Diversification du commerce, vulnérabilité et développement économique.

Élodie Mania

▶ **To cite this version:**

Élodie Mania. Diversification du commerce, vulnérabilité et développement économique.. Economies et finances. Normandie Université, 2020. Français. NNT : 2020NORMR027 . tel-03105391

HAL Id: tel-03105391
https://theses.hal.science/tel-03105391

Submitted on 11 Jan 2021

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.

Normandie Université

THÈSE

Pour obtenir le diplôme de doctorat
Spécialité Sciences Économiques
Préparée au sein de l'Université de Rouen Normandie

Diversification du commerce, vulnérabilité et développement économique

Présentée et soutenue par

Élodie MANIA

Thèse soutenue publiquement le 10 Décembre 2020 devant le jury composé de		
M. Bruno AMABLE	Professeur des universités, Université de Genève	Examinateur
M. Jean-Pierre CLING	Inspecteur général de l'INSEE (HDR), INSEE Paris	Rapporteur
Mme Cécile COUHARDE	Professeur des universités, Université Paris Nanterre	Examinateur
M. Kako NUBUKPO	Professeur titulaire de sciences économiques, Université de Lomé (Togo)	Examinateur
M. Arsène RIEBER	Maître de conférences (HDR), Université de Rouen Normandie	Directeur de thèse
M. Francisco SERRANITO	Professeur des universités, Université Sorbonne Paris Nord	Rapporteur

Thèse dirigée par Arsène RIEBER, Laboratoire d'Analyse des Sociétés, Transformations et Adaptations

UNIVERSITÉ DE ROUEN NORMANDIE

ED242 Ecole doctorale ECONOMIE - GESTION NORMANDIE

LASTA
Laboratoire d'Analyse des Sociétés, Transformations et Adaptations

Trade diversification, vulnerability and economic development

Élodie MANIA

Thesis supervised by

Arsène RIEBER, MCF HDR,
Université de Rouen Normandie, LASTA

Disclaimer

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

This Ph.D. thesis should not be reported as representing the views of University of Rouen Normandy. The views expressed are those of the author and do not necessarily reflect those of the University.

Remerciements

L'élaboration de cette thèse de doctorat n'aurait été possible sans la contribution de plusieurs personnes remarquables.

Je voudrais dans un premier temps exprimer ma plus profonde gratitude à mon directeur de thèse Arsène Rieber, qui a cru en moi et qui m'a offert l'opportunité de m'inscrire en doctorat en économie. Je le remercie pour ses nombreux conseils et sa disponibilité permanente. Ces années de thèse ont été une source d'inspiration et de motivation et m'ont aidée à grandir en tant que chercheur.

J'adresse mes remerciements à Jean-Pierre Cling et Francisco Serranito qui m'ont fait l'honneur d'accepter d'être les rapporteurs de cette thèse en consacrant leur temps précieux à lire et à commenter mes travaux de recherche. Je tiens également à remercier Bruno Amable, Cécile Couharde et Kako Nubukpo de l'honneur qu'ils me font en acceptant de siéger en tant que membres du jury.

Je tiens à témoigner ma reconnaissance à la région Normandie pour m'avoir octroyé un financement dans le cadre d'un contrat doctoral.

Je remercie profondément Anh-Dao Tran pour son soutien et ses conseils pendant ma thèse. Je suis reconnaissante d'avoir eu l'occasion de présenter mon travail lors d'une conférence internationale.

J'adresse mes remerciements aux enseignants-chercheurs en économie de l'Université de Rouen pour leur accueil chaleureux. Un grand merci aux doctorants et jeunes chercheurs en économie. Le travail de thèse est assez solitaire. Cependant, vous avez rendu ces journées au bureau plus agréables en contribuant à créer un environnement de travail harmonieux. Je salue nos sympathiques voisins gestionnaires et juristes que nous côtoyons au quotidien.

La vie quotidienne d'un(e) doctorant(e) consiste non seulement à faire de la recherche, mais aussi à enseigner, à se préoccuper des procédures administratives et parfois à présenter ses travaux en dehors de l'université. J'exprime ma gratitude

aux équipes administratives des laboratoires et de l'ED qui, au cours de ces quatre dernières années, nous ont témoigné leur sympathie et nous ont aidés à démêler les complexités des tâches administratives.

Sur un plan plus personnel, je souhaite tout d'abord remercier infiniment mes parents, à qui je dédie cette thèse, pour leur amour et leur soutien inconditionnels. Ils ont cru en moi et m'ont appris à toujours persévérer dans ce que l'on fait. Quant à ma petite soeur, merci d'être là et d'être toi, tout simplement.

Je remercie ma famille en France, mon cousin, mes cousines et tantes, qui m'ont accueillie les bras ouverts et ont été compréhensifs car, en effet, je n'ai pas été très présente ces quatre dernières années. Je suis profondément reconnaissante envers mon oncle Denis et ma tante Line, sans le soutien et l'intervention desquels je n'aurais pu poursuivre mes études en France. Du fond du coeur, merci.

Je souhaite particulièrement remercier Hong, qui a été plus qu'une collègue et qui m'a donné des conseils forts utiles dans l'aboutissement de ce travail de recherche. I also deeply thank Long and Hong who provided valuable feedback that made it possible to improve the writing of this thesis.

Mention très spécial à mon cher Zidane, pour son soutien infaillible, sa patience et son dévouement et tant d'autres choses. Merci de m'avoir supportée durant ces moments de stress, de comprendre mes horaires tardives et indisponibilités. On va enfin pouvoir les faire, ces vacances !

Enfin, j'adresse mes remerciements à toutes les personnes qui ont contribué de près ou de loin à la réalisation de cette thèse.

Résumé

La littérature économique récente et les grandes instances internationales s'accordent sur les vertus d'une stratégie de développement économique basée sur la diversification. Ce consensus provient d'une part des enseignements de l'histoire des vagues successives des réussites des économies émergentes asiatiques et d'autre part des nombreuses validations économétriques de la relation entre diversification et croissance économique. Pour autant, ce consensus est relativement récent puisqu'il opposait, dans les années 50, les structuralistes aux néo-classiques. Ces derniers s'inspiraient des théories traditionnelles du commerce international qui, depuis Ricardo (1817), prônent le libre-échange et la spécialisation des économies selon leurs avantages comparatifs. A l'inverse, les pionniers du développement insistaient sur le fait que les politiques de développement se doivent d'introduire des distorsions aux mécanismes de spécialisation selon les avantages comparatifs, le processus de changements structurels étant conditionné par la diversification et la composition des exportations.
Dans le cadre de notre doctorat, notre travail de recherche consiste à ré-explorer théoriquement et empiriquement la relation entre la diversification des exportations et le développement économique dans le contexte actuel de la mondialisation. Une première interférence dans le débat provient de l'intégration des pays en développement dans les chaînes de valeur mondiales où les pays ne se spécialisent plus dans la production d'un produit mais dans un segment délimité du processus de production. Les conséquences de cette déconnexion entre la structure productive d'un pays et la diversification de ses exportations sont étudiées au travers d'une extension du modèle post-keynésien de Thirlwall (1979). Cette analyse nous permet de mettre en avant l'hétérogénéité des modèles de diversification de trois régions en développement, à savoir l'Afrique subsaharienne, l'Asie en développement et l'Amérique latine. A la suite de cette analyse, nous tentons d'éclairer la boîte noire que constitue cette relation entre diversification des exportations et croissance économique en nous intéressant aux canaux de transmission de la relation. Pour ce faire, nous exploitons les propriétés d'une version élargie de la loi de Kaldor-Verdoorn en évaluant l'impact de la diversification des exportations sur le taux de croissance de la productivité et le niveau des rendements d'échelle de plusieurs groupes de pays. Dans un second temps, nous nous interrogeons sur la compatibilité d'une stratégie de diversification des exportations avec les défis environnementaux auxquels sont confrontées les nations de nos jours. Nos résultats préliminaires suggèrent qu'un niveau plus élevé des émissions de CO2 est associé à un panier d'exportation plus diversifié. Un examen plus approfondi à partir d'une analyse théorique et d'une étude empirique montre

que l'effet positif de la diversification des exportations sur les émissions de dioxyde de carbone (CO2) concerne particulièrement les pays à revenu plus élevé. Enfin, nous abordons la diversification des exportations sous l'angle de la diversification des partenaires commerciaux au travers d'une étude de cas sur le Vietnam. Dans un modèle de croissance contrainte par la balance des paiements multi-pays, nous analysons les performances de croissance de ce pays en mesurant la contribution de ses partenaires commerciaux à sa contrainte extérieure. Cette étude de cas soulève plus généralement, dans le contexte historique contemporain, les questions de la macro-résilience et des vertus d'un modèle de développement basé exclusivement sur le commerce international.

Mots-clefs : diversification des exportations, commerce, pays en développement, Afrique subsaharienne, Asie en développement, Amérique latine, croissance économique, développement économique, modèle de croissance contrainte par la balance des paiements, environnement, pollution atmosphérique, productivité, résilience macroéconomique.

Codes JEL : E12, F10, F18, F43, O11, Q53, O57

Abstract

Recent economic literature and major international organizations are agreed on the virtues of export diversification as a development strategy for developing countries. The consensus has two main sources: the successful experience of the Asian emerging countries on the one hand, and the numerous empirical studies showing positive relationship between diversification and economic growth on the other hand. The consensus is new since the debate was at the center of the controversies between free-trade and structuralist economists in the 1950s. Since Ricardo (1817), the former had been inspired by traditional theories of international trade and advocated free trade and specialization based on a country's comparative advantages. Conversely, the pioneers of development economics emphasized the need for development policies to introduce distortions into the specialization mechanisms of comparative advantages, as the process of structural change is driven by diversification and export composition.

The thesis explores theoretically and empirically the relationship between export diversification and economic development in the present context of globalization. Firstly, the integration of developing countries into global value chains, where countries no longer specialize in the production of a product but in a delimited segment of the production process, questions the relationship. The consequences of the disconnection between a country's productive structure and its export diversification are analyzed through an extension of Thirlwall's (1979) post-Keynesian model. The analysis allows us to emphasize the heterogeneity of diversification models of three developing regions, namely sub-Saharan Africa, developing Asia and Latin America. We thereafter attempt to open the black box that constitutes the relationship between export diversification and economic growth. The transmission channels of the relationship will be examined by using the properties of an extended Kaldor-Verdoorn Law that assesses the impact of export diversification on productivity growth and the degree of returns to scale for several countries. Secondly, as far as countries are concerned, the compatibility of export diversification strategy with the environmental challenges is questioned. Our preliminary results suggest that a higher level of carbon dioxide (CO2) emissions is associated with a more diversified export basket. Further investigation from theoretical and empirical analyses demonstrates that the positive effect on CO2 emissions is valid for the upper-middle-income and the high-income economies. Finally, we approach export diversification from the perspective of trading partner diversification in a case study on Vietnam. We analyze the country's growth performance by measuring the contribution of its trading partners to its external constraint in a multi-country balance of payments

constrained growth model. The study case questions the macroeconomic resilience and the virtues of a development model driven exclusively by international trade nowadays.

Keywords: export diversification, trade, developing countries, sub-Saharan Africa, developing Asia, Latin America, economic growth, economic development, balance of payments constrained growth model, environment, air pollution, productivity, macro resilience.

JEL codes: E12, F10, F18, F43, O11, O57, Q53.

Long résumé

La réduction de la pauvreté ainsi que le rattrapage économique pour une amélioration du niveau de vie sont principalement les défis majeurs des pays en développement. Dans le contexte actuel de la mondialisation, leur ouverture au commerce international est inévitable. Dès 1980, les pays en développement ont connu une période de libéralisation des échanges, dont la tendance s'est significativement accélérée depuis. Les parts de la production et du commerce des pays en développement dans la production mondiale et dans commerce mondial ont été respectivement de 39 et 32 pour cent en 2000, pour atteindre environ 50 pour cent dans les années 2010 (WTO, 2014). Il s'ensuit que l'accès au marché mondial a fait du commerce international un déterminant majeur de la croissance économique, et donc un élément clé du développement économique. Il est à noter que les deux termes se distinguent : la croissance économique est définie comme étant une augmentation quantitative du produit intérieur brut (PIB) d'une économie, tandis que le développement consiste en un changement structurel induit par la croissance économique contribuant à une amélioration du niveau de vie et de la qualité de vie de la population.

Depuis 1990, le paysage du commerce mondial a évolué avec la hausse progressive des flux commerciaux bilatéraux entre pays en développement. La reconfiguration du commerce international caractérisée par la forte augmentation de la part des flux commerciaux entre pays en développement, dénommés le *commerce Sud-Sud*, a été favorisée par l'émergence de certains pays en développement, notamment les pays émergents membres du G20 (WTO, 2014) : la part des exportations Sud-Sud dans les exportations totales des pays en développement est passée de 33.7 pour cent en 1990 à 57 pour cent en 2012, tandis que du côté des importations Sud-Sud, sa part dans les importations totales atteint 59 pour cent en 2012 (UNCTAD, 2015). En outre, en 1988, la part des chaînes de valeur Sud-Sud dans le commerce mondial est passée de 6 pour cent à 25 pour cent en 2013 (WTO, 2014). Par conséquent, la relation entre le commerce international et le développement économique, notamment par le biais des exportations en tant que composante du PIB, est désormais bien établie.

Cependant, au cours des dernières décennies, les pays en développement se sont

avérés inégaux en termes de trajectoire de croissance économique.

D'une part, l'histoire a été témoin des vagues successives des réussites des économies émergentes, notamment des pays asiatiques, qui ont mis en oeuvre des politiques gouvernementales favorisant la diversification des activités économiques et la diversification des exportations par l'industrialisation en défiant notamment leurs avantages comparatifs : la part des exportations mondiales de produits manufacturés attribuée à l'Asie en développement est passée de 11.1 pour cent à 21.1 pour cent au cours de la période 1996-2010 (UNCTAD, 2015). L'exemple le plus évident est la montée en puissance de la Chine en tant que concurrent mondial et premier exportateur, avec une croissance économique supérieure à 10 pour cent dans les années 2000. L'autre exemple est l'Inde, jouissant d'une croissance rapide d'environ 7.5 pour cent entre 2000 et 2011 (WTO, 2014). Par ailleurs, les revenus des pays émergents du G20 semblent converger vers ceux des pays développés : ils ont augmenté de 5.2 pour cent en moyenne alors que l'activité économique dans les pays développés a ralenti au cours des deux dernières décennies (WTO, 2014).

D'autre part, d'autres pays à la traîne, notamment en Afrique et en Amérique latine dans une moindre mesure, sont caractérisés par des taux de croissances économiques instables, un panier d'exportation restreint et des partenaires commerciaux limités. Ils ont échoué dans plusieurs politiques visant à stimuler leurs performances économiques et ont souffert de la crise de la dette et d'une instabilité macroéconomique.

Il en ressort que le contraste en termes d'évolution de la composition des exportations est flagrant entre les deux groupes de pays en développement : tandis que les produits manufacturés ont éclipsé les produits primaires dans les pays en développement d'Asie, en Afrique et en Amérique latine, la composition des exportations a peu changé et demeure dominée par les produits de base (UNCTAD, 2015). A ce jour, la plupart des pays à faible revenu sont situés en Afrique, tandis que les concurrents commerciaux les plus féroces, à l'exemple de la Chine, sont principalement localisés en Asie de l'Est.

Ainsi, en ce qui concerne les pays en développement, il existe un consensus de nos jours sur les vertus de la diversité de l'activité économique et de la diversification des exportations, définie au sens large comme étant l'augmentation du nombre de produits et/ou de partenaires commerciaux. En effet, les institutions internationales soulignent la vulnérabilité des pays à faible revenu liée à un schéma de spécialisation internationale, en termes de produits et de partenaires. La concentration des exportations soumet ces pays aux risques conjoints de détérioration des termes de l'échange et d'instabilité des recettes d'exportation en raison de la forte fluctua-

tion des prix. Les produits de base et les ressources naturelles sont particulièrement sources de volatilité des recettes d'exportation. Par exemple, entre 2003 et 2008, le prix des produits miniers a augmenté de 178 pour cent, et les prix du poisson et des produits forestiers ont augmenté d'environ 38 pour cent et 26 pour cent respectivement (WTO, 2010).

Sur le plan théorique, la problématique est ancienne et était au coeur, dans les années 50, des controverses entre les économistes en faveur du libre-échange et les structuralistes. Les premiers s'inspiraient des théories traditionnelles du commerce international qui, depuis Ricardo (1817), prônent le libre-échange et la spécialisation des économies selon leurs avantages comparatifs. Les nouvelles théories du commerce international initiées par Krugman (1979) vont réactualiser ce résultat en présence de rendements d'échelle croissants en expliquant que la concentration des exportations est une source de gains pour un pays à l'ouverture au commerce international. Les pionniers de l'économie du développement quant à eux, en s'inspirant des travaux de Prebisch (1950) et de Singer (1950), montraient que la thèse des avantages comparatifs conduisait inéluctablement les pays en développement dans un schéma de "croissance appauvrissante". Pour ces économistes, l'hétérogénéité des caractéristiques structurelles entre les économies sur le plan international renvoie à une configuration des échanges où les pays industrialisés se spécialisent dans les produits industriels à forte valeur ajoutée tandis que les pays en développement se spécialisent dans les produits primaires ou produits intensifs en main-d'oeuvre. Or, les exportations de ces derniers se caractérisent par une élasticité-revenu relativement faible et une faible productivité, et sont soumises à de fortes fluctuations des prix. Ainsi, de l'argument de la volatilité des revenus d'exportation découlant de cette dépendance, d'une part, et de la dégradation des termes de l'échange, d'autre part, se dégage la recommandation d'une diversification des exportations qui serait un moyen de réduire la vulnérabilité de ces économies face aux chocs de la demande extérieure et de bénéficier des retombées technologiques indispensables au décollage économique. Le courant structuraliste contemporain a renouvelé cette thèse critique à l'encontre de la théorie des avantages comparatifs en insistant sur le fait que le processus de changements structurels d'une économie en développement était conditionné par la diversification et la composition de leurs exportations (Cimoli et al., 2011). Par conséquent, les politiques de développement se doivent d'introduire des distorsions aux mécanismes de spécialisation selon les avantages comparatifs. Tout récemment, une convergence théorique s'opère puisque des nouveaux modèles théoriques du "mainstream" présentent également la diversification des exportations comme un facteur de croissance économique. Sur la base d'une

extension du modèle de Krugman (1979), ces modèles dénommés “new new trade theory” (nouvelle nouvelle théorie du commerce international), à l'exemple du modèle de Melitz (2003), introduisent dans les modèles de commerce international une hétérogénéité entre firmes en matière de productivité. Ces modèles montrent qu'une diminution des coûts commerciaux augmente le nombre de firmes exportatrices, ce qui aura pour conséquence d'augmenter la diversité des biens exportés puisqu'en concurrence monopolistique, chaque firme produit une variété de biens différente. Avec un effet de sélection, la réallocation des parts de marchés vers les firmes les plus productives contribue à une augmentation de la productivité à l'échelle agrégée. De ces modèles, on peut en déduire que la diversification des exportations d'une économie résultant d'une intensification du commerce est source de croissance économique. Cependant un clivage entre économistes néo-stucturalistes et économistes du mainstream subsiste : pour les premiers, la diversification des exportations nécessite une intervention active de l'Etat alors que pour les seconds, la diversification des exportations découle naturellement de la réduction des coûts du commerce. Abstraction faite de cette controverse importante en termes de politique économique, un consensus s'est opéré autour d'un résultat : la diversification des exportations contribue positivement à la croissance et au développement économique.
Sur le plan empirique, ce dernier résultat est corroboré par un grand nombre d'études et semble très robuste. Une première série de travaux s'est concentrée sur les méfaits d'une spécialisation exclusive en biens primaires, dénommés “la malédiction des ressources naturelles”, pour les pays en développement. Les arguments testés reprennent la thèse de Prebisch (1959) : la détérioration des termes de l'échange, la volatilité des revenus d'exportation et la faible productivité (Auty, 2000). D'autres travaux testent directement la relation entre la diversification des exportations et la croissance économique. A partir de divers échantillons, il ressort unanimement de ces travaux que la diversification des exportations favorise la croissance économique des pays en développement (IMF, 2017a).

Au-delà de ce consensus, l'efficacité d'un modèle économique est conditionnée par son contexte historique. Un modèle de croissance basé sur la diversification des exportations qui était pourtant source de transformation structurelle propice au développement dans les années 50, à l'exemple des réussites des pays d'Asie, pourrait aujourd'hui engendrer la fragilisation d'une économie du fait de la mondialisation accrue. En effet, de nos jours, l'économie mondiale est caractérisée par une fragmentation verticale de la production où les pays, et notamment les pays en développement, se spécialisent dans des tâches précises de la chaîne de production. Plus précisément, les pays en développement intégrés dans les chaînes de valeur mondiales (CVM) ne

se spécialisent plus dans la production d'un produit, mais dans un segment délimité du processus productif. Ainsi, la composition des exportations de nombreuses économies en développement s'inscrit dans cette nouvelle organisation mondiale de la production. Il en résulte, pour ces économies, que la diversification des exportations en termes de produits ne s'accompagne plus forcément d'une transformation productive favorable au développement économique (McMillan & Rodrik, 2011). L'insertion des pays en développement dans les CVM peut contraindre ces pays à se limiter à leurs avantages comparatifs en se spécialisant dans des tâches peu complexes, intensives en main-d'oeuvre peu qualifiée et caractérisées par un fort contenu en importations. Les vertus de la diversification en termes d'effets d'entrainement sur les autres secteurs productifs sont alors remises en cause : la diversification des exportations n'étant plus que le reflet d'une industrialisation partielle de l'économie. L'intégration d'un pays dans les CVM favorisera certes son industrialisation rapide accompagnée d'une diversification de ses exportations, mais pourra également enfermer ce pays dans "une trappe de sous-industrialisation". Plus précisément, la diversification des exportations ne reflète pas forcément la transformation structurelle de l'économie et donc la dimension "qualitative" de sa croissance économique. De plus, dans le contexte de l'intensification des CVM, les pays engagés sont soumis à une plus forte interdépendance, ce qui crée une vulnérabilité face aux chocs extérieurs. La réussite de la diversification des exportations en termes de partenaires commerciaux à travers l'intégration des économies dans les marchés internationaux, notamment par le commerce Sud-Sud et les accords commerciaux, interpelle de ce fait sur la pérennité d'un tel schéma de développement. Dit autrement, la fragmentation du processus de production à l'échelle internationale soulève de nouvelles interrogations sur les vertus de la diversification pour la croissance et le développement : les nouvelles stratégies d'internationalisation des firmes sont susceptibles d'interférer dans la relation entre diversification des exportations et la croissance économique et par conséquent, au-delà de "ce qu'un pays exporte", mettent en avant l'importance de "comment ce pays exporte" (Lederman & Maloney, 2012).

