = 2.337 Prob > F = 0.1319	F(1, 57) = 2.234 Prob > F = 0.1405	Wooldridge test for autocorrelation	F(1, 57) = 2.529 Prob > F = 0.1173	F(1, 57) = 2.475 Prob > F = 0.1212	F(1, 57) = 2.529 Prob > F = 0.1173
Number of observations	348	348	348	Observations	348	348	348
	Dependant variable	$(REXPY_j)_1$			Dependant variable	$(REXPY_j)_2$	
	(1)	(2)	(3)		(1)	(2)	(3)
FP	0.0195 (3.31)***	0.0196 (3.36)***	0.019 ( 3.20)***	FP	0.0204 (3.32)***	0.0205 (3.37)***	0.0199 (3.20)***
log(GDP pc) lagged	0.1268 (3.79)***	0.1151 (3.56)***	0.1105 (3.30)***	log(GDP pc) lagged	0.1507 (4.26)***	0.1384 (4.06)***	0.132 (3.76)***
EP		0.1484 (3.59)***	0.1442 (2.82)***	EP		0.1564 (3.63)***	0.1528 (3.52)***
log(Labour)	0.1249 (2.42)**	0.1437 (2.79)***	0.1457 (3.49)***	log(Labour)	0.1543 (2.86)***	0.1741 (3.23)***	0.1747 (3.26)***
Imports/GDP			0.0341 (0.61)	Imp			0.046 (0.79)
Constant	-2.53 (-2.70)***	-2.7375 (-2.94)***	-2.7185 (-2.91)***	Constant	-3.1694 (-3.23)***	-3.388 (-3.48)***	-3.362 (-3.43 )***
Wooldridge test for	F(1, 57) = 2.368	F(1, 57) = 2.337	F(1, 57) = 2.234	Wooldridge test for	F(1, 57) = 2.594	F(1, 57) = 2.561	F(1, 57) = 2.389
autocorrelation	Prob > F = 0.1294	Prob > F = 0.1319	Prob > F = 0.1405	autocorrelation	Prob > F = 0.1128	Prob > F = 0.1150	Prob > F = 0.1277
Number of observations	348	348	348	Observations	348	348	348

• Heteroscedasticity robust standard errors have been used, and robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. All regressions include country fixed effect.

	Dependant variable	$(REXPY_j)_1$		Dependant variable $(REXPY_j)_2$						
	(1)	(2)	(3)		(1)	(2)	(3)			
FP	0.021 (3.62)***	0.0214 (3.66)***	0.0209 (3.49)***	FP	0.0223 (3.70)***	0.0226 (3.73)***	0 .022 (3.54)***			
log(GDP pc) lagged (one year)	0.1428 (3.70)***	0.1356 (3.58)***	0.1313 (3.34)***	log(GDP pc) lagged	0.170 (4.20)***	0.1627 (4.09)***	0.1568 (3.80)***			
EP		0.129 (2.98)***	0.1264 (2.90)***	EP		0.1327 (2.91)***	0.129 (2.83)***			
RPOP 1	0.478 (2.48)**	0.472 (2.48)**	0.4745 (2.47)**	RPOP2	0.7432 (2.66)***	0.7326 (2.67)***	0.736 (2.65)***			
Imports/GDP			0.0322 (0.56)	Imports/GDP			0.0437421 (0.72)			
Constant	-0.7866 (-2.47)**	-0.739 (-2.37)**	-0.7157 (-2.24)**	Constant	-1.014 (-3.03)***	-0.9656 (-2.94)***	-0.9333 (-2.78)***			
	Dependant variable	$(REXPY_j)_1$			Dependant variable	$(REXPY_j)_2$				
	(1)	(2)	(3)		(1)	(2)	(3)			
FP	0.0213 (3.67)***	0.0216 (3.71)***	0.0212 (3.53)***	FP	0.0225 (3.74)***	0.023 (3.77)***	0.0223 (3.57)***			
log(GDP pc) lagged	0.1366 (3.49)***	0.131 (3.39)***	0.1269 (3.17)***	log(GDP pc) lagged	0.1644 (4.02)***	0.158 (3.93)***	0.1525 (3.65)***			
EP		0.125 (2.91)***	0.1226 (2.83)***	EP		0.1287 (2.85)***	0.125 (2.76)***			
Rlabour 1	0.5561 (2.91)***	0.493 (2.76)***	0.491 (2.81)***	Rlabour2	0.9231 (3.12)***	0.8425 (3.04)***	0.8428 (3.10)***			
Imports/GDP		. ,	0.031 (0.54)	Imports/GDP			0.0432 (0.71)			
Constant	-0.7369 (-2.28)**	-0.6969 (-2.19)**	-0.674 (-2.07)**	Constant	-0.9746 (-2.90)***	-0.931 (-2.81)***	-0.8995 (-2.65)***			
Number of countries	58	58	58	Number of countries	58	58	58			
Number of observations	348	348	348	Observations	348	348	348			

Table 4.24. (Continued)

• Rlabour 1 is developing country labour force divided by the labour force of the G5. Rpop 1 is developing country population divided by the population of the G5.

• Rlabour 2 is developing country labour force divided by the labour force of 15 developed countries. Rpop 2 is developing country population divided by the population of 15 developed countries.

• Heteroscedasticity robust standard errors have been used, and robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. All regressions include country fixed effect.

			10.510 11201	(00111111004)					
	Dependant variable	$(REXPY_j)_1$		Dependant variable $log(REXPY_j)_1$					
	(1)	(2)	(3)		(1)	(2)	(3)		
log(FP)	0.02 (2.40)**	0.0199 (2.42)**	0.0221 (2.63)***	log(FP)	0.068 (2.12)**	0.068 (2.15)**	0.074 (2.30)**		
log(GDP pc) lagged	0.1005 (2.91)***	0.098 (2.83)***	0.1287 (3.33)***	log(GDP pc) lagged	0.1969 (2.37)**	0.1843 (2.19)**	0.2683 ( 2.94)***		
log(pop)	0.2821776 (3.07)***			log(pop)	0.7163 (2.67)***				
log(labour )		0.1629 (3.20)***		log(labour)		0.4466 (3.16)***			
log(Rpop1)			0.3828 (2.75)***	log(Rpop1)			1.036 (2.45)**		
EP	0.159 (4.00)***	0.1548 (3.89)***	0.1709 (4.38)***	EP	0.409 (3.39)***	0.4026 (3.31)***	0.445 (3.81)***		
Imports/GDP	0.0316 (0.57)	0.0322 (0.56)	0.0383 (0.70)	Imports/GDP	0.0544 (0.46)	0.0558 ( 0.45)	0.0724 (0.62)		
Constant	-3.122 (-3.08)***	-2.966 (-3.13 )***	0.77 (1.79)*	Constant	-9.546 (-3.51)***	-9.608 (-3.97)***	0.62 (0.40)		
	Dependant variable	$(REXPY_j)_2$			Dependant variable	$\log(REXPY_j)_2$			
	(1)	(2)	(3)		(1)	(2)	(3)		
log(FP)	0.0216	0.0215	0.0239	log(FP)	0.0696	0.069	0.0758		
	(2.49)**	(2.52)**	(2.73)***		(2.17)**	(2.21)**	(2.37)**		
log(GDP pc) lagged	0.1216 (3.37)***	0.1186 (3.26)***	0.154 (3.83)***	log(GDP pc) lagged	0.224 (2.70)***	0.2107 (2.50)**	0.304 (3.33)***		
log(pop)	0.3358077 (3.49)***			log(pop)	0.824 (3.07)***				
log(labour)		0.194 (3.65)***		log(labour)		0.509 (3.60)***			
log(Rpop1)			0.4318 (2.99)***	log(Rpop2)			1.1387 (2.70)***		
EP	0.168 (4.05)***	0.1627 (3.92)***	0.179 (4.38)***	EP	0.411 (3.43)***	0.403 (3.33)***	0.4475 (3.83)***		
Imports/GDP	0.0425	0.0432	0.05	Imports/GDP	0.0739	0.0755	0.0936		
	(0.74)	(0.72)	(0.88)		(0.62)	(0.61)	(0.79)		
Constant	-3.80	-3.62	0.8475	Constant	-10.768	-10.781	0.95887		
	(-3.59)***	(-3.66)***	(1.76)*		(-3.95)***	(-4.44)***	(0.62)		
Number of countries	58	58	58	Number of countries	58	58	58		
Number of observations	348	348	348	Observations	348	348	348		

 Table 4.25. (Continued)

• Heteroscedasticity Robust t-statistics are given in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

# 4.4.2.6. Estimation results from a large incomplete panel

Finally, we test the robustness of our results to the use of a different dataset with more recent data. We re-run our regressions using the new database on EXPY from the World Bank & PRMED (online since December 2009).

We use an incomplete (highly unbalanced) panel data on developing and emerging countries. As recommended by Peterson (2009), Egger and Raff (2009) and Hericourt & Poncet (2009), we apply the various estimation techniques to our data in order to assess the robustness of the key variables' significance to multiple corrections of the standard errors for autocorrelation and heteroskedasticity.

The results that we obtained are qualitatively identical to our previous findings. We find again that FDI, GDP (lagged one year), population and export (or market) penetration have positive and significant effects on the export sophistication (see Tables 4.26 - 4.31 and Figure 4.10). Our findings are robust to the panel format, to the number of countries, the period of study the econometric technique choice and to different data sources on EXPY. This gives strong credence to our results.

Figure 4.10. Relationship between lagged GDP per capita (different measures) and EXPY, (in logs), 2004















Dependant variable: log (EXPY)		Fixe	d effect regres	ssion with he		Regression clustered (a level) standa	with at the country ard errors	Fixed effect regression with heteroskedasticity robust standard errors					
	(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)	(12)	(13)		
log (FP)	0.020 (3.52)***	0.038 (4.03)***	0.044 (4.45)***	0.0457 (4.39)***	0.0189 (3.25)***	0.035 (3.65)***	0.044 (4.46)***	0.041 (5.32)***	0.041 (3.15)***	0.044 (2.53)**	0.0457 (4.40)***	0.044 (4.21)***	0.044 (4.23)***
log(GDP ppp constant 2005) lagged ( one year)	0.1596 (6.86)***	0.179 (3.79)***	0.1763 (3.77)***	0.124 (2.44)**									
log(GDP per capita ppp constant 2005) lagged (one year)					0.141 (7.63)***	0.114 (2.63)***	0.184 (4.04)***	0.1499 (4.75)***	0.1499 (2.82)***	0.184 (2.55)**	0.132 (2.69)***		
log(GDP constant us 2000) lagged ( one year)												0.120 (2.49)**	
log(GDP per capita constant us 2000) lagged ( one year)													0.1289 (2.75)***
EP		0.4049 (4.36)***	0.4116 (4.41)***	0.485 (5.18)***		0.4187 (4.49)***	0.4116 (4.42)***	0.4034 (4.47)***	0.4034 (2.63)***	0.4116 (2.63)***	0.4846 (5.16)***	0.4953 (5.24)***	0.4946 (5.22)***
log(pop)			0.203 (1.90)*	0.259 ( 2.30)**			0.391 (3.38)***	0.3157 (4.46)***	0.3157 (2.89)***	0.391 (1.89)*	0.395 (3.11)***	0.243 (2.14)**	0.3737 (2.99)***
log(Manufactured imports/ Total imports)				0.055 (1.25)							0.055 (1.26)	0.0487 (1.14)	0.0485 (1.14)
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Number of countries	82	75	75	75	82	75	75	75	75	75	72	72	72
Number of observations	1823	959	959	959	1823	959	959	959	959	959	913	922	922

# Table 4.26. Incomplete panel Panels results regressions using World Bank & PRMED new database on EXPY over the period 1976-2006

Notes:

• FP denotes 100\*FDI in stock /Exports

• Stars indicate statistical significance levels: \*\*\* Significant at 1% level; \*\* Significant at 5% level, \*Significant at 10% level. t-statistics are reported in parentheses

• The inclusion of EP and Manufactured imports/ Total imports strongly dropped the size of our panel.

• As the basic structure of the dataset is an incomplete longitudinal panel, we use Schaffer's xtivreg2 Stata command [without instruments]. In addition to its use with endogenous regressors, xtivreg2 Stata command estimates basic fixed effect models with exogenous regressors (Schaffer, 2007). This command does not report the constant.

• To report regression with clustered standard errors, we use "xtivreg2" Stata command (without instruments) with "cluster (country)" option.

			Fixed eff	ect (within) reg	ression with Dr	iscoll-Kraay stand	lard errors						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)				
log (FP)	0.0205 (3.51)***	0.038 (5.14)***	0.04 (6.52)***	0.0457 (6.96)***	0.0189 (3.22)***	0.035 (4.17)***	0.044 (6.57)***	0.0457 (6.82)***	0.044 (6.36)***				
log(GDP ppp constant 2005) lagged ( one year)	0.1596 (8.20)***	0.1793 (3.67)***	0.1763 (3.55)***	0.1238 (2.16)**									
log(GDP per capita ppp constant 2005 international \$) lagged (one year)					0.141 (8.24)***	0.114 (2.50)**	0.184 (3.81)***	0.132 (2.42)**					
log(GDP per capita constant 2000 US \$) lagged (one year)									0.1289 (2.02)**				
EP		0.4049 (3.48)***	0.412 (3.54)***	0.485 (4.51)***		0.4187 (3.58)***	0.41 (3.53)***	0.4846 (4.48)***	0.4946 (4.57)***				
log(pop)			0.203 (2.65)***	0.259 (3.07)***			0.391 (5.13)***	0.395 (4.27)***	0.3737 (2.79)***				
log(Manufactured imports/imports)				0.055 (2.46)**				0.055 (2.49)**	0.0485 (2.14)**				
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
R <sup>2</sup> within	0.4069	0.3236	0.3292	0.3488	0.4064	0.3136	0.3308	0.3500	0.3416				
Number of countries	82	77	77	74	82	77	77	74	74				
Number of observations	1823	961	961	915	1823	961	961	915	924				

#### Table 4.27. Dependant variable: log (EXPY) (using World Bank & PRMED database on EXPY)

Notes:

- FP denotes 100\*FDI in stock /Exports
- Stars indicate statistical significance levels: \*\*\*Significant at 1% level; \*\*Significant at 5% level, \*Significant at 10% level.
- Wooldridge autocorrelation test does not reject the presence of autocorrelation.
- Heteroskedasticity and autocorrelation robust t-statistics are reported in parentheses.
- Regression with Driscoll-Kraay standard errors: we employ a version of the variance-covariance matrix estimator for serially and/or spatially correlated data following Driscoll and Kraay (1998). We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional independence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced: Not enough common observations across panel to perform Pesaran's test.

#### List of countries:

Angola, Antigua and Barbuda, Argentina, Armenia, Belize, Benin, Bolivia, Botswana, Brazil, Burundi, Cambodia, Cameroon, Chile, China, Colombia, Comoros, Congo, Dem. Rep., Congo, Cote d'Ivoire, Croatia, Czech Republic, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Estonia, Ethiopia, Gambia, Guatemala, Guinea, Haiti, Honduras, Hungary, India, Indonesia, Iran, Jordan, Kiribati, South Korea, Lao PDR, Lebanon, Lithuania, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Nepal, Nicaragua, Nigeria, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Rwanda, Senegal, Sierra Leone, Singapore, Slovak Republic, Slovenia, South Africa, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Thailand, Togo, Trinidad & Tobago, Uganda, Uruguay, Venezuela, Yemen, Zambia and Zimbabwe.

		Fixed effect regression with Newey-West standard errors											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)				
log (FP)	0.0205 (2.93)***	0.038 (3.59)***	0.044 (3.93)***	0.0457 (3.87)***	0.0189 (2.71)***	0.0348 ( 3.24)***	0.044 (3.94)***	0.0457 (3.88)***	0.044 (3.74)***				
log(GDP ppp constant 2005) lagged ( one year)	0.1596 (5.31)***	0.179 (3.41)***	0.1763 (3.39)***	0.124 (2.24)**									
log(GDP per capita ppp constant 2005) lagged ( one year)					0.1414 (5.97)***	0.114 ( 2.38)**	0.184 (3.63)***	0.1325974 (2.48)**					
log(GDP per capita constant us 2000) lagged ( one year)									0.1289 (2.52)**				
EP		0.4049 (3.84)***	0.4116 (3.88)***	0.485 (4.76)***		0.418 (3.96)***	0.4116 (3.88)***	0.4846 (4.73)***	0.4946 (4.80)***				
log(pop)			0.203 (1.68)*	0.259 (2.03)**			0.391 (2.95)***	0.395 (2.71)***	0.3737 (2.61)**				
log(Manufactured imports/imports)				0.055 (1.23)				0.055 (1.24)	0.0485 (1.12)				
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
R <sup>2</sup>	0.9262	0.9609	0.9613	0.9599	0.9262	0.9603	0.9613	0.9599	0.9594				
Number of countries	82	77	77	74	82	77	77	74	74				
Number of observations	1823	961	961	915	1823	961	961	915	924				

# Table 4.28. Dependant variable: log (EXPY) (using World Bank & PRMED database on EXPY)

Notes :

• Wooldridge autocorrelation test does not reject the presence of autocorrelation.

• Newey-West regressions include country specific effect.

• Heteroskedasticity and autocorrelation robust t-statistics are reported in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

• We use Newey –West /HAC standard errors with one time lag. The results turn out to be quite robust to changes in the selected lag length. Estimators in Stata require the use of "Newey2" Stata command and "force" option with incomplete panel.

	Fixed effe	ect regression	with heterosk	edasticity	Fixed effec	et regression wit	h Newey-West st	andard errors	rs Fixed effect regression with Driscoll-Kraay standard				
		robust stand	lard errors						errors				
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
log (ED)	0.0196	0.0209	0.042	0.045	0.0196	0.0208	0.042	0.045	0.0196	0.0209	0.042	0.045	
log (FP)	0.0180	0.0208	0.042	0.045	0.0180	0.0208	0.042	0.045	0.0100	0.0208	0.042	0.045	
log(GDP per capita current) lagged (one year)	(3.17)	0.04	0.037	(4.53)	(2.00)	0.04	0.037	(3.05)	(5.17)	0.04	0.037	(0.05)	
log(ODI per capita current) lagged (one year)		(1.57)***	(1.00)**			(2 67)***	(1.02)*			(2, 70) * * *	(2 22)**		
1. (CDD menomity man) 1. (	0.142	(4.57)***	(1.99)**	0.1297	0.142	(3.07)***	(1.95)	0.1296	0.142	(2.79)	(2.32)**	0.1296	
log(GDP per capita ppp) lagged (one year)	0.142			0.1286	0.142			0.1286	0.142			0.1286	
	(7.72)***			(2.67)***	(6.05)***			(2.45)**	(8.18)***			(2.33)**	
EP			0.5129	0.479			0.5129	0.479			0.5129	0.479	
			(5.60)***	(5.19)***			(5.16)***	(4.77)***			(4.82)***	(4.51)***	
log(pop)			0.3227	0.4014			0.3227	0.4014			03227	0.4014	
			(2.71)***	(3.10)***			(2.44)***	(2.70)***			(3.63)***	(4.26)***	
log(Manufactured imports/total imports)			0.04	0.055			0.04	0.055			0.04	0.055	
			(0.93)	(1.26)			(0.92)	(1.24)			(1.62)	(2.54)**	
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Within R <sup>2</sup>									0.4070	0.3884	0.3367	0.3502	
R <sup>2</sup>					0.9265	0.9218	0.9593	0.9601					
Adj R <sup>2</sup>					0.9219	0.9170	0.9546	0.9555					
Number of countries	82	83	72	71	82	83	75	74	82	83	75	74	
Number of observations	1823	1897	928	914	1823	1897	931	917	1823	1897	931	917	

# Table 4.29. Dependant variable: log (EXPY) (using World Bank & PRMED database on EXPY)

Notes:

• Constant not reported. All regressions include country fixed effects. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

Wooldridge autocorrelation test does not reject the presence of autocorrelation. The Driscoll-Kraay and Newey-West estimates of the standard errors use one time lag.

• Regression with Driscoll-Kraay standard errors: we employ a version of the variance-covariance matrix estimator for serially and/or spatially correlated data following Driscoll and Kraay (1998). We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional independence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced: Not enough common observations across panel to perform Pesaran's test.

	HAC kernel / Newey-West estimation												
	(1)									(1.0)	(14)	(10)	(10)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
log (FP)	0.0159 (2.33)**	0.019 (2.76)***	0.017 (2.15)**	0.0196 (2.80)***	0.0358 (3.14)***	0.029 (2.24)**	0.036 (3.00)***	0.035 (2.84)***	0.027 (1.97)**	0.029 (2.17)**	0.0286 (2.12)**	0.033 (2.71)***	0.032 (2.55)**
log(GDP pc, constant 2000 US \$ ) lagged ( one year)	0.164 (5.68)***				0.2 (4.23)***	0 0.14 (2.47)**	0.155 (2.97)***	0.17 (3.20)***	0.15 (2.61)***			0.129 (2.41)**	0.144 (2.64)***
log(GDP pc ppp international \$ ) lagged ( one year)		0.159 (5.16)***									0.154 (2.53)**		
log(GDP pc ppp, constant 2000 international \$ ) lagged ( one year)			0.1218 (3.63)***										
log(GDP pc ppp, constant 2005 international \$) lagged ( one year)				0.157 (5.11)***						0.152 (2.49)**			
log( high -tech exports)					0.01 (2.48)**	0.016 (3.68)***	0.0099 (2.44)**					0.01 (2.46)***	
log (100*high tech exports/manufactured exports)								0.006 (1.37)	0.01 (2.19)**	0.01 (2.19)**	0.01 (2.18)**		0.0065 (1.36)
log(pop)	0.055 (0.70)	0.103 (1.26)	0.025 (0.29)	0.098 (1.11)	0.358 (2.79)***	0.4435 (3.49)***	0.3487 (2.51)**	0.3634 (2.60)***	0.452 (3.49)***	0.4678 (3.58)***	0.482 (3.61)***		
log (labour)												0.168 (2.04)**	0.176 (2.12)**
log(Imports, constant 2000 US \$ )						0.0229 (1.07)			0.0319 (1.41)	0.035 (1.56)	0.0337 (1.46)		
log(Manufactured imports/total imports)							0.0716 (1.58)	0.078 (1.67)*				0.066 (1.48)	0.073 (1.58)
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	82	82	82	82	75	64	72	72	64	64	63	71	71
Number of observations	1868	1823	1719	1823	963	830	916	917	831	819	818	903	904

# Table 4.30. Dependant variable: log (EXPY) (using World Bank & PRMED database on EXPY)

Notes :

• Constant not reported. All regressions include country fixed effects. Heteroskedasticity and autocorrelation robust t-statistics are reported in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \* Significant at 10% level.

• Wooldridge autocorrelation test does not reject the presence of autocorrelation.

• As the basic structure of the dataset is an incomplete longitudinal panel, we use the new Stata command "xtivreg2" (without instruments) with "bw" (kernel=Bartlett; bandwidth of 2 is selected) and robust options to report HAC kernel estimator (Schaffer, 2007, Ahlquist and Prakash, 2008; Baum, 2007, 2008). This command does not report the constant.

	Fixed effe	ct regression w	vith clustered ( errors	at country lev	el) standard	Fixed effect regression with Driscoll-Kraay standard errors								
	(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)
log (FP)	0.042 (2.41)**	0.051 (2.66)***	0.045 (2.17)***	0.0466 (2.23)**	0.05 (2.71)***	0.0358 (4.26)***	0.029 (3.08)***	0.036 (4.27)***	0.035 (3.96)***	0.027 (2.59)**	0.029 (3.11)***	0.0286 (3.00)***	0.033 (3.65)***	0.032 (3.43)***
log(GDP pc constant 2000 US \$)	0.18	0.194			0.195	0.2	$0\ 0.14$ (2.47)**	0.155	0.17	0.15			0.129	0.144
log(GDP pc ppp ) lagged ( one year)	(2.07)	(2.70)			(2.00)	(0.70)	(2,)	(1.00)	(2:01)	(2.07)		0.154 (2.61)***	(2.10)	(2.50)
log(GDP pc ppp, constant 2000 international \$ ) lagged ( one year)			0.24 (3.20)***	0.25 (3.27)***										
log(GDP pc ppp, constant 2005 international \$ ) lagged ( one year)											0.152 (2.63)***			
log( high- tech exports)						0.01 (1.87)*	0.016 (4.45)***	0.0099 (1.94)*					0.01 (2.02)**	
log (100*high tech exports/manufactured exports)									0.006 (1.32)	0.01 (2.75)***	0.01 (2.82)***	0.01 (2.79)***		0.0065 (1.35)
High tech exports/manufactured exports	0.0042 (2.67)***	0.497 (3.44)***	0.554 (3.87)***	0.545 (3.79)***	0.496 (3.42)***									
log(pop)	0.37 (1.81)*	0.35 (1.42)		0.44 (1.66)	0.346 (1.41)	0.358 (4.09)***	0.4435 (4.84)***	0.3487 (3.15)***	0.3634 (3.39)***	0.452 (5.03)***	0.4678 (5.97)***	0.482 (6.14)***		
log (labour)			0.303 (2.11)										0.168 (2.07)**	0.176 (2.22)**
$\Delta \log(\text{import value index})$		0.01 (0.39)	0.026 (0.91)											
$\Delta$ import value index				0.0004 (1.33)	0.0004 (2.23)**									
log(Imports, constant 2000 US \$ )							0.0229 (1.38)			0.0319 (1.74)*	0.035 ( 1.82)*	0.0337 (1.67)*		
log(Manufactured imports/total imports)								0.0716 (2.66)***	0.078 (2.83)***				0.066 (2.59)**	0.073 (2.84)***
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within R <sup>2</sup>						0.2995	0.3429	0.3094	0.3058	0.3319	0.3427	0.3427	0.2959	0.2915
Number of countries	75	66	65	66	66	77	71	74	74	71	71	71	73	73
Number of observations	969	845	721	732	845	965	837	918	919	838	826	826	905	906

# Table 4.31. Dependant variable: log (EXPY) (using World Bank & PRMED database on EXPY)

Notes:

• Constant not reported. All regressions include country fixed effects.

• Wooldridge autocorrelation test does not reject the presence of autocorrelation.

• Heteroskedasticity and autocorrelation robust t-statistics are reported in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5%, \* Significant at 10 % level.

# 4.4.3 Putting back the terms of trade deterioration at the forefront of the analysis <sup>172</sup>

We recall that an increase in "z" (i.e., Ricardian sophistication level of export or exports' productivity level of the developing countries) is associated with terms of trade (for goods) deterioration in the Ricardian model developed above (equation 14) and DFS predictions. This section introduces a novel approach to the question of TOT deterioration. We model the effect of export productivity and its implied export sophistication on the developing countries' TOT. We use net barter terms of trade (NBTT), for individual countries, to characterize the evolution of the developing countries' TOT and we study the role of export sophistication in this process.

# 4.4.3.1 Is there a trap for the developing countries?

It has been recognized that the increase in the export sophistication boosts the economic growth (HHR, 2007, Rodrik, 2006; Guariglia and Santos-Paulino, 2008, Jarreau and Poncet, 2009; Minondo, 2009). The strength of the empirical results on the economic growth effect of the export sophistication improvement ignored the terms of trade effect. The important question that crops up is: what has been the terms of trade experience of the South during the period studied by Rodrik (2006) and HHR (2007)? Are these declining in spite of its (the South) diversified and manufactured dominated exports? These questions are addressed here. Importantly, we will show that in spite of the increase in their manufactured exports and the export productivity, many developing countries have experienced TOT deterioration.

According to the World Bank (2002), most of the trade of developing countries is with developed countries. About 73 % of the trade of high-income countries is with other high-income countries, but about 70 % of the trade of low-income and middle-income countries is with high-income countries. In this context, movements in the terms of trade of developing countries are of obvious importance since these constitute one indicator of the gains of these economies from external trade and openness. The basic issue in this section is really about movements in the terms-of-trade of developing countries that trade mostly with developed countries.

<sup>&</sup>lt;sup>172</sup> A paper based on this section is submitted.

According to Sarkar and Singer (1991), in their study over the period 1965-1987, the commodity composition of exports of the developing countries has undergone a major change in the direction of dominance of manufactures in their non-fuel exports, with strong growth in the volume of their manufactured exports. However, this did not allow the developing countries to escape from terms of trade deterioration. The developing countries barter terms of trade in manufactures showed signs of weakness and deterioration rather than improvement. The "terms of trade of the South deteriorated not only in their exchange of primary products for Northern manufactures but also in their exchange of manufactures for Northern manufactures" (Sarkar and Singer, 1993, p. 1620). Wood (1997) compared the price of a basket of developed-country manufactured exports and services with a basket of developing country manufacture exports. He concluded from this that within manufactures, between 1985 and 1995, developing countries had experienced a 20 % decline in their TOT when compared with the manufactures (and some services) exported by high-income economies. Todaro and Smith (2003) note that the increase in manufactured exports has not brought gains to developing countries as they had hoped.

Many of high growth Southern countries are diversified exporters and manufactured items occupy an important place in their export basket. Interestingly enough, Sarkar's (2005) study on the emblematic South Korea experience reflects a rapid increase in the share of manufactured and electronic goods in South Korea's total exports and a deterministic trend decline in South Korea's terms of trade over the period 1967–2001. Despite the increase in the sophistication of South Korea's exports, this country continues to face terms of trade deterioration (see Figure 4.12 for other developing countries). We confirm the result of Sarkar for South Korea, by using the new data on export sophistication. The increase in Korean EXPY is associated with a fall in its TOT (see Figure 4.11).



Figure 4.11: Relationship between EXPY and TOT (in logs), South Korea

Data source: Dani Rodrik (for EXPY) and WDI (for TOT)

It would be expected that export prices of an industrializing country like China would gradually catch up and thus improve its TOT. This is not the case (Gaulier *et al.*, 2007). While China has experienced rapid export growth during the past decades, its export structure has also shown a substantial shift towards manufacturing goods, in particular high-tech goods (Qureshi and Wan, 2008). The rapid shift of China's export composition has also attracted increasing attention with reference to its export quality and technology sophistication recently. Despite the increase in China's EXPY <sup>173</sup>, the deterioration of its general TOT has not changed (Li *et al.*, 2007; Lemoine and Ünal-Kesenci, 2008; Amiti and Freund, 2007). From 1993 to 2000, the index of general terms of trade decreased by 13 % while the index for manufactured goods decreased by 14% during the same period (Zheng and Zhao, 2002, see Table 4.A.2 in Appendix for chapter4). China's TOT decreased by 22% from 1995 to 2002 and by 28% percent between 1996 and 2004<sup>174</sup>. The deterioration of TOT was the result of the fall in export prices of manufactured products and the rise in import prices of parts and components (Gaulier *et al.*, 2007).

 <sup>&</sup>lt;sup>173</sup> Rodrik (2006) and Jarreau & Poncet (2009) note the impressive diversification of China's trade, as its manufactured exports pervaded all sectors of world trade, from low-technology textile to high-tech electronics and computers.
 <sup>174</sup> According to Amiti and Freund (2010), the export price decline in China is consistent with a negative terms-of-trade effect,

<sup>&</sup>lt;sup>1/4</sup> According to Amiti and Freund (2010), the export price decline in China is consistent with a negative terms-of-trade effect, with increased exports pushing down export prices.









# Figure 4.12: Relationship between EXPY and TOT (in logs): selected countries (Data source: Dani Rodrik (for EXPY) and WDI (for TOT))













Some stylized facts describe developing countries' trade structure:

- Despite a diversification of their exports into manufactured goods, most developing countries largely export primary goods. For about 2/3 of the developing countries, prices of primary goods mainly determine their merchandise export income as they still export more primary goods than manufactured goods (WTO, 2002, p. 21)
- Manufactured goods represent 71% of total imports of low-income and middle-income economies, and these come mainly from developed countries (World Bank, 2002, p. 226).

Country	Period	Sign of regression coefficients	Adj R <sup>2</sup>
Argentina	1973 - 1992	negative ***	0.92
Brazil	1970- 1996	negative ***	0.85
Chile	1973- 1992	negative ***	0.78
India	1970 -1995	negative ***	0.72
Korea	1990- 1997	negative ***	0.71
Malaysia	1970 -1991	negative	0.61
Philippines	1970 1991	negative ***	0.87
Sri Lanka	1970 – 1991	negative	0.32
Thailand	1990 – 1995	negative ***	0.79

 Table 4.32. Terms of trade deterioration of selected developing countries

Source: Sarkar (2004, pp 166-167)

Estimates are obtained by fitting a log-linear trend equation log(TOT) = a + bt where t = time

As regards the movement of TOT, we may cite Sarkar (2004), who shows that the Southern TOT have deteriorated, despite the increasing importance of manufactures in their exports. Individual country cases confirm TOT deterioration. The Table above lists the signs of the regression coefficients of time trend regression on TOT as found in Sarkar (2004) in respect of selected Southern countries. These countries and many other developing and emerging countries "are no longer just primary exporters but diversified exports of manufactured goods. Many of the high growth countries from the South have experienced deterioration in TOT despite having a diversified export structure" (Bhattacharya and Raychaudhuri, 2004, p.24). Sarkar (2005) points out that the rising share of manufactured and electronic goods in South Korea's exports (sophistication) had no favourable influence on its terms of trade.

How do terms of trade vary across countries? Figure 4.13 shows a scatter plot of TOT against EXPY (\$ PPP). There is a negative correlation between these two variables.



Figure 4.13: Relationship between EXPY and TOT (in logs), 2006

Data source: World Bank'WDI & PRMED EXPY: export sophistication ; TOT: terms of trade

### 4.4.3.2 Testable estimation, data and econometric analysis

Now we put back the TOT debate at the forefront of empirical analysis. The novelty of our analysis is to study the effect of the sophistication (productivity) of the overall export basket of a developing country and not by distinguishing export structure (manufactured goods exports, primary goods exports). We use two regression specifications in our empirical investigation. First, we use a level regression equation specified as follows:

$$\log(TOT)_{jt} = \partial + \delta_j + \delta_t + \beta_1 \log(EXPY)_{jt} + \beta_2 IMPORTS_{jt} + \varepsilon_{j_t}$$
(24)

where "TOT" is the terms of trade of a developing country measured by NBTT for country *j* in year *t* and is defined as the ratio of export-unit-value (price) to import-unit-value (price) for that country and year, *t* is the "year" of observation.  $\delta_j$  are country specific effects in panel data. IMP is imports. TOT may reflect factor other than imports and EXPY. To the extent that these factors are correlated with imports and export sophistication, its significance in the TOT regression that omits these factors may simply reflect EXPY and imports serving as proxies for other factor influencing TOT. The variables "TOT" and "EXPY" are expressed in natural logarithm. Following the basic prediction of the extended DFS Ricardian model developed above (equation 14), which states that the increase in the export sophistication of the developing country (i.e, Ricardian level of sophistication *z*) is accompanied by a terms of trade (for goods) deterioration<sup>175</sup>, we expect  $\beta_1 < 0$ . Thus, the increase in the export productivity and its implied export sophistication (GDP per capita based measure) is translated into TOT deterioration. This prediction of the theory will be tested on the basis of a sample of developing and emerging countries over the period 1997-2003 using balanced panel and over the period 1980-2006 using incomplete panel.

<sup>&</sup>lt;sup>175</sup> We have showed in chapter 3 that technology transfer via FDI and licensing deteriorates the developing countries' terms of trade.

Variable name	Definition	Source
log(EXPY)	Natural logarithm of export sophistication measured in	Rodrik' database on EXPY
	parity purchasing power	• World Bank & PRMED new database on EXPY (online in December 2009)
		PRMED: The Economic Policy and Debt Department (PRMED) is responsible for the
		World Bank's operational and policy work in the areas of growth, fiscal policy, and
		strategic debt issues, as well as integrative policy analysis and tools for economic
		analysis.
ICT goods imports	Information and communication technology goods imports	World Bank – World Development Indicators
	(% total goods imports)	
	Information and communication technology goods imports	
	include telecommunications, audio and video, computer	
	and related equipment; electronic components; and other	
	information and communication technology goods.	
Imports of goods and services	Imports of goods and services at current US dollar	World Bank – World Development Indicators
Imp /GDP	Imports of goods and services/ GDP	World Bank – World Development Indicators

# Table 4.33. Variables used in analysis: Measurement and Data Sources

• List of countries in the balanced panel

China, Brazil, Uruguay, Costa Rica, Argentina, Hungary, Poland, Turkey, Mexico, Malaysia, India, Colombia, Venezuela, Paraguay, Peru, Chile, El Salvador, Panama, Ecuador, South Korea, Nicaragua, Jordan, Mauritius, Indonesia, Guatemala, Kenya, Uganda, Niger, Nigeria, Senegal and Thailand.

• List of countries in the incomplete panel

Argentina, Bolivia, Burkina Faso, Burundi, Brazil, Indonesia, Cameroon, Chile, China, Colombia, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Ghana, Guinea, Haiti, Honduras, Hong Kong, India, Iran, Kenya, Korea, Mali, Mauritius, Mexico, Mongolia, Namibia, Nicaragua, Niger, Yemen, Vietnam, Venezuela, Uganda, Turkey, Tunisia, Algeria, Angola, Trinidad & Tobago, Togo, Syrian Arab Republic, Sudan, St. Vincent and the Grenadines, St. Lucia, Sri Lanka, South Africa, Poland, Peru, Paraguay, Papua New Guinea.

We consider the TOT level regression. We have to take into account heteroscedasticity and serial correlation potential problems in the residuals. Since a modified Wald test for groupwise heteroskedasticity rejects the null hypothesis of homoscedasticity, we rely on robust standard errors. We test our models for autocorrelation of residuals with Wooldridge's (2002) test for serial correlation; the statistics obtained indicate that there is autocorrelation in the residuals. Therefore, we use an estimator, which is robust with respect to heteroscedasticity and autocorrelation in the residuals.

As recommended by Peterson (2009), Egger and Raff (2010), Baltagi *et al.*(2008) and Hericourt & Poncet (2009), we apply the various estimation techniques to our data in order to assess the robustness of the key variables' significance to multiple corrections on the standard errors. We run our fixed effects regressions using HAC kernel estimator / Newey-West correction for autocorrelation and heteroskedasticity and using Rogers or clustered (at the country level) standard errors. We also re-run our regressions using Driscoll-Kraay correction on standard errors. We do so by employing a version of the variance-covariance matrix estimator for spatially and/or serially correlated data following Driscoll and Kraay (1998) (see Hoechle, 2007; Egger and Raff, 2010).

The TOT often fluctuate widely across time, although the extent to which this occurs varies by country. Given the variations in the TOT across time, we also estimate a time-difference regression equation (see Mansfield and Reinhardt, 2008; Xu and Lu, 2009; Xu and Wang for methodology). We use a difference regression equation specified as follows:

$$\Delta \log(TOT)_{jt} = \alpha + \eta_j + \eta_t + \theta_1 \Delta \log(EXPY)_{jt} + \theta_2 \Delta IMPORTS_{jt} + v_{j_t}$$
(25)

The difference regression equation estimates the link between changes in TOT and changes in EXPY. This is useful as the evolution of TOT is pronounced in the time dimension. Note that the time-differencing level equation (24) would yield a difference equation without country fixed effects, while the difference equation (25) includes country dummies  $(\eta_j)$  to control for the effects of unobserved country features on changes in EXPY. In this sense,

equation (25) is more general than equation (24) in estimating the effects of the EXPY on TOT volatility.

We start our econometric estimation with a fixed effects model, controlling for country and time-specific effects. We investigate the effect of EXPY on the TOT of the developing countries. It is interesting to note that the estimated coefficient on log (EXPY) is negative as expected and significant at 1% and 5% in all regressions in Tables 4.34, 4.35, 3.37 and 4.41. Our findings are robust to lagging log (EXPY) by one year. There is strong conclusive evidence to support the theoretical model on the weakening TOT for developing countries. Importantly, we find qualitatively similar results from the balanced panel using Rodrik' EXPY database and from the incomplete panel using World Bank & PRMED' EXPY database. In Table 4.34 (using Rodrik' EXPY database), EXPY enters with a large and negative coefficient that is statistically significant in all of these specifications. The estimated coefficient on EXPY varies from (-0.18) to (-0.24). Taking the midpoint of this range, the results imply that a 10% increase in EXPY deteriorates TOT by 2.1 percentage points. In Table 4.37 (using World Bank & PRMED'EXPY), the estimated coefficient on EXPY enters with a large and negative coefficient that is statistically significant in all of these specifications. The estimated coefficient varies from (-0.21) to (-0.22) in the Newey-West and Driscall-Kraay regressions. Taking the midpoint of this range, the results imply that a 10% increase in EXPY deteriorates TOT by 2.15 percentage points. We also report regressions using the relative export sophistication (REXPY) measure in Table 3.36. The estimated coefficient on REXPY and log (REXPY) is negative as expected and significant at 1% and 5% in all regressions.

We have replaced EXPY measure by the export concentration index (Herfindahl concentration index)<sup>176</sup> and we find a positive and significative association between this index and the terms of trade (see Table 4.A.3 in the Appendix of chapter 4). The diversification of the exports (i.e., a decrease in export concentration from one year to the next) in a developing country from our sample "*results in a one-off*" deterioration in its TOT, which is in line with the arguments of Sarkar (2001, 2004), Bhattacharya & Raychaudhuri (2004) and UN (2008). The estimated coefficient on the export concentration index is positive and significant at 1% and 5%

 $<sup>^{176}</sup>$  Export concentration index measures the degree to which country's *j* exports are dispersed over various products (UNCTAD 2005). It is normalized to obtain values ranking from 0 to 1 (where 1 is maximum concentration).

level in all regressions. The decrease in the export concentration, which implies more diversification of the export structure, is accompanied by TOT deterioration for the developing countries. From TOT difference regression, the results imply that a developing country would see a larger drop in TOT the faster the decline in the export concentration index (i.e., faster the increase in the export diversification ) in the country.

Following the results from our empirical analysis, we observe deterioration in developing countries' TOT, despite an increase in the export of manufactures by them. Like Sarkar (1997), we show that in the process of catch-up (captured by the increase in EXPY in our case), the developing countries face TOT deterioration.

Tables 4.38- 4.41 report the results of TOT differences and growth rate regressions. The results from the difference regressions are consistent with the ones obtained from the level regressions. Interestingly, the key regressor -EXPY -appears to significantly affect the directional change in TOT. An improvement (increase from one year to the next) in EXPY results in a deterioration of the developing countries' TOT.

According to Gaulier *et al.*(2007, p.238), "*the surge of China's exports associated with the continuous decline of its export prices since 1997 suggests the risk of a downward spiral of cost-competition, as China's prices exert downward pressure on international prices of manufactured products*". In order to assess robustness of our results, we re-run regressions in Table 4.33 without China. Our findings show robustness to this exclusion. Thus, there seems to be a robust negative association between change in a country's TOT and changes in EXPY. Larger drops in TOT occurred in countries with higher improvement in EXPY. We think that countries with higher improvement in EXPY are the ones with more competition in the global market, and hence TOT tend to decrease by a larger amount in such countries. This is one of the adverse effects of an outward-oriented and extensive growth strategy.

The weakening TOT effect of EXPY can be explained as follows.

# • Technological upgrading and low price / quality range

Dimaranan *et al.*(2007) note that outward-oriented industries of standardized or modular products are likely to put strong downward pressures on prices. In recent years, the developing countries' TOT have been influenced by falls in the prices of manufactured goods subject to stiff price competition. The decrease in the export prices corresponds to a decline of domestic prices and results both from high productivity gains in the manufacturing industry and from competition among producers, both on the domestic and foreign markets. Among developing countries, exporters of manufactures faced a persistent deterioration of their TOT. The unit value of their exports declined. *"Productivity growth and the information technology revolution had already set in a trend towards lowering prices of manufactures"* (UN, 2008, p.62). The relatively low unit value of most developing countries' high-technology good exports suggests that to enter the world markets for such products, they have to rely on strong and *"fierce"* price competitiveness. They succeeded in gaining large world market shares in high technology products at the cost of a downward pressure on the prices of the manufactures exported: These exports might correspond to a lower quality level but may also reflect lower production costs and fierce competition between producing firms (see Lemoine and Ünal-Kesenci, 2008).

The technological upgrading and the increase in the export sophistication have not been accompanied by an improvement in the price/quality ladder<sup>177</sup> and most of developing countries' middle & high-technology exports are located at the bottom of the price /quality ladder (less differentiated varieties). This also implies that they do not export the same varieties as technologically advanced countries do. Their technological upgrading does not imply increased direct competition with the technologically advanced economies (Fontagné *et al.*, 2007; Amiti and Freund, 2007; Lemoine and Ünal-Kesenci, 2008; UN, 2008, p. 62).

<sup>&</sup>lt;sup>177</sup>The exports are concentrated in the low price/quality range. Following Xu(2010, p. 483), "although many of China's exported goods belong to sophisticated categories, they may well be the low-quality varieties".

Many developing countries were characterised by a "*reserve army of labour*", keeping wages down and close to the subsistence level. In these labour-surplus economies, product prices were therefore much less likely to rise than those in the developed countries. In addition, the output of the developing countries generally embodied products with low barriers to entry and subject to a downward pressure (squeeze) on prices and margins (see Bloch & Sapsford, 2000; Kaplinsky, 2006; Ocampo, 1993).

# • Product cycle

As discussed in Sarkar (1997, 2001, 2004), the deterioration of the TOT in the developing countries can be presented in terms of product cycles. A new product is often introduced in the technologically advanced countries. Initially there is a strong demand for this product and its income elasticity is very high. Owing to a lack of knowledge of its production technique, the technologically backward countries cannot start its production and continue to produce comparatively older goods with lower income elasticity. By the time the South acquires the knowledge, the technologically advanced countries has introduced another new products. In such a product cycle scenario, the income elasticity of the technologically backward countries' demand for goods produced in the developed countries is likely to be higher than that of the advanced countries' demand for goods produced in the technologically backward countries. Under these circumstances, if the developing countries try to catch up by pressing for a higher rate of growth, the global macro balance requires a steady deterioration in the TOT of the developing countries *vis-à-vis* the developed countries. The Southern catch-up would imply a further TOT deterioration than has been observed.

# • Economic growth

Young (1991) and Matsuyama (1992) argued that learning by doing externalities allow some sectors to have a higher growth potential than others. Countries that specialize in sectors where productivity can be improved due to learning by doing (equated with manufacturing or high-technology sectors) will grow faster than those countries that specialize in sectors in which productivity is not improved through experience (equated with agriculture or low-technology sectors). HHR (2007) find that countries specialized in goods associated with high productivity levels grow faster than countries specialized in goods associated with low productivity levels. Countries latching on more productive exports perform better both in terms of exports and growth. Those countries will export more which will strengthen competition in the world market and exert downward pressure on the export prices.

The increase in export sophistication (GDP based measure) is synonymous to an increase in GDP. A common view in trade and growth theory is that an increase in the domestic goods supply is associated with the deterioration of a country's TOT, as the additional domestic supply is absorbed by international markets at falling prices. The high productivity growth in tradable may cause weakening of the TOT. The TOT losses of "*exporters of manufactures among the developing countries are partly explained by the pace of the catch-up process. This process has been driven by higher productivity in the export sectors, which has given them a competitive edge*" (UNCTAD, 2005, p.4). Under perfect competition in the product markets, productivity growth may fully translates into lower prices. Output growth has a negative impact on relative export prices (see Corsetti *et al.*, 2007, p.101).

Following Acemoglu and Ventura (2002) and Sarkar (2005), to the extent that faster productivity growth translates into faster output increase, the association of higher growth with deteriorating TOT implies that international trade contributes to a stable world income distribution. Bhattacharya and Raychaudhuri (2004) stated that the higher growth rate in the South relative to that of the North is associated with the deterioration of the Southern TOT. Ocampo (1993) and Ocampo & Parra (2006) added that the joint effect of the trends in wages and productivities implies that, whereas the developed countries are able to retain productivity improvement via higher real wages, those of the developing countries are forced to "*export*" technological change via deterioration in the TOT.

		Fixed	-effects (within	<ol> <li>regression</li> </ol>	l			Newey-V	West.		Driscoll-Kraay			
	Stati	stics robust to he	eteroskedasticit	y and cluste	ring on count	ry	Statist	ics robust to het	eroskedasticit	y and	Statistics robust to heteroskedasticity and			
								autocorre	lation		autocorrelation (serial and/or spatial)			
Dependant variable:	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
log(TOT)														
log (EXPY)	- 0.2388***	-0.2046***	-0.238***	-0.18**	-0.183**	-0.2048***	-0.2388***	-0.2046***	-0.238***	-0.18**	-0.2388***	-0.2046**	-0.238***	-0.18**
	(4.07)	(3.04)	(2.84)	(2.06)	(2.07)	(3.07)	(2.83)	(2.62)	(3.05)	(2.42)	(2.79)	(2.30)	(3.02)	(2.05)
log (100*ICT imports /	-0.0774	-0.0399				-0.0396	-0.0774*	-0.0399			-0.0774**	-0.0399		
total imports)	(1.64)	(0.94)				(0.91)	(1.94)	(1.03)			(2.20)	(1.65)		
log(Imports of goods			-0.026	-0.006	- 0.0008				-0.026	-0.006			-0.026	-0.006
and services )			(0.41)	(0.10)	(0.01)				(0.53)	(0.13)			(1.56)	(0.61)
Constant	6.953***	6.56***	7.363***	6.40***	6.273***	6.556***	6.71***	6.36***	7.57***	6.506***	6.95 ***	6.612***	7.363***	6.377***
	(13.55)	(11.31)	(5.06)	(4.88)	(4.43)	(11.46)	(9.53)	(9.67)	(6.32)	(5.41)	(8.89)	(8.55)	(14.53)	(8.83)
Time specific effect	No	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No	Yes
(year dummies)														
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>							0.4534	0.4880						
Number of countries	31	31	36	36	35	30	31	31	36	36	31	31	36	36
					China	China								
					excluded	excluded								
Number of observations	217	217	252	252	245	210	217	217	252	252	217	217	252	252

#### Table 4.34. Balanced panel - TOT level regressions over 1997-2003 period (using Rodrik and HHR database on EXPY)

ICT : Information and communication technology

• Wooldridge autocorrelation test does not reject the presence of autocorrelation.