De plus, de nos jours, les questions environnementales font l'objet d'une préoccupation des nations et devraient être prises en compte dans notre analyse du processus de développement économique. Depuis le début du nouveau millénaire, les pays du monde conviennent que la préservation de la qualité de l'environnement et la lutte contre le changement climatique sont des défis prioritaires. A ce jour, la volonté de réduire les émissions de gaz à effet de serre afin d'atténuer le changement climatique anime les négociations et les accords successifs entre les États membres de l'ONU. Il en va de même dans les débats économiques, où la relation entre les

problèmes de dégradation de l'environnement et la croissance de l'activité économique est au centre des analyses. En ce qui concerne les pays en développement, ceux-ci ont pour mission de relever parallèlement les défis liés à l'environnement et les défis de croissance économique et de réduction de la pauvreté. En effet, une croissance économique vertueuse ne devrait plus nuire à la qualité de l'environnement. En lien avec notre thème de recherche, on peut s'interroger alors sur la compatibilité d'une stratégie de développement basée sur la diversification avec la préservation de l'environnement.

Ainsi, une problématique principale émerge : dans quelles conditions la diversification des exportations peut-elle être un déterminant d'une croissance économique vertueuse dans les pays en développement et quels sont les canaux de transmission de cette relation ?

Dans le cadre de notre thèse de doctorat en sciences économiques, nous souhaitons explorer cette relation sous l'angle macroéconomique. A notre connaissance, peu d'études macroéconomiques ont abordé ce sujet. Notre problématique centrale autour de l'analyse des vertus de la diversification des exportations se décline en plusieurs questions qui seront traitées au fil des chapitres :

i) Prenant acte de la segmentation mondiale du processus productif, nous nous proposons de réinterpréter la relation entre la diversification des exportations et la croissance économique en transposant la problématique vers l'analyse de la soutenabilité de la croissance à long terme. Notre objectif est d'introduire une dimension qualitative dans l'appréciation de la relation entre diversification des exportations et la croissance économique, permettant par exemple de distinguer une "bonne" d'une "mauvaise" diversification en termes de transformations productives. Pour ce faire, nous réévaluons la relation entre la diversification des exportations et le développement économique dans un modèle post-keynésien de croissance contrainte par la balance des paiements. Transposée à notre problématique, ce cadre théorique consiste à confronter la restructuration de l'appareil productif, qui accompagne la diversification des exportations d'une économie, à l'évolution du solde de sa balance courante. L'idée étant qu'à long terme, la contrainte extérieure d'une économie reflète la qualité structurelle de son appareil productif. Par exemple, l'intégration d'une économie en développement dans les CVM au travers des tâches peu complexes sans transformation substantielle de l'appareil productif, à l'exemple des tâches d'assemblage, élargira certes la composition des exportations mais sera accompagnée d'un fort contenu en importations potentiellement insoute-

nable à long terme. A l'inverse, l'intégration à travers des tâches complexes à fort contenu technologique, du fait des effets de retombées sur la structure productive de l'économie en question, desserrera sa contrainte de financement extérieur.

Nous contribuons à la littérature existante sur la relation entre diversification et développement économique en proposant une méthodologie alternative en ce sens que la prise en compte simultanée des exportations et des importations dans l'analyse permet d'apprécier la qualité de la stratégie de diversification dans le contexte de l'internationalisation des firmes. Sur la période 1995-2015, nous trouvons des résultats hétérogènes pour trois échantillons de pays en développement, à savoir l'Afrique subsaharienne, l'Asie en développement et l'Amérique latine. En ce qui concerne les pays en développement d'Asie, les pays avancés concentrent leurs exportations sur des produits existants plus sophistiqués, conduisant à un impact positif sur la croissance économique soutenable à long terme, tandis que les pays arrivés plus tard dans la vague d'industrialisation entretiennent un processus de diversification, affaiblissant leur trajectoire de croissance soutenable. Pour les pays d'Afrique subsaharienne, l'effet de la diversification se limite à un effet transitoire et n'a dès lors aucun impact structurel. Enfin, les résultats pour l'échantillon de pays d'Amérique latine montrent que la concentration a un impact négatif sur le taux de croissance soutenable.

ii) Comment la diversification et la sophistication des exportations affectent-elles la croissance économique et le développement économique dans les pays d'Afrique subsaharienne ?

Comme nous l'avons déjà souligné, les organisations internationales recommandent aux pays d'Afrique subsaharienne une stratégie de développement économique fondée sur la diversification de l'économie et des exportations. En complément, la littérature en économie du développement met en évidence les expériences de croissance contrastées entre les pays d'Afrique subsaharienne et les pays en développement d'Asie. Les deux régions ont emprunté des chemins divergents en termes de transformation structurelle : les pays d'Asie de l'Est et du Sud-Est ont réussi à mettre en oeuvre une stratégie de croissance spectaculaire tirée par les exportations, alors qu'en Afrique, les pays ont accumulé des dettes extérieures et ont connu un échec dans leurs politiques de croissance tirée par les exportations en raison de leur spécialisation dans les exportations de produits à faible productivité. Cependant, malgré le large éventail d'études existantes, le mécanisme qui régit la relation diversification-croissance écono-

mique reste une boîte noire. Pour ouvrir cette boîte noire et proposer une explication des canaux de transmission de cette relation, nous exploitons les propriétés de la loi de Kaldor-Verdoorn (KVL). Celles-ci nous permettront de réexaminer la relation entre la diversification des exportations et la croissance de la productivité en tant que moteur de développement économique pour les pays d'Afrique subsaharienne. KVL affirme que la croissance économique résulte de l'interaction de long terme entre la croissance de la productivité et la croissance de la demande (Kaldor, 1966). Notre analyse a pour objectif d'aller plus loin que l'examen de l'effet de la diversification des exportations sur la croissance de la productivité. Nous identifions par quel mécanisme le changement de la composition des exportations d'un pays constitue un moteur de croissance économique vertueuse en impactant positivement les rendements d'échelle. L'idée étant que l'évolution de la structure des exportations peut affecter le taux de croissance de la productivité et, plus important encore, le niveau des rendements d'échelle.

Notre contribution est triple. Premièrement, cette approche est complémentaire à l'analyse précédente sur les effets de la diversification des exportations sur la contrainte extérieure : dans le cas présent, nous nous concentrons sur le mécanisme interne. Deuxièmement, notre objectif est de participer à la littérature sur les politiques de développement des pays africains. Troisièmement, l'étude nous permet de mener une analyse comparative sur trois échantillons de pays, à savoir l'Afrique subsaharienne, les pays en développement d'Asie et les pays de l'OCDE, afin d'actualiser la loi en comparant les coefficients de Kaldor-Verdoorn entre les économies développées et en développement. Etant donné que les trois régions sont à différents niveaux de développement, l'analyse empirique présente des résultats intéressants. Pour les pays à faible revenu d'Afrique subsaharienne, la concentration des exportations est propice à la croissance de la productivité et à des rendements d'échelle croissants. A l'inverse, pour les pays à revenu intermédiaire d'Afrique subsaharienne, la diversification et la sophistication des exportations ont un effet positif sur les rendements d'échelle croissants. Comparativement, les résultats pour l'Asie en développement montrent que la diversification et la sophistication des exportations ont une forte incidence sur les rendements d'échelle croissants. Et enfin, pour les pays de l'OCDE, la concentration et la sophistication des exportations ont un impact direct et positif sur la productivité. Ces résultats suggèrent, en ce qui concerne les pays d'Afrique subsaharienne, que la stratégie de diversification devient efficace après qu'ils aient pleinement tiré profit, à un stade

initial du processus de développement, de la concentration des exportations basées sur leurs avantages comparatifs.

iii) La relation entre diversification des produits d'exportation et les émissions de gaz à effet de serre présente-elle une tendance générale ?

La stratégie de croissance économique par le biais de la diversification des exportations peut entrer en conflit avec les objectifs environnementaux. Ce constat nous amène à nous demander si la diversification des produits d'exportation est bonne ou mauvaise pour l'environnement. Nous traitons ce sujet en étudiant empiriquement la relation entre la diversification des exportations et la pollution de l'air due aux émissions de gaz à effet de serre, c'est-à-dire les émissions de dioxyde de carbone (CO2). Pour ce faire, nous identifions deux faits stylisés robustes rapportés dans la littérature : la relation en forme de U inversé entre la diversification des exportations et le développement économique, et l'hypothèse de la courbe de Kuznets environnementale (EKC) démontrant que le niveau d'émissions de pollution suit une courbe en U inversé avec le niveau de développement. D'une part, les études empiriques montrent qu'il existe une relation non linéaire entre la diversification des exportations et le développement économique. Plus précisément, les pays entament une étape initiale au cours de laquelle la croissance du revenu est associée à une diversification de la production et des exportations jusqu'à un certain seuil de revenu, et puis dans une seconde étape, ces pays commencent une seconde phase au cours de laquelle la hausse du revenu national accompagne la concentration de la production et des exportations (Imbs & Wacziarg, 2003; Cadot et al., 2011). D'autre part, sur le plan environnemental, le niveau de pollution semble suivre une relation en U inversé avec le développement économique. L'hypothèse de l'EKC suggère qu'au premier stade du développement économique, la pollution augmente avec l'activité économique jusqu'à ce qu'un seuil de revenu soit atteint; ensuite, la hausse du revenu est suivie d'une diminution de la pollution émise. Il ressort fort logiquement de ces deux faits stylisés une relation positive entre la diversification des exportations et le niveau de pollution.

Notre contribution à la littérature est double. Premièrement, nous contribuons au débat sur le lien entre commerce et environnement. À notre connaissance, aucune étude ne s'est interrogée sur l'effet environnemental de la diversification des exportations pour un grand nombre de pays afin d'en dégager une relation globale. Deuxièmement, nous participons à la discussion autour de la validité de la courbe de Kuznets environnementale en complétant la relation par la prise en compte du degré de diversification des exportations. Pour cela, nous

examinons l'impact de la diversification des exportations sur les émissions de dioxyde de carbone (CO2), l'un des principaux gaz à effet de serre, dans les pays développés et en développement sur la période 1995-2013. Nous constatons que la courbe environnementale de Kuznets est valide et que la diversification des exportations a un impact positif sur les émissions de CO2. Nos résultats sont robustes à une variété de méthodes d'estimation.

iv) Comment pouvons-nous évaluer l'effet de la diversification des exportations dans un modèle de commerce intégrant son effet sur l'environnement ?

A la lumière du résultat précédent, nous souhaitons approfondir notre analyse. Les études empiriques et théoriques sur l'environnement attribuent la hausse et la baisse du niveau de pollution décrite par la courbe de Kuznets environnementale à trois effets : l'effet d'échelle ("scale effect"), l'effet de la technique ("technique effect") et l'effet de composition ("composition effect"). L'effet d'échelle, qui est la conséquence d'une simple augmentation de l'activité économique, conduit à une hausse proportionnelle du niveau de pollution. L'effet de la technique apparaît plus tard, lorsque la performance économique est associée à une amélioration de la technique de production, plus efficiente et plus respectueuse de l'environnement, conduisant à une atténuation des émissions de pollution. Enfin, l'effet de composition reflète la composition de la production dans l'économie et a un impact ambigu sur la pollution. Ainsi, nous souhaitons développer un modèle théorique simple qui décompose l'effet du commerce en effets d'échelle, de technique, de composition et de diversification.

Notre contribution au débat sur le lien commerce-environnement consiste en l'élaboration d'un modèle de commerce qui isole l'effet de la diversification des exportations sur les émissions de pollution induit par l'amélioration de la compétitivité-prix. Plus précisément, l'originalité du modèle repose sur la distinction entre la composition des exportations et le nombre de produits exportés, qui à notre connaissance ne sont pas explicitement identifiés dans les modèles existants. Nous examinons ensuite les leçons tirées du modèle à travers une analyse empirique sur un échantillon de 135 pays sur la période 2000-2014. Nous constatons que dans l'ensemble, la diversification des exportations entraîne une augmentation des émissions de CO2. Cependant, en prenant les pays séparément en fonction de leur niveau de revenu, une analyse plus approfondie révèle que l'effet positif de la diversification des produits exportés sur le niveau de la pollution de l'air concerne uniquement les pays à revenu plus élevé.

v) A partir d'une étude de cas sur le Vietnam, nous abordons la diversification des exportations sous l'angle de la diversification des partenaires en énonçant l'interrogation suivante : la diversification des marchés induite par une croissance tirée par le commerce conduit-elle à une résilience macroéconomique plus forte ?

Le Vietnam présente de nos jours l'une des réussites économiques les plus remarquables dans la mise en oeuvre d'une stratégie de développement axée sur les exportations, avec une diversification spectaculaire aussi bien en termes de produits que de partenaires commerciaux. Réalisant l'une des croissances les plus rapides parmi les économies en développement, l'économie est également l'une des plus ouvertes au commerce extérieur. Nous analysons la performance économique du pays au cours des trente dernières années vis-à-vis de la contribution de ses partenaires commerciaux sur sa contrainte extérieure. Les conséquences de l'adhésion à l'Organisation Mondiale du Commerce (OMC) en 2007 et la vulnérabilité du pays suite au choc de la pandémie de Covid-19 sont également examinées à travers un modèle multi-pays de croissance contrainte par la balance des paiements. Nos résultats montrent que son adhésion à l'OMC a fortement resserré sa contrainte extérieure, ce qui s'explique principalement par une plus grande dépendance aux importations vis-à-vis des chaînes de valeur régionales. Par ailleurs, la prévision du FMI sur le taux de croissance du pays dans le contexte de la crise sanitaire mondiale liée à la Covid-19 nous permet d'observer que le Vietnam serait en déficit courant du fait de sa dépendance à certaines relations commerciales avec les partenaires qui ont subi fortement les effets négatifs de la pandémie. Plus généralement, cette étude de cas sur le Vietnam pose, dans le contexte actuel de la mondialisation, les questions de la résilience macroéconomique et des vertus d'un modèle de développement tirée exclusivement par le commerce international.

En guise de perspectives, les travaux présentés dans ce manuscrit nous inspirent quelques pistes de recherche futures.

Tout d'abord, un modèle multisectoriel de croissance contrainte par la balance des paiements devrait être proposé afin d'identifier les secteurs prometteurs et propices à un taux de croissance de long terme plus élevé compatible avec l'équilibre de la balance des paiements.

Deuxièmement, la diversification des importations mériterait une attention particulière. Peu d'études ont porté sur le rôle des importations, et plus particulièrement de la diversification des importations, dans la transformation structurelle d'une écono-

mie. Cependant, le peu de littérature sur le sujet met en avant certains arguments tels que le lien de causalité entre la productivité et la diversification des importations, et l'impact positif de la diversification des importations, notamment dans les intrants intermédiaires, sur la diversification des exportations (Bas & Strauss-Kahn, 2014). Par exemple, Parteka & Tamberi (2012) présentent l'évolution conjointe de la diversification des importations et des exportations le long de la trajectoire du développement et constatent que l'évolution de la diversification des importations est similaire à celle des exportations, c'est-à-dire que les pays ont tendance à diversifier leurs importations lorsque le niveau de revenu augmente. Il serait alors intéressant d'étudier le rôle de la diversification des importations dans la dynamique des changements structurels, à moyen et long terme, et de l'intégrer dans un modèle de croissance qui prend en compte l'interaction entre la diversification des exportations et celle des importations dans le processus de croissance.

Notre problématique devrait également s'élargir à l'analyse du secteur spécifique des services. Le secteur des services dans l'économie mondiale d'aujourd'hui est vital car il participe au fonctionnement du commerce et facilite la connexion entre les chaînes de valeur mondiales. Par exemple, les télécommunications, l'énergie et les transports sont des facteurs clés essentiels qui sont déterminants dans la compétitivité sur les marchés internationaux. Par conséquent, le secteur des services est un vecteur crucial de la performance économique et de la croissance économique. Au cours des dernières décennies, il a joué un rôle croissant dans le commerce et la transformation structurelle des pays à faible revenu à mesure que sa part dans la valeur totale des exportations augmente. La part du secteur des services dans les exportations totales des pays en développement est passée de 14 à 17 pour cent de 2005 à 2016 (UNCTAD, 2017). Le marché du tourisme est un autre exemple. L' UNCTAD (2017) estime que l'Afrique et l'Asie augmenteront leur parts dans le nombre d'arrivées de touristes internationaux au cours de la période 2016-2030. Le secteur est vital pour certains pays les moins avancés, par rapport au reste du monde : par exemple, le secteur du tourisme et du voyage à Madagascar représente 17.6 percent de ses exportations totales en 2018. [1]D'une part, leur caractère unique en matière de ressources naturelles (paysage, soleil, faune et flore) et culturelles montrent que ces pays ont un avantage comparatif dans les déterminants du tourisme et, d'autre part, l'existence de liaisons sectorielles vers l'amont solides, car l'afflux de visiteurs augmenterait la demande de biens produits par d'autres industries (à l'exemple des services tels que le transport et la communication, la construction, l'alimentation et les boissons),

1. The Atlas of Economic Complexity: What did export Madagascar in 2018, https://atlas.cid.harvard.edu/explore?country=136&product=undefined&year=2018&productClass=HS&target=Product&partner=undefined&startYear=undefined

favoriserait les investissements et encouragerait la diversification de l'ensemble de l'économie (UNCTAD, 2017). Il serait alors intéressant d'étudier plus en détails le secteur des services et d'examiner l'interaction entre la structure des services et la transformation structurelle.

Contents

General Introduction **35**

Context . . . 35

Motivation and research question . . . 38

Results and contributions . . . 40

Outline . . . 45

Chapter 1: Literature review **47**

Introduction . . . 47

1.1 Export structure, economic development and theoretical underpinnings 48

1.1.1 Old debates on trade and growth theories: a divergence of insights . . . 49

1.1.1.1 The traditional trade theories and the virtues of specialization . . . 49

1.1.1.2 The rich, the poor and the specialization pessimism . 50

1.1.2 The New new trade theories and the New Structural Economics: a consensus on diversification . . . 53

1.1.2.1 The New new trade theory: a dynamic industry model 53

1.1.2.2 The New Structural Economics . . . 54

1.1.2.3 The role of the manufacturing sector and the Balance of Payments Constrained Growth (BOPCG) models in structural change . . . 56

1.2 On the linkage between diversification and economic development: the origins of the revival interest . . . 60

1.2.1 A contrasting experience between developing Asian countries and other developing regions (Africa and Latin America): the importance of history . . . 60

1.2.1.1 The East Asian miracle: the successive waves of industrialization in Eastern Asia. . . . 61

1.2.1.2 A (still) lagging Africa and lack of competitiveness of Latin America . . . 63
1.2.1.3 The curse of natural resources . . . 65
1.2.2 The inverted U-shaped relationship between diversification and development: a robust stylized fact . . . 66
1.3 So, what is diversification and how to measure it ? A literature review on the measures and the dimensions of diversification . . . 68
1.3.1 The traditional measure of concentration . . . 69
1.3.2 The margins of export diversification . . . 71
1.3.3 Sophistication of exports . . . 73
1.3.4 The Global value chains . . . 80
1.4 How can an export diversification strategy be a driver of development and why should a developing country choose such a strategy ? . . . 82
1.4.1 Determinants . . . 82
1.4.1.1 Country characteristics . . . 82
1.4.1.2 Trade policies as determinant of export diversification 84
1.4.1.3 The role of relative prices . . . 86
1.4.2 Benefits . . . 87
1.4.2.1 A remedy to the "curse of natural resources" . . . 87
1.4.2.2 On macroeconomic stability and sustained economic growth and development . . . 88
1.4.2.3 Effects on productivity . . . 88
Conclusion . . . 89

Chapter 2: Product export diversification and sustainable economic growth in developing countries 91
2.1 Introduction . . . 92
2.2 Export diversification in developing countries . . . 96
2.2.1 Measuring tool . . . 96
2.2.2 Stylized facts . . . 97
2.3 Balance of Payments Constrained Growth Theory and export diversification . . . 102
2.3.1 The theoretical framework . . . 102
2.3.1.1 The stationary state and the definition of the long-run sustainable growth path . . . 104
2.3.1.2 The impact of export diversification on the sustainable growth rate . . . 106
2.3.2 Estimation issues . . . 107

2.4 Results . . . 109
2.5 Conclusion . . . 115

Appendices **117**
2.A Countries by region . . . 117
2.B Export diversification in selected countries over time (1995-2015) . . . 118
2.C Estimation results: impact of export product diversification in the 3 developing regions . . . 119

Chapter 3: Export diversification, export sophistication and the actuality of Kaldor-Verdoorn's Law in Sub-Saharan Africa, Developing Asia and OECD countries **126**
3.1 Introduction . . . 127
3.2 Export diversification and Kaldor-Verdoorn's Law: an alternative approach . . . 129
3.2.1 Export diversification and Kaldor-Verdoorn's Law: a literature review . . . 129
3.2.2 The expanded version of the Kaldor-Verdoorn Law . . . 134
3.3 Data used and Stylized Facts . . . 136
3.3.1 Data description . . . 136
3.3.2 Stylized facts . . . 140
3.4 Specification and empirical methodology . . . 144
3.4.1 Empirical specifications . . . 144
3.4.2 Preliminary tests and econometric methodology . . . 145
3.5 Results and Discussions . . . 147
3.5.1 Impact of export diversification and sophistication in Sub-Saharan Africa: a comparative analysis . . . 148
3.5.2 A comparison within the Sub-Saharan African region . . . 156
3.6 Concluding Remarks . . . 159