• Heteroskedasticity and autocorrelation robust t-statistics (absolute value) are reported in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \* Significant at 10 % level.

• Newey-West and Driscoll-Kraay estimates of the standard errors use one time lag.

• List of countries: China, Brazil, Uruguay, Costa Rica, Argentina, Hungary, Poland, Turkey, Mexico, Malaysia, India, Colombia, Venezuela, Paraguay, Peru, Chile, El Salvador, Panama, Ecuador, South Korea, Nicaragua, Jordan, Mauritius, Indonesia, Guatemala, Kenya, Uganda, Niger, Nigeria, Senegal and Thailand.

• Besides addressing the problem of heteroscedasticity and autocorrelation, multicollinearity is also examined using Variance inflation factors (VIF). There is evidence of the multicollinearity problem if the mean VIF is greater than 6 and the largest individual VIF is greater than 10 (Gujariti, 2004; Enders, 2004; Baum, 2006; Kennedy, 2003; Chatterjee and Price, 1991). The VIFs look fine here. The results confirm that our variables do not suffer from any multicollinearity problem.

Variables	log(EXPY)	ICT goods imports / total goods imports)	log (100*ICT goods imports /total goods imports)	log(Imports of goods and services )	
VIF	1.62	1.62			Mean VIF= 1.62
	1.81		1.81		Mean VIF= 1.81
	2.48			2.48	Mean VIF= 2.48

			Fixed-effe	ects (within) re	egression	Newey-West Driscoll-Kraay							
		Statistics ro	bust to hetero	skedasticity a	nd clustering o	on country		Statistics robu	st to heteroske	dasticity and	Statistics rol	bust to heterosked	asticity and
					-			autocorrelation			autocorrelation (serial and/or spatial)		
Dependant variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(1)	(2)	(3)
log(TOT)													
log (EXPY)	- 0.2137***	- 0.1917***			-0.319***	-0.246***		-0.2137**	-0.1917**		-0.2137**	-0.1917**	
	(3.38)	(2.90)			(2.85)	(3.01)		(2.55)	(2.51)		(2.36)	(2.14)	
log (EXPY) lagged			-0.156**	-0.177***			-0.1618***			-0.156**			-0.156**
(one year)			(2.63)	(2.80)			(3.09)			(2.40)			(2.49)
100* ICT imports /	-0.0086***	- 0.0046						-0.0086***	- 0.0046		-0.0086***	- 0.0046***	
imports	(2.75)	(1.37)						(3.09)	(1.56)		(3.60)	(2.99)	
log(Imports of goods and			- 0.085		-0.068					- 0.085*			- 0.085***
services) lagged			(1.59)		(1.39)					(1.95)			(2.98)
(one year)													
log(Imports of goods and				-0.030									
services)				(0.43)									
log (Import value index)						-0.0105							
						(0.20)							
log (Import value index)							-0.0866**						
lagged (one year)							(2.20)						
Constant	6.65***	6.418***	7.997***	6.90***	9.085***	6.8878***	6.456***	6.446***	6.264***	8.342***	6.65***	6.3887***	7.997***
	(11.81)	(10.41)	(6.86)	(4.85)	(6.37)	(9.18)	(13.57)	(9.18)	(9.66)	(7.97)	(8.31)	(7.83)	(19.10)
Time specific effect	No	Yes	No	No	No	No	No	No	Yes	No	No	Yes	No
(year dummies)													
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>								0.4552	0.4886	0.3879			
Number of countries	31	31	36	36	36	36	36	31	31	36	31	31	36
Number of observations	217	217	216	216	216	252	252	217	217	216	217	217	216

# Table 4.35. Robustness checks - TOT level regressions over 1997-2003 period (using Rodrik database on EXPY)

• Wooldridge autocorrelation test does not reject the presence of autocorrelation.

• Heteroskedasticity and autocorrelation robust t-statistics (absolute value) are reported in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \* Significant at 10% level.

• Newey-West and Driscoll-Kraay estimates of the standard errors use one time lag.

• List of countries: China, Brazil, Uruguay, Costa Rica, Argentina, Hungary, Poland, Turkey, Mexico, Malaysia, India, Colombia, Venezuela, Paraguay, Peru, Chile, El Salvador, Panama, Ecuador, South Korea, Nicaragua, Jordan, Mauritius, Indonesia, Guatemala, Kenya, Uganda, Niger, Nigeria, Senegal and Thailand.

	I	Fixed-effects	(within) regressi	on		N	lewey-West.				Driscoll-Kraa	y
	Statistics r	obust to heter	roskedasticity ar	nd clustering	Statistics	robust to hete	roskedasticity	Statistics robust to heteroskedasticity and				
		on	country					autocorrelation (serial and/or spatial)				
Dependant variable: $log(TOT)$	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)
log(REXPY)	-0.189** (2.40)	-0.196** (2.55)			-0.189** (2.53)	-0.1499** (2.09)	-0.196*** (2.66)			-0.189** (2.50)	-0.196** (2.55)	
REXPY			-0.5578***	-0.5226**				-0.5578**	-0.5226**			-0.5226**
			(2.74)	(2.33)				(2.52)	(2.27)			(2.48)
log(Imports of goods and services )	-0.0276			-0.0196	-0.0276	-0.008			-0.0196	-0.0276		-0.0196
	(0.44)			(0.29)	(0.56)	(0.17)			(0.37)	(1.47)		(0.87)
log (Import value index)		-0.01	-0.0003				-0.01	-0.0003			-0.01	
		(0.19)	(0.01)				(0.23)	(0.01)			(0.48)	
Constant	5.092***	4.49***	4.8799***	5.3177***	5.3066***	4.801***	4.26***	4.745***	5.544***	5.09***	4.49***	5.3178***
	(3.43)	(17.30)	(21.37)	(3.50)	(4.11)	(3.79)	(13.26)	(20.49)	(4.25)	(10.33)	(29.06)	(11.97)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	No	No	No	No	Yes	No	No	No	No	No	No
R <sup>2</sup>					0.4275	0.4666	0.4263	0.4193	0.4200			
Number of countries	36	36	36	36	36	36	36	36	36	36	36	36
Number of observations	252	252	252	252	252	252	252	252	252	252	252	252

# Table 4.36. Robustness checks – Relative export sophistication (REXPY) as RHS variable (using Rodrik database on EXPY) TOT level regressions over 1997-2003 period

Wooldridge autocorrelation test does not reject the presence of autocorrelation. ٠

Heteroskedasticity and autocorrelation robust t-statistics (absolute value) are reported in parentheses. \*\*\*Significant at 1% level, \*Significant at 5% level, \* Significant at 10% level. ٠

Newey-West and Driscoll-Kraay estimates of the standard errors use one time lag. ٠

List of countries: China, Brazil, Uruguay, Costa Rica, Argentina, Hungary, Poland, Turkey, Mexico, Malaysia, India, Colombia, Venezuela, Paraguay, Peru, Chile, El Salvador, Panama, Ecuador, ٠ South Korea, Nicaragua, Jordan, Mauritius, Indonesia, Guatemala, Kenva, Uganda, Niger, Nigeria, Senegal and Thailand.

 $REXPY_{j} = \frac{EXPY_{j}}{mean \ EXPY \ 15_{developed}}$  is based on the mean EXPY of 15 developed countries: Australia, Austria, Canada, Denmark, Finland, France, Germany, Iceland, Italy, Japan, the ٠

Netherlands, Norway, Sweden, the United Kingdom, and United States (this list is from Zhu and Trefler (2005)).

	Regression with Newey-West standard errors			FE regression heteroskedastic standard errors	with ity robust	Regression v Kraay stan	vith Driscoll- idard errors	FE regression with AR(1) correction (Baltagi and Wu's (1999) method)	
Dependant variable: $log(TOT)$	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(2)
log (EXPY)	-0.210 *** (2.79)	- 0.211*** (2.81)	-0.22*** (2.88)	-0.210*** (3.41)	- 0.211*** (3.43)	-0.210 *** (3.95)	- 0.211*** (3.99)	-0.1465*** (4.32)	-0.143*** (4.24)
Imports/GDP		-0.033 (0.31)			-0.0327 (0.38)		-0.033 (0.27)		0.2926*** (3.39)
log (100*Imports/GDP)	- 0.007 (0.19)		-0.01 (0.27)	- 0.0073 (0.24)		- 0.007 (0.22)		-0.0557** (2.02)	
Constant	6.68 *** (10.49)	6.608*** (10.27)	6.7*** (10.17)					-0.094** (2.24)	-0.13*** (3.11)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup> (from OLS regression)	0.4047	0.4047	0.4089						
R <sup>2</sup> within						0.1846	0.1847	0.3046	0.3077
Number of countries	52	52	51	52	52	52	52	52	52
Number of observations	1104	1104	1077 China excluded	1104	1104	1104	1104	1052	1052

#### Table 4.37. Incomplete panel - TOT level regressions over 1980-2006 period (using World Bank & PRMED new database on EXPY)

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \* Significant at 10% level.

• Wooldridge autocorrelation test does not reject the presence of serial autocorrelation.

• Newey-West and Driscoll-Kraay estimates of the standard errors use one time lag.

• Regression with Driscoll-Kraay standard errors: we employ a version of the variance-covariance matrix estimator for serially and/or spatially correlated data following Driscoll and Kraay (1998). We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional independence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced: Not enough common observations across panel to perform Pesaran's test.

• FE regression with AR(1) correction applied with Baltagi and Wu's (1999) method reports standard errors estimates robust to disturbances being autocorrelated with AR(1) process. We use "xtregar" Stata command to estimate a fixed-effects panel model with AR1 structure. However, this method does not correct heteroskedasticity. We use the LBI option because panel is unbalanced.

• List of countries: Argentina, Bolivia, Burkina Faso, Burundi, Brazil, Indonesia, Cameroon, Chile, China, Colombia, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Ghana, Guinea, Haiti, Honduras, Hong Kong, India, Iran, Kenya, Korea, Mali, Mauritius, Mexico, Mongolia, Namibia, Nicaragua, Niger, Yemen, Vietnam, Venezuela, Uganda, Turkey, Tunisia, Algeria, Angola, Trinidad & Tobago, Togo, Syrian Arab Republic, Sudan, St. Vincent and the Grenadines, St. Lucia, Sri Lanka, South Africa, Poland, Peru, Paraguay and Papua New Guinea.

• Besides addressing the problem of heteroscedasticity and autocorrelation, multicollinearity is also examined using Variance inflation factors (VIF). There is evidence of the multicollinearity problem if the mean VIF is greater than 6 and the largest individual VIF is greater than 10 (Gujariti, 2004; Enders, 2004; Baum, 2006; Kennedy, 2003; Chatterjee and Price, 1991). The VIFs look fine here. The results confirm that our variables do not suffer from any multicollinearity problem.

Variables	log(EXPY)	Imports s / GDP	log (100*Imports/GDP)	
VIF	1.02	1.02		Mean VIF= 1.02
	1.00		1.00	Mean VIF= 1.00

	FE regression	Regression West star	with Newey- ndard errors	Regression w	Regression with clustered (at country level) standard errors					
Dependant variable: $\Delta \log(TOT)$	(1)	(2)	(3)	(1)	(2)	(1) Driscoll-Kraay correction with lag(1) option	(2) Driscoll-Kraay correction with lag(1) option	(3) Driscoll-Kraay correction with lag(0) option	(1)	(2)
$\Delta \log$ (EXPY)	-0.139*** (3.53)	-0.136*** (3.45)	-0.126*** (3.24)	- 0.139*** (3.44)	-0.136*** (3.38)	-0.139*** (3.30)	-0.136*** (3.26)	-0.136*** (3.32)	-0.139** (2.38)	- 0.136** (2.34)
$\Delta$ Imports/GDP		- 0.274** (2.27)	-0.197* (1.78)		- 0.274** (2.37)		- 0.274** (2.18)	- 0.274* (1.98)		- 0.274*** (3.55)
$\Delta \log (100*$ Imports/GDP)	-0.053 (1.48)			-0.053 (1.43)		-0.053 (1.31)		· · · · · ·	-0.053 (1.44)	
Constant				0.005 (0.12)	0.007 (0.17)					
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time specific effect (year dummies)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ramsey' test for omitted variable	F(3, 966) = 1.25 Prob > F = 0.2893	F(3, 966) =0.21 Prob > F=0.8901	F(3, 900) =1.45 Prob > F =0.2263							
R <sup>2</sup>				0.1335	0.1389					
Number of countries	52	52	49 Algeria, Angola and Venezuela ( as oil exporting countries) are excluded	52	52	52	52	52	52	52
Number of observations	1048	1048	979	1048	1048	1048	1048	1048	1048	1048

### Table 4.38. Incomplete panel - TOT difference regressions over 1980-2006 period

(Using World Bank & PRMED new database on EXPY)

Wooldridge autocorrelation test rejects the presence of serial autocorrelation in TOT difference regressions.

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.

Regression with Driscoll-Kraay standard errors: we employ a version of the variance-covariance matrix estimator for serially and/or spatially correlated data following Driscoll and Kraay (1998).
 We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional dependence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced: Not enough common observations across panel to perform Pesaran's test..

• Fisher Test for panel unit root using an augmented Dickey-Fuller and Phillips-Perron test (with or without trend) for unbalanced panel format allow us to reject the possibility of non-stationarity in  $\Delta \log(TOT)_{ir}$  and in  $\log(TOT)$ . The tests have been performed using the xtfisher Stata-routine written by Merryman (2005).

• We use Stata "ovtest" command to test for omitted variables from the equation. Ramsey' test for omitted variable, after controlling for fixed effects, fails to reject the null hypothesis of no omitted variables.
	FE regres	Regression wit	th Newey-West	Regression with Driscoll-Kraay standard errors				FE regression with clustered (at country level) standard			
	heteroskedasticity ro	heteroskedasticity robust standard errors		standard errors							
										errors	
Dependant variable	(1)	(2)	(1)	(2)	(1)	(2)	(3)	(4)	(1)	(2)	
$\int \Lambda \log(TOT)$ , $\frac{1}{\log(TOT)}$ ,					Driscoll-	Driscoll-	Driscoll-	Driscoll-			
					Kraay	Kraay	Kraay	Kraay			
					correction	correction	correction	correction			
					with lag(0)	with lag(0)	with lag(1)	with lag(1)			
					option	option	option	option			
$\left[ \Lambda \log(FXPY) \right] / \log(FXPY)$	-0.263***	-0.261***	-0.263***	-0.261***	-0.263***	-0.261***	-0.263***	-0.261***	-0.263**	-0.261**	
$\begin{bmatrix} \Delta \log(LM I)_{it} \end{bmatrix} = \log(LM I)_{i,t-1}$	(3.57)	(3.55)	(3.45)	(3.44)	(3.51)	(3.48)	(3.40)	(3.39)	(2.36)	(2.36)	
$\int \Delta IM \int I/IM$		-0.006		-0.006		-0.006		-0.006		-0.006	
$\begin{bmatrix} \sum i i \\ it \end{bmatrix}$ $\prod i i, t-1$		(0.93)		(0.91)		(0.96)		(0.94)		(0.99)	
$\int \Delta \log(IM) = \frac{1}{\log(IM)}$	-0.0124		-0.0124		-0.0124		-0.0124		-0.0124		
$[\Delta \log(m)_{it}]/\log(m)_{i,t-1}$	(0.55)		(0.52)		(0.53)		(0.51)		(0.52)		
Constant			0.0026	-0.001							
			(0.30)	(0.26)							
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Time fixed effect (year dummies )	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Ramsey' test for omitted variables	F(3, 966) = 1.72	F(3, 966) = 1.38									
	Prob > F = 0.1613	Prob > F = 0.2461									
Number of countries	52	52	52	52	52	52	52	52	52	52	
Number of observations	1048	1048	1048	1048	1048	1048	1048	1048	1048	1048	

#### Table 4.39. Incomplete panel - TOT rates of change' regressions over 1980-2006 period

(Using World Bank & PRMED new database on EXPY)

Wooldridge autocorrelation test rejects the presence of serial autocorrelation in TOT rates of change' regressions.

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \* Significant at 10% level.

• Regression with Driscoll-Kraay standard errors: we employ a version of the variance-covariance matrix estimator for serially and/or spatially correlated data following Driscoll and Kraay (1998). We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional dependence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced: Not enough common observations across panel to perform Pesaran's test.

• We use Stata command "xtivreg2, fe" (without instruments) with robust option to report FE regression with heteroskedasticity robust standard errors and FE regression with clustered (at country level) standard errors.

	FE regress heteroskedasticity rob	Regression wit standar	h Newey-West d errors	Regression with Driscoll-Kraay standard errors				Regression with clustered (at country level) standard errors		
Dependent variable $\left[ \Lambda \log(TOT) \right]$	(1)	(2)	(1)	(2)	(1)	(2)	(3)	(4)	(1)	(2)
					Driscoll-	Driscoll-	Driscoll-	Driscoll-		
					Kraay	Kraay	Kraay	Kraay		
					correction	correction	correction	correction		
					with $lag(0)$	with $lag(0)$	with $lag(1)$	with $lag(1)$		
					option	option	option	option		
$\left[ \Lambda \log(EXPY) \right] / \log(EXPY)$	- 1.176***	- 1.169***	- 1.176***	- 1.169***	- 1.176***	- 1.169***	- 1.176***	- 1.169***	- 1.176**	- 1.169**
	(3.56)	(3.54)	(3.48)	(3.46)	(3.37)	(3.34)	(3.27)	(3.25)	(2.47)	(2.46)
$\left[ \Lambda IM \right] / IM$		- 0.028		- 0.028		- 0.028		- 0.028		- 0.028
$L \xrightarrow{\text{min}} it \int \prod_{i,t-1} i_{i,t-1}$		(0.89)		(0.87)		(0.90)		(0.88)		(0.94)
$\left[ \Lambda \log(IM) \right] / \log(IM)$	- 0.0513		- 0.0513		- 0.0513		- 0.0513		- 0.0513	
$[\Delta \log(m)_{it}] / \log(m)_{i,t-1}$	(0.47)		(0.45)		(0.45)		(0.43)		(0.45)	
Constant			0.0064	-0.011						
			(0.16)	(0.27)						
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect (year dummies )	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ramsey' test for omitted variables	F(3, 966) = 1.04	F(3, 966) = 0.48								
	Prob > F = 0.3741	Prob > F = 0.6997								
Number of countries	52	52	52	52	52	52	52	52	52	52
Number of observations	1048	1048	1048	1048	1048	1048	1048	1048	1048	1048

#### Table 4.40. Incomplete panel- TOT difference regressions over 1980-2006 period

(Using World Bank & PRMED new database on EXPY)

Wooldridge autocorrelation test rejects the presence of autocorrelation in TOT difference regressions.

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \* Significant at 10% level.

• Regression with Driscoll-Kraay standard errors: we employ a version of the variance-covariance matrix estimator for serially and/or spatially correlated data following Driscoll and Kraay (1998). We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction. Unfortunately, because our samples are highly unbalanced, we are unable to implement any of the available tests for cross-sectional dependence in panel data (Hoyos and Sarafides 2006, Hoechle, 2007). According to the Pesaran's (2004) CD test, our panel is highly unbalanced: Not enough common observations across panel to perform Pesaran's test..

• We use Stata command "xtivreg2, fe (without instruments) with robust option to report OLS estimation with fixed effect.

#### Regression with Driscoll-Kraay standard errors Fixed effect regression Regression with Driscoll-Kraay correction Regression with Newey-West standard errors (with lag(1) option) with (with lag(0) option) heteroskedasticity (with lag(1) option) robust standard errors Dependant variable Dependant (1)(2)(3) (1)(2)(3) (4) (5) (1)(2)(1)(2)(3) (4) $\Delta \log(TOT)_{ii}$ variable: log(TOT)log(EXPY) -0.346 -0.343 -0.346 -0.343-0.305 $\Delta \log(EXPY)$ -0.0929 -0.0897 -0.0989 -0.097 -0.0929 -0.0897 (3.64)\*\*\*(3.61)\*\*\* (4.93)\*\*\*(4.73)\*\*\*(3.95)\*\*\*(2.55)\*\* (2.48)\*\*(2.45)\*\*(2.95)\*\*\*(2.48)\*\*(2.39)\*\*-0.3387 -0.3387 log(EXPY) lagged -0.30 (4.34)\*\*\* (3.31)\*\*\* (4.85)\*\*\* (one year) -0.4437-0.4437 -0.193 -0.244 Imports /GDP ΔImports /GDP -0.34 -0.34 (2.62)\*\*\*(1.72)\* (1.33)(2.21)\*\* (1.62)(2.21)\*\*Imports /GDP -0.221 -0.017 -0.221 lagged (one year) (1.28)(0.11)(0.83)log(100\*imports/GDP) -0.0537 -0.0537 $\Delta \log(100*imports/GDP)$ -0.0987-0.073-0.0987 (2.13)\*\*(2.21)\*\* (0.82)(0.55) $(1.72)^*$ Constant 7.878 7.76 7.723 Constant 0.0789 0.08 (8.86)\*\*\* (8.88)\*\*\* (8.22)\*\*\* (3.81)\*\*\* (3.90)\*\*\*Country fixed effect Yes Yes Yes Yes Yes Yes Yes Yes Country fixed effect Yes Yes Yes Yes Yes Yes Year dummies Yes Yes Yes Yes Yes No No Year dummies Yes Yes No Yes Yes Yes No 37 37 37 37 37 37 37 37 Number of countries 37 37 37 Number of countries 37 37 Number of observations 629 592 629 592 Number of observations 629 629 629 592 592 592 592 592 592 592

#### Table 4.41. Balanced panel - TOT level and difference regressions over the period 1990-2006

(Using World Bank & PRMED new database on EXPY)

Note:

Wooldridge autocorrelation test does not reject the presence of autocorrelation in TOT level regression. Wooldridge autocorrelation test rejects the presence of autocorrelation in TOT difference regressions.

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \* Significant at 10% level.

Newey-West and Driscoll-Kraay estimates of the standard errors use one time lag in TOT level regressions.

• Regression with Driscoll-Kraay standard errors: we employ a version of the variance-covariance matrix estimator for serially and/or spatially correlated data following Driscoll and Kraay (1998). We use the new Stata command "xtscc" (Hoechle, 2007) to report Driscoll-Kraay correction.

• List of countries: Algeria, Angola, Argentina, Bolivia, Brazil, Burkina Faso, Burundi, Cameroon, Chile, China, Colombia, Ecuador, Egypt, El Salvador, Ghana, , Guinea, Haiti, Honduras, Hong Kong, Indonesia, Kenya, Korea, Mali, Mexico, Nicaragua, Niger, Paraguay, Peru, Poland, South Africa, Sudan, Togo, Tunisia, Turkey, Uganda and Venezuela.

#### 4.4.3.3 Instrumental variable estimation and exogeneity tests

The export sophistication (EXPY) can be expected to be endogenously determined. We expect thus countries with higher EXPY will export more which may lead to deterioration in TOT. On the other hand, the worsening of TOT may lead to a depreciation of the domestic currency which sustains the competitiveness of exporters and thus increase their exports (included in the calculation of EXPY index) (see Broda and Tille, 2003). Consequently, instrumental variable (IV) approach is advisable to deal with potential endogeneity of EXPY with respect to TOT.

In our next step, we deal with the suspicious endogeneity of our variable of interest EXPY more precisely and develop an instrumentation strategy. This approach intends to deal with empirical biases due to three distinct problems: *(i)* the potential reverse effect of TOT on EXPY, *(ii)* the potential correlation between the export sophistication and the regression residuals which contain random shocks and other omitted factors and *(iii)* the measurement error bias.

Tables (4.42)-(4.44) give the results of IV regressions. We use different lags of log (EXPY) as instruments. In some regressions, we add a measure of FDI, high-tech exports (divided by manufactured exports), log (labour), log (population), ICT exports (divided by total exports) as extra-instruments with a total of three excluded instruments in the IV regressions. Several tests suggest the validity of instruments. The first stage is characterized by a partial R<sup>2</sup> higher than 10% and a F-test of excluded instruments significant at 1% level and higher than 10. Two additional tests help to verify the validity of our instruments: first, the Hansen test of overidentifying restrictions and the weak identification test. The insignificance of the Hansen test of overidentifying restrictions indicates that the orthogonality of the instruments to the error term cannot be rejected. Overidentification tests cannot reject excludability suggesting that our instruments are appropriate<sup>178</sup>. Second, we obtain a Kleibergen-Paap Wald F-stat above the informal threshold of 10 suggested by Staiger and Stock (1997) to assess the validity of instruments.

<sup>&</sup>lt;sup>178</sup> The Hansen test of over-identifying restrictions helps checking that instrumental variables are valid (i.e. uncorrelated with the error term) and that the excluded instruments are correctly excluded from the estimated equation. Under the null hypothesis, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. A rejection casts doubt on the validity of the instruments. In no case, the validity of our instruments is rejected.

This statistic is also reported together with critical value Stock-Yogo weak identification test for 10% and 15% maximal IV size distortion as tabulated by Stock and Yogo (2005). If there are three or more instruments (thus, there are two or more overidentifying restructions), the relative-bias criterion can be used (Cameron and Trivedi, 2009, p. 194). Thus, we report critical values based on a 5% and 10% maximum bias of the IV estimator relative to the OLS at the 5% confidence level, as tabulated by Stock and Yogo (2005). The test rejects the null hypothesis if the computed statistic exceeds the critical value. The results with respect to the quality of the instruments are overall quite satisfactory. Overall, these tests suggest that the second stage estimates are reliable, i.e. that export sophistication is accompanied by a deterioration of the developing countries' TOT. Durbin Wu Hausman test does not reject the exogeneity (at the 10% confidence level) of EXPY with respect to TOT. The IV estimates are not appropriate. The exogeneity of EXPY is robust to the use of more recent data and to the panel format (balanced or incomplete). We confirm the negative, direct and significant association of EXPY with TOT.

	0		<u> </u>	
	(1)	(2)	(3)	(4)
log (EXPY)	-0.621***	-0.474***	-0.455***	-0.5035**
	(4.21)	(3.20)	(3.11)	(2.03)
log(100*ICT imports /total imports)	-0.035	-0.037	-0.037	-0.069*
	(0.82)	(0.91)	(0.92)	(1.76)
Country fixed effect	Yes	Yes	Yes	Yes
Hansen J statistic of overidentifying	equation exactly identified	1.274	0.935	1.207
restrictions		Chi-sq(2) P-val = 0.5290	Chi-sq(2) P-val = $0.6265$	Chi-sq(2) P-val = 0.5468
First-stage F-test	45.73***	28.41***	27.53 ***	13.00***
Partial R <sup>2</sup> for excluded instruments	0.1230	0.2208	0.2184	0.1516
Kleibergen-Paap rk Wald F statistic	45.732	28.406	27.531	13.000
Stock-Yogo weak ID test critical values				
5% maximal IV relative bias		13.91	13.91	13.91
10% maximal IV relative bias		9.08	9.08	9.08
10% maximal IV size	16.38			
15% maximal IV size	8.96			
Instruments (excluded) for IV regressions	First lag of log (EXPY)	First lag of log (EXPY), High-	First lag of log (EXPY),	log(FDI/world FDI)
		tech exports /manufactured	High-tech exports	Population density, ICT
		exports, FDI in stock/world	/manufactured exports ,	exports
		FDI	FDI in flow/world FDI	
Durbin-Wu-Hausman test of endogeneity	1.127	0.490	0.296	0.146
	Chi-sq(1) P-val = 0.2884	Chi-sq(1) P-val = 0.4839	Chi-sq(1) P-val = 0.5863	Chi-sq(1) P-val = 0.7027
Number of countries	31	31	31	31
Number of observations	186	186	186	217

 Table 4.42. IV regressions: log (EXPY) instrumented (Using Rodrik database on EXPY)

• In columns, (1), (2) and (3), t-statistics (absolute value) are robust to heteroskedasticity and clustering on country (robust to arbitrary within-group correlation). In column 4, t-statistics (absolute value) are robust to heteroskedasticity and autocorrelation (HAC kernel estimator).

• The excludability of (excluded) instruments is checked. Our instruments are appropriate. Our first stage F-statistics are above 10, consistent with Staiger and Stock's (1997) "rule of thumb".

	(1)	(2)	(3)	(4)	(5)	(6)
log (EXPY)	- 0.799**	- 0.799***	-0.754**	-0.754***	- 0.738***	- 0.504**
	(2.02)	(2.65)	(1.99)	(2.71)	(2.00)	(2.13)
log(100*ICT imports /total imports)	- 0.0599	- 0.0599	-0.063	-0.063	-0.0329	- 0.036
	(1.13)	(1.28)	(1.19)	(1.35)	(0.71)	(0.90)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Hansen J statistic of overidentifying	2.585	3.935	1.896	2.764	0.763	0.845
restrictions	P-val = 0.2746	P-val = 0.1398	P-val = 0.3876	P-val = 0.2511	P-val = 0.6829	P-val = 0.6555
First-stage F-test	13.79 ***	17.67***	25.02 ***	17.37***	12.25***	12.36***
Partial R <sup>2</sup> for excluded instruments	0.1080	0.1080	0.1302	0.1302	0.1845	0.2759
Kleibergen-Paap rk Wald F statistic	13.794	17.665	25.019	17.372	12.253	12.359
Stock-Yogo weak ID test critical values						
5% maximal IV relative bias	13.91	13.91	13.91	13.91	13.91	13.91
10% maximal IV relative bias	9.08	9.08	9.08	9.08	9.08	9.08
Instruments (excluded) for IV regressions	FDI/GDP, ICT	FDI/GDP, ICT	log(real FDI), ICT	log(real FDI), ICT	log(100*FDI stock/World	First lag of log(100*FDI
	exports/total exports,	exports/total exports,	exports/total exports,	exports/total exports,	FDI), First lag of	stock/World FDI),
	log(labour)	log(labour)	log(labour)	log(labour)	log(100*FDI stock/World	log(labour), High-tech
					FDI), log(population)	exports/manufactured
						exports
Durbin-Wu-Hausman test of endogeneity	0.734	1.348	0.601	1.431	1.313	0.300
	P-val = 0.3917	P-val = 0.2457	P-val = 0.4382	P-val = 0.2315	P-val = 0.2519	P-val = 0.5840
Number of countries	31	31	31	31	31	31
Number of observations	217	217	210	210	186	217

#### Table 4.43. IV regressions: log (EXPY) instrumented (Using Rodrik database on EXPY)

• In columns (1) (3), (5) and (6), t-statistics (absolute value) are robust to heteroskedasticity and clustering on country (robust to arbitrary within-group correlation). In columns (2) and (4), t-statistics (absolute value) are robust to heteroskedasticity and autocorrelation (HAC kernel estimator).

• The excludability of (excluded) instruments is checked. Our instruments are appropriate. Our first stage F-statistics are above 10, consistent with Staiger and Stock's (1997) "rule of thumb".

	(1)	(2)	(3)	(4)
	(1)	(2)	(5)	(+) IV CMM estimation
				IV-GIVINI ESTIMATION.
	0.0424	0.0541	0.0(51)	log (EXPT) instrumented
log (EXPY)	- 0.243*	- 0.254*	- 0.267**	- 0.243**
	(1.92)	(1.94)	(1.99)	(2.05)
log(100*Imports/GDP)	- 0.0178	-0.0168		-0.017
	(0.48)	(0.45)		(0.47)
Imports/GDP			-0.085	
			(0.83)	
Time fixed effect (year dummies)	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes
Hansen J statistic of overidentifying restrictions	equation exactly identified	0.041	0.551	0.041
	1 2	Chi-sq(1) P-val = $0.8394$	Chi-sq(2) P-val = $0.7592$	Chi-sq(1) P-val = 0.8394
First-stage F-test	68.20 ***	36.68 ***	26.62***	36.68 ***
Partial R <sup>2</sup> for excluded instruments	0.3726	0.3725	0.3737	0.3725
Kleibergen-Paap rk Wald F statistic	68.20	36.677	26.617	36.677
Stock-Yogo weak ID test critical values				
5% maximal IV relative bias			13.91	
10% maximal IV relative bias			9.08	
10% maximal IV size	16.38	19.93		19.93
15% maximal IV size	8.96	11.59		11.59
Underidentification test (Kleibergen-Paap rk LM statistic)	77.397	78.338	77.993	78.338
	Chi-sq(1) P-val = 0.0000	Chi-sq(2) P-val = 0.0000	Chi-sq(3) P-val = 0.0000	Chi-sq(2) P-val = 0.0000
Instruments (excluded) for IV regressions	First lag of log (EXPY)	First lag of log (EXPY) and	First lag of log (EXPY) second	First lag of log (EXPY) and
		second lag of log(EXPY)	lag of log(EXPY) and third lag	second lag of log(EXPY)
			of log(EXPY)	
Durbin-Wu-Hausman test of endogeneity	0.166	0.195	0.125	0.195
0 1	Chi-sq(1) P-val = 0.6833	Chi-sq(1) P-val = 0.6584	Chi-sq(1) P-val = 0.7235	Chi-sq(1) P-val = 0.6584
Number of countries	52	52	52	52
Number of observations	1089	1073	1053	1073

### Table 4.44. IV regressions: log (EXPY) instrumented (Using World Bank & PRMED new database on EXPY)

• t-statistics (absolute value) are robust to heteroskedasticity and autocorrelation (HAC kernel estimator). In column 3, we report t-statistics (absolute value) robust to heteroskedasticity and clustering on country (robust to arbitrary within-group correlation)

• In column (4), we account for the possibly complex variance-covariance structure of the residuals relying on the two-step efficient generalized method of moments (GMM) estimator. The Stata command xtivreg2 was used with gmm - two steps, robust and bw options.

• Our first stage F-statistics are above 10, consistent with Staiger and Stock's (1997) "rule of thumb".

#### 4.5 Conclusion

We presented a continuum Ricardian trade model, in which the specialization pattern depends on the technological gap. This is an interesting framework to discuss the determinants of EXPY from the developing countries. Technological catch-up requires absorptive effort to foster learning and the development of technological capabilities in the South. This technology and knowledge absorption via FDI and export penetration aims at reducing the technological gap and diversifying the export structure towards high productivity goods.

The developing country, by opening to trade and foreign involvement and by absorbing technological inflows, will upgrade its export structure and export relatively more in the more complex industries. By improving its catch-up, the Southern country enlarges the range or the scope of goods towards goods with a higher technological sophistication. We have examined variations in the level of export sophistication across developing countries. Using a panel of developing and emerging countries, we have analysed the effect of technological absorption by means of FDI, exporting and labour productivity and "*discovery*" spillover effect (linked to population or country size) on the export sophistication of the developing countries. We find strong evidence of the importance of export penetration, labour productivity, FDI and "*discovery*" spillover captured by country size for technology absorption which leads the developing countries to move towards exporting goods with higher productivity levels.

We have explored the effect of the export sophistication on the terms of trade of the developing countries. Based on our empirical work, we have come to the conclusion that the theoretical debate on the TOT is justified. Our findings are mostly in line with the literature on worsening TOT of the developing countries and confirm the predictions of DFS's (1977) Ricardian continuum model. The robustness of our findings to the panel format (balanced or incomplete) and its size, to EXPY database's choice (Rodrik database or World Bank & PREMED database) and to the econometric technique choice, gives credence to our results.

The level of sophistication of the developing country's exports cannot stop the decline in commodities' TOT. It is obvious that the magnitude of export sophistication increase (diversification toward high value added goods) did not improve the developing countries' TOT. The increase in the export sophistication has been accompanied by a strong competition in global markets and has not been accompanied by a significant improvement in the price/quality ladder. Most of developing countries' middle & high technology exports are located at the bottom of the price /quality ladder (less differentiated varieties).

#### 4.A. Appendix of chapter 4

The export sophistication or export productivity index (EXPY) was developed by Rodrik (2006) and HHR (2007). This index is a quantitative indicator that sorts traded goods in terms of their productivity and improves the traditional measures of a country's revealed comparative advantages (RCA), which basically compares the relative proportion of the country's exports of a particular good with relation to those of a country or region.

The models of the determinants of international competitiveness within a comparative advantages framework use the concept of Revealed Comparative Advantage (RCA) as a proxy for comparative advantage or disadvantage. The RCA measures the actual distribution of exports between countries and is formally expressed as the ratio of the competitiveness of each sector to the competitiveness of the entire economy. The formal expression for RCA

$$RCA_{ij} = \frac{\left(X_{ij} / \sum_{j} X_{ij}\right)}{\sum_{i} X_{ij} / \sum_{i} \sum_{j} X_{ij}}$$

where

X = some indicator of international competitiveness i = sector or industry j = country

Instead, the main contribution of (EXPY) is that it takes a weighted average of the per capita incomes (GDP) of the countries exporting a commodity, where the weight reflects the RCA of each country in that product, that is, an income-productivity level that corresponds to a country's export basket. First, Rodrik (2006) construct an income-productivity measure PRODY associated to each good<sup>179</sup>. PRODY is the weighted sum of the per capita GDP of countries exporting a given product, and thus represents the income level associated with each of these goods.

Then the PRODY index for good k is given by

$$PRODY_{k} = \sum_{j} \frac{x_{jk/X_{j}}}{\sum_{j} (x_{jk}/X_{j})} Y_{j}$$

Where countries are indexed by  $_{j}$  and goods are indexed by  $_{l}$ . For any given year, the value of total exports of a country j equals

$$X_j = \sum_l x_{jl} \; .$$

 $Y_j$  denotes the per capita GDP of country j. The numerator is the value share of the commodity k in the country overall export basket. The denominator aggregates the value share across all countries exporting the good.

<sup>&</sup>lt;sup>179</sup> PRODY is the original notation used by Rodrik (2006), as it measures a product's (PROD) content of income (Y).

The reason that the share, rather than the absolute value, of a particular product is used as the weight is to avoid the dominance of large countries. Higher income countries tend to have higher labour productivity, so by our theoretical model they tend to produce products with more technological contents. The construction of the EXPY uses an approach similar to that used by the revealed comparative advantage: a product has a higher EXPY if it is exported more by high-income countries.

The technological content index of country j's exports is then defined as the weighted average of the technological content index of its exported products: Export productivity EXPY for a country "j" is given by

$$EXPY = \sum_{l} \frac{x_{jl}}{X_{j}} PRODY_{l}$$

That is the export productivity indicator is a weighted index of the representative income associated with a country's exports where the weight is the value share of a particular commodity in the country's total exports

Dependant variable:	Static IV-FE	Static IV-FE	Static IV-FE	Static IV-FE	Static IV-FE	Static IV-FE
log (EXPY)	(1)	(2)	(3)	(4)	(6)	(7)
- · · ·	Instrumented: FDI/exports	Instrumented: FDI/exports	Instrumented:FDI/exports	Instrumented: FDI/exports	Instrumented: EP	Instrumented: FDI/exports
	_		_	_		
FP	0.0669	0.073	0.0637	0.0719	0.047	0.0699
11	(1.78)*	(1.90)*	(1.77)*	(1.91)*	(2.51)**	(2.13)**
log(GDPnc) lagged	0.204	0.260	0.199	0.260	0.203	0.199
105(0D1 pc) hugged	( 3.04)***	(2.44)**	(3.01)***	(2.44)**	(1.37)	(2.95)***
EP	0.298	0.3006	0.297	0.303	0.833	0.2976
	(2.57)**	(2.52)**	(2.59)**	(2.57)**	(1.70)*	(2.55)**
$\log(Pop)$	0.41	0.581	0.4139	0.608	0.534	0.4026
	(1.64)	(1.75)*	(1.66)	(1.86)*	(1.03)	(1.64)
Imp/GDP	0.0418	0.0413274	0.0500247	0.0477	-0.1207	0.0428
	(0.38)	( 0.36)	(0.47)	(0.43)	(-0.91)	(0.41)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes	Yes	No
Arellano-Bond test for	z = 0.05 Pr > z = 0.9567	z = 0.06 Pr > z = 0.9542	z = 0.09 Pr > z = 0.9281	z = 0.09 Pr > z = 0.9316	z = -0.65 Pr > z = 0.5177	z = 0.08 Pr > z = 0.9396
autocorrelation in IV context	1 ( 70444	10.04***	25.57***	20.02***	24 (0444	26.20***
First-stage F-test	16.70***	19.04***	35.57***	39.02***	24.60***	26.38***
Partial R <sup>2</sup> for excluded instruments	0.2392	0.2565	0.2458	0.2584	0.1097	0.2748
Hansen J statistic of overidentifying	0.012	0.046	Equation exactly identified	equation exactly identified	0.443	0.835
restrictions	$Ch_{1}-sq(1) P-val = 0.9145$	$Ch_{1}-sq(1) P-val = 0.8305$			Chi-sq(1) P-val = 0.5056	$Ch_{1}-sq(2) P-val = 0.6588$
Kleibergen-Paap rk Wald F statistic	16.700	19.041	35.566	39.024	24.596	26.379
Stock-Yogo weak ID test critical	10% maximal IV size 19.93	10% maximal IV size19.93	10% maximal IV size 16.38	10% maximal IV size 16.38	10% maximal IV size 19.93	5% maximal IV relative bias 13.91
values:	15% maximal IV size 11.59	15% maximal IV size 11.59				10% maximal IV relative bias 9.08
			(T 1 ) (T T 1 )		a 11 APP	
Instruments (excluded) for IV	First lag of FDI/exports,	first lag of FDI/exports,	first lag of FDI/exports	First lag of FDI/exports	Second lag of EP,	First lag of FDI/exports,
regressions	institutional quality	institutional quality			telecommunications	manufactured exports/total exports,
					infrastructure	telecommunications infrastructure
Durbin-Wu-Hausman test of	0.349	0.483	0.306	0.559	0.942	0.237
endogeneity	Chi-sq(1) P-val = 0.5547	Chi-sq(1) P-val = 0.4872	Chi-sq(1) P-val = 0.5802	Chi-sq(1) P-val = 0.4545	Chi-sq(1) P-val = 0.3317	Chi-sq(1) P-val = 0.6266
Number of observations	336	336	348	348	336	348

#### Table 4.A.1. IV regressions and exogeneity checks

• We use the Arellano-Bond (1991) test for autocorrelation implemented by Rodman (2009) for the IV context. The test was originally proposed for a particular linear Generalized Method of Moments dynamic panel data estimator, but is quite general in its applicability. It can be applied to linear GMM regressions in general, and thus to ordinary least squares (OLS) and two-stage least-squares (2SLS) regressions, which can be seen as special cases of linear GMM. It is appropriate for both time-series and cross-section time-series (panel) regressions. It can also be made consistent in the presence of various patterns of error covariance. In OLS regression (with fixed effects) in levels, the AR (1) test is relevant.

• Our first stage F-statistics are consistently above 10, consistent with Staiger and Stock's (1997) "rule of thumb".

Dependant variable: log (EXPY)	Static IV-FE	Static IV-FE			
	(7)	(8)			
	Instrumented: EP	Instrumented: EP			
FP	0.048	0.048			
11	(2.67)***	(2.70)***			
$\log(GDPnc)$ lagged	0.17	0.12.			
log(ODI pe) lagged	(1.67)*	(2.14)**			
FP	0.4	0.417			
	(3.21)***	(3.66)***			
$\log(Pon)$	0.430	0.33			
	(1.08)	(1.21)			
Imp/GDP	0.025	0.018			
	(0.26)	(0.19)			
Country fixed effect	Yes	Yes			
Year dummies	Yes	No			
Arellano-Bond test for autocorrelation in IV context	z = -0.06 Pr > z = 0.9510	z = -0.09 Pr > z = 0.9322			
First-stage F-test	50.73	74.97			
Partial R <sup>2</sup> for excluded instruments	0.1765	0.1999			
Hansen J statistic of overidentifying restrictions	1.184	0.922			
	Chi-sq(1) P-val = $0.2766$	Chi-sq(1) P-val = 0.3369			
Kleibergen-Paap rk Wald F statistic	50.728	74.969			
Stock-Yogo weak ID test critical values:	10% maximal IV size 19.93	10% maximal IV size 19.93			
	15% maximal IV size 11.59	15% maximal IV size 11.59			
Instruments (excluded) for IV regressions	ICT exports and institutional quality	ICT exports and institutional quality			
Durbin-Wu-Hausman test of endogeneity	0.876	0.768			
	Chi-sq(1) P-val = 0.3494	Chi-sq(1) P-val = 0.3809			

(Continued)	IV	regressions and	l exogeneity	checks

Robust t-stats (absolute values) are reported in parentheses. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level.
Our first stage F-statistics are consistently above 10, consistent with Staiger and Stock's (1997) "*rule of thumb*".

Category	Terms of trade
All products	-13 %
Non fuel-primary products	- 2%
Manufactured goods	-14 %
Labour-/resource- intensive products	- 11 %
Low-tech products	- 3%
Medium –tech products	- 18%
High-tech products	-20%

Source: Zheng and Zhao (2002)

#### Table 4.A.3. Robustness checks: TOT level and difference regressions - Export concentration index as RHS variable over the period 1995-2006 (Incomplete panel)

	Regression kernel e	with HAC stimates	Regress clustered (	ion with at country	Regression with Driscoll-Kraay standard errors				FE regression with heteroskedasticity		Regression with Driscoll-Kraay correction with lag(0) option			ection with	
			level) stall							err	ors				
Dependant variable:	(1)	(2)	(1)	(2)	(1)	(2)	(3)	(4)	Dependant variable	(1)	(2)	(1)	(2)	(3)	(4)
log(TOT)									$\left[\Delta \log(TOT)_{it}\right]$						
Export concentration	0.635	0.6333	0.635	0.6333	0.635	0.6355	0.635	0.6333	∆Export	0.132	0.134	0.132	0.1796	0.1342	0.1804
	(5.29)***	(5.18)***	(3.75)***	(3.73)***	(5.10)***	(5.03)***	(4.80)***	(4.73)***	concentration	(2.10)**	(2.10)**	(2.91)***	(3.48)***	(3.03)***	(3.56)***
Imports /GDP	- 0.598		- 0.598		- 0.459		- 0.598		∆Imports /GDP	- 0.38		- 0.38	- 0.2786		
	(2.96)***		(1.97)*		(4.92)***		(7.18)***			(2.13)**		(1.91)*	(1.40)		
log(100*imports/GDP)		- 0.2214		- 0.2214		- 0.148		- 0.2214	$\Delta log(100*imports/GDP)$		- 0.115			- 0.1147	- 0.075
		(2.69)***		(1.81)*		(2.87)***		(4.99)***			(1.61)			(1.64)	(1.05)
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Year dummies	Yes	Yes	Yes	No	Yes	No
Number of countries	52	52	52	52	52	52	52	52	Number of countries	52	52	52	52	52	52
Number of observations	565	565	565	565	565	565	565	565	Number of observations	512	512	512	512	512	512

Note:

• Wooldridge test does not reject the presence of autocorrelation in the level regressions and rejects the presence of autocorrelation in the difference regressions. Driscoll-Kraay estimates of the standard errors use one time lag in TOT level regressions.

• The t-stats (absolute values), in parentheses, are based on standard error estimates obtained from the covariance matrix estimators in the column headings. \*\*\*Significant at 1% level, \*\*Significant at 5% level, \*Significant at 10% level. Constant not reported.

• Export concentration is a Herfindahl index computed over the value of country's exports to the world. The Herfindahl index has been normalized to obtain values ranking from 0 to 1 (maximum concentration). It is UNCTAD's definitive measure of (the inverse of) product portfolio diversification.

• From our empirical analysis, the diversification of the products a developing country exports (i.e., a decrease in export concentration from one year to the next) results in a deterioration in its terms of trade, which is in line with the intuition of Sarkar (2001, 2004) and Bhattacharya & Raychaudhuri (2004).

• List of countries: Argentina, Bolivia, Burkina Faso, Burundi, Brazil, Indonesia, Cameroon, Chile, China, Colombia, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Ghana, Guinea, Haiti, Honduras, Hong Kong, India, Iran, Kenya, Korea, Mali, Mauritius, Mexico, Mongolia, Namibia, Nicaragua, Niger, Yemen, Vietnam, Venezuela, Uganda, Turkey, Tunisia, Algeria, Angola, Trinidad &Tobago, Togo, Syrian Arab Republic, Sudan, St. Vincent and the Grenadines, St. Lucia, Sri Lanka, South Africa, Poland, Peru, Paraguay and Papua New Guinea.

# **General conclusion**

This thesis shows that the Ricardian theory provides us with a relevant and appropriate framework to study a number of important issues related to FDI, multinationals' activities, TT and international trade. Importantly, we accentuate the usefulness of the Ricardian approach and point out its tractability and fruitfulness in examining these issues.

We emphasized new theoretical and empirical aspects of the integration of FDI and TT in the Ricardian model. In chapter 1, we have taken a somewhat narrow approach to a broad literature on FDI. The Ricardian growth theory, when generalized and interpreted in a broader sense, has the ability to explain the phenomenon of outward FDI and capture the reality of international production. We have reconsidered Ozawa's view of the Japanese OFDI and have showed that his arguments still hold. We adopt a 'push-factor' approach based on the pressure effect of the "Ricardian bottleneck" to explain the outward direct investment. We show that generalized Ricardian growth remains an appealing framework to understand the macroeconomic push factors for outward direct investment. Our study examines the association between OFDI of the emerging countries and economies in transition and the internal macroeconomic determinants. Our econometric results show that OFDI acts as an escape response to the "Ricardian bottlenecks" at home. The increase in the energy consumption and dependency, the economic growth, the labour shortage, the increase in the population density, the increase in the share of fuel imports to total imports, the increase in the electricity production from natural gas, the trade balance and the deteriorating environmental conditions exert a push effect for investing abroad.

Our empirical findings, consistent with the theoretical predictions, confirm this escape response to the growth bottlenecks. The robustness (to different techniques of estimations, different specifications, different formats of panel) and appropriateness of our results give credence to the findings that there are strong and robust internal macroeconomic factors that push for investing abroad and that OFDI acts as an escape from the "*Ricardian bottlenecks*" in the emerging countries and economies in transition.