Appendices **161**
3.A Country List . . . 161
3.B Summary Statistics . . . 161

Chapter 4: Export diversification and CO2 emissions: an augmented environmental Kuznets curve **165**
4.1 Introduction . . . 166
4.2 Stylized facts . . . 170
4.3 Data, specification and methodology . . . 173

4.3.1 Data . . . 173
4.3.2 Equation Specification . . . 174
4.3.3 Methodology . . . 175
4.3.4 Preliminary tests . . . 177
4.4 Empirical results . . . 179
4.5 Concluding remarks . . . 184

Chapter 5: Trade and the environment: assessing the effect of export diversification on pollution emissions 187
5.1 Introduction . . . 188
5.2 The theoretical model . . . 191
5.2.1 The model . . . 191
5.2.1.1 The pollution emissions . . . 192
5.2.1.2 Producers . . . 192
5.2.2 Scale, technique and composition effects . . . 193
5.2.2.1 The aggregated composition effect . . . 194
5.2.2.2 The industry level composition effect . . . 194
5.2.2.3 Introduction of output symmetry . . . 195
5.2.3 The effect of export diversification on pollution emissions . . . 197
5.2.3.1 Country characteristics . . . 197
5.2.3.2 Impact of export diversification on pollution emissions 199
5.3 Empirical Analysis . . . 202
5.3.1 Data calculations and sources . . . 202
5.3.2 Estimation equations and empirical methodology . . . 204
5.3.3 Results and discussions . . . 205
5.3.3.1 All country analysis . . . 205
5.3.3.2 More advanced countries versus less advanced countries 207
5.3.3.3 Robustness checks . . . 210
5.4 Conclusion . . . 212

Appendices 213
5.A The Composition Effect definition . . . 213
5.A.1 The aggregated composition effect . . . 213
5.A.2 The disaggregated composition effect . . . 213
5.B The Emission Pollution expression . . . 214
5.B.1 The emission pollution before symmetry assumption . . . 214
5.B.2 pollution emission expression after symmetry assumption . . . 216
5.C The effect of export diversification on pollution emissions . . . 216

5.D List of countries . . . 218
5.E Summary statistics . . . 218

Chapter 6: Vietnam's trade-led growth, balance of payments and macro resilience **221**
6.1 Introduction . . . 222
6.2 Research background . . . 225
6.2.1 On the basic model . . . 225
6.2.2 Our multi-country version of Thirlwall's law . . . 227
6.3 Data and estimation issues . . . 231
6.3.1 Data Analysis . . . 231
6.3.2 Estimation results on the long-run elasticities . . . 233
6.4 The BP equilibrium growth rate . . . 235
6.4.1 Overall analysis . . . 235
6.4.2 An analysis by sub-period . . . 239
6.5 Trade-led growth and macroeconomic resilience . . . 240
6.5.1 How WTO accession can explain the external constraint development ? . . . 241
6.5.2 Trade-led growth and balance of payments constraint in the face of global shocks . . . 246
6.6 Conclusion . . . 249

Appendices **252**
6.A Vietnam's trading partner groups . . . 252
6.B Data sources and definitions . . . 252
6.C Unit root tests . . . 253
6.D Econometric estimates of trade elasticities . . . 254

General Conclusion **263**

List of Tables and Figures

1.1 **Developing regions' growth trend (1950-2008)** 61
1.2 **Growth rates by country groups** 64
1.3 **Within and Between components of Theil index** 68
1.4 Product Complexity Index in 1995 and 2017 77
1.6 Economic complexity index in 1995 and 2017 78
1.5 Product Space for Vietnam and Madagascar in 1995 and 2018 79

2.1 **Export diversification by region over time (1995-2015)** 98
2.2 **Extensive vs. intensive margins in 1995 and 2015** 99
2.3 The relationship between export diversification and sustainable growth 108
2.5 Direct and indirect effects of export diversification 111
2.6 Theil index in developing regions 118
2.7 Extensive and intensive Theil indices in developing regions 119
2.8 Impact of export product diversification on Developing Asia (Export function) 120
2.9 Impact of export product diversification in Developing Asia (Import function) 121
2.10 Impact of export product diversification on sub-Saharan Africa (Export function) 122
2.11 Impact of export product diversification in sub-Saharan Africa (Import function) 123
2.12 Impact of export product diversification in Latin America(Export function) 124
2.13 Impact of export product diversification in Latin America (Import function) 125

3.1 **Linkage between level of gross domestic product in real terms and product export diversification (1995-2017)** 141

3.2 **Linkage between level of income and product export diversification (1995-2017)** . . . 142
3.3 **Linkage between level of gross domestic product and export sophistication (1995-2017)** . . . 143
3.4 **Linkage between income and export sophistication (1995-2017)** 144
3.5 Preliminary tests . . . 146
3.6 Kaldor-Verdoorn's Law in Sub-Saharan Africa, Developing Asia, and OECD . . . 149
3.7 Impact of export diversification (measured by HH index) and expanded Kaldor-Verdoorn's Law . . . 151
3.8 Impact of export diversification (measured by Theil index) and expanded Kaldor-Verdoorn's Law . . . 153
3.9 Impact of export sophistication and expanded Kaldor-Verdoorn's Law 155
3.10 Middle-income and Low-income countries in sub-Saharan Africa . . . 157
3.11 Country list . . . 162
3.12 Summary statistics . . . 163

4.1 **Relationship between economic development and CO2 emissions (1995-2013)** . . . 171
4.2 **Relationship between economic development and export diversification (1995-2013)** . . . 172
4.3 List of countries . . . 174
4.4 Summary of descriptive statistics and sources . . . 175
4.5 Pesaran (2004) cross-sectional dependence test and unit root tests . . . 177
4.6 Cointegration tests . . . 179
4.7 Main estimation results . . . 180
4.8 Results for robustness check estimations . . . 182

5.1 **The evolution of home and foreign prices as a function of polluting intensity** . . . 199
5.2 Estimation results for all countries . . . 206
5.3 Estimation results for less advanced countries and more advanced countries . . . 209
5.4 Estimation results for robustness checks . . . 211
5.5 List of countries . . . 219
5.6 Summary statistics . . . 220

6.1 **Trade openness in % of GDP for Vietnam, Developing Asia and LMI group (1990-2018)** . . . 223
6.2 **Vietnam's current account balance in current USD millions (1990-2017)** . . . 224
6.3 A summary of the estimated elasticities . . . 234
6.4 Geographical breakdown of Vietnam's BoP constrained growth rate (1990-2017) . . . 236
6.5 **Average annual growth rates of relative prices by trading partner (in %)** . . . 237
6.6 **Average annual GDP growth rates for Vietnam's trading partners (in %)** . . . 238
6.7 Trade market shares (in %) . . . 238
6.8 Vietnam's BoP constrained and actual growth rates by sub-periods . 239
6.9 **Breakdown of the total tightening in Vietnam's BoP constraint between the two sub-periods 1990-2007 and 2008-2017** . . . 242
6.10 A full breakdown of the total decrease in Vietnam's BoP-constrained growth rate between 1990-2007 and 2008-2017 by effect and by partner area (in %) . . . 244
6.11 Some projections on Vietnam's economic growth (2018-2024) . . . 248
6.13 Unit root test results . . . 255
6.14 Results for import equations with Gregory and Hansen (1996) estimation . . . 256
6.15 Results for import equations with Pesaran, Shin and Smith (2001) estimation . . . 256
6.16 Results for export equations with Engle and Granger (1987) estimation 257
6.17 Results for export equations with Engle and Granger (1987) estimation(continued) . . . 258
6.12 Results for import equations with Engle and Granger (1987) estimation 259
6.18 Results for export equations with Gregory and Hansen (1996) estimation 260
6.19 Results for export equations with Gregory and Hansen (1996) estimation (continued) . . . 261
6.20 Results for export equations with Pesaran, Shin and Smith (2001) estimation . . . 262

General Introduction

Context

After gaining independence, one of the main challenges facing developing countries is the reduction in poverty in order to increase their standard of living and converge with developed economies. In the context of globalization, the increasing trade openness through their participation in international trade was inevitable. Since 1980, developing countries have undergone a period of accelerated trade liberalization. The developing countries' share in global output and global trade rose from 39 and 32 percent respectively in 2000 to reach around 50 percent of both in 2014 (WTO, 2014). Access to global markets has made international trade a major determinant of economic growth and therefore a key driver in economic development. It should be noted that the two terms must be differentiated: economic growth is defined as an increase in the gross domestic product (GDP) of an economy and economic development is the structural change induced by the economic growth that contributes to a qualitative increase of the standard of living of the population.

Since 1990, the world trade landscape has changed with a progressive increase in bilateral trade flows between developing countries. The reconfiguration of international trade characterized by the deep increase in the share of trade flows between developing countries, broadly known as the *South-South trade*, has been led by the emergence of certain rapidly growing countries, notably emerging countries members of G20 (WTO, 2014).[2] The share of South-South exports in total developing countries' exports rose from 33.7 percent in 1990 to 57 percent in 2012, while on the import side of South-South trade, the share in total imports was of 59 percent in 2012 (UNCTAD, 2015). In addition, from 1988, the share of South-South Global Value Chains (GVCs) increased from 6 percent of global trade to 25 percent in 2013 (WTO, 2014). Thus, the relationship between international trade and economic de-

2. List of countries members of G20: South Africa, Germany, Saudi Arabia, Argentina, Australia, Brazil, Canada, China, South Korea, United States of America, France, India, Indonesia, Italia, Japan, Mexico, United Kingdom, Russia, Turkey, European Union.

velopment, notably through exports as an aggregated component of the GDP, is now well established.

However, over the last few decades, developing countries have been experiencing an uneven pace in terms of growth trajectory.

On the one hand, history has witnessed successive waves of successful growth of emerging economies, notably Asian countries, which have implemented government policies that promoted economic and export diversification by defying their comparative advantage. Indeed, the share of world manufacturing exports attributed to developing Asia has increased from 11.1 percent to 21.1 percent over the period 1996-2010 (UNCTAD, 2015). The most obvious example is the rise of China as a global competitor and the largest exporter, with an economic growth rate beyond 10 percent in the 2000s. The other example is India, growing at high rates around 7.5 percent between 2000 and 2011 (WTO, 2014). Emerging countries in the G20 seem to have generated incomes that converge towards those of developed nations: they have grown by 5.2 percent on average whereas economic activity in developed countries has slowed down over the two last decades. (WTO, 2014).

On the other hand, other nations are lagging behind, notably in Africa, and to a lesser extent in Latin America, and are characterized by unstable economic growth, narrowed export baskets and limited trading partners. They have experienced the failure of several economic policies and suffered from debt crisis and macroeconomic instability.

There is a striking contrast in terms of the evolution in export composition between the two groups of developing countries: while manufactures have surpassed primary products in developing Asian countries, in Africa and Latin America, the composition of exports has not changed and has been dominated by commodities (UNCTAD, 2015). Nowadays, most of the low-income countries are located in Africa, whereas the fiercest competitors in trade, notably China, are located in East Asia.

Thus, as far as developing countries are concerned, there is a consensus on the virtues of diversity of economic activity and export diversification, broadly defined as the increase in the number of products or trading partners. International institutions emphasize the vulnerability of low-income countries linked to a pattern of international specialization, in terms of products and partners. The concentration on a few exports exposes them to the risk of a deterioration in the terms of trade and instability in export earnings because of price fluctuations. In particular, commodities and natural resources are sources of volatility in export earnings. For instance, between 2003 and 2008, the price of mining products increased by 178 percent and prices of fish and forestry products rose by 38 percent and 26 percent respectively

(WTO, 2010).

This consensus on the virtues of export diversification is relatively recent. On the theoretical level in the 1950s, debate was stimulated by controversies between economists promoting free trade and structuralist economists. Since Ricardo (1817), the former had been inspired by traditional theories of international trade and advocated free trade and specialization based on a country's comparative advantages. The new theories of international trade initiated by Krugman (1979) updated the thesis by considering the increasing returns to scale and showed the benefits of a country opening up to international trade through export concentration.

Inspired by Prebisch (1950) and Singer (1950), the pioneers of development economics discussed how the comparative advantage argument definitely led developing countries to a worsening of their growth path. They explained that the heterogeneity of structural characteristics between countries led to a trade configuration in which industrialized countries exported high value-added manufactured goods and less developed countries exported primary products or labor-intensive goods that have low income elasticity, low productivity and strong price fluctuations. The volatility of export earnings and the declining terms of trade were condemning developing economies to "immiserizing" growth. Therefore, export diversification was seen as a solution as it reduces an economy's vulnerability to external demand shocks and is conducive to the technological spillovers that are essential for economic take-off.

Emphasizing the importance of diversification and composition of exports for the structural transformation in a developing nation, the contemporary structuralist school has revived the argument against the comparative advantages theory which highlights the need for development policies to distort the specialization mechanisms (Cimoli et al., 2011). However, recently, there has been a theoretical convergence. New versions of mainstream models also present export diversification as a factor for economic growth. Based on an extension of Krugman (1979)'s model, the "new new trade theory" introduces heterogeneity in productivity between firms into trade models. Within a monopolistic competition framework where each firm produces a variety of differentiated good, these models, such as Melitz (2003), show that a reduction in trade costs increases the number of exporting firms and will naturally increase export diversification. The increase in productivity at the aggregated level occurs through a selection effect where the market shares are reallocated to the most productive firms. Therefore, these models explain economic growth as the consequence of export diversification following trade intensification.

However, a major difference remains between neo-structuralist economists and mainstream economists. Whereas the former recommend an active state interven-

tion for export diversification, the latter argue that it is naturally associated with a reduction in trade costs. Except for this important economic policy controversy, a consensus has been reached around the statement that export diversification contributes positively to economic growth and development.

Empirically, several robust studies corroborate the benefits of diversification on various samples of developing countries. A first wave of studies called the "natural resource curse" has focused on the harms of an exclusive specialization in primary goods for developing countries, such as the decline in the terms of trade between industrialized and non-industrialized countries, volatility of export earnings and low productivity (Auty, 2000). Other studies directly emphasize the positive impact of export diversification on economic growth in developing countries (IMF, 2017a). More specifically, the pioneering works of Imbs & Wacziarg (2003) and Cadot et al. (2011) show that the first stage of a country's development process is characterized by a positive and strong linkage between per capita income and diversification of production and exports.

Motivation and research question

Beyond this consensus, the effectiveness of an economic model is conditioned by its historical context. A growth model based on export diversification that was source of structural transformation for development in the 1950s, such as the successes of Asian economies, may lead to economic fragility nowadays due to the intense economic globalization process since 1990.

Nowadays, the world economic landscape is dominated by highly vertical fragmentation of production where countries, especially developing ones, participate in specific tasks in the production chain. The export composition of many developing economies falls within this new world production system where economies integrated into global value chains (GVCs) no longer specialize in the production of a product, but in a delimited segment of the production process.

It follows that product export diversification is no longer necessarily accompanied by a productive transformation favorable to economic development (McMillan & Rodrik, 2011). The integration of developing countries in GVCs may force them to limit themselves to their comparative advantages by specializing in low-skilled tasks characterized by a high import content. Therefore, the virtues of diversification, such as the spillover effect on other productive sectors, is called into question. The diversification of exports would induce a partial industrialization of the economy: the integration of a country into international markets will certainly promote its

rapid industrialization from diversification of exports, but may also lock the country in "a trap of under-industrialization". These arguments emphasize the fact that the structural transformation of an economy and the qualitative dimension of its economic growth are not necessarily reflected in the success of export diversification.

In addition, in the context of the intensification of GVCs, the countries involved are subject to greater interdependence, which is a source of vulnerability to external shocks. The successful diversification of exports in terms of trade partners through the integration of economies into international markets, especially through South-South trade and trade agreements, questions the sustainability of such a development scheme.

Therefore, the international fragmentation of the production process raises new questions about the virtues of diversification for growth and development. The new firm internationalization strategies are likely to interfere in the relationship between export diversification and economic growth and therefore, beyond "what a country exports", put forward the importance of "how that country exports"(Lederman & Maloney, 2012).

Moreover, to achieve economic development, environmental issues are of concern to nations and should be taken into account in our analysis. Since the beginning of the new millennium, countries around the world have agreed that preserving the quality of the environment and mitigating climate change are priority challenges. So far, the desire to reduce greenhouse gas emissions to mitigate climate change drives negotiations and successive agreements between UN member states. The same is true in economic debates, where the relationship between environmental degradation and the growth of economic activity is at the center of discussions. As far as developing countries are concerned, their mission is to meet the challenges of the environment alongside the challenges of economic growth and poverty reduction. Indeed, a virtuous economic growth should not harm the quality of the environment anymore. One can then question the compatibility of a development strategy based on diversification with the preservation of the environment.

In light of these arguments, a principal key question arises: what are the conditions under which export diversification can be a determinant of virtuous economic growth in developing countries and through which transmission channels the relationship occurs ?

As part of our doctoral thesis in economics, we aim to explore the relationship between export diversification and sustained economic growth at macroeconomic level. To our knowledge, few macroeconomic studies have addressed this subject.

Our key question will be broken down into topics that will address the following questions:

i) How can we assess the quality of a country's productive structure resulting from export diversification in today's context of globalization ?

ii) How do export diversification and export sophistication affect the sustained economic growth and economic development in the sub-Saharan African region ?

iii) Does the linkage between product export diversification and greenhouse gas emissions exhibit a general pattern ?

iv) How can we assess the effect of export diversification within a trade-environment nexus model ?

v) From a country case study of Vietnam, we approach export diversification from the perspective of partner diversification by asking the following question: has market diversification induced by trade-led growth brought Vietnam to a stronger macroeconomic resilience ?

Results and contributions

Therefore, the above topics will be examined consecutively throughout the chapters in this manuscript.

i) Taking note of the international segmentation of production, we propose to re-explore the relationship between export diversification and economic growth in chapter 2 by shifting the focus towards an analysis of the long-run sustainability of economic growth. Our purpose is to introduce a qualitative dimension into the assessment of the linkage between export diversification and economic growth, making it possible to distinguish "good" from "bad" diversification in terms of productive transformation. We re-assess the relationship between export diversification and economic development within a post-keynesian balance-of-payments-constrained growth (BOPC) model. Integrated into our research question, the theoretical framework will allow us to compare the structural transformation of productive capacities that accompanies an economy's export diversification with the evolution of the current account balance. The idea is that an economy's external constraint reflects the structural quality of its productive apparatus in the long run. For example, a developing economy's integration into GVCs through low-skilled tasks, such as assembly tasks, without substantial transformation of the productive apparatus, will certainly

broaden the composition of exports. However, it will be accompanied by a high import content that is potentially unsustainable in the long run. Conversely, integration through high-skilled tasks with a high technological content could relax its external financing constraint as a result of spillover effects on the economy's productive structure.

We contribute to the existing literature on diversification and development linkage by proposing an alternative methodology. The simultaneous consideration of exports and imports in the analysis enables us to assess the quality of diversification strategy in the context of firm internationalization. Over the period 1995-2015, we find heterogeneous results for three samples of developing countries, namely sub-Saharan Africa, Developing Asia and Latin America. Advanced developing Asian countries are following a concentration of exports in terms of more sophisticated existing products which has a positive impact on the long-run sustainable economic growth, whereas latecomers' diversification process has weakened their sustainable growth path. For sub-Saharan African countries, the effect of diversification is limited to a transitory effect. Lastly, results for the Latin America sample exhibit a concentration which negatively impacts the sustainable growth rate.

ii) Chapter 3 examines the role of export diversification and export sophistication on the sustained economic growth process in sub-Saharan Africa.

As we have mentioned earlier, international organizations recommend that sub-Saharan African countries follow an economic development strategy based on the diversification of their economy and exports. In addition, literature on development economics highlights the contrasting growth experienced by the countries of sub-Saharan Africa and the developing countries of Asia. The two regions have taken divergent paths in terms of structural transformation: while in Africa, countries have accumulated external debt and have experienced failure in their export-led growth policies due to their specialization in low productivity products, the countries of East and Southeast Asia have succeeded to implement export-oriented growth strategy. However, despite the wide range of existing studies, the mechanism governing the diversification-economic growth relationship remains a black box. To open this black box and propose an explanation of the transmission channels of this relationship, we use the properties of the Kaldor-Verdoorn law (hereafter KVL) that will re-examine the relationship between export diversification and productivity growth as an engine of economic development in sub-Saharan African countries. KVL as-

serts that economic growth results from the long-term interaction between productivity growth and demand growth (Kaldor, 1966). Our analysis aims to go further than examining the effect of export diversification on productivity growth. We identify the mechanism through which the change in the country's export composition acts as an engine of virtuous economic growth by positively impacting returns to scale. The idea is that changes in export structure can affect the rate of productivity growth and, more importantly, the level of returns to scale.

Our contribution is threefold. First, this approach is complementary to the previous analysis of the effects of export diversification on the external constraint: in this case, we focus on the internal mechanism. Second, our objective is to contribute to the literature on development policies for African countries. Third, we intend to conduct a comparative analysis on three samples of countries, namely sub-Saharan Africa, developing countries in Asia and OECD countries, in order to update the law by comparing the Kaldor-Verdoorn coefficients of developed and developing economies. Since the three regions are at different stages of development, the empirical analysis presents interesting results. For low-income countries in sub-Saharan Africa, the concentration of exports is conducive to productivity growth and increasing returns to scale. For middle-income countries in sub-Saharan Africa however, the diversification and sophistication of exports have a positive effect on increasing returns to scale. Comparatively, the results for developing Asia show that export diversification and sophistication have a strong impact on increasing returns to scale, and finally for OECD countries, the concentration and sophistication of exports have direct and positive effect on productivity. These results suggest that for sub-Saharan Africa, the diversification strategy becomes effective after economies have taken full advantage, at an initial stage of the development process, of the concentration of exports on the products for which they have a comparative advantage.

iii) In Chapter 4, we focus on environmental issues by investigating the general relationship between export diversification and air pollution from greenhouse gas emissions, that is the carbon dioxide (CO2) emissions.

Economic growth strategy through export diversification should not conflict with the objectives of environmental preservation. This observation leads us to question whether export diversification in terms of products is good or bad for the environment. We address the topic by empirically studying the rela-

tionship between export diversification and air pollution due to greenhouse gas emissions, that is, CO2 emissions. To do so, we identify two robust stylized facts reported in the literature: the inverted U-shaped pattern between export diversification and economic development on the one hand, and the environmental Kuznets curve (EKC) hypothesis, showing an inverted U-shaped relationship between pollution emissions and economic development, on the other. Empirical studies show that there is a non-linear relationship between export diversification and economic development. Specifically, countries enter an initial stage in which income growth is associated with product and export diversification until an income threshold is reached, and then these countries begin a second stage in which the rise in product and export concentration is associated with development (Imbs & Wacziarg, 2003; Cadot et al., 2011). On the environmental impact, the level of pollution seems to follow an inverted U-shaped relationship with economic development. Specifically, the EKC hypothesis suggests that at the first stage of economic development, pollution increases with economic activity until an income threshold is reached; then, the increase in income is followed by a decrease in pollution emissions. The observation of the two stylized facts may reflect that increase in CO2 emissions is positively associated with export diversification.

In this chapter, our contribution to the literature is twofold. First, we contribute to the debate on trade-environment nexus. To the best of our knowledge, no research study has yet questioned the effect of export diversification on a large group of developed and developing countries. Second, we participate in the debate on the validity of the EKC, which shows that pollution emissions follow an inverted U-shaped linkage with the level of development. We empirically investigate the relationship from a sample of 98 developed and developing countries over the period 1995-2013 in order to derive a generalized pattern. We find that the EKC is valid and export diversification has a positive impact on CO2 emissions. Our findings are robust to any change in estimation methods.

iv) In light of the previous results, in Chapter 5, we construct a simple theoretical model that decomposes the trade effect into scale, technique, composition and diversification effects.

Empirical and theoretical studies on the environment attribute the rise and fall in the level of pollution described by the EKC to three effects: the scale effect, the technique effect and the composition effect. The scale effect, which

is the environmental consequence of a simple increase in economic activity, leads to a proportional increase in the level of pollution. The technique effect appears later, when economic performance is associated with technical progress improving the quality of the environment and leading to emission alleviation. Finally, the composition effect reflects the impact of a change in production composition of the economy and has an ambiguous impact on pollution. Thus, we develop a simple theoretical model that decomposes the effect of trade into effects of scale, technique, composition and diversification.

Our contribution to the debate on the trade-environment nexus relies on a proposition of a trade model that isolates the export diversification effect on pollution emissions induced by improvement in price competitiveness. More specifically, the novelty is the distinction between composition of exports and the range of exported goods, which to our knowledge was not precisely identified in other models. We then examine the lessons drawn from the model through an empirical analysis on a sample of 135 countries over the period 2000-2014. We find that overall, export diversification would generate an increase in CO2 emissions. However, taking the countries separately according to their income level, further investigation shows that the positive impact of export diversification on CO2 emissions concerns solely countries with higher income.

v) In chapter 6, we present a country case study on Vietnam. Vietnam is one of the most remarkable success stories in implementing an export-led development strategy with a dramatic increase in export diversification in terms of products and trading partners. Indeed, in achieving one of the most rapid growth rates among the developing economies, the country is also one of the most open economies. In this last chapter, our aim is to investigate the economic performance of the country over the last thirty years *vis-à-vis* the respective contribution of partner areas to its external constraint. The consequences of WTO accession in 2007 and vulnerability to external shocks in the case of covid-19 pandemic are examined through a multi-country balance-of-payments-constrained growth model. Overall, Vietnam is doing well with respect to its balance of payments constraint. However, the accession to WTO has strongly tightened its external constraint that is mostly explained by higher import dependence from regional value chains. Finally, the IMF projection of growth rates in the context of Covid-19 pandemic enables us to observe that Vietnam would be in a current account deficit because of its dependence in some trade relations. More generally, this case study on Vietnam questions, in the current context of

globalization, the macroeconomic resilience and the virtues of a development model driven exclusively by international trade.

Outline

This manuscript is constructed as follows. Chapter 1 explores the literature review on export diversification and economic development. Chapters 2 to 6 gather the topics discussed above. Chapter 2 examines the qualitative dimension of economic growth resulting from product export diversification for sub-Saharan Africa, Developing Asia and Latin America in a BOPC model. Chapter 3 investigates the relationship between export diversification, export sophistication and the Kaldor-Verdoorn's Law in sub-Saharan Africa, Developing Asia and OECD countries. Chapter 4 gives an empirical analysis on the general relationship between export diversification and CO2 emissions in an augmented environmental Kuznets curve context. Chapter 5 assesses the effect of export diversification on pollution emissions within a trade-environment nexus model. Chapter 6 focuses on Vietnam, its trade-led growth, balance of payments and macroeconomic resilience. Finally, the general conclusion will outline the main results of our research work and our recommendations for the direction of possible future research.

Chapter 1

Literature review

Introduction

In this first chapter, we will present the literature review on the relationship between trade diversification and economic development in developing countries. There is a consensus on the benefits of economic and export diversification as a development strategy. It is believed that it reduces vulnerability to external shocks, minimizes volatility of export earnings and fosters sustained export growth. The debate is not new and was at the center of concerns in the 1950s. Opposed to the traditional trade theories that advocate specialization according to comparative advantages, structuralist economists argue that developing economies mostly endowed with primary products go through declining terms of trade, condemning them to a slow growth. The debate is revived today with a consensus on the positive effect of diversification on structural transformation. It has two main sources. The first is the wave of emerging countries that successfully implement export-oriented growth. The second is the strand of recent empirical studies highlighting a robust stylized fact which shows that along the development path, diversification and economic development have an inverted U-shaped relationship. More specifically, as far as developing countries are concerned, the stylized fact emphasizes that economic development is associated with an increase in diversity of production and exports.

Thereafter, the rise of emerging countries integrating into the world economy has dramatically changed the international trade landscape. The expansion of the Global Value Chains (GVCs) and the uneven path of the development process undergone by developing nations have raised economists' interests on the importance of trade structure and have contributed to fueling economists' studies in measuring and analyzing the determinants and consequences of trade diversification.

This chapter is structured as follows. The first section explores the theoretical underpinnings that link economic development to the structure of exports. The second section presents the empirical origins of the interest in diversification. The third section discusses the existing definitions and measurements of diversification variable. Finally, section four will present its determinants and benefits.

1.1 Export structure, economic development and theoretical underpinnings

Economic theories are constantly evolving in order to describe and explain economic dynamics. Their ultimate purpose is to enhance human welfare and improve standards of living. Especially, Arthur Lewis (1984), quoted by Thirlwall (1986), says that an *"economist's dream would be to have a single theory of growth that took an economy from the lowest level of say $100 per capita, past the dividing line of $2,000 up to the level of Western Europe and beyond."*. However, a single growth theory cannot fully describe all the transformation processes of different countries at different development stages. But in the era of globalization, the road to development undeniably lies in success in trade integration and the resulting structural change. Since exports are a component of aggregated output, an increase in output growth would positively correlate with greater market size by opening up to international trade. In addition to the increase in market size, existing literature suggests that due to induced externalities, greater increasing returns to scale and higher productivity, economies will gain more if they shift to exports.

These benefits are closely related to the structure of export composition. More precisely, controversies and debates on the relationship between the export structure and economic development contribute to enrich the knowledge in trade and development theories. Over decades, free trade and specialization have been recommended by traditional trade theory as gains from trade induced welfare, whereas the structuralist economists put forward the disadvantage of such a strategy for developing economies. Latterly, trade diversification has become the favored consensus.

To present the evolution of theories on export diversification, we divide the following subsections into two parts. In the first section, we review the old debates on the linkage between growth and the composition of trade that opposed the mainstream theories, namely the orthodox theories, to the structuralists theories. In the second section, we present the recent theories and discussions on trade and growth issues.

1.1.1 Old debates on trade and growth theories: a divergence of insights

1.1.1.1 The traditional trade theories and the virtues of specialization

The proponents of traditional trade theories are Adam Smith, David Ricardo and Heckscher-Ohlin-Samuelson. They advocate free trade and specialization as gains from trade induced welfare. Expound in his book entitled *"An Inquiry into the Nature and Causes of the Wealth of Nations"* in 1776, Adam Smith's growth and development theory was the earliest and certainly one of the most famous in the history of thought. In this book, Smith shows the efficiency gains of two countries from trading in goods in which they have absolute advantages, and demonstrates that the increase in productivity and economic growth is generated by the rise in specialization and division of labor. In order to consider a case in which a country could have an absolute advantage in all goods, David Ricardo (1817), in his book *"On the Principles of Political Economy and Taxation"*, introduced the concept of comparative advantage. He explains in a model with a single production factor, namely labor, two goods and two countries that a country which has an absolute advantage in the production of all goods will always have an interest in specializing in the good where it is relatively more efficient and in importing the other good. In the twentieth century, the increasing importance of capital in industry has made these economic theories mismatched to economic reality. This is why the Heckscher-Ohlin-Samuelson theory (HOS model), well-known as the "standard model" in trade theory and in line with Ricardo's comparative advantage, introduces a two-factor model, capital and labor, to explain the gain from free trade and export specialization according to factor endowments: relatively capital-abundant countries gain from trade by exporting capital-intensive goods and importing labor-intensive commodities, and conversely, relatively labor-abundant countries benefit from trade by exporting labor-intensive goods and importing capital-intensive goods.

However, these models do not explain the increasing volume of trade in similar goods between two countries. For instance, Grubel & Lloyd (1975) report an empirical investigation into how countries export and import the same goods and services, by creating a new measurement of intra-industry trade. Further questions arise such as: why do two countries exchange similar goods and, in that context, how a comparative advantage could emerge to create wealth from export specialization ? The new international trade theories, initiated by Krugman (1979) show that the more similar two countries are (in terms of endowments, technology and consumer taste), the higher are the intensity of intra-branch trade, thanks to economies of scale and

to consumer taste for diversity. The result is a new form of concentration where countries specialize the same goods but in different varieties. The exploitation of increasing returns to scale, which is source of comparative advantage in the context of imperfect competition, is possible through the expansion of the market (Krugman, 1979, 1980). In dynamic frameworks, attention has been brought to the comparative advantage obtained from technological innovation. For instance, Grossman & Helpman (1989) developed a dynamic multi-country framework integrating intra-industry trade influenced by research and development (R & D) and Inter-industry trade determined by resource endowments. The model shows that new products in differentiated varieties can be produced and comparative advantages are created through R & D in intertemporal trade. In addition, it predicts an Heckscher-Ohlin pattern of trade when production and R & D require fixed proportions of factors of production.

Until the early twentieth century, the mainstream school of thought preached *laissez-faire* and free trade as the best way to successfully reach a sustainable growth. However, these mainstream theories failed to explain the differences in growth rate and the inequalities in development between countries. More specifically, they did not give any explanation for why there are productivity differences between countries (Prebisch, 1959). Indeed, developed countries are specializing in increasing returns sectors whereas poor countries are concentrating on diminishing returns sectors (Thirlwall, 2002a). In his book entitled *"Stages of Economic Growth"* published in 1960, Rostow presents the key stages of structural transformation that an economy passes through, from a production structure specialized in agriculture and crops in a "traditional society" to an industrialized and diversified economy with "high mass consumption".

1.1.1.2 The rich, the poor and the specialization pessimism

Implicitly, Rostow's stages of development associate production diversification with higher level of standard of living. However, structuralist economics, which is considered by many as the alternative to the mainstream orthodox approach, stresses that in the real world, developing countries face different challenges which constrain their passage through the stages of development. These ideas fall within a world economy that is divided into two groups of countries according to the centre-periphery models: the countries of the centre, also called the countries of the North, that are the rich countries and the countries of the periphery or the countries of the South, that are the poor ones.

A first wave of Structuralism gathers economists working on development topics by putting forward the central role of a structural productive transformation for economic development and emphasizes the economic consequences with respect to the heterogeneity of economic structures between countries. Developed in the early 1950s after World War II, the first wave of Structuralist economists was at the origin of the development economics that was acknowledged for the first time as an entire branch of economics. [3]

Pioneering works studied the mechanisms of structural change that economies in the periphery, formerly qualified as "underdeveloped" countries, went through and point out the crucial role governments should play in the development process. The "old Structuralist" approach to development theories argues that development inequality comes from market failure. In Latin America, Prebisch (1950), head of ECLAC until 1963 and among the pioneers of development economics, was influenced by Keynes and acknowledged that *laissez-faire* does not work anymore (Bernardin-Haldemann, 1974). The thesis of Prebisch (1950) and Singer (1950) stipulates that primary products are characterized by a secular decline of the terms of trade relative to manufacturing goods, and hence reveals the worsening situation brought about by specialization in primary commodities. Prebisch (1959) shows that the rich countries, endowed in R & D and innovation, export manufactured products with high value added and high productivity, whereas poorer countries specialize in primary commodities with low value added. The economic growth of the latter will be constrained by the income elasticity of imports since increase in income in these economies would lead to a higher demand for imports than its exports can afford and cause structural imbalance. According to Bhagwati (1958), free trade could generate an "immiserizing growth", where economic growth induced by exports generates a deterioration in the terms of trade and reduces the country's real living standard when the economic growth is outweighed by the decline in terms of trade.

Another pioneer in development economics is Arthur Lewis. According to Lewis (1954), an underdeveloped economy is characterized by an unlimited supply of unskilled labor and the existence of a dual economy ("capitalist" sector and "subsistence" sector). The author emphasizes that structural transformation proceeds through the migration of labor factor from subsistence sector to the capitalist sector as capital formation occurs from the accumulation of profits and re-investments. The model gives a central role to capitalists for economic development process: the expansion of the capitalist sector generates growth of profits relative to national

3. Rosenstein-Rodan, Arthur Lewis, Ragnar Nurkse, Raùl Prebisch, Hans Singer, Gunnar Myrdal, Celso Furtado, Albert Hirschman, Hollis B. Chenery and Michael Bruno are among the first wave of development economists (Lin & Monga, 2014).

income and increases the share of reinvested income which in turn increases substantially the national income. Governments therefore plays an important role in implementing policies to foster the capital formation.

It emerges from these studies that active state interventions through industrial policies should be implemented to favor a structural transformantion from a traditional economy based on the agricultural sector, characterized by low productivity and technologies with diminishing returns to scale, to a modern economy with diversified industry, involving high productivity activities and technologies with increasing returns to scale. Arguments developed here would motivate the consideration of multi-sectoral growth model rather than single-sectoral growth model (Amado & Dávila-Fernández, 2016).

In the 1980s, new waves of Structuralist thinking emerged in response to neoclassical criticisms after the failure of intensive government interventions in most developing countries from the 1970s (Lin & Monga, 2014). It led to a new version of the structuralism insights that was labelled as the Neo-structuralism or the New structuralism approach. This approach brings together structuralist and post-Keynesian precepts, and initially attempted to respond to the problems of industrialization and macroeconomic instability, such as demand-supply imbalance, financial fragility and inflation, faced by Latin American countries and then by other developing countries in general after trade liberalization. In a pioneering alternative approach, Lance Taylor (1991) constructs a pragmatic "structuralist macroeconomics" opposed to the International Monetary Fund (IMF) orthodox macroeconomics. Drawn from historical experiences of some poor countries, such as the example of Zimbabwe which had been deindustrialized to specialize in raw materials after liberalization (Taylor, 1996), some of his key features are the importance of dynamics and cumulative causation in line with Kaldor and Pasinetti's framework for economic growth. It proposed adjustments and stabilization policies to economic issues encountered after pursuing a market-friendly development strategy. Therefore, Taylor (1996) emphasizes the need for external balance equilibrium. By emphasizing the structural differences between the countries of the North and the South, the New Structuralism is based on the idea that the growth of a developing country which is opened to international trade is constrained by its external position. Thirlwall (1979) presents economic growth theories, condensed in the well-known Thirlwall's Law, which are in this line and will be developed in the following section.

1.1.2 The New new trade theories and the New Structural Economics: a consensus on diversification

1.1.2.1 The New new trade theory: a dynamic industry model

Initiated by Melitz (2003), a new wave of trade models, well-known as the New New trade theory, introduce heterogeneity in firms in terms of productivity in order to capture the diversity of firms. Marc Melitz (2003) provides an extension of Krugman (1980)'s trade model under increasing returns to scale and monopolistic competition *à la* Dixit-Stiglitz (Dixit & Stiglitz, 1977), where the concept of heterogeneity in firm productivity is integrated into a dynamic trade framework. The model shows how international trade impacts on the inter-firm reallocation through the reallocation effect induced by difference in firm productivity.

On the domestic market, each firm is facing a fixed sunk market cost when entering a market and does not know in advance its own productivity until it begins to produce and sell. Indeed, firms have different levels of productivity. New entrants will have on average lower productivity and a higher probability of exiting than old firms. At stationary equilibrium, the model assumes that aggregate variables are constant over time and each firm's productivity does not change from one period to another. It follows that a new firm entering the market with negative profit will immediately exit or may be forced to exit because of either a bad shock or a repetition of bad shocks. Therefore, under free entry, any firm drawing lower productivity than the lowest required productivity level (for positive profits) will leave the market. At equilibrium, the mass of successful new firms replaces the mass of incumbent firms that exit in order to keep the aggregated variables constant over time. It is shown that the welfare per worker increases with country size and product variety.

When firms are exposed to international trade, the outcomes remain the same as in a closed economy when there is no variation in trade cost, in other words there are no consequences at firm level. However, the real world is more complicated: exporting firms face export market entry costs and country size differs inducing wage differences. The impact of trade liberalization occurs through two channels: the increase of trading partners and the decrease in trade costs. The author shows that the increase in the number of partners generates a reallocation effect among trading firms such that all firms experience a loss in domestic sales and the least productive firms will exit. In addition, less productive firms that do not export will experience profit loss and the most efficient firms will reap both market (domestic and foreign) shares and profits. It follows that at aggregated level, the reallocation of market shares towards the more productive firms leads to a gain in aggregated

productivity and welfare. The decrease in trade cost generates the same outcomes, as it forces the least productive firms to exit, induces new entry into the export market and contributes to an increase in aggregated productivity.

To sum up, at industry level, the reallocation of market shares will be made endogenously after the opening up to trade. As the least productive firms will exit the market and reallocate their market shares to the more productive ones, at the aggregated level, the opening up to international trade will generate an increase in aggregated productivity and country's welfare.

It emerges from this model that export diversification is naturally reached with trade intensification after a decrease in trade costs. Thus, although the Structuralists and the mainstream economists disagree on the role of the governments, it is worth noting that the new new trade theory made them reach a consensus: export diversification is good for economic growth.

1.1.2.2 The New Structural Economics

In the context of globalization and in a world where developing countries are divergent in fighting poverty and implementing development strategy, Justin Y. Lin (2010) presents a new framework for rethinking economic development that combines the structuralist approach and the neoclassical approach and is named the New Structural Economics.

Lin & Monga (2010) have defined the approach in these terms: *"it starts with the observation that the main feature of modern economic development is continuous technological innovation and structural change. The optimal industrial structure in an economy, that is, the industrial structure that will make the economy most competitive domestically and internationally at any specific time, is endogenous to its comparative advantage, which in turn is determined by the given endowment structure of the economy at that time"*. Thus, a stage of development corresponds to a particular comparative advantage which is determined by its factor and infrastructure endowments. Therefore, to develop, a country must exploit these comparative advantages on the domestic and international markets and improve its endowment structure through capital and human capital accumulations. Lin & Monga (2010) state that technological innovation is continuous and can be transferred from one country to another; the developing country would benefit from the technological gap through the learning process and acquire a new comparative advantage. The authors are convinced that proactivity of governments is the key factor to the success of the development strategy and, the main difference with the "old" structuralist approach is that policies should help to follow the comparative advantage rather that defying

it. State intervention in the market is necessary to address market failure and to facilitate information circulation between industries in order to ease the economy's transition from one stage to another of the development process. In line with the Growth Report provided by the World Bank (Growth Commission, 2008), this school of thoughts argues that openness through the integration in the world economy are conditions of a successful development strategy, as well as macroeconomic stability and high rates of savings and investment. Therefore, along its development path, a country will diversify its industrial structure through industrial upgrading. To put it differently, the NES approach agrees that export diversification is good for economic growth.

Chang Ha-Joon, influenced by heterodox approaches, responds to Lin's view of the NES in a debate on the role of state intervention related to a country's comparative advantage (Lin & Chang, 2009). Both economists acknowledge the benefits of industrial upgrading policies implemented by governments. However, Chang diverges from Lin's assumption on facilitating the exploitation of the comparative advantage as it neglects the limited factor mobility. He emphasizes the need for a country to defy its comparative advantage along the development process: in order to acquire higher technological capabilities, a country that upgrades its industrial structure needs to protect it in a first step, such as in the infant-industry protection in newly industrialized countries of Asia, because it does not have a comparative advantage in that industry. As physical and human capital are specific to each sector, the accumulation of "general capital or labor" at national level in order to reach a "right" capital/labor ratio for entering a specific industry is non-sense. Ultimately, the two protagonists agree to differ in their views: whereas Lin is convinced that a "comparative-advantage-conforming" should take place because upgrading to new industries involves small "skips on the rungs" that the state should facilitate, Chang still believe that the "comparative-advantage-defying" should be advised because of the risky nature of the technological learning process.

Dani Rodrik (2011a) comments on the New Structural Economics approach. He argues that the mentioned key difference with the traditional structuralist economics in government intervention, advocating policies that favor comparative advantage rather than defying it is quite confusing, since Lin (2010) actually asks governments through policy recommendations to defy comparative advantages. However, he states that his divergence from Lin's approach is in the second order, and overall, he agrees with his insights.

1.1.2.3 The role of the manufacturing sector and the Balance of Payments Constrained Growth (BOPCG) models in structural change

The mainstream growth theories, neoclassical and new growth theories, are criticized for being supply-oriented and constructed on factor inputs that are exogenously determined. As pointed out by Thirlwall (2002a), poor countries first face demand constraints before supply constraints are involved.