In chapter 2, we have used a simple two-country, two-good Ricardian trade model in order to reformulate Kojima correspondence principle. We have considered the case in which the developed country has an absolute advantage in the production technology of each good. It has comparative advantage in producing one good, which it exports to the developing country and imports the good in which it has comparative disadvantage. The analysis indicates that the emergence of world market prices generates differences in the absolute profit rates between industries having a comparative advantage and disadvantage. This divergence in absolute profit rates and the industry specificity of intangible capital and technology lead to FDI from the developed country's disadvantaged industry to the developing country's comparatively advantaged industry. The investing developed country will gain from this type of investment, even without receiving income from abroad, due to an improvement in its terms of trade.

In chapter 3, in the first section, we have examined, within Ricardian setting with CES utility function, the conditions under which North-South TT is immiserizing for the developing country. We have singled out the respective role of the relative size of both countries, the efficiency of the technology which is transferred, and the elasticity of substitution between the goods which are produced. In the second section of this chapter, we have examined the effects on terms of trade and welfare of TT originating from the comparatively disadvantaged sector in the developed country and going to the comparatively advantaged sector (the same sector) in the developed country gains by transferring its technology abroad, even without receiving payment. The developed country gains more if the developing country has to pay royalties or quasi rents as a counterpart of such transfer. The developing country's welfare decreases (compared to free trade without TT) if the quasi rents and royalties that it must pay to the developed country are large compared to the increase in the efficiency of its labour linked to the TT.

In terms of policy implications, this thesis single out the effect of technological inflows on the developing countries' welfare. It has been recognized that TT via FDI and licensing increases growth for receiving developing countries. However, welfare assessments must recognize that investment returns and royalties may be repatriated. We show that FDI and licensing may decrease developing country welfare due to the transfer of income to

foreigners, mainly due to the repatriation of quasi-rents and royalties to the developed investing countries. Our empirical assessment in chapter 3 is based on panel data analysis on developing countries. We have shown that licensing and inward FDI deteriorate the developing countries' terms of trade.

In chapter 4, we presented a North-South continuum Ricardian trade model in which the specialization pattern depends on the technological gap. This is an interesting framework for discussing the determinants of export sophistication from Southern countries. Technological catch-up requires absorptive effort to foster learning and the development of technological capabilities in the South. This technology and knowledge absorption aims at reducing the technological gap and diversifying the export structure towards high productivity goods.

The main qualitative insight of our Ricardian framework with continuum of goods can be summarized as follows: the developing country, by opening to trade and foreign involvement and by absorbing technological inflows, will upgrade its export structure and export relatively more in the more complex industries. By improving its catch-up, the Southern country enlarges the range or the scope of goods towards goods with a higher technological sophistication. In this model, an increase in Ricardian sophistication index shifts the South's export shares towards more sophisticated goods. Such shifts in export sophistication level are observable. We use Rodrik's (2006) export sophistication measure as a proxy for the Ricardian sophistication level to motivate our empirical analysis.

This chapter is important because empirical research on export sophistication is still in its infancy. We examine variations in the level of export sophistication (EXPY) across developing countries. Using a panel of developing countries, we have analysed the effect of technological absorption by means of FDI, exporting and labour productivity and "*discovery*" spillover effect (linked to population or country size) on the export sophistication of the developing and emerging countries. We find strong evidence of the importance of export penetration, labour productivity, FDI and "*discovery*" spillover captured by country size for technology absorption, which leads the developing and emerging countries to move towards exporting goods with higher productivity levels.

Our next contribution in chapter 4 is to measure the effects of developing countries' catch-up and the increase in their export sophistication on their terms of trade. We find that the increase in the export sophistication of developing countries is accompanied by a deterioration of their overall terms of trade, which is in line with the Ricardian prediction in the DFS (1977) model. The developing countries, in their catching up effort, are forced to "*export*" technological change via deterioration in the terms of trade. The increase in the export sophistication has been accompanied by a strong competition in the global markets and has not been accompanied by an improvement in the price/quality ladder and most of the price/quality ladder (less differentiated varieties).

A detailed theoretical Ricardian discussion on the terms of trade deterioration for the developing countries is beyond the scope of our thesis in chapter 3 and chapter 4. We have shown that the theoretical debate on the terms of trade is justified. Our empirical applications in chapter 3 and in the last section of chapter 4 have been concerned with the developing countries' terms of trade. The decline of the developing countries' terms of trade is "*not a myth but a reality*"<sup>180</sup>. The results from this study complement those from Sarkar (2004) and Ram (2004), and provide a useful reference point for future research on this important subject.

This thesis highlights challenges for future theoretical and empirical researches. To address empirically the issue of the welfare effect of FDI and licensing in the developing countries discussed within Ricardian trade settings in chapter 3, it would be useful for future research to focus on the welfare and indirect utilities' measures or to construct welfare measures. Of course, as any empirical research, the investigation of welfare effect of FDI depends on the availability of higher-quality data. There is another field in which the Ricardian trade model with a continuum of goods offers a promising direction of research, namely the study of convergence and divergence in the international economy. Therefore, a second direction of future research is to examine and to discuss the conditions that lead to the convergence and divergence in the international economy. The ability of the South to upgrade its export sophistication depends on its efforts for catching-up. The idea is to examine theoretically and empirically whether the export sophistication (EXPY) is a key condition for international convergence.

<sup>180</sup> Sarkar (2001) p. 323

## References

Acemoglu, D. and Ventura, J.(2002), "The world income distribution", *Quarterly Journal of Economics*, vol.117: pp. 659–694.

Addison, T. and Heshmati, A. (2004), "The new global determinants of FDI flows to developing countries: the importance of ICT and Democratization", in Bagella, M., Becchetti, L., Hasan, I. Hunter, W.C. (editors), *Monetary Integration, Markets and Regulation: Research In Banking and Finance*, vol.4:pp.151–186.

Ahlquist, J.S. and Prakash, A. (2008), "The influence of foreign direct investment on contracting confidence in developing countries", *Regulation & Governance*, vol. 2: pp. 316-339.

Aitken, B and Harrison. A. (1999), "Do domestic firms benefit from direct foreign investment? evidence from Venezuela," *American Economic Review*, vol.89:pp. 605-618.

Akamatsu, K. (1962), "Historical pattern of economic growth in developing countries", *The Developing Economies*, pp.3–25.

Akbara, Y.H. and McBride, J.B.(2004), "Multinational enterprise strategy, foreign direct investment and economic development: the case of the Hungarian banking industry", *Journal of World Business*, vol.39: pp. 89-105.

Almeida, R. and Fernandes, A.M. (2008), "Openness and technological innovations in developing countries: evidence from firm-level surveys", *The Journal of Development Studies*, vol. 44.pp: 701-727.

Amano, A. (1977), "Specific factors, comparative advantage and international investment", *Economica*, vol.44:pp.131-144.

Amiti, M. and Freund, C.(2007), "China's export boom", *Finance and Development*, vol.44: p.38-41, International Monetary Fund.

Amiti, M. and Freund, C.(2010), "An anatomy of China's export growth", in Feenstra, R. and Wei, S.J. (editors), *China's growing role in world trade*, University of Chicago Press, pp.35-63.

Andres.J., Hernando,I. and Kriiger,M.(1996), "Growth, inflation and the exchange rate regime", *Economics Letters*, vol.53:pp.61-65.

Antràs, P. (2005), "Incomplete contracts and the product cycle", *American Economic Review*, vol.95:pp.1054-1073.

Arellano M. and Bond,S. (1991), "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", *Review of Economic Studies*, vol.58: pp. 277–297.

Athukorala, P. (1993), "Manufactured exports from developing countries and their terms-of-trade: A reexamination of the Sarkar-Singer results", *World Development*, vol.21:pp.1607–1613.

Athukorala, P.(2000), "Manufactured exports and terms-of-trade of developing countries: Evidence from Sri Lanka", *Journal of Development Studies*, vol.36: pp. 89–104.

Bai, C., Tao, Z. and Wu,C.(2004), "Revenue sharing and control rights in team production: theories and evidence from joint ventures", *Rand Journal of Economics*, vol.35:pp. 277–305.

Balassa,B.(1963), "An empirical demonstration of comparative cost theory", *Review of Economics and Statistics*, vol.45:pp. 231-238.

Balassa,B.(1965), "Trade liberalisation and revealed comparative advantage", *The Manchester School of Economics and Social Studies*, vol.33: pp. 99-117.

Balasubramanyam, V.N., Salisu, M. and Sapsford, D. (1996), "Foreign direct investment and growth in EP and IS Countries", *Economic Journal*, vol.106:pp. 92-105.

Baldwin, R.E. (2004), "Openness and growth: what is the empirical relationship?" in Baldwin, R.E. and Winters, L. Alan (editors), *Challenges to Globalization: Analyzing the Economics*, Chicago: National Bureau of Economic Research-University of Chicago Press.

Baldwin, R., Braconier, H. and Forslid, R. (2005), "Multinationals, endogenous growth and technological spillovers: Theory and evidence", *Review of International Economics*, vol.13:pp. 945–963.

Baltagi B.H.and Wu P.(1999), "Unequally spaced panel data regression with AR(1) disturbances", *Econometric Theory*, vol.15:pp.814–823.

Baltagi, B. H., Egger, P. and Pfaffermayr, M. (2008), "Estimating regional trade agreement effects on FDI in an interdependent world", *Journal of Econometrics*, vol. 145: pp. 194-208.

Banga, R.(2006), "The export-diversifying impact of Japanese and US foreign direct investments in the Indian manufacturing sector", *Journal of International Business Studies*, vol.37:pp.558-568.

Bao, Q., Sun, P., Yang, J. and Li, S.(2010), "Does High-Tech Export Cause More Technology Spillover? Evidence from Contemporary China", University of Nottingham Research Paper No. 2010/06.

Barnett, H. and Morse, C. (1969), Scarcity and growth: the economics of natural resource availability, The John Hopkins Press, Baltimore.

Barrel, R. and Pain, N. (1997), "Foreign direct investment, technological change and economic growth within Europe", *The Economic Journal*, vol.107:pp. 1770–1786.

Bascle,G.(2008),"Controlling for endogeneity with instrumental variables in strategic management research", *Strategic Organization*, vol. 6: pp.285 - 328.

Batra,R.N. and Ramachandran, R.(1980), "Multinational firms and the theory of international trade and investment", *American Economic Review*, vol.70: pp. 278-290.

Baum, C.F. (2006), *An Introduction to Modern Econometrics Using Stata*, College. Station, TX: Stata Press. Baum, C.F. (2007), Instrumental variables: Overview and advances, Boston College and DIW Berlin.

Baum,C.F.(2009),Instrumental variables and panel data methods in economics and finance,Boston College and DIW Berlin.

Baum,C.F.,Schaffer.M. and Stillman,S.(2007), "Enhanced routines for instrumental variables/generalized method of moments estimation and testing", *Stata Journal*,vol. 7: pp. 465-506. Preprint: Boston College Economics working paper no.667.

Beladi, H., Jones, R.W. and Marjit, S.(1997), "Technology for sale", *Pacific Economic Review*, vol. 2: pp. 187-196.

Beladi,H.,Marjit.S. and Oladi.R.(2006), "Uniform technical progress: can it be harmful?", *Pacific Economic Review*, vol.11: pp. 33-38.

Bénassy-Quéré, A., Fontagné, L. and Lahreche-Revil, A.(2001), "Exchange-rate strategies in the competition for attracting foreign direct investment", *Journal of the Japanese and International Economies*, vol. 15: pp. 178–198.

Benvignati, A.M.(1983),"International Technology Transfer Patterns in a Traditional Industry", *Journal of International Business Studies*, 14:pp. 63-75.

Bernard, A. and Jensen, B.(1999), "Exceptional exporter performance: cause effect, or both?", *Journal of International Economics*, vol. 47:pp. 1-25.

Bernard, A., Eaton, J., Jensen, B.and Kortum, S.(2001), "Plants and productivity in international trade", *American Economic Review*, vol.93:pp. 1268-1290.

Bhagwati, J. N. (1958), "Immiserizing growth: a geometrical note", *Review of Economic Studies*, vol.25.pp: 201-206.

Bhagwati, J. (1973), "The theory of immiserizing growth: Further applications", in Connolly, M.and Swoboda, A. (editors), *International Trade and Money*, Toronto: University of Toronto Press, pp.45-54.

Bhagwati, J.N., Srinivasan, T.N. and Wan, H.Y.(1978), "Value subtracted, negative shadow prices of factors in project evaluation, and immiserising growth: Three paradoxes in the presence of trade distortions", *Economic Journal*, vol. 88: pp. 121–25.

Bhattacharya, J. and Raychaudhuri, A. (2004), "Endogenous growth in a North-South framework with human capital accumulation and technology transfer", *Journal of International Trade & Economic Development*, vol. 13: pp. 23-56.

Billington, N.(1999), "The Location of foreign direct investment: An empirical analysis", *Applied Economics*, vol.31: pp. 65-76.

Bitzer, J., Schröder, P. and Gorg, H.(2008), "Can trade really hurt? An empirical follow-up on Samuelson's controversial paper", University of Nottingham Research paper 2008/34

Bloch, H. and Sapsford, D.(2000), "Whither the terms of trade? An elaboration of the Prebisch-Singer hypothesis", *Cambridge Journal of Economics*, vol. 24: pp. 461-481

Blomstrom, M. and Wang, J-Y. (1992), "Foreign investment and technology transfer: a Simple Model", *European Economic Review*, 36.137-155.

Blomstrom, M. and Kokko, A.(1994), "Home country effects of foreign direct investment: Sweden", in Globerman, S. (editor), *Canadian Based Multinationals Industry*, Ottawa, Canada: Industry Canada Research, pp. 341-364.

Blomstrom, M and A. Kokko (1997) 'The Impact of foreign investment on host countries: a review of empirical evidence, World Bank Policy Research Working Paper No. 1745, available at

http://www.fetp.edu.vn/shortcourse/0203/Trade03/Readings/The%20impact%20of%20foreign%20investme nt%20on%20host%20countries.pdf

Blomstrom, M. and Kokko, A. (1998), "Multinational corporations and spillovers", *Journal of Economic Surveys*, vol.12:pp. 247-277.

Blomstrom, M. and Kokko, (2001) "Foreign direct investment and spillovers of technology", *International Journal of Technological Management*, vol. 22:pp. 915-923.

Blomström, M. and H. Persson. (1983), "Foreign investment and spillover efficiency in an underdeveloped economy: evidence from the Mexican manufacturing industry", *World Development*, vol. 11: pp. 493-501.

Blomström, M. and Wolff, E.(1994), "Multinational corporations and productive convergence in Mexico", in Baumol, W. Nelson R.and Wolff, E.(editors), *Convergence of productivity: Cross-national studies and historical evidence*, Oxford :Oxford University Press, pp. 263-283.

Blomström, M., Konan, D. and Lipsey, R.E. (2000), "FDI in the restructuring of the Japanese economy", NBER working paper No. 7693.

Blomstrom, M., Lipsey, R.E. and Zejan, M., (1994), "What explains the growth of developing countries", in in Baumol, W. Nelson R.and Wolff, E.(editors), *Convergence of Productivity: Cross-national Studies and Historical Evidence*, Oxford University Press, New York, pp. 243-259.

Blonigen, B.A.(2005), "A review of the empirical literature on FDI determinants", *Atlantic Economic Journal*, vol. 33:pp. 383-403.

Blonigen, B., Davies, R. and Head, K.(2003), "Estimating the knowledge-capital model of the multinational enterprise: Comment", *American Economic Review*, vol.93:pp.980-94.

Bombardini, M., Kurz, C.and Morrow, P. (2009), "Firm heterogeneity and Ricardian trade: the impact of domestic competition on export performance" Research paper available at,

http://www.economics.utoronto.ca/morrow/bkm14December2009.pdf

Bond, E.(2007), "Market linkages with fragmented production", North American Journal of Economics and Finance, vol.16:pp. 119–135.

Borensztein, E., Gregorio, J.and Lee, J.(1998), "How does foreign direct investment affect economic growth?", *Journal of International Economics*, vol. 45: pp. 115-135.

Braconier, H., Norbäck, P-J. and Urban, D. (2005), "Multinational enterprises and wage costs: vertical FDI revisited", *Journal of International Economics?*, vol. 67: pp. 446-470.

Brainard, S.L.(1993), An Empirical assessment of the factor proportions theory, *NBER working paper no.* 4269.

Brainard,S.L.(1997), "An empirical assessment of the proximity-concentration trade off between multinational sales and trade", *American Economic Review*, vol. 87: pp. 520-544.

Bramati,M.C. and Croux, C.(2007), Robust estimators for the fixed effects panel data model, *Econometrics Journal*, vol.10: pp. 521–540.

Brander, J.A, and Spencer, B.J. (1983): "International R&D rivalry and industrial strategy", *Review of Economic Studies*, vol.50. pp: 707-722.

Brecher, R., Diaz-Alejandro, C., (1977), "Tariffs, foreign capital and immiserizing growth", *Journal of International Economics*, vol. 7:pp. 317–322.

Brecher, R.A. and Feenstra. R.C (1983), "International trade and capital mobility between diversified economies", *Journal of International Economics*, vol. 14:pp. 321-339.

Brixiova,Z.,Li, W.and Yousef, T.(2009), "Skill shortages and labour market outcomes in Central Europe", *Economic Systems*, vol.33: pp.45-59.

Broda,C.(2004),"Terms of trade and exchange rate regimes in developing countries"; Journal of International Economics, vol. 63: pp. 31-58.

Broda,C. and Tille,C.(2003), "Coping with terms-of-trade shocks in developing countries", Current Issues in Economics and Finance, Federal Reserve Bank of New York.

Buckley,P.J.(2007),"The strategy of multinational enterprises in the light of the rise of China", Scandinavian Journal of Management, vol.23: pp. 107–126

Buckley, P.J. and Casson, M.C. (1976), The future of the multinational enterprise, Homes & Meier: London.

Buckley, P., Clegg, J., Zhen, P., Siler, P. and Giorgioi, G.(2007), "The Impact of FDI on the Productivity of China's Automotive Industry", *Management International Review*, vol.47:pp.707-724.

Buckley, P. J., Clegg, J., Cross, A., Liu, X., Rhodes, M. and Voss, H.(2008), "Explaining China's outward FDI: An Institutional Perspective" in Sauvant, K. (editor), *The Rise of transnational corporations from emerging markets: threat or opportunity?*, Cheltenham, Edward Elgar, pp.107-158.

Buckley, P. J., Clegg, J., Cross, A., Zheng, P., Voss, H. and Liu, X. (2008), "The determinants of Chinese outward foreign direct investment", *Journal of International Business Studies*, vol.38: pp.499-518.

Burgstaller, A., (1985), North South trade and capital flows in a Ricardian model of accumulation, *Journal of International Economics*, vol.18:pp. 241-260.

Burton, F.N. and H, Saelens.(1987), "Trade barriers and Japanese foreign direct investment in the colour television industry", *Managerial and Decision Economics*, vol.8:pp. 285-293.

Cai, K.G.(1999), "Outward foreign direct investment: A novel dimension of China's integration into the regional and global economy", *The China Quarterly*, vol.160:pp. 856-880.

Cameron, A.C and Trivedi, P.K. (2009), Microeconometrics using Stata, STATA Press.

Campos, N. and Kinoshita. (2002), "Foreign direct investment as technology transferred: Some evidence from the Transition Economies", *The Manchester School*, vol. 70:pp. 398-412.

Cardoso, E., Dornbusch, R., (1989), "Foreign private capital flows", in Chenery, H., Srinivasan, T.N. (editors), Handbook of Development Economics, Vol. 2. North-Holland, Amsterdam, pp. 1387–1439.

Carr, D.L., Markusen, J.R. and Maskus, K.E.(2001), "Estimating the knowledge-capital model of the multinational enterprise", *American Economic Review*, vol.91:pp. 693-708.

Carstensen, K., and Toubal, F. (2004), "Foreign direct investment in Central and Eastern European countries: a dynamic panel analysis", *Journal of Comparative Economics*, vol.32: pp. 3-22.

Caselli, F. and Coleman, W. (2001), "Cross-country technology diffusion: the case of computers, *American Economic Review*, vol.91: pp. 328-335.

Cassette, A., Farvaquez, E. and Hericourt, J.(2010), "Spending, economy or politics: what makes you win? Empirical evidence from French municipal elections", available at:

http://www.jma2010.fr/fichiers/507/CFH2avectables.pdf

Caves, R.E. (1971), "International corporations: The industrial economics of foreign investment", *Economica*, vol.38:pp. 1-27.

Caves, R.E. (1974), "Multinational firms, competition and productivity in host-country markets", *Economica*, vol.41:pp. 176-93.

Caves, R.E.(1996), "Multinational enterprise and economic analysis", Cambridge Surveys of Economic Literature.

Cecchini, L. and Lai-Tong, C.(2008), "The links between openness and productivity in Mediterranean countries", *Applied Economics*, vol.40:pp. 685-697

Ceglowski, J. and Golub, S. (2007), "Just how low are China's labour costs?", *The World Economy*, vol. 30:pp. 597-617.

Chatterjee, S. and Price, B. (1991), "Regression analysis by example", New York: John Wiley.

Cheng, L.K.(1984), "International competition in R&D and technological leadership: an examination of the Posner–Hufbauer hypothesis", *Journal of international Economics*, vol.17: pp. 15-40.

Cheng, L. K. and Ma, Z. (2010), "China's outward foreign direct investment" in Feenstra, R. and Wei, S.J. (editors), *China's growing role in world trade*, University of Chicago Press, pp.545-580.

Cheng, L.K., Qiu, L.D. and Tan, G.(2000), "Technology transfer, foreign direct investment and international trade: a Ricardian approach", Paper provided by Econometric Society in its series Econometric Society World Congress 2000.

Cheng, L.K., Qiu, L.D. and Tan, G.(2001),."Foreign direct investment and international fragmentation of production". In: Ardnt, Sven, Kierzkowski, Henryk.(Editors.), Fragmentation: New Production Patterns in the World Economy. Oxford University Press, Oxford, pp. 165–186.

Cheng, L.K., Qiu, L.D. and Tan, G. (2005), "Foreign direct investment and international trade in continuum Ricardian model", *Journal of Development Economics*, vol.77: pp. 477-501.

Cheung, Y. W. and Qian, X. W. (2009), "Empirics of China's outward direct investment", *Pacific Economic Review*, vol. 14:pp. 312-341

Chipman, J. S. (1971), "International trade with capital mobility: A substitution theorem", in Bhagwati, J., Jones, R., Mundell, R. and Vanek, J. (editors.), *Trade, Balance of Payments, and Growth*, (North-Holland, Amsterdam), pp. 201-37.

Choi, J.P. (2001), "Protectionist response to import competition in declining industries reconsidered", *European Journal of Political Economy*, vol.17: pp. 193-200.

Choudhri, E. Hakura, D.(2002),"International trade and productivity growth - exploring the sectoral effects for developing countries," IMF Working Papers 00/17, International Monetary Fund

Chuang, Y-H. (1998), "Learning by doing, the technology gap and growth", *International Economic Review*, vol.39:pp. 697-721.

Chung, W. (2001), "Identifying technology transfer in foreign direct investment: influence of industry conditions and investing firm motives", *Journal of International Business Studies*, vol.32:pp. 211-229.

Cimoli, M. (1988), "Technological gaps and institutional asymmetries in a North-South model with a continuum of goods", *Metroeconomica*; vol.39: pp. 245 - 274.

Cimoli, M. and Dosi,G.(1995), "Technological paradigms, patterns of learning and development: an introductory roadmap", *Journal of Evolutionary Economics*, vol.5: pp.242-268.

Cimoli, M. and Porcile, G.(2010), "Specialization, wage bargaining and technology in a multigoods growth model," *Metroeconomica*, vol. 61: pp. 219-238.

Cimoli, M., Porcile, G. and Holland, M.(2006), "Technological Asymmetries, Convergence and Divergence in a Model with a Continuum of Goods", *Nova Economia*, São Paulo School of Economics, Getulio Vargas Foundation.

Cimoli, M., Porcile, G. and Rosas, L. (2004), "Especialización, tecnología y crecimiento en el modelo ricardiano", Working Papers n°:004, Universidade Federal do Paraná, Department of Economics.

Cimoli, M., Holland, M., Porcile, G., Primi, A. and Vergara, S. (2006), "Growth, structural change and technological capabilities. Latin America in a comparative perspective", LEM Papers Series 2006/11, Laboratory of Economics and Management (LEM), Sant'Anna School of Advanced Studies, Pisa, Italy. (Paper presented at the Seminar "*Globalización, Conocimiento y Desarrollo*" UNAM, México D.F., March 15-17, 2006).

Clerides S., Lach.S. and Tybout, J. (1998), "Is 'learning-by-exporting' important? micro-dynamic evidence from Colombia, Mexico and Morocco", *Quarterly Journal of Economics*, vol.113: pp. 903-948.

Coe, D. and Helpman, E. (1995), "International R&D spillovers", *European Economic Review*, vol.39:pp.859-887.

Coe, D., Helpman, E. and Hoffmaister, H.W. (1997), "North-South R&D spillovers", *The Economic Journal*, vol.107: pp.134-149.