Kaldor, in the 1970s, proposed a regional demand-driven growth model in which the sustained growth emerged from a virtuous relationship between output growth and productivity growth. He puts forward the central role of the manufacturing sector that is the source of increasing returns to scale and virtuous growth, and the difference in growth rates between poor and advanced countries because of the diminishing returns to scale in the agricultural and mining sectors specialized in by less advanced countries. Kaldor stated three Laws that govern economic dynamics and structural change at his Inaugural Lecture at Cambridge University (Kaldor, 1966) and at the Frank Pierce Memorial Lectures at Cornell University in 1966 (Kaldor, 1967). Thirlwall (2017) enunciates theses three Laws in his tribute to Kaldor. The first Law stipulates that the economic growth rate of an economy is positively related to the growth rate of its manufacturing sector. From that first Law, it follows that in a causal relation, the manufacturing is an engine of growth because growth in demand for manufacturing induces productivity and externalities, which leads to the second Law. The Kaldor's second Law, well-known as the Kaldor-Verdoorn Law, explains that economic growth emerges from the dynamic relationship between output growth rate in manufacturing and labor productivity growth rate in manufacturing (Kaldor, 1966; McCombie et al., 2002) because of the increasing returns to scale in that sector. And lastly, according to the third Law, productivity in the non-manufacturing sector increases when the growth rate of manufacturing output augments. This last assumption suggests that as the manufacturing activities expand, the migration of labor from agricultural and mining (or non-manufacturing) to the manufacturing sector would increase the productivity in the agricultural and mining sectors because of the diminishing returns in these sectors.

It emerges from these statements that structural demand for manufacturing output matters for economic growth, and exports are a source of autonomous demand at the advanced development stage (Thirlwall, 2002a). Kaldor (1970) enriches his model with an open economy in an export-led growth framework in which the Verdoorn Law regulates the virtuous growth. Formalized by Thirlwall & Dixon (1975), the model takes into account free trade and free mobility of factor inputs. However, Thirlwall suggests that in an open economy, as far as developing countries are

concerned, rapid economic growth may lead to an increase in exports and imports, which imposes external constraint.

As part of heterodox tradition, at the end of 70's, Thirlwall (1979) constructed the Balance of Payments Constrained Growth (BOPCG) model that combines the New Structuralist and the Post-Keynesian precepts in a demand-oriented approach to economic growth. The author's approach is based on the preoccupation of the difference of growth rate between nations, more importantly between rich and poor nations. Rooted in center-periphery models of growth and development, Thirlwall (1983)'s model shows that the countries' growth performance can be assessed through their balance of payments position.

He explains that in the long run, the economic growth rate compatible with a balance of payments (BoP) equilibrium converges towards the ratio between growth rate of exports and the income elasticity for imports. Indeed, only the autonomous demand, namely the exports, can finance the imports without compromising the other components of the demand equation. This mechanism is famously known as the Thirlwall Law and the author expresses it in these terms: *"In the long run, no country can grow faster than the rate consistent with the balance of payments equilibrium on the current account unless it can finance an ever growing deficit which, in general, it cannot"*. Consequently, an increase in export growth rate would relax the external constraint by increasing the long run economic growth compatible with BoP equilibrium, and conversely, the higher the demand elasticity for imports is, the more the long run growth is constrained because an increase in economic growth would increase the appetite for imports.

The starting point of the model is that export and import volumes are a function of demand, and hence are determined by income and price competitiveness expressed in relative price. Therefore, export function and import function are expressed as follows:

$$X = (\frac{P_d}{P_f E})^{\phi} Z^{\varepsilon} \tag{1.1}$$

$$M = (\frac{P_f E}{P_d})^{\psi} Y^{\pi} \tag{1.2}$$

Where X is the volume of exports, M is the volume of imports, P_d is the domestic price, P_f is the foreign price and E is the exchange rate in domestic currency, ϕ and ψ (with $\phi < 0$ and $\psi < 0$) are respectively the price-elasticities of demand for exports and imports; Z and Y are respectively world income and domestic income; ε and π are respectively the income elasticities of demand for exports and imports and have

positive values.

Considering the exports and imports values, the balance of payments equilibrium is given by:

$$P_d X = P_f EM \tag{1.3}$$

Taking the growth rates in equations (1.1) and (1.2) implies that:

$$x = \phi(p_d - e - p_f) + \varepsilon z \tag{1.4}$$

$$m = -\psi(p_d - e - p_f) + \pi y \tag{1.5}$$

where lower case letters stand for growth rate variables. Finally, substituting (1.4) and (1.5) in equation (1.3) gives:

$$y_{BoP} = \frac{(1 + \phi + \psi)(p_d - e - p_f) + \varepsilon z}{\pi} \tag{1.6}$$

where y_{BoP} is the growth rate consistent with the balance of payments equilibrium. Equation (1.6) gives interesting information. An amelioration of the terms of trade ($p_d - e - p_f > 0$) would improve the long-run growth rate. The Marshall-Lerner condition, that demonstrates the improvement of the trade balance after depreciation ($e > 0$), is observed when the sum of price elasticities is greater than unity, in other words when $1 + \phi + \psi < 0$. The increase in income elasticity of exports ε, as well as an improvement in the world income growth z, allows to relax the external constraint. Finally, a greater appetite for imports, determined by an increase in π, would worsen the BoP income growth rate.

In the stationary state, the relative price remains constant ($p_d - e - p_f = 0$). Then, the long-run economic growth rate compatible with the BoP equilibrium will become:

$$y^*_{BoP} = \frac{\varepsilon z}{\pi} \tag{1.7}$$

Equation (1.7) defines Thirlwall's Law described earlier. As far as developing countries are concerned, y^*_{BoP} is the upper limit beyond which the actual growth rate would be unsustainable in the long run because the external debt would increase indefinitely. Under the threshold growth rate, the country would accumulate trade surpluses. Then, one can support that developing countries' exports should be characterized by higher income elasticity of demand for exports and reduce its appetite for import in order to initiate a sustained economic growth process.

In line with Prebisch (1950), Thirlwall (1979, 1983) describes the mechanism

behind the center-periphery configuration in terms of the characteristics of income elasticities of demand for exports and imports (respectively ε and π). Exports of economies from the North (the centre), mainly manufactured products, are embedded by high income elasticity of demand, whereas exports from the South (the periphery), comprised of primary commodities, are subject to low income elasticity of demand. The difference in growth performance between rich and poor countries explained by the lower income elasticity demand for primary commodities on the one hand, and the deterioration in terms of trade endured by less developed countries on the other (Prebisch's thesis), may be synthetized in a rule such that the long-run economic growth rate differences of one country relative to others is determined by the ratio between ε and π. It emerges that the objectives of diversification within this model would be to influence the two elasticities: export diversification should increase the income elasticity of exports and reduce the appetite for imports.

Nowadays, the BoP constrained growth model still has a substantial place in development literature. Thirlwall (2019) has listed the major contributions and extensions to his model over the past forty years. Thirlwall & Hussain (1982) include capital flow in the current account equilibrium equation. Araujo & Lima (2007) derived a multi-sectoral Thirlwall's Law in a Pasinettian framework and show that long-run sustainable economic growth not only depends on income elasticities but is also impacted by changes in export and import compositions. The disaggregation in sectors allows to attribute to each sector a level of demand elasticity and hence, makes it possible to identify the sectors with higher demand elasticity. As far as products are concerned, the quality of a country's export diversification is assessed such that it should induce higher demand elasticities of exported goods and lower demand elasticities for imported goods. In an empirical application on sub-Saharan countries, a BoP constraint growth model with partner disaggregation has been proposed by Bagnai et al. (2016). The authors generalize Thirlwall's Law in order to measure the participation of each trading partner in a country's external constraint. The success in trading partners' diversification is determined by each partner's characteristics in terms of elasticities (ε and π). More importantly, the model shows that the quality of trade diversification is jointly measured by a high level of the weighted sum of income elasticities of demand for exports and a low weighted sum of income elasticities of demand for imports. The two last extensions underline the importance of trade structure to sustained economic growth. One can understand that sectoral diversification and partner diversification would provide a country with more resilience to external shocks on the one hand and increase the growth rate compatible with the current account equilibrium on the other. Indeed,

it has been shown empirically in several studies that machinery and high-tech industries show higher income elasticities whereas primary commodities are embedded with low income elasticity (Thirlwall, 2019), which means that for a less advanced country, a better way to develop is to diversify its exports.

From a theoretical realm, it is undeniable that today, there is a consensus that the structural change conducive to development must be accompanied by a diversification of productive structure and export structure. However, what are the facts and pioneering empirical studies behind this consensus ?

1.2 On the linkage between diversification and economic development: the origins of the revival interest

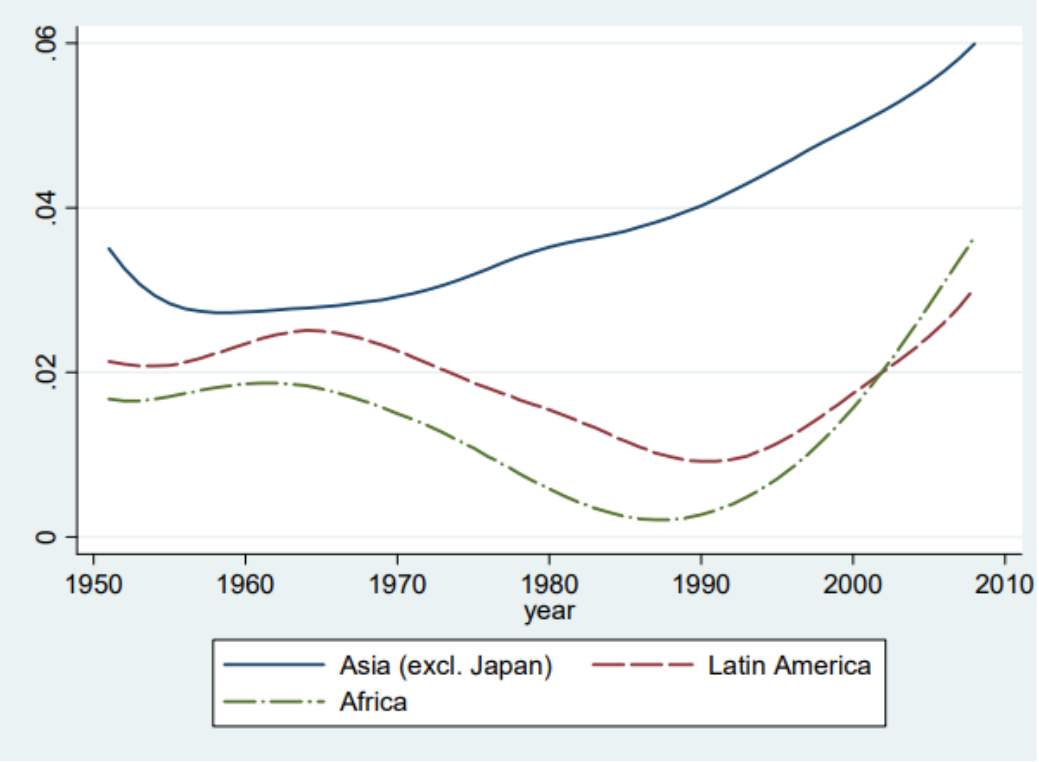
Empirically, the consensus has its source in two events: the spectacular experience of East Asian and emerging economies contrasting with the lack of progress of other developing regions on the one hand, and the wave of studies on the U-shaped relationship between export concentration and economic development on the other.

1.2.1 A contrasting experience between developing Asian countries and other developing regions (Africa and Latin America): the importance of history

Since the early 1970s, two distinct trends have emerged in developing regions (Cadot et al., 2016): on the one hand, developing Asian countries have undergone a successive phase of industrialization by sharply increasing their growth rate and, on the other hand, African and Latin American countries have failed to achieve virtuous growth and development (see Figure 1.1). The 1980s however, as depicted in Figure 1.1, have seen a turning point in growth trends and a recovery that coincide with the increase in trade liberalization and market-oriented economic reform (Shafaeddin, 2005; Lin & Monga, 2014). Subsequently, the international trade landscape has evolved dramatically at the beginning of the 21st century with the increase of *South-South* trade, mainly led by emerging economies from Asia. Indeed, trade between developing countries has increased from 8 percent of world trade in 1990 to around 25 percent in the 2010s (WTO, 2014). The new configuration is such that emerging countries, mainly from Asia, export manufactured products and import

natural resources and commodity products from the rest of the developing world. The increase in demand for natural resources led to a rise in price for these goods and boosted exports in resource-based economies.[4] The rise of China's influence has been a major determinant of change in the export structure of other developing countries, such as developing Asian countries, as well as sub-Saharan African and Latin American countries. It followed that the latter's development process has been affected by international demand and supply shocks, respectively, from export opportunities in primary products but also export tensions in manufacturing products (Chaponnière & Lautier, 2013).

Figure 1.1 – Developing regions' growth trend (1950-2008)



Source: Rodrik, Dani, 2011. The Future of Economic Convergence, NBER Working Paper No. 17400.

1.2.1.1 The East Asian miracle: the successive waves of industrialization in Eastern Asia.

In recent decades, the world economic landscape has been affected by the successive emergence of Asian countries as successful models of economic growth. Lite-

4. It should be noted that natural resources mainly refer to raw materials from the natural environment that are scarce and used in production or consumption, whereas commodity broadly defines the homogeneous status of a product and refers mostly to agricultural goods (WTO, 2010).

rature points out that industrialization in East Asia did not follow the neoclassical model (World Bank, 1993). For instance, by defying their comparative advantage in building capital-intensive industries, governments in East Asian countries, namely Japan and South Korea, and more recently China, have succeeded in implementing economic growth strategies (Rodrik, 2011a).

By implementing interventionist economic policies, such as infant industry protection, they were able to defy their comparative advantages in order to diversify their economy and their exports. In the 1960s, the first country to undertake an intensive restructuring was Japan, followed by the four Tigers from East Asia (namely South Korea, Taiwan, Hong-Kong and Singapore). They implemented a state-led development strategy and a regional division of labor led by Japan in the context of a development process which Japanese scholars, such as Akamatsu (1962), have metaphorically called a "wild geese flying pattern".

With the exception of Japan, these countries were initially very poor. They began with a period of import substitution and then switched to export promotion policies. A high growth rate of investment and capital, increasing endowments in human capital for education and R & D were key factors in promoting high value-added activities such as manufacturing, and made these countries becoming developed ones in the 1990s. Later, a second wave of Tigers in the South East Asia (Thailand, Malaysia, Indonesia and Philippines to a lesser extent) at the end of the 1990s followed the previous cohort. Strengthened by a desire for cooperation, growth and development in Asian countries, the creation of the Association of Southeast Asian Nations (ASEAN) and the Asian Free Trade Area (AFTA) has helped to intensify intra-regional trade. Followed by China in the 1990s, and later by Vietnam in the 2000s, low labor cost has made these countries successively very competitive after integrating international trade in participating in low-skilled tasks.

Nowadays, China as the world's leading economy, behind the US for the moment, testifies unquestionably to its success as a global competitor and principal game changer of international trade structure. Regarding Vietnam, its current success story of impressive growth following China's path is characterized by a rapid increase in employment in the manufacturing sector (Rodrik, 2018). These countries have diversified their exports from agricultural to manufactured goods in order to initiate spectacular economic growth. The rise of geographical fragmentation of production, namely the Global Value Chains (GVCs), has changed the international trade pattern and massively contributed to the successive emergence of developing Asian countries (World Bank, 1993; WTO & IDE-JETRO, 2011; WTO, 2014). Indeed, their comparative advantage in labor-intensive tasks and the adoption of

an export-led industrialization strategy, for instance through special administration areas widely called "export processing zones" (EPZ) that promote export industries and investments (see WTO & IDE-JETRO (2011)), enable them to integrate into international markets and become formidable competitors.

1.2.1.2 A (still) lagging Africa and lack of competitiveness of Latin America

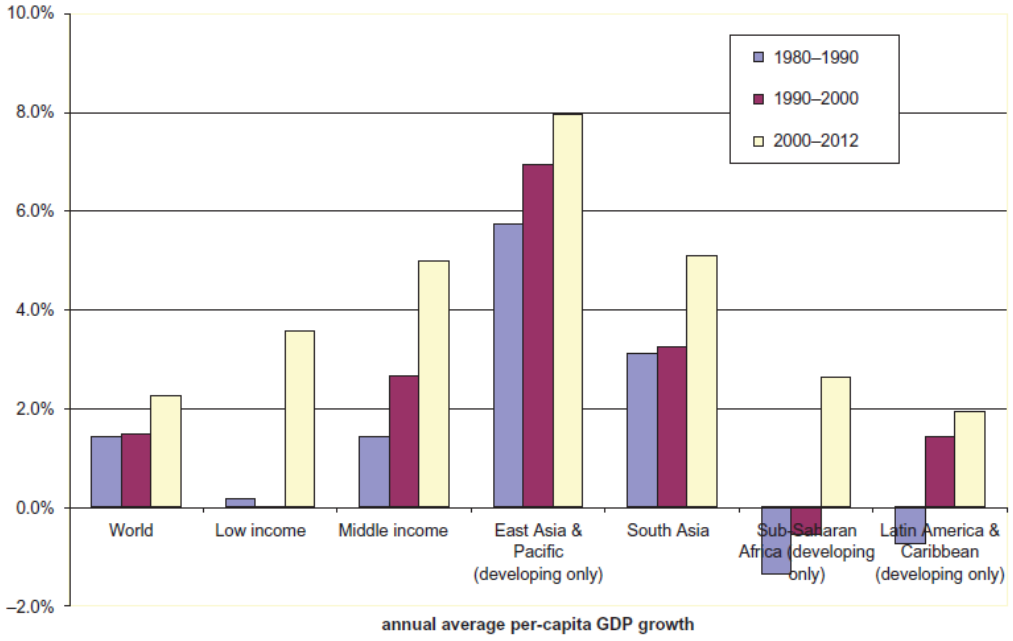
Historically, African countries have experienced ups and downs in terms of economic trends. After a deteriorating economic performance in the 1980s, the 2000s seemed to be the decade of growth opportunities for the continent.

Indeed, the majority of African countries had been characterized by negative economic growth before the 2000s (Figure 1.2). In contrast with the "East Asian miracle", Easterly & Levine (1997) speak about an "African's growth tragedy" since independence to describe the failure in public policy, schooling and political instability due to ethnic fragmentation, as structural causes of deterioration of growth performance. Akyüz & Gore (2001) blame the successive policies and adjustment programs, mostly led by the World Bank, that have failed to establish a sustained accumulation process linking savings, investment and exports. They emphasize that the small number of exported products, mainly composed of commodities, are source of vulnerability for these nations. However, in the 2000s, the increasing demand from China for primary product and natural resources has provided African countries with an economic opportunity. Extant economic development literature has applauded the improvement in economic performance in Africa, mainly led by a favorable external environment. Increasing price along with increasing export volumes of primary commodities to emerging Asian markets have become a windfall for economic growth during the 2000s, even if it does not equal that of Asian countries. However, as stated by Rodrik (2018), despite an improvement in their "growth fundamentals" (such as opening up to international trade, improvement in institutional environment, democracy and the end of civil wars), the recent change in China's economic model by slowing down its external activity could impact the sustainability of African countries' economic growth. Regarding the structural change in Africa, the diminishing scale of industrialization and the low productivity in sectors has persuaded the author to forecast lower economic growth than expected.

Latin American countries are richer and more industrialized than those in Africa (McMillan et al., 2014). In the theoretical realm, Latin American economic history has been briefly presented in the first section with the development of Structuralism and Neo-structuralism thinking. The thinking evolved following the debt crisis and

unsustainable external constraints in the region. Cimoli et al. (2010) explained why the region failed to converge with the developed countries. They showed from data of exports and imports during the period 1964-2004 that the region's increasing appetite for imports was not followed by the same increase in exports, in contrast to Asian economies, and macroeconomic policies in the 1970s and 1990s contributed to the change in import elasticity. However, during the commodity boom in the 2000s, the rise in demand from the South led to an improvement in the average economic growth rate in Latin America that reached nearly 5 percent (De La Torre et al., 2015). At the same time, Latin American nations have been undermined by harsh competition in manufacturing exports from emerging Asian exporters. Nowadays, Latin American economic growth seems to be globally heterogeneous between countries. Although some economies, such as Brazil, Chile (which is a developed country) and Mexico, have emerged economically, the region globally concentrated its exports in natural resources and faces strong competition from Asian emerging countries.

Figure 1.2 – Growth rates by country groups



Source: Rodrik, Dani, 2016. An African Growth Miracle ? Journal of African Economies, 1-18 from World Development Indicators, World Bank.

To sum up, as mentioned in the first section, manufacturing sector holds a central role as an engine of growth, because of the existence of high sectoral productivity. Indeed, Rodrik (2011b) suggests that convergence between developed and developing countries is possible but resources need to be reallocated towards specific manu-

facturing industries that are key to growth. However, Rodrik (2016) states that the share of the manufacturing sector within output and employment follows an inverted U-shaped process and he is concerned that the turning point is happening earlier with the bulk of low and middle-income economies (sub-Saharan Africa and Latin America) in the modern world than it did with advanced economies, except for some more recently Asian economies. He argues that trade and globalization may play a central role in this trend and Asian countries may not have been impacted because of their competitiveness in manufacturing. Put differently, African countries, especially from the sub-Saharan region, seem to have missed the stage of industrialization (Cadot et al., 2016); and Latin American countries have experienced a hard hit in the industrial sector because of lack competitiveness with Asian exports, that led them to specialization in resource-based industries (Shafaeddin, 2005). The gap in performance has its source mainly in the difference of labor productivity (Rodrik, 2011b). McMillan et al. (2014) show some interesting results on labor mobility and labor productivity within the three regions. They show that countries endowed in natural resources have low labor productivity because productivity in natural resources exploitation does not spread to other sectors. In the context of globalization, they suggest that the difference in labor mobility between key industrial sectors and the difference in labor productivity within these industries leads to a structural change conducive to development. In developing Asia, these adjustments have been successfully accomplished. Conversely, in Latin American and Africa, labor have been reallocated towards less productive sectors. However, the authors show that in some African countries since 2000, there is timid structural change encouraging higher productivity growth.

Refering to the positive correlation between slow economic growth and exports of natural resources, development economists put forward the hypothesis of "the curse of natural resources".

1.2.1.3 The curse of natural resources

The "curse of natural resources" is a hypothesis formulated by Sachs & Warner (2001) in their empirical study, postulating that countries highly endowed with natural resources would have slow growth than resource-poor ones, *ceteris paribus*. For instance, the Prebisch-Singer hypothesis in the 1950s, in line with this belief, suggests that the resource rich exporter would experience declining terms of trade. In the 1980s, the "Dutch disease" effects predicted that the increase in earnings from the booming exports of a specific natural resource would shrink the manufacture sector and lead to a decline of growth. The concentration of exports in that specific

resource would appreciate the exchange rate and decrease the global competitiveness of the country, on the one hand, and would take away the potential economic benefits from manufacturing sector expansion on the other (Sachs & Warner, 1997). In a in comparative study across countries, Sachs & Warner (2001) show that resource-abundant countries seem to be less competitive because of higher price. However, Auty (2001) suggests that the low efficiency is rather due to political influence. A natural resource-driven growth strategy in a resource abundant country is likely to lead to a policy distortion from government in order to pursue rent rather than seek for the country's overall economic benefits. Thus, according to the "curse of natural resources" hypothesis, to entail rapid growth, export composition should be diversified. However, despite solid historical records and the wave of empirical works, the "curse" is softened by some studies. Bravo-Ortega & de Gregorio (2007) state that with appropriate investments in human capital and robust institutions, the wealth in natural resource may become an asset that is good for development.

1.2.2 The inverted U-shaped relationship between diversification and development: a robust stylized fact

The second source of the consensus on the virtues of export diversification is a wave of empirical studies showing a robust stylized fact about the relationship between diversification and level of economic development. A seminal work by Imbs & Wacziarg (2003) shows that the evolution of sectoral concentration in terms of employment and production follows a non-monotonical pattern along the development path. More precisely, there is a U-shaped linkage between production concentration at the sectoral level and the level of income per capita. They use sectoral data on value-added and employment covering several countries and calculate several measures of dispersion to assess the degree of sectoral concentration. From a parametric and non-parametric analysis, their results show that the early stages of development coincide with a diversification across sectors until a turnaround point, mostly around 9000 USD in 1985 PPP, and thereafter the country starts a second stage where the increase in per capita income is accompanied by a concentration. Their findings hold robust for OECD countries, as well as for sub-Saharan African and Southeast Asian samples. Thus, they observe that their results contradict the traditional trade and growth theories that predict a linear concentration-per capita income nexus following the economy's endowments and suggest further investigations for future research.

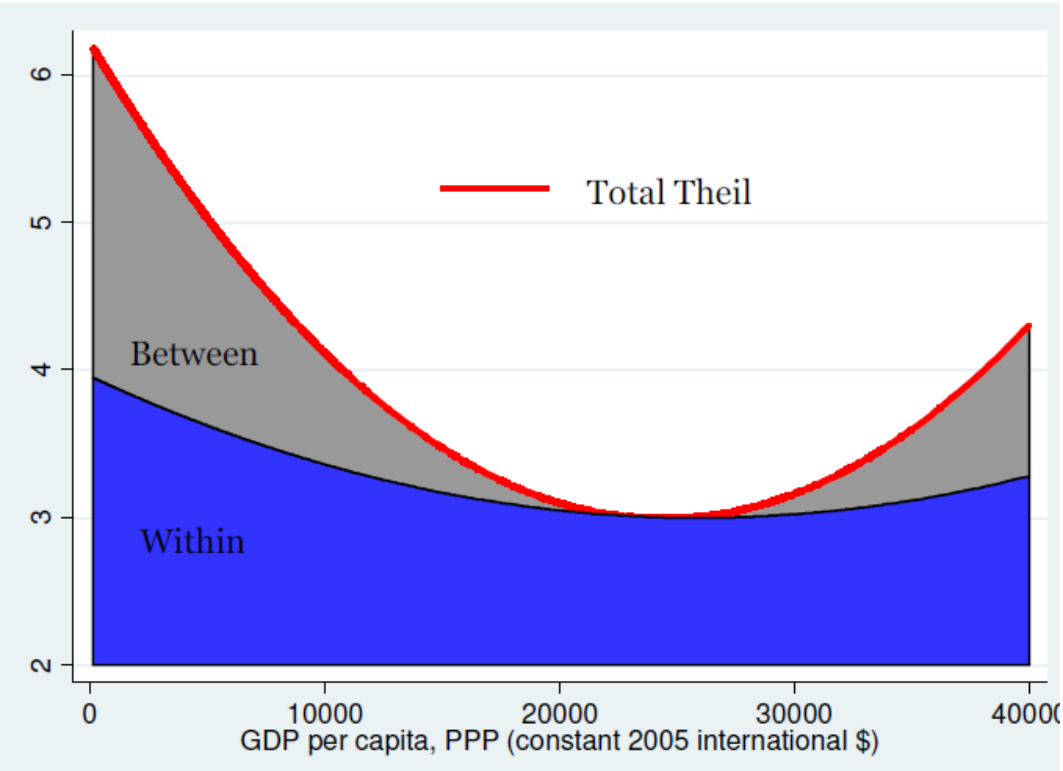
Koren & Tenreyro (2007) confirmed the existence of a U-shaped relationship between the concentration of production and the level of development. They go

further by identifying sources of volatility in poor countries and show that along the development path, volatility reduction is associated with a decrease in sectoral concentration. More precisely, the volatility is closely related to sectors in which countries are specialized at the early stages of development. Therefore, as the country develops, the shift to less risky sectors is accompanied by a U-shaped trend in which there is sectoral diversification until a threshold point from which concentration takes place along with development.

Furthermore, numerous empirical studies have been conducted to verify the existence of the same pattern in trade. Klinger & Lederman (2006) used a panel of 130 countries covering the period 1992-2003 and found the same inverted U-shaped pattern for export diversification. However, their turning point occurs later than in Imbs & Wacziarg (2003), that is at 22500 USD PPP. Using several measures, Parteka (2007) conducted a non-parametric analysis and found a robust non-linear trend in manufacturing along the development path. They confirm from the manufacturing data of 32 countries back to 1980 that in a first phase, export specialization in terms of employment diminishes when GDP per capita grows, then it stabilizes in the manufacturing sector or follows a trend of specialization.

Cadot et al. (2011) and IMF (2014b) staff observe the same pattern for export concentration and economic development linkage, although the curve is less marked with a turning point around 25000 USD. In order to understand how the U-shaped curve is formed, Cadot et al. (2011) broke down the diversification into two components (see Figure 1.3): extensive export diversification which is defined as the diversification into new products, and intensive export diversification that is described as a more balanced share among existing exported products. Using highly disaggregated (4991 product lines) export data on 156 countries over 19 years, the authors find the same pattern as Imbs and Wacziarg's with a turning point at 25000 USD PPP. In particular, the decomposition into two components (the between component and the within component), makes it possible to interpret the U-shaped linkage between export concentration and the level of development. Their analysis unveils what's behind the hump (Figure 1.3). Indeed, the increase in diversification at the first stage mostly occurs through the extensive margin (between) until around 22000 USD PPP. The intensive margin (within) dominates at the turning point, and thereafter the extensive margin leads the concentration phenomenon. Besides, it is stated graphically that the level of concentration is lower for developed countries than for the poorest economies.

Figure 1.3 – Within and Between components of Theil index



Source: Cadot et al. (2011), calculations using Comtrade

1.3 So, what is diversification and how to measure it ? A literature review on the measures and the dimensions of diversification

In the previous sections, we have defined the origins of the growing interest in diversification as a development engine. Thus, it is important to give an exact definition to this term. The International Monetary Fund (IMF, 2014b) defines diversification as *"the shift to a more varied production structure, involving the introduction of new or expansion of pre-existing products, including higher quality of product"*. More precisely, diversification can occur through exported products or trading partners (in terms of markets). In addition, although very little discussed in the literature, one can also very well speak of the diversification of imports, as being the shift to more varied imported products. Typically, along the developing country's growth path, as stated in the literature, diversification of production and exports consist of a shift from commodity and resource-based specialization to manufacturing goods.

As far as development literature is concerned, estimation of the change in export

composition has been the subject of several studies. The definition of diversification is usually coupled with a mathematical expression of a measure of diversification. Roughly speaking, measures of concentration, such as the Gini coefficient and Herfindahl-Hirschman, assess the degree of dispersion of the product shares. Moreover, the nature of the change in composition can be assessed by the diversification margins, that is along the extensive or the intensive margins. The measure of sophistication incorporates a qualitative dimension to the measurement by attributing to each product a level of quality. Finally, the change in export mix can be assessed through the value added from the Global Value Chains. To ease our interpretations, in this section, we will focus on export diversification, although the same calculation is valid for sectors and imports. We develop in the following sections four types of measurements.

1.3.1 The traditional measure of concentration

The first indicators of diversification are mostly borrowed from other economic fields and gauge the level of concentration, such as the GINI index, that has been traditionally used to measure income inequality, and the Herfindahl-Hirschman index, that measures market concentration of a given sector or industry.

Imbs & Wacziarg (2003) used several indicators of diversification, such as the GINI coefficient, in their work to investigate the relationship between production diversification and level of development. The GINI coefficient is inspired by the Lorenz curve (Lorenz, 1905) that graphically represents the income distribution to assess inequality between individuals in a country. Based on the comparison of cumulative proportions, the GINI coefficient gives a statistical measure by comparing the income inequality to the perfect state where all individuals would earn the same income. Transposed to trade, the coefficient measures the gap between the perfect state, where the volume of exports is equally distributed among products, and the actual dispersion by calculating their difference. In other words, the GINI coefficient measures the inequality in volume of exported products. When all products have the same share of export volume, the index value equals 0. Conversely, when all export shares are equal to 0 except the last one, the index equals 1, which indicate extreme inequality. The index is mathematically given by:

$$GINI = 1 - \sum_{k=1}^{n}(X_k - X_{k-1})/n \text{ with } X_k = \sum_{l=1}^{k} s_l \tag{1.8}$$

X_k is the cumulative export share until product k, s_l is the share in volume

of product l with $s_l = x_l/(\sum_{j=1}^{n} x_j)$, and n is the number of products. A major limitation of the index is that it does not inform about the number of produced (or exported) products.

Two of the other most used indicators of diversification in the empirical literature are the Herfindahl index and the Hirschman index (for example, see Stanley & Bunnag (1986); Ben Hammouda et al. (2006); Lederman & Maloney (2003) among others) and their variants. More specifically, the World Bank calcultes on its platform World Integrated Trade Solution (WITS) the Herfindahl-Hirschman Concentration Index (HH) which measures dispersion of trade value across an exporter's products or its trading partners (for example see Agosin et al. (2012); Tran et al. (2017)). Its mathematical expression is as follows:

$$HH_i = \frac{\sum_{k=1}^{n_i}(\frac{x_k}{X_i})^2 - (\frac{1}{n_i})}{1 - \frac{1}{n_i}} \tag{1.9}$$

X_i is the total value of exports of country i, x_k is the value of exports of product k of i, and n_i is the number of products exported by country i. The index value is between 0 and 1 and a higher value indicates a more concentrated composition of exports around a small number of products. The mathematical expression of the HH index allows us to understand that it gives more weight to the higher shares and its change is more sensitive to the variation of the extreme share values.

However, the Herfindahl-Hirschman index has the same limitation as the GINI coefficient in that it gives the degree of diversification at the intensive margin, which means that a lower value indicates more balanced export shares amongst products that have already been exported, and therefore, the index does not take into account the prospect of diversification based on the export of new products.

The third concentration index is the Theil's entropy index (Theil, 1972). Mobilized in many studies and with variants (Parteka & Tamberi, 2011; Agosin et al., 2012; IMF, 2014b; Cadot et al., 2011, 2013), the index is preferred because of its property to make it possible to decompose diversification into two components. The first component is the diversification at the intensive margin, which is defined by a more balanced share of the volume of existing products, and the second part is the diversification at the extensive margin, which accounts for the diversification of exports by exporting new products. Following the IMF (2014b) and Cadot et al. (2011) expression, the Theil index is calculated as:

$$\text{Theil index} = \frac{1}{n}\sum_{k=1}^{n}\frac{x_k}{\mu}\ln\left(\frac{x_k}{\mu}\right) \tag{1.10}$$

with $\mu = \frac{1}{n}\sum_{k=1}^{n} x_k$, n is the number of export lines and x_k is the export value of product k. A relatively high level of the index corresponds to a relative concentration of exports while, conversely, a relatively low level of the index reveals a diversified structure of exports.

1.3.2 The margins of export diversification

The change in export basket can be decomposed into several parts. For instance, as indicated previously, the Theil index's advantage is that it can be disaggregated in order to measure different margins of diversification. It can be decomposed into the "between" component (or the extensive margin) denoted T^B, which measures the diversification of exports into new products, and the "within" component, denoted T^W, which measures the diversification of exports at the intensive margin defined by a more balanced share of the volume of existing products. The Theil index (T) can then be written:

$$T = T^B + T^W \tag{1.11}$$

For each country and each year, the extensive Theil T^B is calculated by:

$$T^B = \sum_{j=0}^{1} \frac{n_j}{n}\frac{\mu_j}{\mu} \ln\left(\frac{\mu_j}{\mu}\right) \tag{1.12}$$

And the intensive margin or intensive Theil T^W:

$$T^W = \sum_{j=0}^{1} \frac{n_j}{n}\frac{\mu_j}{\mu}\left[\frac{1}{n_j}\sum_{k\epsilon j}\frac{x_k}{\mu_j}\ln\left(\frac{x_k}{\mu_j}\right)\right] \tag{1.13}$$

where group 1 ($j = 1$) corresponds to active export lines, that is, the group of products in which the countries are currently exporting, and the group 0 ($j = 0$) are the inactive export lines, n is the number of products existing in the world, n_j is the total number of products in each group j, μ_j is the average value of exports in each group and (μ_j/μ) is the relative average of exports in each group. Thus, a variation in the between component (ΔT^B) corresponds to a concentration ($\Delta T^B > 0$) or a diversification ($\Delta T^B < 0$) at the extensive margin, and a change in the within component (ΔT^W) is associated with a concentration ($\Delta T^W > 0$) or a diversification ($\Delta T^W < 0$) at the intensive margin.

Hummels & Klenow (2005) developed diversification indices to assess the participation of intensive, extensive and quality margins of exports in different countries' trade. They used data on exports of around 5000 product categories of 126 countries

in the year 1995 and found that the extensive margin's share accounts for 62 percent of the exports of richer economies; and they export higher quality for each product. The first margin, that is the extensive margin, is defined as the weighted number of categories of products exported by a country relative to the world. The extensive margin of diversification for country j compared to reference country (for example the rest of the world) k is given by:

$$EM_{jm} = \frac{\sum_{i \epsilon I_{jm}} p_{kmi} x_{kmi}}{\sum_{i \epsilon I} p_{kmi} x_{kmi}} \tag{1.14}$$

Where I_{jm} is the set of products in which country j has a positive value of exports to market m and I is the set of existing products in the world. p and x are respectively the price and volume of each product. Thus, for the authors, the extensive margin is defined as the count of exported products in value (nominal) that is weighted by their importance in the world's exported value. For Hummels & Klenow (2005), the intensive margin (IM) is described as the intensity in export value of the set of products exported by country j to markets m relative to that of reference country k for the same set of products to the same markets. The intensive margin is given by:

$$IM_{jm} = \frac{\sum_{i \epsilon I_{jm}} p_{jmi} x_{jmi}}{\sum_{i \epsilon I_{jm}} p_{kmi} x_{kmi}} \tag{1.15}$$

The advantage of Hummels and Klenow's margins over the Theil decomposition is that the two margins definition, unlike Theil and its decomposition, take into account the economic importance of each good in trade.

Brenton & Newfarmer (2007) construct an index in order to investigate the change in composition of exports. They disaggregate the export growth of 99 countries over the period 1995-2004 into export growth in new products and new markets (extensive margins), and export growth in existing products to existing markets (intensive markets). Between two years, they consider each possible scenario by identifying three types of intensive margins and three types of extensive margins. There is a change in export volume along the intensive margins when there is an increase, or a decrease, or an extinction of the export of existing products to current markets. There is an evolution of export volume along the extensive margin when there is a new export either in terms of product (to existing market), or in terms of a new market (of existing products), or both, that is the export of new product to new market.

Then, Brenton & Newfarmer (2007) construct the index of export market pene-

tration (IEMP), measured in number of products, consistent with their definition of extensive margin as the increase of imported products I in country j from exporter country i. It is logical therefore that a country with highly diversified exports in terms of products and trading partners would have less capacity to enter a new market. This affirmation corroborates results in Cadot et al. (2011) above.

Let's define the follows:

$N_{ijk} = 1$ if $X_{ijk} > 0$ and $N_{ijk} = 0$ otherwise,

And

$P_{jk} = 1$ if $M_{jk} > 0$ and $P_{jk} = 0$ otherwise.

Where X_{ijk} is the value of exports of product k from country i to country j and M_{jk} is the imports of good k in country j. It follows that the index of export market penetration is equal to:

$$IEMP_i = \frac{\sum_{k\epsilon I} N_{ijk}}{\sum_{k\epsilon I} P_{jk}} \tag{1.16}$$

For the exporter country i, a relatively low value of the index informs that the potentiality of export in the market is still large. As far as developing countries are concerned, the authors emphasize that the growth in exports mainly occurs through the intensive margin, and more specifically in the increase in trade flows of existing products toward current markets. At the extensive margin, although to a lesser extent, the export of existing products to new geographical partners outpaces the export of new products.

1.3.3 Sophistication of exports

Hausmann et al. (2007) brought some stylized facts into light: the composition of the export basket is associated with the level of development. The sets of products exported by an economy are determined not only by its endowments but also by entrepreneurs' incentives to invest in new sectors. To assess the quality of a country's productive structure, they construct the index EXPY, that aims to capture the productivity level associated with a country's export structure. To do this, they rank each product by first constructing an index that measures product sophistication described as the score of each product according to the level of income. Each product possesses a ranking index (PRODY) that associates the income per capita of every country (approximated by the per capita GDP Y_j) to productivity. For product k, its value of PRODY would be:

$$PRODY_k = \sum_j \frac{\left(\frac{x_{jk}}{X_j}\right)}{\sum_j \left(\frac{x_{jk}}{X_j}\right)} Y_j \tag{1.17}$$

x_{jk} is the volume of exports of product k in country j; X_j is the total export in country j ; $\sum_j (x_{jk}/X_j)$ is therefore the aggregated share of product k in all countries. Y_j is the GDP per capita of each country. Thus, the index reveals the average of per-capita GDPs, weighted by the revealed comparative advantage of each countries j in the product k.

Then, at a country level, the authors give the index of export sophistication $EXPY$, corresponding to the weighted average $PRODY$ of products in a country's export basket:

$$EXPY_j = \sum_k \left(\frac{x_{jk}}{X_j}\right) PRODY_k \tag{1.18}$$

However, the main limitation of the index of sophistication is related to its concept and its motivation. An index of product sophistication based on the income level of the exporting economy is tautological (or circular) because rich country export rich-country products and poor countries export poor-country products (Felipe et al., 2012). Lederman & Maloney (2012) give two examples: banana PRODY would have a low rank in PRODY if low-income economies export bananas, and if high-income countries produce cold fusion reactors, the associated PRODY will be high.

In the context of structural transformation, Hidalgo & Hausmann (2009) address the above criticism and aim to examine the non-tradable capabilities (which incorporate knowledge, know how, organizations, etc...) that is embedded in a country's productive structure, as it is closely related to sustained economic growth. By evaluating the complexity of a country's productive structure, they assume that the more complex and numerous the capabilities, the more diversified and complex the goods produced, and the more economic growth is sustained when it induces new sets of capabilities that allow the production of new goods, and so on.

Therefore, the complexity of sets of capabilities may be assessed through the complexity of produced goods. For the sake of clarity, the authors explain the mechanism through a metaphor. Let us consider a child's bucket of Lego pieces. Each piece is a capability and the child's bucket is a given country. Then, the child can construct different Lego models, which correspond to the products that a country can produce. Now, to integrate the notion of complexity, let us suppose that there is a group of children (that is a group of countries) that have their own bucket of

Lego pieces. A child would be able to construct a relatively complex Lego model if he has a diversity of Lego pieces and if some of them are exclusive to his own bucket. In other words, an economy's economic complexity could be assessed through the properties of the products in the export basket.

Then, to assess the capabilities available in a country, Hausmann et al. (2014) observed the diversification and the ubiquity of its export basket. Based on export diversification and product ubiquity, they constructed the Product Complexity Index (PCI) which ranks each product according to its complexity and the Economic Complexity Index (ECI) that measures the complexity of a country's productive structure. The authors emphasize that the ECI is predictive of future economic growth: the higher the initial ECI, the higher the economic growth rate in the future. To conceptualize the evolution of the complexity of productive structure, Hausmann et al. (2014) map the path to prosperity by constructing the *Product Space*, which represents the network between every existing product in the world and shows the distance between products according to their proximity or similarities in terms of capabilities used for their production (see also Hausmann & Bailey (2006) with the PRODY index). The Product Space assesses about the ability of a country to "jump" from one product to a new product, depending on the required capabilities and their proximity. To better understand the process along the development trajectory, the authors like to use the metaphor of monkeys and trees. The explanation is as follows: let the product space be a forest full of trees, that are the products. Trees that have similar capabilities are near to each other, and conversely, trees that need different capabilities are distant from each other in the forest. The monkey represents the firm and a group of monkeys refers to a country. Monkeys live in the trees, in other words, the firms produce goods. The structure of the Product Space captures the characteristics of goods in terms of heterogeneity and their interconnections. In the center of the forest, products are more complex, densely packed, and closely connected with other groups of products which produce positive externalities. In the periphery, products are sparser, need less capabilities for production and are less connected. In that configuration, the development process consists of the monkeys migrating progressively towards the center, by colonizing more trees (diversification) with more complex goods (and complexity).