Colacelli, M. (2010), "Export Responses to Real Exchange Rate Fluctuations: Development

Status and Exported Good Effect", Barnard College, Columbia University, available at

http://www.columbia.edu/~mc2602/files/Colacelli-Exports.pdf

Collins, S. (1985), «Technical Progress in a Three-Country Ricardian Model with a

Continuum of Goods", Journal of International Economics, vol.19:pp.171-79.

Comin, D. and Hobijn, B. (2004), "Cross-country technology adoption: making the theories face the facts", Journal *of Monetary Economics*, vol.51:pp. 39-83.

Connolly, M. (2003), "The dual nature of trade: Measuring its impact on imitation and growth", *Journal of Development Economics*, vol. 72: pp. 31-55.

Corsetti, G., Martin, P. and Pesenti, P. (2007), "Productivity, terms of trade and the 'home market effect", *Journal of International Economics*, vol. 73: pp. 99-127

Costinot, A. (2009a), "An elementary theory of comparative advantage", *Econometrica*, vol. 77: pp. 1165-1192.

Costinot, A. (2009b), "Jobs, jobs: A "new" perspective on protectionism", *Journal of the European Economic Association*, vol.7: pp. 1-31.

Costinot, A. (2009c), "On the origins of comparative advantage", *Journal of International Economics*, vol.77: pp. 255-264.

Costinot, A. and Komunjer, I. (2008), "What Goods Do Countries Trade? A Structural Ricardian Model", working paper available at

http://econ.ucsd.edu/~ikomunje/files/papers/trade.pdf

Coxhead, I. (2007), "A new resource curse? Impacts of China's boom on comparative advantage and resource dependence in Southeast Asia", *World Development*, vol.35: pp. 1099–1119.

Crozet, M.(2009), "Changes in the concept of comparative advantages: discussion", *The new international division of labour*, Cournot Centre for Economic Studies, 12-13 December 2009.

Cutler, H., Berry, D.J. and Ozawa, T.(2003), "Market recycling in labour-intensive goods, flying geese style: an empirical analysis of East Asian Export to the US", *Journal of Asian Economics*, vol.14: pp. 35-50.

Damijan, J.P. and Rojec, M. (2007), "Foreign direct investment and the catching-up process in the new EU member states: Is there a flying geese pattern?", *Applied Economics Quarterly*,

vol. 53:pp. 91-118.

Damijan, J.P. and Rojec, M. (2008), "Relocation via foreign direct investment from old to new EU member states: Scale and structural dimension of the process", *Structural Change and Economic Dynamics*, vol.19: pp. 53-65.

Davis, R. (1995), "Intra-industry trade: a Heckscher–Ohlin–Ricardo approach", *Journal of International Economics*, vol.39:pp.201-226.

Davidson, R. and MacKinnon, J. (1993), *Estimation and inference in econometrics*, Oxford University Press, New York.

Deardorff, A. (2007), "The Ricardian model", University of Michigan, available at: http://www.fordschool.umich.edu/rsie/workingpapers/Papers551-575/r564.pdf

Deng, P. (2004), "Outward investment by Chinese MNCs: Motivations and implications", *Business Horizons*, vol. 47: pp. 8–16.

Deng,P.(2007),"Investing for strategic resources and its rationale: The case of outward FDI from Chinese companies", Business Horizons, vol.50: pp.71-78.

Dent, C.M. and Randerson, C.(1996), "Korean foreign direct investment in Europe: The determining forces", The Pacific Review, vol.9: pp. 531-552.

De Hoyos, R., and Sarafidis, V. (2006). "Testing for cross-sectional dependence on panel-data models", The Stata Journal, vol.6: pp. 482-496.

Di Maio, M., Tamagni, F. (2008), "The Evolution of World Export Sophistication and the Italian Trade Anomaly," *Rivista di Politica Economica*, vol. (98).pp: 135-174.

Dimaranan, B., Ianchovichina, E. and Martin, W. (2007), "China, India, and the future of the world economy: Fierce competition or shared growth?", The World Bank Policy Research Paper 4304, World Bank, Washington, DC.

Dornbusch, R. and Park.Y.C.(1987), "Korean growth policy", Brooking Papers on Economic activity, vol.2:pp.389-444.

Dornbusch, R., Fisher.S.and Samuelson.P.A. (1977), "Comparative advantage, trade and payments in a Ricardian model with a continuum of goods", American Economic Review, vol. 67: pp.823-839.

Dosi, G., Pavitt, K. and Soete, L. (1990), The economic of technical change and international trade, New York University Press.

Dowling, M. and Cheang, C.T.(2000), "Shifting comparative advantage in Asia: new tests of the "flying geese" model", Journal of Asian Economics, vol.11: pp. 443-463.

Driscoll, J.C., and Kraay.A.C.(1998),"Consistent covariance matrix estimation with spatially dependent panel data", Review of Economics and Statistics, vol.80: pp.549-560.

Drukker, D.M.(2003), "Testing for serial correlation in linear panel-data models", Stata Journal, vol.2:pp. 1-10.

Du, X. and Hayes, D. (2009), "The impact of ethanol production on US and regional gasoline markets", Energy Policy, vol. 37:pp.3227-3234

Dunning, J.H.(1980),"Toward an eclectic theory of international production: Some empirical tests", Journal of International Business Studies, vol.11: pp. 9–13.

Dunning, J.H.(1988), *Explaining international production*, London, Unwin Hyman.

Dunning, J.H. (1993), Globalisation of business, London and New York, Routledge.

Dunning, J.H., Van Hoesel, R. and Narula.R. (1998), "Explaining the new wave of outward FDI from developing countries", International Business Review, Special Issue.

Eaton, J. and Kortum, S. (2002), "Technology, geography and trade", Econometrica, vol. 70:pp. 1741-1779.

Edwards, S.(1993), "Openness, trade liberalization and growth in developing countries," Journal of Economic Literature, vol.31: pp. 1358-1393.

Edwards,S.(1998),"Openness, productivity and growth: What do we really know?", Economic Journal, vol.108: pp. 383-398.

Edwards,L.and Golub,S. (2004),"South Africa's international cost competitiveness and productivity in manufacturing", World Development, vol.32: pp.1323-1339

Egan, M.L. and Mody, A. (1992), "Buyer-seller links in export development", World Development, vol.20:pp. 321-334.

Egger, P. and Pfaffermayr, M.(2001),"A note on labour productivity and foreign inward direct investment", Applied Economics Letters, vol.8: pp. 229-232

Egger, P. and Raff, H. (2010), "Tax rate and tax base competition for foreign direct investment", available at

http://www.ecpol.vwl.unimuenchen.de/downloads/publis/dischinger publis/egger raff mar2010.pdf

Elmawazini, K., Manga, P.and Saadi, S. (2008), "Multinational enterprises, technology diffusion, and host country absorptive capacity: A note", Global Economic Review, vol.37:pp.379 -386.

Enders, W. (2004), Applied econometric time series, 2nd edition, Wiley.

Enos, J. (1989), "Transfer of technology". *Asian-Pacific Economic Literature*, vol.3.pp: 3–37. Enos, J., Lall, S and Yun, M. (1997), "Transfer of Technology- an update", *Asian-pacific economic literature*, vol(11): pp.56-66.

Falvey, R.E. (1979), "Specific factors, comparative advantage and international investment: an extension", *Economica*, vol.46: pp.77–82.

Falvey, R., Greenaway, D., Yu, Z. and Gullstrand, J.(2004), "Exports, restructuring and industry productivity growth", Research Paper 2004/40. Nottingham: University of Nottingham.

Farrell, R., Gaston, N. and Sturm, J.E.(2004), "Determinants of Japan's foreign direct investment: an industry and country panel study, 1984-1988", *Journal of the Japanese and International Economics*, vol.18: pp.161-182.

Feenstra, R. (2004), Advanced international trade: Theory and evidence, Princeton University Press.

Feenstra, R. and G. Hanson.(1996), "Foreign investment, outsourcing and relative wages", in Feenstra R, Grossman,G and Irwin, D, (editors)., *Political economy of trade policy: essays in honor of Jadish Bhagwati*, MIT Press, Cambridge, pp. 89-127.

Fergusson, D.G.(1978), "International capital mobility and comparative advantage: the two-country, two-factor case", *Journal of International Economics*, vol. 8:pp.373-396.

Fernandez-Arias, E. and Hausmann, R. (2001), "Is foreign direct investment a safer form of financing?", *Emerging Markets Review*, vol. 2: pp. 34-49.

Fiaschi, D. and Signorino, R. (2003), "Consumption patterns, development and growth: Adam Smith, David Ricardo and Thomas Robert Malthus", *European Journal History of Economic Thought*, vol. 10:pp.15–24.

Findlay, R. (1978), "Some aspects of technology transfer and direct foreign investment", *American Economic Review*, vol. 68: pp. 275-79.

Findlay, R. (1980), "The terms of trade and equilibrium growth in the world economy", American *Economic Review*, vol.70: pp. 291-299.

Fleisher, B., Li, Haizheng. And Zhao, M.Q. (2010), "Human capital, economic growth and regional inequality in China.", Journal of Development Economics, vol.92: pp. 215-231

Fontagné, L., Gaulier, G., Zignago, S. (2008), "Specialization across varieties and North-South competition", *Economic Policy*, vol. 23: pp.51-91.

Frobel, F., J, Heinrichs J. and Kreye, O.(1980), "The new international division of labour", Cambridge UK, Cambridge University Press.

Fransman, M. (1986), technology and economic development, London: Mcmillan Press.

Frynas, J. G. and Paolo, M. (2007), "A new scramble for African oil? Historical, political, and business perspectives", *African Affairs*, vol.106: pp. 229-251.

Gaisford, J.D. (1999), "Asymmetric effects of endowment changes on foreign direct investment source and host countries", Canadian *Economics Journal*, vol. 24: pp. 940-957.

Gancia, G.and Bonfiglioli, A. (2008), "North-South trade and directed technical change," *Journal of International Economics*, vol.76:pp.276-295.

Gaulier, G., Lemoine, F. and Ünal-Kesenci, D. (2007), "China's emergence and the reorganisation of trade flows in Asia," *China Economic Review*, vol. 18: pp. 209–243.

Garcia-Herrero, A and Koivu, T (2008), "China's exchange rate policy and Asian trade", *Economie Internationale*, vol.116:pp.53-92.

Gereffi, G.(1999), "International trade and industrial upgrading in the apparel commodity chain", *Journal of International Economics*, vol. 48:pp.37–70.

Geroski, P. A. (1979), "Direct foreign investment by Kiyoshi Kojima source", *The Economic Journal*, vol. 89: pp. 162-164.

Gholami, R., Lee, S.Y and Hesmati, A. (2006), "The causal relationship between information and communication technology and foreign direct investment", *The World Economy*, vol. 29: pp. 43-62.

Gilbert.J. and Oladi, R. (2007) "Capital specificity, imperfect labour mobility and growth in developing economies", *International Review of Economics and Finance*, vol.18: pp.113-122.

Giljum, S., Behrens, A., Hinterberger, F., Lutz, C. and Meyer, B. (2008), "Modelling scenarios towards a sustainable use of natural resources", *Europe Environmental Science & Policy*, vol.11 :pp. 204-216

Ginzberg, A. and Simonazzi, A. (2005), "Patterns of industrialization and the flying geese model: the case of electronics in East Asia", *Journal of Asian Economics*, vol.15: pp. 1051–1078.

Girma, S., Greenaway, D., Kneller, R., 2003. Export market exit and performance dynamics: A causality analysis of matched firms, *Economics Letters*, vol. 80 :pp. 181–187.

Glass, A. J. and Saggi. K. (1998), "International technology transfer and the technology gap", *Journal of Development Economics*, vol. 55: pp. 369-398.

Glass, A.J. and Saggi.K. (2002), "Multinational Firms and Technology Transfer", *Scandinavian Journal of Economics*, vol. 104:pp. 495-513.

Glass, A. J. and Saggi. K.(2008), "International technology transfer: the role of foreign direct investment", in Dutt, A. and Ros, J. (editors), *International Handbook of Development Economics*, Edward Elgar, Cheltenham, pp.137-150.

Globerman, S. (1979), "Foreign direct investment and `spillover' efficiency benefits in Canadian manufacturing industries", *Canadian Journal of Economics*, vol. 12:pp. 42-56.

Goldberg, L.S. and Klein, M.W. (2001), "International trade and factor mobility: An empirical investigation", in Guillermo. A. Obstfeld, M. and Dornbusch, R. (editors), *Money, Capital Mobility, and Trade Essays in Honor of Robert A. Mundell*, MIT Press, 2001, pp. 273-302.

Goldstein, M., Mathieson, D.J. and Lane, T.(1991), "Determinants and systemic consequences of international capital flows", IMF Occasional Paper No. 77.

Golub, S.S. (1995), "Comparative and absolute advantage in the Asia-Pacific region. Pacific Basin", Working Paper Series PB 95-09, Federal Reserve Bank of San Francisco, San Francisco.

Golub, S.S. (1998), "Does Trade with Low-Wage Countries Hurt American Workers?", in King, P. (editor), *International Economics and International Economic Policy: A Reader*, pp.132-142.

Golub, S.S. (1999), Labor Costs and International Trade, Washington: American Enterprise Institute.

Golub, S.S and Hsieh. C.T, (2000), "The Classical theory of comparative advantage revisited", *Review of International Economics*, vol. 8: pp. 221-234.

Golub ;S.S., Jones, R.W. and Kierzkowski, H.(2007), "Globalization and country-specific service links", *Journal of Economic Policy Reform*, vol.10: pp. 63 – 88.

Görg, H. and Greenway, D.(2004), "Much ado about nothing? do domestic firms really benefit from foreign direct investment", *World Bank Research Observer* 19, 171–197.

Gorg, H. and Strobl, E. (2000), "Multinational Companies and Productivity Spillovers: A Meta-Analysis with a Test for Publication Bias," Centre for Research on Globalisation and Labour Markets, Research Paper 17.

Gorg, H. and Strobl, E. (2001), "Multinational companies and productivity spillovers: A Meta-analysis," *Economic Journal*, vol. 111: pp.723-739.

Griliches, Z.(1994), "Productivity, R&D, and the data constraints", *American Economic Review*, vol.84: pp. 1-23.

Greene, W.H. (2003) Econometric Analysis, Prentice Hall, Upper Saddle River, NJ (2003).

Grossman, G. and Helpman, E. (1991), *Innovation and growth in the global economy*, Cambridge, MA: MIT.

Grossman, G. and Helpman, E.(1995), "Technology and trade" in Grossman, G. and Rogoff, K.(editors), *Handbook of International Economics*, Vol. 3 (Amsterdam: North Holland), pp. 1279-1337.

Grossman, G. and Levinsohn, J. (1989), "Import competition and the stock market return to capital", *American Economic Review*, vol.79: pp. 1065–1087.

Grünfeld, L.(2006), "Multinational production, absorptive capacity, and endogenous R&D spillovers", *Review of International Economics*, vol.14:pp. 922-940

Guariglia, A. and Poncet, S.(2008), "Could financial distortions be no impediment to economic growth after all? Evidence from China," *Journal of Comparative Economics*, vol. 36: pp.633-657.

Guariglia, A. and Santos-Paulino, A.U. (2008), "Export productivity, finance, and economic growth: Are the Southern engines of growth different?,", Working Papers RP2 008/27, World Institute for Development Economic Research (UNU-WIDER).

Gujarati, D. (2004), Basic Econometrics, 4th edition, The McGraw-Hill Company.

Hannah, L., Kim, K. H. and Mills, E.S. (1993), "Land use controls and housing prices in Korea", *Urban Studies*, vol. 30: pp.147–156.

Hanson, G H., Mataloni, R. J. and Slaughter M.J.(2001), Expansion strategies of U.S. multinational firms, in Rodrik D. and Collins S. (eds.), *Brookings Trade Forum 2001*, pp. 245-294.

Hanson, G H., Mataloni, R. J. and Slaughter M.J.(2003), "Vertical production networks in multinational firms", NBER Working Paper No. 9723.

Harding, T., and Javorcik, B.S.(2007), "The effect of FDI on export diversification in Central and Eastern Europe", note for the trade policy conference "Export Growth and Diversification: Pro-active Policies in the Export Cycle", World Bank, 2007

Harrigan, J. (1997), "Technology, Factor Supplies, and International Specialization: Estimating the Neoclassical Model", *American Economic Review*, vol. 87:pp.475-494.

Harrigan, J. (2003), "Specialization and the Volume of Trade: Do the Data Obey the Laws?" in Choi, K. and Harrigan, J. (editors), *The Handbook of International Trade*, Basil Blackwell, London, UK, pp.85-118.

Hatzius, J. (2000), "Foreign direct investment and factor demand elasticities", *European Economic Review*, vol.44:pp.117-1143.

Hausmann, R. and Klinger, B. (2008), "South Africa's export predicament", *The Economics of Transition*, vol. 16: pp.609-637

Hausmann, R., Hwang, J. and Rodrik, D. (2007), "What you export matters", *Journal of Economic Growth*, vol.12: pp. 1-25

Havrylchyk, O. and Poncet, S. (2007), "Foreign direct investment in China: reward or remedy", World Economy, vol. 30: pp. 1662-1681.

Helleiner, G. (1989), "Transnational corporations and direct foreign investment", in Chenery, H., Srinivasan, T.N. (editors), *Handbook of Development Economics*, Vol. 2. North-Holland, Amsterdam, pp. 1341–1480.

Helpman, E. (1984), "A simple theory of trade with multinational corporations", *Journal of Political Economy*, vol.92:pp.451-471.

Helpman, E. (1985), "Multinational corporations and trade structure", *Review of Economic Studies*, vol.52:pp.443-458.

Helpman, E. and Krugman, P.(1985), Market Structures and Foreign Trade, MIT Press, Cambridge.

Hericourt, J. and Poncet, S.(2009), "FDI and credit constraints: Firm-level evidence from China", *Economic Systems*, vol. 33: pp.1-21.

Hering L. and Poncet, S (2009), "Direct and indirect impact of economic geography on wages", *China Economic Review*, vol.20: pp.1-14.

Hicks, R. (1973), "The mainspring of economic growth", *Swedish Journal of Economics*, vol.75:pp.336-348.

Hicks, R. (1981), "The mainspring of economic growth", American Economic Review, vol.71:pp.23-29.

Hicks, R. (1974), "The future of industrialism", International Affairs, vol. 50: pp. 218-229.

Hiley, M. (1999), "Industrial restructuring in ASEAN and the role of Japanese foreign direct Investment", *European Business Review*, vol.99: pp.80-90.

Ho, P.Sai-Wing.(1992), "A Ricardian interpretation of the provision of public housing services in Hong Kong", *Cambridge Journal of Economics*, vol. 16: pp. 207-225.

Ho, P.Sai-Wing.(1995), "A non-tradable wage good in a Ricardian model", *Metroeconomica*, vol.46: pp. 178–192.

Hobday, M. (1995), Innovation in East Asia, Edward Elgar Publishing Ltd., Hants, England.

Hoechle, D.(2007), "Robust standard errors for panel regressions with cross-sectional dependence", *The Stata Journal*, vol.7:pp. 281-312.

Hoekman, B.R., Maskus, K.E. and Saggi, K (2005), "Transfer of technology to developing countries: Unilateral and multilateral policy options", *World Development*, vol.33: pp. 1587–1602.

Hollande, M., Porcile, G. (2005), "Brecha Tecnologica y Crescimiento en America Latina", in Cimoli, M. (editor), *Heterogeneidad Estructural, Asimetrias Tecnologicas y Crecimiento en America Latina*, UN Publication, Santiago de Chile, pp. 40-63.

Holland, M., Porcile. G. and Cimoli, M. (2006) Technological Asymmetries, Convergence and Divergence in a Model with a Continuum of Goods, *Nova Economia*, São Paulo School of Economics, Getulio Vargas Foundation.

Hong, E. and Sun, L. (2006), "Dynamics of internationalization and outward investment: Chinese corporations' strategies", *The China Quarterly*, vol.187: pp. 610-634.

Horstmann, I.J., and Markusen, J.R. (1987), "Strategic investments and the development of multinationals", *International Economic Review*, vol. 28:pp.109-121.

Horstmann, I.J., and Markusen, J.R. (1992), "Endogenous market structures in international trade", *Journal of International Economics*.vol.20:pp. 225-247.

Hosseini, H. (2005), "An economic theory of FDI: A behavioural economics and historical approach", *The Journal of Socio-Economics*, vol.34:pp.528–541.

Hui, E-C. and Ho,V.S-M. (2003), "Does the planning system affect housing prices? Theory and with evidence from Hong Kong", *Habitat International*, vol.27: pp. 339–359.

Hutzschenreuter, T. and Gröne, F. (2009), Product and geographic scope changes of multinational enterprises in response to international competition, *Journal of International Business Studies*, vol.40:pp.1149-1170.

Hymer, S. (1976). *The International Operations of National Firms: A Study of Direct Foreign Investment*, Cambridge: MIT Press.

International Energy Agency 2007. World Energy Outlook 2007.

Inada, K. and Kemp, M.C. (1969), "International Capital Movements and the theory of tariffs and trade", *Quarterly Journal of Economics*, vol.81:pp.1-38.

Itoh, M. and Kiyono, K. (1987), "Welfare enhancing exports subsidies", *Journal of Political Economy*, vol. 95: pp.115-132.

Jarreau, J.and Poncet, S. (2009), "Export Sophistication and Economic Performance: Evidence from Chinese Provinces", CEPII Working Paper, N°2009-34

Jenkins, R. and Edwards, C. (2006), "The economic impacts of China and India on sub-Saharan Africa: Trends and prospects", *Journal of Asian Economics*, vol. 17: pp.207–225.

Jensen, C. (2002), 'Foreign direct investment, industrial restructuring and the upgrading of polish exports', *Applied Economics*, 34 (2), pp. 207–217.

Jiang, W.(2009), "Fuelling the Dragon: China's Rise and Its Energy and Resources Extraction in Africa", *The China Quarterly*, 199:pp. 585-609.

Jones, R. W. (1967), "International capital movements and the theory of tariffs and trade", *Quarterly Journal of Economics*, vol. 81:pp.1-38.

Jones R. W. (1971) "A Three-Factor Model in theory, Trade and History", in J. Bhagwati ed. *Trade, Balance of Payments and Growth*, Essays in Honor of C.P. Kindleberger, North Holland, Amsterdam.

Jones, R.W.(1979), "Technical progress and real income in a Ricardian trade model". in ch. 17 Jones, R, *International trade: Essays in Theory*, North-Holland, Amsterdam.

Jones, R.W. (1980), "Comparative and absolute advantage", *Swiss Journal of Economics and Statistics*, vol.3:pp.235-260.

Jones, R.W. (1994), "Trade and capital mobility: A Ricardian setting", *Nagasaki prefecture University Review*, vol.28:pp.77-89.

Jones, R.W.(2000), Globalization and the theory of input trade, MIT Press, Cambridge, MA.

Jones, R.W.(2008a), "Key international trade theorems and large shocks", *International Review of Economics and Finance*, vol.17: pp. 103-112.

Jones, R.W.(2008b), "Technology and income distribution issues in trade models", *CESifo Economic Studies*, vol.54, 551-562.

Jones R.W. and Ruffin R.J. (2008) "The technology transfer paradox", Journal of International Economics, vol. 75:pp. 321-328

Ju, J. and Yang, X.(2009), "Hicks theorem: Effects of technological improvement in the Ricardian model", *International Review of Economics & Finance*, vol. 18: pp. 239-247

Kabiraj T. and Marjit, S. (2003), "Protecting consumers through protection: the role of tariff-induced technology transfer", *European Economic Review*, vol.47:pp.113-124.

Kalotay, K.(2004), "The European flying geese: New FDI patterns for the old continent?", *Research in International Business and Finance*, vol. 18: pp.27 - 49.

Kaplinsky, R.(2006), "Revisiting the revisited terms of trade: Will China make a difference?", World Development, vol.34: pp. 981-995.

Kant, R. (2008), "The rise of TNCs from emerging markets: challenges faced by firms from India", in Sauvant, K. (editors), The *Rise of Transnational Corporations from Emerging Markets: Threat or Opportunity?*, Edward Elgar

Keller, W. (1998), "Are international R&D spillovers trade related? Analyzing spillovers among randomly matched trade partners", *European Economic Review*, vol. 42: pp. 1469–1481.

Keller, W. (2000), "Do trade patterns and technology flows affect productivity growth?," *World Bank Economic Review*, vol.14: pp. 17–47.

Keller, W.(2004), "International technology diffusion", *Journal of Economic Literature*, vol. 42: pp. 752–782. Reprinted in Greenaway, D., Görg, H. and Kneller, R(editors.), *Globalization and Productivity*, Edward Elgar Publishing Ltd, Cheltenham, UK

Keller, W.(2008a), "Transfer of technology", in Blume, L. and Durlauf, S, New Palgrave Dictionary of Economics, 2<sup>nd</sup> edition, Macmillan.

Keller, W.(2008b), "Diffusion of technology", in Blume, L. and Durlauf, S.(editors), *New Palgrave Dictionary of Economics*, 2<sup>nd</sup>, Macmillan.

Keller, W.and Acharya, R. (2009), "Technology transfer through imports", *Canadian Journal of Economics*, vol. 42:pp. 1411-1448.