However, there may be an obstacle to achieving a virtuous diversification. Countries are not equally embedded in terms of capabilities and their initial position within the product space affects their opportunities for growth and development. If monkeys initially live in trees that are densely packed in the center, it is relatively easy for them to jump from tree to tree. In other words, if initial capabilities are

similar for producing several goods, product diversification would be relatively easy as the accumulation of capabilities would be progressive. Put differently, countries that are positioned in the center can easily reach several sectors and consequently can diversify its exports to more complex goods. For example, machinery products and chemical products are located in the center of the product space. Conversely, if monkeys initially live in trees that are relatively isolated from each other in the periphery, the process would be harder: monkeys would be stuck because the accumulation of capabilities is harder. In other words, the country would either diversify with few products with low complexity in the periphery or be trapped in specialization. For instance, agricultural products such as cereals and cotton, and mining products are located on the periphery of the product space. It appears that from the product space approach, countries' development paths are predetermined by their embedded capabilities.

Table 1.4 and Table 1.6 below list respectively the products and countries at the top and at the bottom of the rank in terms of complexity in 1995 and 2017. As far as products are concerned, we list the five most complex and the five least complex exported products. In 1995, machinery and apparatus based on the use of X-rays are the most complex among exported products and agricultural products such as cocoa and coconuts are the least complex. In 2017, the least complex goods are mineral, and stone ores and the most sophisticated products are complex entities such as cermets and lathes. According to the measure of economic complexity index, Japan has had the most sophisticated export basket in 1995 and 2017, followed by Germany and Switzerland. It is worth noting that Eastern European countries such as Austria, the Czech Republic and Slovenia are listed among the top ten countries, which is intriguing given their developement level. The least complex economies mostly include sub-Saharan African countries such as Angola and Nigeria, that are very concentrated in petroleum oils, and also Mauritania and Burkina Faso. In 1995, some countries from Asia are listed among the bottom ten countries, namely Laos and Myanmar.

Figure 1.5 presents a comparison of the Product Space for Vietnam and Madagascar between 1995 and 2018. Focusing first on Vietnam, the country has dramatically increased the number of exported products. Vietnam has seen a sharp change in the composition of its exports over the period 1995-2018 from an agricultural-based and light manufacturing products to highly diversified manufacturing exports. Madagascar's export composition did not change drastically between 1995 and 2018: agricultural products (such as vanilla and coffee) and textile and fabric products still have significant shares in total exports. However, natural resources such as Nickel

Table 1.4 – Product Complexity Index in 1995 and 2017

	1995			2017	
Code	Product	PCI 1995	Code	Product	PCI 2017
1662	Machines to extrude, draw, cut manmade textile fibres	2.8068	1068	Photographic plates and film, exposed and developed, other than motion-picture film	2.4918
1811	Apparatus based on the use ofX-rays or of alpha, beta or gamma radiations, whether or not for medical, surgical, dental or veterinary uses	2.3701	1088	Chemical element/compound wafers doped for electronic	2.3923
929	Halides and halide oxides of nonmetals	2.3688	1601	Of other cermets	2.2028
1542	Nickel tubes, pipes and tube or pipe fittings	2.3588	1592	Cermets and articles thereof, including waste and scrap	2.0757
1104	Petroleum resins, coumarone-indene resins, polyterpenes, polysulfides, polysulfones	2.3336	1676	Lathes (including turning centers) for removing metal	2.0734
Code	Product	PCI 1995	Code	Product	PCI 2017
805	Cocoa shells, husks, skins and other cocoa waste	-2.9667	889	Tin ores and concentrates	-3.3216
1120	Natural rubber, balata, gutta-percha, guayule, chicle and similar natural gums, in primary forms or in plates, sheets or strip	-2.9243	890	Chromium ores and concentrates	-2.8428
804	Cocoa beans, whole or broken, raw or roasted	-2.6506	910	Petroleum oils and oils obtained from bituminous minerals, crude	-2.8187
755	Copra	-2.5598	897	Other ores and concentrates	-2.5891
712	Coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled	-2.534	895	Niobium (columbium), tantalum, vanadium or zirconium ores and concentrates	-2.5035

Source: The Atlas of Economic Complexity, https://atlas.cid.harvard.edu/.

and Cobalt are extensively exported in 2018. [5]

Figure 1.6 – Economic complexity index in 1995 and 2017

1995			2017		
code	Country	ECI	code	Country	ECI
JPN	Japan	2.48	JPN	Japan	2.34
DEU	Germany	2.28	CHE	Switzerland	2.10
SWE	Sweden	2.20	DEU	Germany	1.98
CHE	Switzerland	2.15	KOR	Korea, Rep.	1.89
FIN	Finland	1.99	SGP	Singapore	1.80
AUT	Austria	1.94	CZE	Czechia	1.75
GBR	United Kingdom	1.80	SWE	Sweden	1.71
USA	USA	1.76	AUT	Austria	1.69
FRA	France	1.73	FIN	Finland	1.63
BEL	Belgique	1.57	SVN	Slovenia	1.59
code	Country	ECI	code	Country	ECI
PNG	Papua New Guinea	-2.48	GIN	Guinea	-2.16
AGO	Angola	-2.15	BFA	Burkina Faso	-1.83
NGA	Nigeria	-2.06	PNG	Papua New Guinea	-1.82
UGA	Uganda	-2.03	NGA	Nigeria	-1.70
MRT	Mauritania	-1.94	AGO	Angola	-1.67
MMR	Myanmar	-1.58	COG	Congo, Rep.	-1.67
COD	Congo, Dem. Rep.	-1.35	MRT	Mauritania	-1.59
GIN	Guinea	-1.32	TKM	Turkmenistan	-1.52
YEM	Yemen	-1.32	COD	Congo, Dem. Rep.	-1.46
LAO	Laos	-1.32	ETH	Ethiopia	-1.46

Source: The Atlas of Economic Complexity, https://atlas.cid.harvard.edu/

The above index of country complexity is indeed persuasive in predicting a country's further development trajectory, as it intends to assess the capabilities incorporated in a country through the sophistication rank of its exported products.

However, Lederman & Maloney (2012) put forward some statements that attract attention. Exogenous factors of capabilities can interfere in the choice of product

5. See what export Vietnam and Madagascar in the Atlas of Economic Complexity https://atlas.cid.harvard.edu/explore.

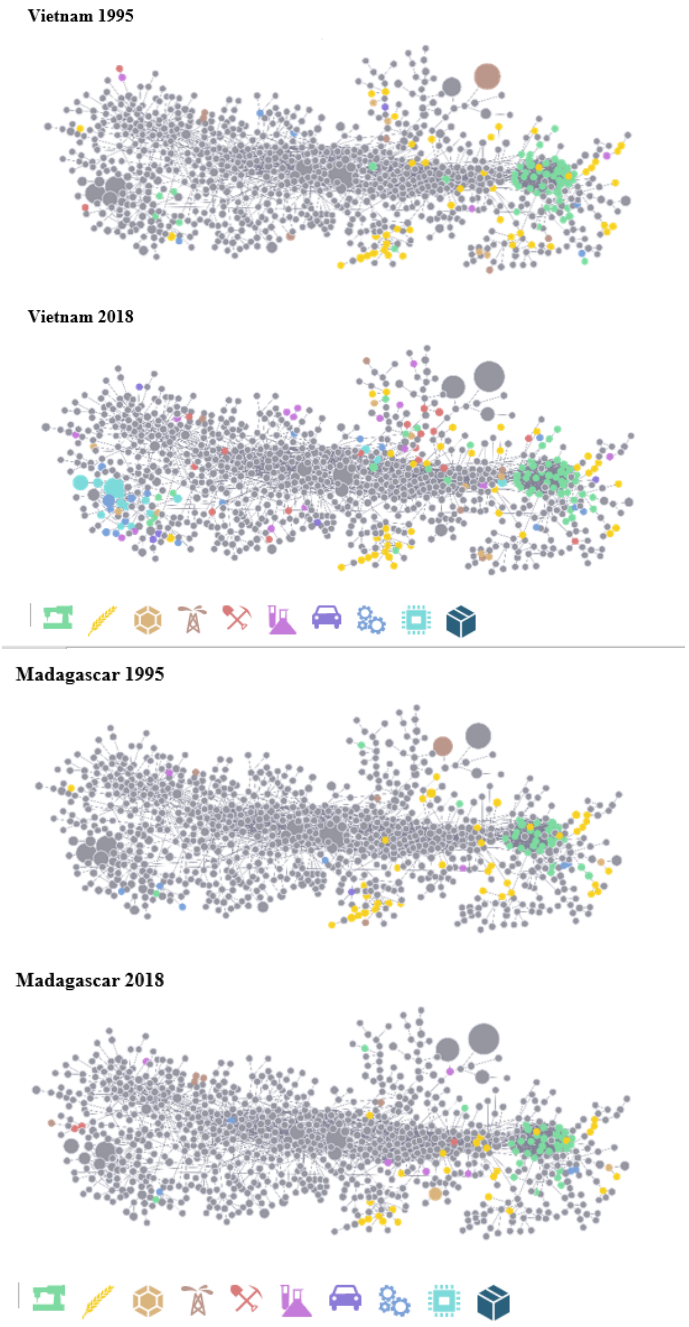


Figure 1.5 – Product Space for Vietnam and Madagascar in 1995 and 2018

Source: Atlas of Economic Complexity, the Growth Lab at Harvard University

mix. It is very possible that the tree to which the monkeys are willing to jump is already occupied, in other words, the comparative advantage in the new good and the resulting gains are limited as the market is already very competitive. In addition, they claim that studies should focus on *how a country exports* rather than

what it exports. Indeed, in the present context of globalization, configuration of international trade is characterized by a fragmentation of the global production process through Global Value Chains (GVCs), which are defined by the fact that the stages of production of a product are located across several countries. Therefore, the production of goods nowadays is to a large extent internationally fragmented and perhaps cannot anymore be reflected by the Product Space as the distance between the trees is altered. In other words, the composition of the export basket no longer accurately reflects the capabilities inherent to the country: a country may export high quality goods because it is specialized in unskilled assembly tasks. That is the case of China (for instance, see the example on the iPad and iPhone in Kraemer et al. (2011)). It follows that in addition to the importance of exports, the study of the quality of productive transformation implies that within the analysis must be a consideration of the importation of intermediary goods. It emerges from these arguments that today's context of globalization increasingly questions the use of the product line as a unit of analysis.

1.3.4 The Global value chains

As far as the evolution of trade in history is concerned, globalization has been progressive over the years. The 19th century saw the industrial revolution and improvements in transportation that are conducive to the ease of exporting and importing tradable goods. Recently, decreasing trade costs and the improvements in technology and logistics have made it possible to reduce production cost by fragmenting the production process and offshoring tasks. The phenomenon has boosted trade volume and encouraged diversity of trading goods (WTO & IDE-JETRO, 2011; WTO, 2014). Indeed, the division of labor (theoretically developed by Adam Smith) combined with economies of scale made the GVCs more profitable internationally because of low wages in developing economies.

The trade in intermediate goods, such as parts, components and accessories, shows that countries are increasingly specializing in tasks rather in goods. According to the OECD TiVA database[6], in 2015, the share of imports and exports in intermediate goods in gross imports and exports for East and South-East Asia were respectively 69.36 and 51.27 percents, and the same shares for the OECD member countries were respectively 60.62 and 57.41 percents.

The comparative advantage of some developing countries in performing intensive-labor tasks has enabled them to become integrated into international trade through

6. Trade in Value Added, Website: https://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm.

the GVCs and develop their economies by implementing policies to attract FDI. Especially, Amurgo-Pacheco & Pierola (2008) observe that trade in pieces and components in the machinery sector constitute 51.65 percent of the share of change in extensive margin for developing countries. At the firm level, economists widely refer to the "smiling curve" to describe the linkage between level of value-added and the location of tasks performed along the production chain. Inspired by Stan Shih, Acer founder and CEO in 1990, it mainly explains that the stage of fabrication, especially assembly, involves low value-added because a bigger share of added value has moved to pre and post-fabrication services (stages of pre-fabrication are R & D, product concept and design; and stages of post-fabrication are marketing, sales, and after sales services). These high value-added stages are located in the North, while production stage (or fabrication) is in the South (Baldwin, 2012). The deepening of the smile compared to forty years ago, suggests that the "good jobs" stay in the North and the "bad jobs" have been relocated to the South.

Taking these elements into account, the previous diversification indices do not capture the quality of tasks performed in each country in the production chains of a given good. In addition, it seems that the sophistication indices calculated from the products of export basket are likely to fail to assess the structural change and the story behind the capability accumulation accompanied by economic sophistication because the export of high tech products, for example, may be due to the assembly activity in the exporting country and therefore do not induce all the expected spillovers and economic growth. This is what is called the statistical artifact. Identifying the real contribution of an economy to the value chains would permit to assess the real effect of trade on structural transformation.

Therefore, a new measure of international trade is needed. WTO & IDE-JETRO (2011) mention a new statistical measurement, the "trade in value added" (TiVA) approach, that instead of counting the number of exported products, will focus on the level of countries' value-added or the domestic content embedded in the final exported goods. To measure the TiVA, an international Input-Output table enables the tracing of the origins of intermediate goods and services by taking into account all backward linkages between countries and sectors and computing the value added of imported inputs. Other data on national input-output tables are utilized to measure national GVCs, such as the World Input-Output Database (WIOD), constructed by researchers at the University of Groningen; and the Eora global supply chain database, elaborated by researchers at the University of Sydney (World Bank, 2020b). The main limitations of these measurements are the data coverage in terms of countries and sectoral disaggregation, especially for developing countries,

and the burdensome methodology given the complexity of computing each country's contribution incorporated into a single final good.

1.4 How can an export diversification strategy be a driver of development and why should a developing country choose such a strategy ?

To answer the above question, we will consecutively present the determinants of exports diversification and its outcomes or its benefits for economic development.

1.4.1 Determinants

In this subsection, let us put the diversification variable on the left-hand side of the specification equation and make a review of the literature that questions what could explain an increase in diversification of economic structure and exports. Some structural drivers have already largely been discussed on theoretical and empirical levels. On the theoretical level, state intervention would lead to diversification according to the Structuralism approach. As far as the empirical studies are concerned, the inverted U-shaped linkage between diversification and development (Imbs & Wacziarg, 2003) shows on the first part of the development path that the diversification occurs when the income per capita rises. Conversely, it is clearly demonstrated that structural transformation through diversification of economic activities fosters economic growth and development (IMF, 2014b). As stated by several studies (Ben Hammouda et al., 2006; Agosin et al., 2012), the causal relationship between diversification and development seems to be bidirectional. In addition, the product proximity in the Product space (Hausmann et al., 2014) tends to show that future diversification depends on the products already produced due to similarity in required capabilities. Hence, diversification through quality upgrading depends on the length of the quality ladder.

In addition, the literature suggests that other factors are sources of diversification, such as country characteristics, trade policies and relative price.

1.4.1.1 Country characteristics

Country characteristics such as the level of economic development, endowments in human capital, investments and natural resources are some of the drivers of change in export composition.

The first country characteristic is the level of economic development, as shown by stylized facts developed earlier in this chapter. Hummels & Klenow (2005) have argued that more advanced countries tend to export higher numbers of products. Parteka & Tamberi (2011) find similar results using data from 60 countries over twenty years (1985-2004). Country specific characteristics as determinants of change in product mix are highlighted in their study. The country size, approximated by GDP value and population, is found to be positively correlated with manufacturing sector diversification and corroborates the idea that the diversification process is linked with the exploitation of economies of scale and depends on the importance of the size of markets that are geographically accessible. Similarly, a study conducted by Rahul et al. (2019) confirms that the size of the economy, governance quality and human capital have positive effect on the degree of product diversity. Indeed, another country characteristic that is a driver of diversification is its skilled labor. In terms of capabilities brought by labor, or in other words human capital, Agosin et al. (2012) aimed to determine the long-run factors of diversification in countries around the world in their empirical analysis over the period 1962-2000. Their findings suggest that factor endowments, such as human capital accumulated through education, play a significant role in promoting diversity of exports. It is consistent with the mechanism that human capital accumulation leads to the production of more complex goods and facilitates a shift from commodity-based to manufacturing exports: more skilled labor would be associated with a comparative advantage in producing more complex good, and therefore expand the range of exported products. This last argument is in line with the Product Space approach developed earlier where the accumulation of capabilities would lead to the production of a range of more complex goods (Hidalgo & Hausmann, 2009). On the microeconomic level, in line with the Product Space approach in which economies follow a predetermined path of export diversification, Hausmann & Rodrik (2003) explain that success in an export-oriented strategy depends on entrepreneurs learning what they are good at producing in order to discover new products in which they have a comparative advantage. Government intervention should facilitate these discoveries in the private sector.

Investment is another determinant without which economies could not built capital stock. Ben Hammouda et al. (2006) investigated the role of diversification in the context of Africa's future development. From an empirical analysis of African countries over the period 1996-2001, they identify some key elements that are engines of diversification. They find that investment is a crucial determinant in the diversity of export basket, and more importantly, there is an optimum amount of in-

vestment beyond which any extra-amount of investment becomes less efficient. The Gross Fixed Capital Formation would help to accumulate capital stocks in order to build infrastructure and foster a transformation of the productive structure. The efficiency of investments (private and public) depends on the environment in which economic agents evolve. Good governance and reduction of conflicts are therefore other variables that can positively influence diversification (Ben Hammouda et al., 2006).

1.4.1.2 Trade policies as determinant of export diversification

Besides the development level, better conditions of integration in international markets, such as trade agreements and joining the World Trade Organization, would stimulate the effort of export diversification.

Dennis & Shepherd (2011) use data for 118 developing countries and show that trade facilitation fosters export diversification. By assessing export diversification at the extensive margin, described as the export of new products, they find that the decrease in export costs, international transport, or market entry by ten percent, leads to an increase in export diversification by three, four, and one percent respectively. Conversely, trade openness may trigger trade concentration, corroborating traditional trade theory favoring specialization in goods in which an economy has a comparative advantage. Indeed, Agosin et al. (2012) find that trade openness is a robust determinants as it induces export specialization. According to the authors, this result is explained by the fact that trade liberalization increases the comparative advantage of the country in its factor endowments, especially for commodity exporting countries, then increasing its exports in these traditional sectors. Ben Hammouda et al. (2006) find similar results for Africa: trade liberalization could have led countries in the continent to specialize in more primary products.

Trade agreements seems to be a robust determinant. Feenstra & Kee (2011) investigated the effect of the introduction of Mexico into the North America Free Trade Area (NAFTA) in 1994, entailing tariff reductions on exports to US markets, and the introduction of China as a member of the World Trade Organization (WTO). They found that the reduction of tariffs following the integration in trade for both countries expanded the variety of exported products, even if there was competition between Mexico and China on the US market. In the same vein, Parteka & Tamberi (2011) suggest that the proximity to international markets, through the quality of institutions and trade agreements, plays a role in the diversification process. As far as African countries are concerned, the size of domestic markets is

small and regional integration would give them the double advantage of increasing the market size and diversifying their production. Almost every African country is a state member of a regional economic communities, for example the SADC (Southern African Development Community), COMESA (Common Market for Eastern and Southern Africa) and ECOWAS (Economic Community of West African States). However intra-regional trade remains low (14 percent of total trade) because of a focus on exporting to the North (UNCTAD, 2018). As intra-regional trade flow is predominantly constituted of manufacturing goods (in other words, demand from other African countries), regional integration aptly fosters diversification, conversely to export demand from the North that is concentrated on primary products (UNCTAD, 2018). In the same vein, Regolo (2017) examined the destination of newly exported goods of bilateral trade from 116 countries over the period 2000-2010 and found that newly exported goods, as far as low and middle-income countries are concerned, are associated with regional trade. The author suggests therefore that facilitation of market access through improvement in transportation infrastructure and intra-regional trade liberalization should be favored in order to foster learning by exporting effects and thus generate export diversification. The origins of trading partners matter because of the nature of their domestic demand. Regolo (2013) examined the degree of export diversification of a country in the context of bilateral exports to the North and to the South of 102 trading partners over the period 1995-2007. The author shows that export diversification is higher when the partners involved in bilateral trade are equally endowed, or in other words, participating in South-South or North-North trade. The author explains that a diminishing trade costs, more specifically in transport costs between developing countries in order to improve market access would induce a higher degree of diversification of exports. Thus, trading partners matter. Indeed, integration in regional trade can increase trade dependence that arises from trade in tasks and intermediary goods in the context of global value chains.

Conversely, as far as developing countries are concerned, Amurgo-Pacheco & Pierola (2008) found that trade with the North would promote the diversification process, and the impact is even stronger for Asian countries. They highlight that market proximity (in terms of the distance), the reduction of trade costs, and the market size seem to participate in the increase of the number of products in the export basket.

1.4.1.3 The role of relative prices

Participation in international trade has made the change in relative prices an important determinant of export diversification. Indeed, logically, the decrease of domestic price in common currency, either because of the price itself or because of the exchange rate, would make exported products more competitive on international markets. However, on a macroeconomic level, the effectiveness of the decrease in nominal exchange rate is conditioned by its impact on combined exports and imports, in other words, on trade balance. The Marshall-Lerner condition measures that effect through the sum of import and export demand elasticities. Indeed, if the devaluation is followed by a worsening of trade balance (in that case, the sum of price elasticities of exports and imports in absolute term is less than unity), it would mean that because of the increase in price of imported goods, the dependency of the economy on imports outweighs its gains from exporting goods at more competitive prices. The inverse scenario occurs when a devaluation is followed by surpluses of trade balance. Therefore, the relationship between exchange rate and export diversification should be first considered in that context.