Keller, W. (2010), "International trade, foreign direct investment, and technology spillovers", in Hall, H. and Rosenberg, N. (editors), *Handbook of the Economics of Innovation*,

Elsevier, North-Holland, forthcoming

Keller, W., and Yeaple, S. (2009), "Gravity in the weightless economy", NBER Working Paper No. 15509. Kemp, M.C. (1962), "Foreign direct investment and the national advantage", *Economic Record*, vol.38:pp.56-62.

Kemp, M.C.(1966), "The gain from international trade and investment: A neo-Heckscher-Ohlin approach", *American Economic Review*, vol.56:pp.788-809.

Kemp, M.C. (1969), *The Pure Theory of International Trade and Investment*. Prentice-Hall, Englewood Cliffs.

Kendix, M and Walls, W.D (2010), "Estimating the impact of refinery outages on petroleum product prices" *Energy Economics*, forthcoming

Kennedy, P.(2003), A Guide to Econometrics, Fifth Edition, MIT Press, MA.

Khang,C.(1968), "A neoclassical growth model of a resource-poor open economy", *International Economic Review*, vol.9: pp.329-338.

Khang, C.(1970), "A generalized Ricardian growth model", Metroeconomica, vol.22: pp. 193–206.

Kim, T-H.(1999), "International trade, technology transfer, growth, and welfare in a Schumpeterian model of endogenous growth", *Review of International Economics*, vol.7: pp. 37-49.

Kindelberger, C.P. (1969), American Business Abroad: Six Lectures on Direct Investment, Yale University Press: New Haven.

Kojima, K.(1973),"A macroeconomic approach to foreign direct investment", *Hitotsubashi Journal of Economics*, vol.16: pp. 1-21

Kojima, K (1975), "International Trade and Foreign Direct Investment: Substitutes or. Complements," *Hitotsubashi Journal of Economics*, vol.16: pp. 1-12

Kojima, K.(1977a), "Transfer of technology to developing countries: Japanese type versus. American type", *Hitotsubashi Journal of Economics*, vol.17: pp.1-14

Kojima, K.(1977 b), "Japan and a new world economic order", Croom Helm London

Kojima,K.(1978), Direct foreign investment: a Japanese model of multinational business operations, Groom Helm London

Kojima, K. (1982), "Macroeconomic versus international business approach to direct foreign investment", *Hitotsubashi Journal of Economics*, vol.23: pp. 1-19

Kojima, K.(1990), *Japanese Direct Investment Abroad*. International Christian University. Social Science Research Institute Monograph Series 1. Mitaka, Tokyo.

Kojima,K.(1991),"Trade-oriented direct foreign investment reconsidered", *Asian Economic Journal*, vol.5 : pp.259 -274

Kojima,K.(2000), "The flying geese model of Asian economic development: origin, theoretical extensions, and regional policy implications", *Journal of Asian Economics, vol.* 11: pp. 375-401.

Kojima, K. and Ozawa, T.(1984)<sup>4</sup> Micro and macro economic models of direct foreign investment: toward a synthesis<sup>2</sup>, *Hitotsubashi Journal of Economics*, vol.25: pp. 1-20

Kojima, K. and Ozawa, T. (1985), "Toward a theory of industrial restructuring and dynamic comparative advantage", *Hitotsubashi Journal of Economics, vol.* 26: pp.135-145

Kokko, A.(1994), "Technology, market characteristics and spillovers", *Journal of Development Economics*, vol.43: pp. 279-293.

Kokko, A. (1996), "Productivity spillovers from competition between local firms and foreign affiliates", *Journal of International Development*, vol. 8: pp. 517-530.

Kokko, A., Tansini, R. and Zejan.M. (1996), "Local technological capability and productivity spillovers from FDI in the Uruguayan manufacturing sector", *Journal of Development Studies*, vol. 32:pp. 602-611.

Kokko, A., Tansini, R. and Zejan.M. (2001), "Trade regimes and spillover effects of FDI: Evidence from Uruguay", *Weltwirtschaftliches Archiv*, vol. 137: pp. 124-149.

Kopits,G.F.(1976), "Intra-firm royalties crossing frontiers and transfer pricing behavior", *The Economic Journal*, vol. 86:pp. 791-805.

Korhonen, P. (1994), "The theory of the flying geese pattern of development and its interpretations", *Journal of Peace Research*, vol.31:pp. 93.108.

Kraay, A., (1997)," Exports and economic performance: Evidence from a panel of Chinese enterprises", Working Paper.World Bank, Washington, DC.

Krugman, P.(1979), "A model of innovation, technology transfer, and the world distribution of income", *Journal of Political Economy*, vol.87:pp.253-266.

Krugman, P.(1986), "A 'technology gap' model of international trade," in Jungenfelt,k and Hague,D. (editors.), *Structural Adjustment in Advanced Economies*, London : Macmillan, pp. 35-49 / reprinted as Ch. 10 in Krugman (1994), *Rethinking International Trade*, MIT Press, Cambridge.

Krugman, P.(2000),. "Fire-Sale FDI," NBER Chapters, in: Capital Flows and the Emerging

Economies: Theory, Evidence, and Controversies, pp 43-60.

Krugman, P. and Obstfeld, M. (2005), *International economics: Theory and policy*, 7th edn, Boston: Addison Wesley

Kumakura, M.(2007), "What's so special about China's exports? A comment", *China &World Economy*, vol. 15:pp. 18–37.

Kumar, N. and Chadha,A.(2008), "India's outward foreign direct investments in steel industry in a Chinese comparative perspective", United Nations University - Maastricht Economic and social Research and training centre on Innovation and Technology

Lall, S.(2000), "The technological structure and performance of developing country manufactured exports, 1985-1998", *Oxford Development Studies*, vol.28.

Lall, S., Weiss, J. and Zhang, J. (2006), "The 'sophistication' of exports: A new trade measure", *World Development*, vol.34:pp. 222-237.

Laussel, D., Michel, P. and Paul, T. (2004), "Intersectoral adjustment and unemployment in a two-country Ricardian model", *Louvain Economic Review*, vol. 70: pp. 169-192.

Larudee, M. and Koechlin, T.(1999), "Wages, productivity, and foreign direct investment flows", *Journal of Economic Issues*, vol.33:pp. 419-426.

Lee,C.H.(1984),"On Japanese macroeconomic theories of direct foreign investment", *Economic Development and Cultural Change*, vol.32:pp713-723

Lee, C.H. (1990), "Direct foreign investment, structural adjustment, and international division of labour: a dynamic macroeconomic theory of direct foreign investment", *Hitotsubashi journal of economic*, vol. 31pp: 61-72.

Lee, C.H. and Ogawa, K.(1995), "Returns on capital and outward direct foreign investment: the case of six Japanese industries", *Journal of Asian Economics*, vol.6: pp.437-467

Lemoine, F. and Unal-Kesenci, D.(2008), "Rise of China and India in international trade: From textiles to new technology", *China & World Economy*, vol. 16: pp 16-34.

Lewis, W. A. (1954). "Economic development with unlimited supplies of labour", *The Manchester School*, vol. 22: pp. 139–191.

Li, M.(2007), "Trade, technological progress, and inequality: theory and evidence from China", University of Wisconsin-Madison

Lii, S.Y.(1994), "Japanese direct foreign investment and trade flows in the Asia-Pacific region", Asian Economic Journal, vol.8:pp. 181-203

Linnemann, H.(1977), "Natural resources and economic growth", De Economist, vol.125:pp. 465-483.

Linnemann, H, Dijck, P. and Verbruggen, H.(1987), "Export-oriented industrialization in developing countries", Council for Asian Manpower Studies, Singapore University Press.

Li H., Huang, P. and Li, J.(2007), "China's FDI net inflow and deterioration of terms of trade: Paradox and explanation", *China & World Economy*, vol.15

Lipsey, R.E.(1999), "Affiliates of U.S. and Japanese multinationals in east Asian production and trade", NBER working paper; n°: 7292

Lipsey, R.E.(2004), "Home-and host-country effects of foreign direct investment", in Baldwin, R.E and Winters, L.A (editors.), *Challenges to Globalization*, Chicago: University of Chicago Press. pp 333-382.

Liu, X. and Wang,C.(2003), "Does foreign direct investment facilitate technological progress? evidence from Chinese industries", *Research Policy*, vol.32:pp.945–953.

Liu, X., Siler, P., Wang, C. and Wei, Y.(2000); "Productivity spillovers from foreign direct investment: Evidence from UK industry level panel data", *Journal of International Business Studies*, vol. 31: pp. 407-425.

Liu X., Parker D., Vaidya K. and Wei Y.(2001), "The impact of foreign direct investment on labour productivity in the Chinese electronics industry", *International Business Review*, vol. 10:pp 421-439.

Lu,C.(2005), "Foreign direct investment and the degree of southern penetration", *working paper*, Academia Sinica.

Lu, C.(2007), "Moving up or moving out? A unified theory of R&D, FDI and trade", *Journal of International Economics*, vol. 71:pp. 324-343

Lucas, R.E.(1988), "On the mechanics of economic development", Journal of Monetary Economics, vol.22:pp.3 - 42.

Lumenga-Neso, O., Olarreaga, M. and Schiff, M.(2005), "On indirect trade-related research and development spillovers", *European Economic Review*, vol.49:pp.1785–1798.

MacDougall, G.(1951), "British and American Exports: A Study Suggested by the Theory of Comparative Costs", *Economic Journal*, pp. 697.724.

Madariaga, N. and Poncet, S. (2007), "FDI in China: spillovers and impact on growth", *The World Economy*, vol. 30:pp. 837-862.

Maizels, A.(2000), "The manufactures terms of trade of developing countries with the United States, 1981-1997", QEH Working Paper series, QEHWPS36, Oxford university,

Maizels, A., Palaskas, T.B. and Crowe, T.(2002), "New evidence on the North-South terms of trade", in Sapsford, D. and Chen, J.R (editors.), *Development Economics and policy : The conference to celebrate the 85 th birthday of Professor Hans Singer*, Mc Millan.

Makki, S.S. and Somwaru, A.(2004), "Impact of foreign direct investment and trade on economic growth: evidence from developing countries", *American Journal of Agricultural Economics*, vol.86:pp.795-801

Manning, C. (2002), "Structural change, economic crisis and international labour migration in East Asia", *The World Economy*, vol.25:pp.359-385

Mansfield, E.D. and Reinhardt, E.(2008), "International institutions and terms of trade volatility", available at

http://econ.snu.ac.kr/m8/paper/International%20Institutions%20and%20Terms%20of%20Trade%20Volatility.pdf

Marin, D., Lorentowicz, A. and Raubold, A.(2003): "Ownership, Capital or Outsourcing: What Drives German Investment in Eastern Europe?", in Herrmann, H. and Lipsey, R. (editors), *Foreign Direct Investment in the Real and Financial Sector of Industrial Countries*, Springer Verlag, Heidelberg, pp.147-163.

Marjit, S. and Beladi, H.(2009), "Is trade in technology superior to trade in goods?", *Bulletin of Economic Research*, vol.61:pp.195-200.

Markusen, J.R. (1983), "Factor movements and commodity trade as complements", *Journal of International Economics*, vol.14:pp. 25-43.

Markusen, J.R. (1984), "Multinationals, multi-plant economies, and the gains from trade", *Journal of International Economics*, vol. 16:pp. 205-226.

Markusen.J.R.(1995), "The boundaries of multinational Enterprises and the theory of international trade", *Journal of Economic Perspective*, vol.9:pp.169-189.

Markusen, J.R. (1997), "Trade versus Investment Liberalization", NBER working paper 6231.

Markusen, J.R. (2002), Multinational firms and the theory of international trade. Cambridge: MIT Press.

Markusen, J.R.and Maskus, K.E. (2002), "Discriminating among Alternative Theories of the Multinational Enterprise", *Review of International Economics*, vol.10:pp.694-707.

Markusen, J.R. and Maskus, K.E. (2003), General equilibrium approaches to the multinational Enterprise: a review of theory and evidence, in Choi K. and Harrigan, J.(editors), *Handbook of international trade* 

Markusen, J.R. and Svensson, L. (1985), "Trade in goods and factors with international differences in technology", *International Economic Review*, vol. 26:pp.175-192.

Markusen, J.R. and Venables, A.J. (1998), "Multinational firms and the new trade theory", *Journal of International Economics*, vol.46: pp.183-203.

Markusen, J.R. and Venables, A.J. (1999), "Foreign direct investment as a catalyst for industrial development", *European Economic Review*, vol.43: pp.335 – 356.

Markusen, J.R. and Venables, A.J. (2000), "The theory of endowment, intra-industry and multinational trade", *Journal of International Economics*, vol.52:pp.209-234.

Martínez-Zarzoso, I., Nowak-Lehmann D., F. and Horsewood, N.(2009), "Regional trading agreements beneficial? static and dynamic panel gravity", *North American Journal of Economics and Finance*, vol.20:pp.46-65.

Maskus, K.E., and A.Webster.(1995), "Comparative advantage and the location of inward foreign direct investment: evidence from the UK and South Korea", *The World Economy*, vol.18:pp.315-328.

Matsuyama, K. (1992),"Agricultural productivity, comparative advantage and economic growth", *Journal of Economic Theory*, vol. 58: pp. 317-334,

Matsuyama, K. (2000),"A Ricardian Model with a Continuum of Goods under Nonhomothetic Preferences: Demand Complementarities, Income Distribution and North-South Trade," *Journal of Political Economy*, vol.108. pp:1093-1120.

Matsuyama, K.(2007), "Ricardian trade theory", in L. Blume and S. Durlauf, eds., *the New Palgrave Dictionary of Economics*, 2nd Edition, Macmillan.

Mayer, W. (1974), "Short-run and long-run equilibrium for a small open economy", *Journal* of *Political Economy*, vol.82:pp.955-967.

Mbaye, A. A. and Golub, S. (2002), "Unit labor costs, international competitiveness and exports: The case of Senegal", *Journal of African Economies*, vol.11: pp. 219-248.

McCombie, J.S.L and Thirlwall A. (1994), *Economic growth and the balance of payments constraint*, New York: St. Martin Press.

Melvin, J. R. (1995), "Trade and investment with constant and increasing returns to scale", *Canadian Journal of Economics*, vol. 28:pp. 24-45.

Merryman, S. (2005), "XTFISHER: Stata module to compute Fisher type unit root test for panel data", Statistical Software Component No. S448201, Boston College Department of Economics.

Meyer, K.(1995), "Direct foreign investment in Eastern Europe: The role of labour costs", *Comparative Economic Studies*, vol.37: pp. 69-88.

Ministry of Commerce of the People's Republic of China, 2006 Statistical Bulletin of China's Outward Foreign Direct Investment.

Minondo, A.(2009), "Exports' productivity and growth across Spanish regions", *Regional Studies*, pp.1360-0591.

Moenius, J.(2007), "Measuring comparative advantage: A Ricardian approach", working paper, University of Redlands, available at :

http://www.haveman.org/EITI07/moenius.pdf

MOFTEC'S Offshore Plant Project.(2000), "Inward flow should be accompanied by outward flow: Policy analyses of China's offshore plant operations", *International Trade* 5, 9–13 (in Chinese).

Molana, H. and Vines, D. (1989), "North-South growth and the terms of trade: A Model on Kaldorian lines", *Economic Journal*, vol.99:pp. 443-453.

Mollick, A.V., Faria, J.R. and Albuquerque.P. and León-Ledesma, M. (2008), "Can globalization stop the decline in commodities' terms of trade?", *Cambridge Journal of Economics*, vol.32:pp. 683–701.

Morck, R., Yeung, B. and Zhao, M. (2008), "Perspectives on China's outward foreign direct investment", *Journal of International Business Studies*, vol.39:pp.337-350.

Mowery, D.C., Rosenberg, N. (1989), *Technology and the Pursuit of Economic Growth*, Cambridge University Press, Cambridge.

Mussa, M. (1974), "Tariffs and the distribution of income: The importance of factor specificity, substitutability, and intensity in the short and long run", *Journal* of *Political Economy*, vol.82:pp.1191-1203.

Navaretti, G. B., Galeotti, M. and Mattozzi, A. (2004), "Moving skills from hands to heads: does importing technology affect export performance in textiles", *Research Policy*, vol.33:pp.879–895.

Nachum, L., Dunning J.H. and Jones, G.G. (2000), "UK FDI and the comparative advantage of the UK", *The World Economy*, vol.23:pp.701-720.

Neary, P.(1995), "Factor mobility and international trade", *Canadian Journal of Economics*, vol.28:pp. 4-23.

Negishi, T. (1982), "The labour theory of value in the Ricardian theory of international trade", *History of Political Economy*, vol. 14: pp.199-210.

Negishi, T.(1985), "Economic Theories in a non-Walrasian Tradition", Cambridge University Press.

Nesset, E.(2004), "Exports and productivity in a small open economy: a causal analysis of aggregate Norwegian data", *Journal of Policy Modeling*, vol. 26:pp.145-150.

Newey, W. K. and West, K.D. (1987), "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix", *Econometrica, vol.* 55:pp. 703-708

Nichols, A and Schaffer, M.(2007), Cluster Errors in Stata, paper presented at the 2007 UK

Stata Users Group meeting. download at: http://www.stata.com/meeting/13uk/nichols crse.pdf

Noorbakhsh, F., Poloni, A. and Youssef, F. (2001), "Human capital and FDI inflows to developing countries: New empirical evidence", *World Development*, vol. 9:pp. 1593-610.

Nunnenkamp, P. and Spatz, J. (2004), "FDI and Economic Growth in developing economies: How relevant are host-economy and industry characteristics?", *Transnational Corporations*, United Nations.

Obstfeld, M.and Rogoff, K.(1996), Foundations of international macroeconomics. Cambridge, MA: MIT Press.

Ocampo, J.A.(1993), "Terms of trade and center-periphery relations", in Sunkel, O. (editor), *Development from within: toward a Neostructuralist Approach for Latin America*, Boulder (CO) and London: Lynee Rienner Publishers., pp.333-357.

Ocampo, J.A. and Parra, M.A. (2006), "The commodity terms of trade and their strategic implications for development", in Jomo, K.S.(editor), *The Long Twentieth Century – Globalization Under Hegemony: The Changing World Economy*, Oxford University Press, New Delhi, pp. 164-194,

Okamoto, Y. and Sjöholm, F.(2005), "FDI and the dynamics of productivity in Indonesian manufacturing", *Journal of Development Studies*, vol. 41: pp. 160-182.

Okubo, T. (2009), "Firm heterogeneity and Ricardian comparative advantage within and across industries", *Economic Theory*, vol.38:pp. 533-559.

Onaran,O. and Stockhammer, E. (2008), "The effect of FDI and foreign trade on wages in the Central and Eastern European Countries in the post-transition era: A sectoral analysis for the manufacturing industry", *Structural Change and Economic Dynamics*, vol.19:pp. 66-80.

Oslington, P. (2000), "Japanese contribution to the theory of international trade", *Japanese economic Review*, vol.51:pp.334-348

Ozawa, T. (1971), *Transfer of technology from Japan to developing countries*, New York: United Nations Institute for Training and Research

Ozawa, T. (1975), "The Emergence of Japan's Multinationalism: Patterns and Competitiveness," Asian Survey, vol.15:pp. 1036–1053.

Ozawa, T. (1977), "Japan's resource dependency and overseas investment," *Journal of World Trade Law*, vol.11:pp. 52–73.

Ozawa, T.(1978), "Japan's multinational enterprise: the political economy of outward dependency", *World Politics*, vol. 30:pp.517-537

Ozawa,T.(1979a), "International investment and industrial structure: new theoretical implications from the Japanese experience", *Oxford Economic Papers*, vol.31:pp.72–92.

Ozawa, T. (1979b), *Multinationalism, Japanese style: The political economy of outward dependency*, Princeton: Princeton University Press.

Ozawa, T. (1980), "Japan's new resource diplomacy: government-backed group investment," *Journal of World Trade Law*, vol.14. pp. 3-13

Ozawa, T. (1982), "A newer type of foreign investment in third world resource development", *Rivista Internazionale di Scienze Economiche e Commerciali*, vol. 29:pp.1133-1151, Also reprinted in Bruce McKern (ed.), Readings in Transnational Corporations and the Natural Resource Industries, UNLTNC, London: Routledge, 1993.

Ozawa, T. (1990), "The '*Flying-Geese*' paradigm: toward a co-evolutionary theory of MNC-assisted growth", in Fatemi, K. (editor), *The new world order: internationalism, regionalism and the Multinational corporations*, Amsterdam & New York, pp. 209-223.

Ozawa, T.(1992), "Foreign direct investment and economic development", *Transnational Corporations*, vol.1:pp.27-54.

Ozawa, T.(1993), "Foreign direct investment and structural transformation: Japan as a recycler of market and industry, *Business and the Contemporary World*, vol.5:pp. 129–150.

Ozawa,T.(1996),"Japan:the Macro-IDP, meso-IDPs and the technology development path(TDP)", in Dunning, J. and Narula, R. (editors), *Foreign direct investment and Governments:Catalysts for economic Restructuring*, London: Routledge, pp. 142-173

Ozawa, T. (2001), "The "hidden" side of "Flying-Geese" catch-up model: Japan's dirigiste institutional set up and deepening financial morass", *Journal of Asian Economics*, vol. 12: pp. 471 - 491.

Ozawa, T. (2003), "Pax Americana-led Macro-clustering and Flying-geese style Catch-up in East Asia: Mechanisms of Regionalized Endogenous Growth", *Journal of Asian Economics*, vol. 13:pp. 699–713.

Ozawa,T.(2005), Institutions, industrial upgrading, and economic performance in Japan: The 'Flying-Geese' paradigm of catch-up growth, Cheltenham, U.K.: Elgar

Ozawa,T.(2007), "Professor Kiyoshi Kojima's contributions to FDI theory: trade, structural transformation, growth, and integration in East Asia", Columbia University

Ozawa,T.(2008), "History repeats itself: evolutionary structural change and TNCs' involvement in infrastructure overseas, flying-geese style". Background paper prepared for UNCTAD World investment report 2006.

Ozawa, T.(2009), The rise of Asia; the "Flying-geese" theory of tandem growth and regional agglomeration, Edward Elgar Publishing. 2009

Ozawa, T, and Castello., S. (2001), "Toward an 'International Business' Paradigm of Endogenous Growth: Multinationals and Governments as Co-Endogenisers." *International Journal of the Economics of Business*, vol.8 :pp. 211–228.

Pack, H and Saggi, K.(1997), "Inflows of Foreign Technology and Indigenous Technological Development," *Review of Development Economics*, vol.1:pp.81-98.

Pagan, A.(1984), "Model evaluation by variable addition", in Hendry, D.F and Wallis, K.F. (editors), *Econometrics and Quantitative Economics*, Blackwell: Oxford, chapter 5, pp.103-134.

Pamlin, D.and Long, B. (2007), China's outward investment flows, World Wildlife Fund.

Pavitt, K. (1985), "Technology transfer among the industrially advanced countries: an overview", in Rosenberg, N. and Frischtak, C. (editors.), *International Technology Transfer. Concepts, Measures and Comparisons*, Praeger Publishers, New York. pp. 3-23.

Pavcnik, N.(2002), "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants", *Review of Economic Studies*, vol.69: pp. 245-276.

Petersen, M. (2009), "Estimating standard errors in finance panel data sets: comparing approaches", *Review* of *Financial Studies*, vol.22: pp.435-480.

Pesaran, M. (2004), "General Diagnostic Tests for Cross Section Dependence in Panels?", *Cambridge Working Papers in Economics No. 0435* Faculty of Economics, University of Cambridge.

Poncet,S. (2004),"La dynamique des migrations intérieures en Chine : Frontières et forces centripètes", *Revue économique*, vol. 55 :pp. 623-632

Poncet, S. (2007), Inward and Outward FDI in China, Working paper at the Panthéon-Sorbonne-Economie, Université Paris I CNRS and CEPII, published at the homepage of the university Paris1:http://team.univparis1.fr/teamperso/sponcet/Perso/Book%20chapter%20Poncet%20April%2028%20 2007.pdf.

forthcoming In David Greenaway, Chris Milner and Shuyie Yao (editors), *China and the World Economy: consequences and challenges*, Palgrave. Londres, UK,

Poncet, S. and Hering, L.(2009), "Market access on individual wages: evidence from China", *Review of Economics and Statistics*, forthcoming.

Porcile, G. and Cimoli, M. (2007), "Tecnología, diversificación productiva y crecimiento: un modelo estructuralista", *Economia e Sociedade, Campinas*, vol. 16: pp. 289-310.

Porcile, G., Holland, M., Cimoli. M. and Rosas, L. (2006), "Especialización, tecnología y crecimiento en el modelo Ricardiano", *nova Economia Belo Horizonte*, vol. 16:pp. 483-506.

Prasad, E., Rogoff, K., Wei, S-J. and Kose, M.A. (2003), *The effects of financial globalization on developing countries: some empirical evidence*, International Monetary Fund Occasional Paper 220. Washington: International Monetary Fund.

Prebisch, R. (1950), *The economic development of Latin America and its principal problems*, New York: United Nations.

PRMED ( The Economic Policy and Debt Department (World Bank) ), (2009), EXPY database.

Pugel, T.A.(1982), "Endogenous technological change and international technology transfer in a Ricardian trade model", *Journal of International Economics*, vol.13:pp.321-335.

Purvis, D. D. (1972), "Technology, trade and factor mobility", Economic Journal, vol.82:pp. 979-999.

Qiu, L.(2003), "Comparing sectoral FDI incentives: comparative advantages and market opportunities", *Annals of Economics and Finance*, vol.4:pp. 383-408.

Quinn, J. B., (1969), "Technology transfer by multinational companies", *Harvard Business Review*, 147–161.

Qureshi, M.S. and Wan, G. (2008), "Trade expansion of China and India: Threat or opportunity", *World Development*, vol.31:pp.1327-1350.

Rahman, M. and Thorbecke, W. H. (2007), "How would China's exports be affected by a unilateral appreciation of the RMB and a joint appreciation of countries supplying intermediate imports?", RIETI Discussion Paper No. 07-E-012.

Ram,R.(2004), "Trends in developing countries' commodity terms-of-trade since 1970", *Review of Radical Political Economics*, vol.36: pp.241-253.

Ramamurti, R. and Singh, J. (2009), *Emerging multinationals in emerging markets*, Cambridge University Press.

Rana, P.B. (1990), "Shifting comparative advantage in Asian and Pacific countries", *The International Trade Journal*, vol.4: pp. 243-259.

Randerson, C.and Dent, C.M. (1996), "Korean and Japanese foreign direct investment in Europe: an examination of comparable and contrasting patterns', *Asian Studies Review*, vol.20:pp.45-69.

Redor, D. and Saadi, M.(2010), "International technology transfer to developing countries: when is it immiserizing?" (in revision), University Paris-Est Marne-La-Vallée.

Reis, A.B. (2001), "On the welfare effects of foreign investment", *Journal of International Economics*, vol.54:pp.411-427.

Reis, A.B. (2006), "Welfare, taxes and foreign investment", *Journal of Economic Dynamics & Control*, vol.30:pp.1045-1061.

Reitzes J.D. and Rousslang, D.J. (1988), "Domestic versus international capital mobility: some empirical evidence", *The Canadian Journal of Economics*, vol.21:pp. 312-323.

Rezgui,S.(2004), « Localisation géographique, commerce international et diffusion des connaissances technologiques », *Economie Internationale*, vol.97 :pp.129-144.

Ricardo, D. ([1817] 1951). On the Principles of Political Economy and Taxation. In The Works and Correspondence of David Ricardo, Vol.I Edited by Sraffa, P., Cambridge University Press.

Rivera-Batiz, L.A. and Romer, P. M. (1991), "International trade with endogenous technological change", *European Economic Review*, vol. 35:pp. 971-1001.

Rodriguez, F. and Rodrik, D. (2001), "Trade policy and economic growth: a Skeptic's guide to the crossnational evidence", in ed. Bernanke, B. and Rogoff, K(editors) , *NBER macroeconomics annual*, Cambridge, MA: MIT Press.

Rodrik, D.(2006), "What Is So Special about China's Exports?" China & World. Economy, vol.14:pp. 1-19 Rogoff,K.(2006), "Paul Samuelson's contributions to economics", in Szenberg, M, Ramrattan, L.and

Gottesman, A. (editors), Samuelsonian Economics and the Twenty-First Century, Oxford University Press, pp.212-224.

Romer, P. M.(1990), "Endogenous technological change", *Journal of Political Economy*, vol.98: pp.71-102.

Romer, P. (1993), Two strategies for economic development: using ideas and producing ideas, In: Proceedings of the Annual World Bank Conference on Development, Washington, D.C.

Roodman, D.(2009), "How to do xtabond2: An introduction to difference and system GMM in Stata", *Stata Journal*, vol.9:pp. 86-136.

Root, F.R. (1994), *International trade and investment*, Cincinnati: South-Western Publishing, Seventh Edition (1994).

Ruffin,R.J.(1984), "International factor movements", in Jones,R.W.and Kenen,P.B. (editors), *Handbook of International Economics*, Vol.1, Amsterdam: North Holland, pp.237-288.

Ruffin, R.J.(2002), "David Ricardo's discovery of comparative advantage", *History of Political Economy*, vol.34:pp.727-748.

Ruffin, R.J. (2009), "Globalization and income inequality", Trade and Development Review, vol.2:pp.56-69.

Ruffin, R.J. and Jones, R.W. (2007), "International technology transfer: Who gains and who loses?," *Review of International Economics*, vol.15:pp.209-222.

Sachs, J.D. and Warner, A.M. (1995), "Economic reform and the process of global integration", *Brookings Papers on Economic Activity*, vol.1:pp.1-118.

Saggi,K.(1999), "Foreign direct investment, licensing, and incentives for innovation", *Review of international Economics*, vol.7:pp. 699-714.

Saggi,K.(2002), "Trade, foreign direct investment, and international technology transfer: A survey", *World Bank Research Observer*, vol.17:pp.191-235.

Saggi. K.(2009), "International Technology Transfer and Foreign Direct Investment", in Ramkishen S. R. and Kenneth A. R.(editors), *Princeton Encyclopedia of the World Economy*, Princeton University Press, pp. 460-464.

Sakakibara, M. and Porter, M.E.(2001), "Competing at home to win Abroad: Evidence from Japanese industry", *The Review of Economics and Statistics*, vol.83:pp.310-322.

Samuelson, P.A. (2004), "Where Ricardo and Mill rebut and confirm arguments of mainstream economists supporting globalization", *Journal of Economic Perspectives*, vol.18:pp.135-146.

Santos-Paulino, A.U. (2002), "Trade liberalisation and export performance in selected developing countries", *Journal of Development Studies*, vol. 39:pp.140-164.

Santos-Paulino, A.U.(2008), "Export productivity and specialization in China, Brazil, India and South Africa", Working Papers RP2008/28, World Institute for Development Economic Research (UNU-WIDER).

Sarkar, P. (1997), "Growth and terms of trade: a North-South macroeconomic framework", *Journal of Macroeconomics*, vol. 19: pp. 117-133.

Sarkar, P. (2001), "The North-South terms-of-trade debate: A re-examination", *Progress in Development Studies*, vol. 1:pp. 309-327.

Sarkar, P. (2004), "Export diversification, market shares and the issues of North–South terms of trade", in Bhattacharjea, A. and Marjit, S. (editors), *Globalization and the developing economies: theory and evidence*, Centre for Studies in Social Sciences New Delhi, India : Manohar, pp. 157-176.

Sarkar, P. (2005), "Rising manufacture exports and terms of trade: the case study of Korea", *Progress in Development Studies*, vol.5:pp.83-88.

Sarkar, P.and Singer, H. W.(1991), "Manufactured exports of developing countries and their terms-of-trade since 1965", *World Development*, vol.19:pp. 333–340.

Sarkar, P.and Singer, H.W. (1993), "Manufacture-manufacture terms-of-trade deterioration: A reply", *World Development*, vol.21:pp.1617–1620.
Sarkar, J. and Sarkar, P. (2008), "Whither new international economic order?", Jadavpur University, Kolkata, India.

available at http://papers.ssrn.com/sol3/papers.cfm?abstract\_id=1103528

Sasaki,T.(1998), "International division of labour and capital export in a Ricardian model", *Economic Journal of Hokkaido University*, vol.27:pp.1-9.

Shatz, H. J. and Venables, A J. (2000), "The geography of International Investment", in. Clark, G.L., Feldman, M.and Gertler, M.S.(editors), *The Oxford Handbook of Economic Geography*, Oxford University Press, pp. 125-145

Schaffer, M.E.(2007), "XTIVREG2: STATA module to perform extended IV/2SLS, GMM and AC/HAC, LIML and K-class Regression for Panel Data Models", available at: http://ideas.repec.org/c/boc/bocode/s456501.html

Schott, K. (2003), "One size fits all? Heckscher-Ohlin specialization in global production", *American Economic Review*, vol.93:pp. 686–708.

Schott, P.K. (2008), "The relative sophistication of Chinese exports", *Economic Policy*, vol.53:pp.5–49.

Schweinberger, A.G.(2002), "Foreign aid, tariffs and non-traded private or public goods", *Journal of Development Economics*, vol.69:pp.255-275.

Singer,H.W.(1950), "The distribution of gains between investing and borrowing countries", American Economic Review, vol.40:pp.473-485.

Singh,N.and Marjit,S.(2003), Joint ventures, international investment and technology transfer, Oxford University Press, New Delhi, India

Solow, R.M. (1957), "Technical Change and the Aggregate Production Function", *Review of Economics and Statistics*, vol 39: pp. 312–320.

Son, J.Y. and Kim, K.H.(1997), "Analysis of urban land shortages: the case of Korean cities", *Journal of Urban Economics*, vol.43:pp.362-384.

Spilimbergo, A. (1998), "Deindustrialization and trade", *Review of International Economics*, vol.6:pp. 450-60.

Staiger, R.W. (1988), "Organized labor and the scope of international specialization", *Journal of Political Economy*, vol.96:pp.1022-1047.

Staiger, D. and Stock, J.H., (1997), "Instrumental variables regression with weak instruments", *Econometrica*, vol.65:pp.557-586.

Stern, R.(1962), "British and American productivity and comparative costs in international trade", *Oxford Economic Papers*, vol.14:pp.275-296.

Stock, J.H., Wright, J.H. and Yogo, M. (2002), "A survey of weak instruments and weak identification in Generalized Method of Moments", *Journal of Business and Economic Statistics*, vol. 20: pp. 518–529.

Stock, J.H. and Yogo, M.(2005), "Testing for weak instruments in linear IV regression", in Donald W.A. and Stock, J.H. (editors), *Identification and Inference for Econometric Models: essays in Honor of Thomas Rothenberg*, Cambridge University Press, pp. 80-108.

Sun,H.(2001), "Foreign direct investment and regional export performance in China", *Journal of Regional Science*, vol.41:pp.317-336.

Svensson, L. (1984), "Factor trade and goods trade", *Journal of International Economics*, vol.16:pp. 365-378.

Takarada, Y. (2006), "Welfare effects of technology transfer", Pacific Economic Review, vol.11:pp.75-86.

Tarun, K. and Marjit, S.(2003): "Protecting consumers through protection: the role of tariff-induced technology transfer," *European Economic Review*, vol.47: pp.113-124.

Taylor,S.(1993), "Quality ladders and Ricardian trade", *Journal of International Economics*, vol.34:pp. 225-249.

Teece,D.J.(1977), "Technology transfer by multinational firms: the resource cost of transferring technological know-how", *Economic Journal*, vol.87:pp. 242-261.

Thompson, E.R. (2002), "Clustering of foreign direct investment and enhanced technology transfer: evidence from Hong Kong firms in China", *World Development*, vol.30:pp.873-889.

Thompson, E.R. (2003), "Technology transfer to China by Hong Kong's cross-border garment firms", *The Developing Economies*, pp. 88-111.

Thompson, H.(1983), "Trade and international factor mobility", Atlantic Economic Journal, pp.45-48.

Thompson, H.(1985)," International capital mobility in a specific factor model", *Atlantic Economic Journal*, pp.76-79.

Thompson,H.(1992), "Production and trade with international capital movement and payments", *Southern Economic Journal*, vol.58:pp.743-749.

Thompson,H.(1993), "Foreign management, international capital, and income redistribution", *International Economic Journal*, vol.7:pp.33-41.

Thompson, H. (1997), "International capital and nontraded goods in the long run", *International Review of Economics and Finance*, vol.6:pp.379-390.

Tolentino, P.E. (1993), *Technological innovation and Third World multinationals*, Routledge, London and New York.

Tolentino, P.E. (2000), *Multinational corporations: emergence and evolution*, Routledge, London and New York.

Todaro, M.P. and Smith, S. C. (2003), Economic development, 8th ed. New York: Addison-Wesley.

Uchiyama,T.(2000), "Ricardo on machinery: a dynamic analysis", *European Journal of the History of Economic Thought*, vol.7:pp. 208–227.

Uekawa,Y.(1972),"On the existence of incomplete specialization in international trade with capital mobility", *Journal of International Economics*, vol.2: pp.1-24.

UN (United Nations) (2008), World Economic Situation and Prospects 2008, New York, 2008

UNCTAD (United Nations Conference on Trade and Development).(1990), World Investment Report, Geneva, Switzerland: UNCTAD

UNCTAD.(1991), World Investment Report. Geneva, Switzerland: UNCTAD.

UNCTAD.(1995), World Investment Report. Geneva, Switzerland: UNCTAD.

UNCTAD.(1996), World Investment Report . Geneva, Switzerland: UNCTAD.

UNCTAD.(2001), World Investment Report . Geneva, Switzerland: UNCTAD.

UNCTAD.(2003), World Investment Report . Geneva, Switzerland: UNCTAD.

UNCTAD. (2005), Trade and Development Report, Geneva, Switzerland: UNCTAD.

UNCTAD.(2006), *World Investment Report*. FDI from Developing and Transition Economies: Implications for Development. Geneva, Switzerland: UNCTAD.

UNCTAD.(2007), *World Investment Report 2007*; Transnational Corporations, Extractive Industries and Development. Geneva, Switzerland: UNCTAD.

UNCTAD.(2008a) : Trade and Development Report. Geneva, Switzerland: UNCTAD.

UNCTAD.(2008b). World Investment Report. Geneva, Switzerland: UNCTAD.

UNCTAD. (2009). FDI database

Urata,S.(1991),"The rapid increase of direct investment abroad and structural change in Japan", in Ramstetter,E.D.(editor), *Direct Foreign Investment in Asia's Developing Economies and Structural Change in the Asia-Pacific Region*, West view Press, Boulder and Oxford, pp. 175–199.

Urata, S. and Kawaï, H.(2000), "The determinants of the location of foreign direct investment by Japanese small and medium-sized enterprises", *Small Business Economics*, vol.15:pp. 79–103.

US Department of Energy (1996), Report .1996.

Uzagalieva, A. Cukrowski, J.(2006), "Labor market flexibility, international competitiveness and patterns of trade", *Economia Internazionale*, vol.59:pp. 225-246.

Van Hoesel, R.(1998), "The emergence of Korean and Taiwanese multinationals in Europe: prospects and limitations", *Asia Pacific Business Review*, vol.4:pp.109-129.

Van Hoesel, R. (1999), New multinational enterprises from Korea and Taiwan : beyond export-led growth, London; New York : Routledge.

Verardi, V.and Croux, C.(2009), "Robust regression in Stata", The Stata Journal, vol. 9:pp. 439-453.

Vernon, R. (1966), "International investment and international trade in the product cycle", *Quarterly Journal of Economics*, vol.80 :pp.190-207.

Vu,T.B.(2008),"Foreign direct investment and endogenous growth in Vietnam", *Applied Economics*, vol. 40:pp.1165-1173.

Waldkirch, A (2010), "Comparative advantage FDI? A host country perspective", Colby College, available at:

http://www.apec.umn.edu/faculty/pglewwe/Minnconf/papers\_by\_presenters\_last\_name/Waldkirch\_01.05.1 0\_cafdi.pdf

Wang, J.Y.(1990), "Growth, technology transfer, and the long-run theory of international capital movements", *Journal of International Economics*, vol.29:pp. 225–271.

Wang, J.Y.and Blomstrom, M. (1992), "Foreign investment and technology transfer", *European Economic Review*, vol.36:pp.137-155.

Wang, Z. and Wei, S-J. (2007), "The rising sophistication in China's exports: Assessing the roles of processing trade, foreign invested firms, human capital and government policies,"working paper for the NBER Conference on China is growing role in world trade.

Wang, Z. and Wei, S.J. (2010), "What accounts for the rising sophistication of China's exports?" in Feenstra, R. and Wei, S.J. (editors), *China's growing role in world trade*, University of Chicago Press, pp.63-109.

Westphal, L. (2002), "Technology strategies for economic development in a fast changing global economy", *Economics of Innovation and New Technology*, vol.11: pp. 275-320.

Westphal, L.E.,Kim, L.and Dahlman,C.(1985) "Reflections on the republic of Korea's acquisition of technological capability", in Rosenberg,N. and Frischtak,C.(editors), *International Technology Transfer*, New York: Praeger Publishers, pp. 167–221.

Wong, K-Y. (1986), "Are international trade and factor mobility substitutes ?", Journal of International Economics, vol.21:pp. 341-356.

Wong, K-Y.(1995), International trade in goods and factor mobility, Cambridge, MA: MIT Press.

Wood, A. (1997), "Openness and wage inequality in developing countries: the Latin American challenge to East Asian conventional wisdom", *World Bank Economic Review*, vol.11:pp.33–57.

Wooldridge, J.M.(2002), Econometric analysis of cross section and panel data, Cambridge, MA: MIT Press.

World Bank, (2002), World development indicators: 2002. Washington, DC: World Bank.

World Bank, (2005), World development indicators: 2005. Washington, DC: World Bank, CD-ROM

World Bank. (2006), World development indicators: 2006. Washington, DC: World Bank

World Bank. (2008), World development indicators: 2008. Washington, DC: World Bank

World Bank. (2009), World development indicators: 2009. Washington, DC: World Bank

World Trade Organization.(WTO) (2002), Annual report 2002. Geneva: World Trade Organization.

Wu, X. D. (2000). Foreign direct investment, intellectual property rights, and wage inequality in China. *China Economic Review*, vol.11:pp. 361–384.

Wu, F. and Yeo, H.S.(2002), "China's rising investment in Southeast Asia: trends and outlook", *Journal of Asian Business*, vol.18:pp.41-61.

Wu, H.L.and Chen, C.H.(2001), "An assessment of outward foreign direct investment from China's transitional economy", *Europe-Asia Studies*, vol.53:pp. 1235-1254.

Xing, Y.(2007), "Foreign direct investment and China's bilateral intra-industry trade with Japan and the US", *Journal of Asian Economics*, vol.18:pp. 685-700.

Xu, B.(2007), "Measuring China's export sophistication," working paper, China Europe International Business School.

Xu,B.(2010),"The sophistication of exports: is China special?", *China Economic Review*, vol. 21:pp. 482-493.

Xu,B. and Lu, J.(2008), "The Impact of Foreign MNEs on Export sophistication of host countries: Evidence from China", Fifth Annual *JIBS* Paper Development Workshop.

Xu,B. and Lu, J.(2009), "Foreign direct investment, processing trade, and the sophistication of China's exports", *China Economic Review*, vol. 20:pp.425-439.

Xu,B. and Wang, J.(2000), "Trade, FDI, and International Technology Diffusion, *Journal of Economic Integration*, Vol.15, pp:585 – 601.

Yang, R. and Yao, Y.(2007), "Limited catch-up and China's economic growth.", in Wong, J. and Liu, W.(editors), *China's Surging Economy: Adjusting for More Balanced Development*, World Scientific, New York, pp.155-183.

Yang, R., Yao, Y.and Zhang, Y. (2009), "Technological structure and its upgrading in China's exports", *China Economic Journal*, vol 2: pp.55 – 71.

Yao, S. (2009), "Why are Chinese exports not so special?", China & World Economy, vol.17:pp. 47-65.

Yeaple, S.R.(2001), "The determinants of U.S. outward foreign direct investment: market access versus comparative advantage", Working paper, University of Pennsylvania.

Yeaple, S.R.(2003), "The role of skill endowments in the structure of U.S. outward foreign direct investment", *Review of Economics and Statistics*, vol.85: pp.726-734.

Yeaple S.R. (2006), "Offshoring, foreign direct investment, and the structure of U.S. trade", *Journal of the European Economic Association*, vol. 4:pp.602-611.

Yi, Kei-Mu. (2003), "Can vertical specialization explain the growth of world trade?", *Journal of Political Economy*, vol.111:pp.52-102.

Young,A.(1991), "Learning by doing and the dynamic effects of international trade", *Quarterly Journal of Economics*, vol.106:pp. 369-405.

Young, L. and K. Miyagiwa.(1986), "International investment and immiserizing Growth", *Journal of International Economics*, vol. 20:pp.171-178.

Zhang, Z. and Hock,O.(1996), "Trade interdependence and direct foreign investment between ASEAN and China", *World Development*, vol.24:pp. 155-170.

Zhang, K.H. and Song, S. (2000), "Promoting Exports: The Role of Inward FDI in. China", China Economic Review, vol.11:pp. 385-396.

Zheng, Z. and Zhao,Y.(2002), "China's terms of trade in manufactures", UNCTAD Discussion Paper No. 161, Geneva: UNCTAD.

Zhu, J.(2000), "The impact of industrial land use policy on industrial change", *Land Use Policy*, vol.17:pp. 21-28.

Zhu,J.(2002), "Industrial globalisation and its impact on Singapore's industrial landscape", *Habitat International*, vol.26:pp.177-190.

Zhu, S.C.and Trefler, D. (2005),"Trade and inequality in developing countries: a general equilibrium analysis", *Journal of International Economics*, vol. 65: pp. 21-48.

Zimmerman, P.R. (2009), "Statistical variability and the deterrent effect of the death penalty", *American Law and Economics Review*, vol.11: pp. 370-398.

Zukowska-Gagelmann, K. (2002),"Productivity Spillovers from Foreign Direct Investment in Poland", *Economic Systems*, vol.106:pp.407–473.

Zweig, D. and Jianhai, B. (2005), "China's global hunt for energy", Foreign Affairs, vol.84:pp. 25-38.

## List of abbreviations and acronyms

EXPY: export sophistication, export productivity
FDI: foreign direct investment
GDP pc: gross domestic product per capita
ICT: Information and communications technology
MNF: Multinational firm
OFDI: outward FDI
PRMED: The Economic Policy and Debt Department (World Bank)
REXPY: Relative export sophistication
TOT: terms of trade
TT: Technology transfer
WDI: World Development Indicators
WTO: World Trade Organisation
PPP: purchasing parity power
UNCTAD: United Nations Conference on Trade and Development

## Résumé

Cette thèse met l'accent sur les approches ricardiennes de croissance et de commerce international pour traiter l'investissement direct étranger (IDE), le transfert technologique et le commerce international, construit et développe de nouvelles approches théoriques et prédictions ricardiennes. Des analyses économétriques sont ensuite effectuées pour tester ces prédictions. Cette thèse se compose de quatre chapitres. Deux parties qui contiennent chacune deux chapitres sont présentées. La première partie propose une revisitation et une reformulation des approches macroéconomiques de l'IDE (en particulier l'IDE sortant) suivant une approche ricardienne. La deuxième partie traite les relations entre l'IDE, le transfert technologique, la sophistication des exportations et les termes de l'échange des pays en développement et fournit des analyses empiriques à l'appui pour tester les nouvelles prédictions ricardiennes.

Le premier chapitre réexamine et généralise l'approche de l'IDE par la théorie ricardienne de croissance. Ce chapitre prolonge l'analyse d'Ozawa, met l'accent sur « les goulots d'étranglement ricardiens » et le risque de trappe à stagnation industrielle à la Ricardo-Hicks et examine les facteurs « push » expliquant l'investissement direct sortant. Les prédictions de cette approche sont ensuite testées sur un panel de pays émergents et en transition. Les résultats économétriques confirment les prédictions théoriques de l'approche macroéconomique d'Ozawa appliquée au Japon : l'histoire se répète.

Le second chapitre développe un modèle ricardien classique en introduisant l'IDE Nord Sud. Nous reformulons « *le principe de correspondance* » développé par Kojima. Nous montrons que la correspondance entre les taux de profits absolus et les avantages comparatifs explique l'émergence de l'IDE originaire des secteurs comparativement désavantagés dans les pays développés et destinés aux secteurs comparativement avantagés dans les pays en développement.

Le troisième chapitre, dans sa première section, développe un modèle ricardien Nord-Sud avec transfert de technologie. Notre contribution consiste à examiner le rôle de l'élasticité de substitution entre les biens dans les conséquences du transfert technologique sur les termes de l'échange et le bien-être des pays. Les conditions d'une baisse des termes de l'échange pour le pays en développement sont explicitées, et finalement sont précisées les conditions dans lesquelles le bien être du pays en développement peut baisser à la suite de ce transfert de technologie. La seconde section prolonge l'analyse aux cas du transfert technologique via l'IDE et les licenses. Les tests empiriques montrent que les IDE entrants et le versement de royalties s'accompagnent d'une baisse des termes de l'échange pour les pays en développement.

Le quatrième chapitre associe le modèle ricardien avec un continuum de biens aux travaux empiriques de Hausmann, Hwang et Rodrick (2007) et de Rodrik (2006) sur la sophistication des exportations, Un modèle empirique est développé afin d'établir les liens qui existent entre la présence des firmes étrangères-synonyme d'un transfert technologique- et la sophistication des exportations des pays en développement. Ensuite, la question des termes de l'échange des pays en développement est mise en évidence. Les tests empiriques montrent que l'augmentation de la sophistication des exportations des pays en développement s'est accompagnée d'une baisse de leurs termes de l'échange.

**Discipline** : Sciences Economiques

Mots-clés : théorie ricardienne, IDE, transfert technologique, licence, termes de l'échange, bien-être, sophistication des exportations.

**Intitulé et adresse du laboratoire** : Equipe de Recherche sur l'Utilisation des Données Individuelles Temporelles (ERUDITE), équipe d'accueil 437 - Fédération TEPP (CNRS) Bâtiment Bois de l'Etang, 5 bd. Descartes, 75454 Marne - La - Vallée, France

Courriel : saadi@univ-mlv.fr