Tran et al. (2017) investigated the directional causality between export diversification and real exchange rate in middle income economies (in Asia and Latin America) over the period 1995-2013. They find that overall, there is two-way causality. The two variables are endogenous such that the variation of the real exchange rate induces a change in the shares of exported products in overall export volume, and a feedback occurs afterwards. The change in export diversification causes a variation in real exchange rate. However, the causality runs from the real exchange rate to export diversification when South markets are considered, and as far as Asian South-South trade is concerned, price is a driver of export diversification when focusing on individual country analysis.

On a continental level, Ben Hammouda et al. (2006) observe that for Africa, depreciation of exchange rate is conducive to specialization. As we have seen in a previous section, most African countries have a limited export basket (IMF, 2014b) and depreciation is conducive to a more concentrated range of products. However, as stated by Mosley (2018), the change in real exchange rate in poor countries, notably in Africa, would induce diversification and a higher performance in manufacturing exports if it is followed by government protection, especially in terms of input subsidy. In the case of Chile, as a consequence of economic liberalization in the 1970s, diversification of exports to more agricultural products has been stimulated by the depreciation of real exchange rates (de Piñeres & Ferrantino, 1997). More specifically, Agosin et al. (2012) suggest that improvement in the terms of trade tend to

drive to specialization in exports, but the impact is dampened by human capital. This result is in line with the context of the Dutch disease phenomenon if an improvement in terms of trade occurs in countries with low human capital. Conversely, an increase in skilled labor would be associated with a comparative advantage in more complex good, and therefore generate an increase in the range of exported products.

To sum up, the determinants highlight the role of State intervention through domestic policies in investments and education, and international trade policies (trade agreements between nations and trade facilitations). Consequently, the success of export diversification is not a simple result of globalization. As seen above, free trade may lead to specialization according to comparative advantage. Conversely, active industrial policies, such as infant-industry protection, can enable the accumulation of capabilities that lead to diversification and upgrade the industry structure which are at the heart of the economic development process.

1.4.2 Benefits

Now, let us move to the diversification variable on right-hand side of the equation and identify the economic variables that could be impacted by a change in diversification. To a certain extent, the benefits of the diversification of economic structure have already been discussed in previous sections. As far as developing countries are concerned, the robust stylized facts developed earlier enable us to understand that successful export diversification and sophistication informs about the sustainability of a country's growth trajectory. What are the effects that accompany that economic growth ?

1.4.2.1 A remedy to the "curse of natural resources"

As we have seen in the previous section, countries that are rich in natural resources are less efficient and less competitive on international markets, and therefore have slower growth. Indeed, some economists have suggested that dependency on natural resource exports can trap nations in low-income level (WTO, 2010). Hence, one of the most obvious impacts of a strategy based on export diversification is resilience to external shocks by alleviating dependency on traditional goods, such as commodities, primary products, and natural resources, which experience volatility of export earnings (IMF, 2014b). This leads to the second advantage of export basket diversity, which is macroeconomic stability.

1.4.2.2 On macroeconomic stability and sustained economic growth and development

Diversification seems to be negatively correlated with volatility of export earnings from the perspective of a portfolio approach. Export earnings stability could therefore be obtained through export diversification because it reduces risk of earnings volatility and therefore ensures sustainability of economic growth (Stanley & Bunnag, 1986; Tran et al., 2017).

Failure in structural transformation through diversification of exports and quality upgrading could lead to a "middle income trap" where economies are trapped in low-skilled and low-technology goods. The comparative advantage in labor intensive tasks may exacerbate the specialization in these activities in the context of GVCs. In the case of Chilean exports, de Piñeres & Ferrantino (1997) explain that the long run relationship between growth and export diversification could be a transitionary stage towards equilibria, where changes in export composition occurs in periods of crisis.

1.4.2.3 Effects on productivity

The questions on export-productivity nexus and its directional causality have been discussed in the literature. Fernandes & Isgut (2015) find evidence of learning-by-exporting by Colombian manufacturers over the period 1981-1991. As stated by de Piñeres (1996), the relationship is ensured through positive technological externalities. Indeed, the literature suggests that increase in diversification, broadly speaking, due to export growth, fosters economic growth through the increase in productivity. Therefore, logically, specialization would induce low productivity. Lederman & Maloney (2003) find that export specialization is conducive to a slower growth due to its restraining effect on productivity. Hausmann & Bailey (2006) state that the exploitation and the development of comparative advantage in certain goods, such as production in light manufacturing, can generate intra and inter-spillover that can benefit other firms. As far as Africa is concerned, Ben Hammouda et al. (2006) examined the effect of export diversification on sustained economic growth through total factor productivity. Their empirical analysis suggests that increase in the degree of diversification improves a country's total factor productivity. McMillan et al. (2014) emphasize that the mechanism behind diversification-led productivity linkage relies on the labor flow from low productivity activities to high productivity ones. However, globalization, encouraging specialization, would trap African countries in their comparative advantage in natural resources. African governments should im-

plement diversification strategies towards activities with higher productivity than the "subsistence" sector.

Conclusion

To sum up, this chapter contributes to the literature review on the link between composition of exports and development and helps to explain the virtuous nature of diversification through its benefits.

However, as far as developing countries are concerned, some questions arise about the impact of export diversification in terms of products and trading partners on external constraint, and the transmission channels through which export diversification leads to sustained economic growth along the development process. In the light of these concerns, the following chapters will address these issues individually by re-exploring the export diversification-economic growth nexus. From theoretical and empirical analysis with cross-country and country case studies, the further works will put forward the qualitative dimension of diversification in terms of a sustained growth path.

Chapter 2

Product export diversification and sustainable economic growth in developing countries

Abstract

A consensus on the virtues of an economic development strategy based on export diversification has emerged from the recent economic literature. The purpose of this chapter is to revisit that relationship by questioning the sustainability of such a strategy. Drawing on a balance of payments constrained growth model, we compare the re-composition of productive capacities that follows export diversification with the evolution of countries' external financing constraints. Based on econometric estimates of panel data, the lessons of the model allow us to analyze and compare, over the period 1995-2015, export diversification in three samples of developing countries, namely: Latin America, sub-Saharan Africa and Developing Asia. [7]

Keywords: BoP constrained growth model, export diversification, sustainable economic growth, developing countries.

JEL codes: F1, F43, 011, 057

7. This chapter is the updated version of an original paper co-authored with Rieber Arsène (LASTA, University of Rouen Normandy, France). A version of this chapter has been presented at the 16th International Convention of the East Asian Economic Association (EAEA), National Taïwan University, Taïwan (October 27-28, 2018) ; and at the GDRI-IDE 2018 (Economie Internationale du Développement) conference, CERDI (Centre d'Etudes et de Recherches sur le Développement International), Clermont-Ferrand, France (November 15-16, 2018). A shorter version of this chapter is published in the journal Structural Change and Economic Dynamics with citation "Mania, E. and Rieber, A. (2019). Product export diversification and sustainable economic growth in developing countries. *Structural Change and Economic Dynamics*, 51, 138-151".

2.1 Introduction

Major international organizations, led by the International Monetary Fund (IMF), have agreed recently to extol the virtues of an economic development strategy based on export diversification (IMF, 2014b). For a developing economy, it is argued, export diversification makes it possible to stabilize export earnings in the face of price volatility in international markets and acts as a driver of economic growth through the technology spillovers from which other sectors benefit (de Piñeres & Ferrantino, 2000; Lederman & Maloney, 2012). This consensus has two main sources. The first is the successful experience of the Asian NICs' industrialization (World Bank, 1993). Since the end of the 1970s and in a global context of trade liberalization, these countries have adopted pro-active policies for export promotion based on the structural transformation of their economies, including export diversification. The second source of this new consensus on the virtues of export diversification is an empirical study by Imbs & Wacziarg (2003). In an international cross-sectional study, they identify a U-shaped linkage between per capita income and the degree of production concentration. Subsequently, observation of the quadratic relationship has been extended to the relationship between export diversification and level of development (Klinger & Lederman, 2006; Parteka, 2007; Easterly et al., 2009; Cadot et al., 2013): the first stage of economic development is followed by a diversification of exports. These empirical results coincide with the recommendations of the major international institutions.

As far as theory is concerned, the debate is not new and was at the center of the controversies of the 1950s between free-trade and structuralist economists. Since Ricardo (1817), the former had been inspired by traditional theories of international trade and preached free trade and specialization based on a country's comparative advantages. Initiated by Krugman (1979), the new theories of international trade update this debate by considering the increasing returns to scale. They show that concentration of a country's exports is a source of gains when the economy is opened up to international trade. Furthermore, Prebisch (1950) and Singer (1950)'s works inspired the pioneers of development economics. The latter argue that the comparative advantage thesis inevitably led developing countries to an "immiserizing" growth. For these economists, the differences in economic structures between countries produce a commercial exchange configuration in which industrialized countries export high value-added industrial products and developing countries export primary or labor-intensive goods. However, developing countries' exports are characterized by relatively low levels of income elasticity, low productivity and strong price fluctuations. The volatility of export earnings and the deterioration of the terms of

trade condemn developing economies to an "immiserizing" growth. The recommended remedy is export diversification, on the grounds that it reduces an economy's vulnerability to external demand shocks and is conducive to the technological spillovers that are essential for economic take-off. The contemporary structuralist school subsequently revived the argument against the comparative advantages theory: the process of structural change in a developing economy is driven by the diversification and composition of its exports (Vera, 2006; Botta, 2010; Cimoli et al., 2010, 2011). Consequently, development policies need to introduce distortions into the specialization mechanisms of comparative advantages theory (Lederman & Maloney, 2012). To support their theoretical arguments, several authors note that the NICs of Asia and China became industrialized by defying their comparative advantages and diversifying their export structure (Amsden, 1989; Wade, 1990; Lin & Chang, 2009; Rodrik, 2011a). More recently, there has been a theoretical convergence, with new versions of mainstream models also introducing export diversification as a factor in economic growth. Based on an extension of Krugman's 1979 model, these models, called "new new trade theory", introduce heterogeneity in productivity between firms into the international trade models (Melitz, 2003; Chaney, 2008; Feenstra & Kee, 2008). They show that a reduction in trade costs increases the number of exporting firms. Since in monopolistic competition each firm produces a variety of different goods, the decrease in trade costs will lead to increasing export diversification. Through a selection effect, the reallocation of market shares to the most productive firms then contributes to an increase in productivity at the aggregate level. It can be shown from these models that an economy's export diversification resulting from trade intensification drives economic growth. However, a division remains between neo-structuralist economists and mainstream economists. For the former, export diversification requires active state intervention, whereas for the latter, it is naturally associated with a reduction in trade costs. Apart from this important economic policy controversy, a consensus has been reached around the notion that export diversification contributes positively to economic growth and development.

This argument has been corroborated by many studies on various samples of developing countries and seems empirically very robust. For developing countries, a first set of studies focused on the harm caused by an exclusive specialization in primary goods: the "natural resource curse". The arguments tested draw on Prebisch's thesis (Prebisch, 1959) of a decline in the terms of trade between industrialized and non-industrialized countries, volatile export earnings and low productivity (Sachs & Warner, 1997; Auty, 2000, 2001; Collier & Dehn, 2001). Other studies directly test the relationship between export diversification and economic growth. They show

unanimously, from various samples of countries, that export diversification contributes to developing countries' economic growth (Lederman & Maloney, 2006; Agosin, 2007; Naudé & Rossouw, 2011; IMF, 2014a,b, 2017b). Recent works improve this result by comparing export diversification with a country's productive structure. The pioneering study by Hausmann et al. (2007) shows that export diversification should be assessed according to the level of sophistication of the exported products: certain products are more promising than others in terms of economic development. Drawing on the capabilities approach, Hidalgo & Hausmann (2009) developed this thesis by comparing product characteristics (product complexity) to country characteristics (country complexity). They show that the complexity of a product is a function of the capabilities it requires. By linking country's export diversification to the complexity of the export baskets, their method makes it possible to assess the complexity of a country's productive structure (Felipe et al., 2012). In addition, Hidalgo et al. (2007) propose the Product Space, a mapping tool that can be used to visualize networks between goods according to the similarity of the capabilities required to produce them. The Product Space differentiates a country's exports on the basis of their ability to facilitate future diversification into higher-productivity products. The merit of this recent literature is that it introduces a qualitative measure into the assessment of the relationship between export diversification and economic development.

However, new firm internationalization strategies are likely to affect the qualitative assessment of the relationship between export diversification and economic growth. In fact, nowadays, the global economy is characterized by a vertical fragmentation of production process, in which countries, particularly developing countries, specialize in specific tasks in a good's production chain. Developing countries integrated into global value chains (GVCs) no longer specialize in the production of a specific good, but in a defined segment of the production process: the operation consists of adding value to a good's production chain (UNCTAD, 2013; Koopman et al., 2014). Thus, many developing economies' export composition integrates this new organization of global production. For these economies, therefore, export diversification is no longer necessarily accompanied by a productive transformation conducive to economic development (McMillan & Rodrik, 2011). Indeed, developing countries' integration into GVCs may trap them in the limitations of their comparative advantage as a result of an enforced specialization in low-complexity, labor-intensive tasks with high import content. The benefits of diversification in terms of spillover effects for other productive sectors are thus called into question: export diversification is no more than a reflection of an economy's partial industrialization. In

other words, a country's integration into a GVC will admittedly foster rapid industrialization accompanied by export diversification but may also lock its economy into "an under-industrialization trap" (Baldwin, 2012). Consequently, export diversification measured by export data does not necessarily reflect the economy's structural transformation and therefore the "qualitative" dimension of its economic growth. In similar terms, Lederman & Maloney (2012) argue that the recent literature findings on Hidalgo & Hausmann (2009)'s country complexity indicator can be distorted because these indicators are based on the complexity of exported goods and not on the complexity of the tasks performed. Thus, the measure of complexity of a country's productive structure may be overvalued because of the country's integration into the global value chain through a complex good even though the task actually performed is a low-complexity task. Aware of the problem, International institutions now provide databases on value added that distinguishes foreign value-added from domestic value-added for a country's exports . Unfortunately, these databases provide data over a very limited period and do not allow a product-specific analysis. Consequently, the use of international trade data to analyze export diversification across a large sample of countries is still inevitable.

In comparison to the existing literature, we propose in this paper an alternative methodology that can be used to analyze the quality of exports in terms of productive transformation. In addition, our approach aims to take into account the potential bias introduced by the global fragmentation of the production processes. Our purpose is to introduce a qualitative dimension into the assessment of the linkage between export diversification and economic growth, making it possible, for example, to distinguish "good" from "bad" diversification in terms of productive transformation. In this regard, Thirlwall (1979)'s law introduces a binding external constraint to growth (the so-called theory of balance-of-payments-constrained growth) and seems to be an approach that is particularly well suited to our purpose. The original intuition of Thirlwall's Law is that an economy's external constraint reflects the quality of its productive structure in the long run. More precisely, in a demand-led growth model, Thirlwall (1979)'s model links an economy's structural changes to its external financing constraint by determining a threshold growth rate beyond which growth will be qualified as "non-sustainable" in the long run. Thus, the quality of a country's productive structure can be assessed through the value and evolution of this threshold growth rate. Incorporated into our problematic, this theoretical framework will allow us to compare the structural transformation of productive capacities that accompanies an economy's export diversification with the evolution of the current account balance. The idea is that an economy's ex-

ternal constraint reflects the structural quality of its productive structure in the long run. For example, a developing economy's integration into GVCs through low-complexity tasks without substantial transformation of the productive structure, such as assembly tasks, will certainly broaden the composition of exports but will be accompanied by a high import content that is potentially unsustainable in the long run. Conversely, integration through complex tasks with a high technological content will relax its external financing constraint as a result of spillover effects on the economy's productive structure. Thus, taking as our starting point an extended version of Thirlwall (1979)'s law, we begin by proposing a theoretical framework that enables us to identify the required conditions for virtuous export diversification for long-run sustainable growth. We will then use the lessons from our model to analyze, for the period 1995-2015, the impact of export diversification on the sustainable growth of three samples of developing countries, namely: Latin America, sub-Saharan Africa and Developing Asia. The three regions experienced very contrasting levels and changes in their export composition. Our econometric results will enable us to assess, for each of the three groups, the more or less virtuous nature of these evolutions for the long-run economic growth.

The article is organized as follows. In the second section, we will analyze the evolution of export diversification in the selected developing countries in the three regions. In the third section, we will develop our theoretical model and the estimation issues. Section four will present and analyze the econometric results for our three samples of countries. Finally, the last section will summarize the main conclusions.

2.2 Export diversification in developing countries

2.2.1 Measuring tool

We chose to measure the diversification level by means of the Theil index (Theil, 1972), which is undoubtedly one of the most used indexes in the literature on export diversification (Cimoli et al., 2011; Agosin et al., 2012; Cadot et al., 2013). The index is proportional to the level of concentration and inversely proportional to the level of export diversification. In terms of index measurement, the greater the scale of disaggregation is, the better the assessment of diversification or concentration will be.

The Theil index has the advantage of disaggregating the degree of diversification into two components: diversification across the extensive margin (namely the between component) and diversification at the intensive margin (the within com-

ponent). More precisely, a country's export diversification across products can result from the export of new products (diversification at the extensive margin) and from the diversification of exports of existing products, which is reflected in a convergence of the export shares of the goods already exported (diversification at the intensive margins)(Cadot et al., 2011). By construction, the overall Theil index is the sum of the "between" component (or the extensive margin) and the "within" component (or the intensive margin) (See Subsection 1.3.2 for more details). It should be noted that the contribution of the extensive margin to export growth can only be smaller than the contribution of the intensive margin: a new exported good usually accounts for a relatively small share of the export composition and contributes only marginally to export growth. And moreover, in the next period the product is already on the intensive margin (Cadot et al., 2013). Over and above the statistical interpretation, the lesser importance of the extensive margin can also be explained in economic terms. The contribution of the extensive margin requires that the varieties of newly created products are "sustainable". Quite logically, therefore, the greater contribution of the intensive margin to export growth is confirmed by numerous econometric studies (Evenett & Venables, 2002; Brenton & Newfarmer, 2007; Amurgo-Pacheco & Pierola, 2008).

2.2.2 Stylized facts

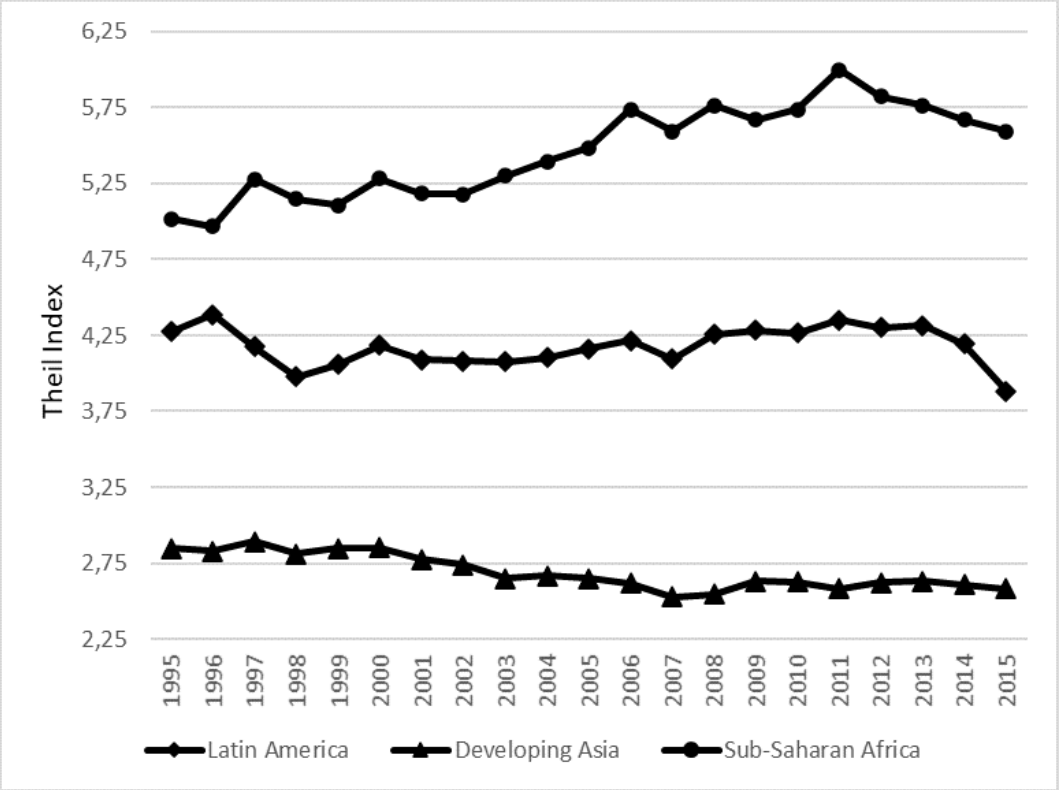
The diversification indices are calculated from CEPII's BACI database, which is drawn from the COMTRADE database and provides annual bilateral trade flows of more than 200 countries, covering the period 1995-2015. The goods exchanged are entered under the HS6 nomenclature, with a 6-digit degree of disaggregation (more than 5000 products). The extreme disaggregation makes it possible to obtain a more accurate and precise measurement of diversification. In order to investigate the impact of export diversification on sustainable growth over the period 1995-2015, 54 developing countries are selected from three regions: Latin America (LA), sub-Saharan Africa (SSA) and developing Asia (DA) (see Appendix 2.A). Our geographical division is justified by the observation that the three regions have their own characteristics: over the last two decades, developing Asian countries have experienced rapid export-driven growth, the Latin America region includes mostly middle-income countries and the SSA area includes most of the low-income economies, dependent on a small range of traditional commodities (Bosker & Garretsen, 2012).

Examination of the evolution of export diversification across products at regional level shows that the three developing areas have very different export structures (Fi-

gure 2.1). Developing Asian countries have the highest level of export diversification in the three zones. In addition, it has been rising steadily over the past 20 years, although the level of increase has been low. In fact, this evolution conceals heterogeneity of trajectories between countries, which can be divided into two groups. One is made up of the most advanced countries in the zone, such as China, India and Malaysia, which have embarked on a process of re-concentrating their exports. The other includes "latecomer" countries, such as Vietnam, Laos and Cambodia, which are in a phase of accelerated export diversification (Mathai et al., 2016) (see Appendix 2.B, Figure 2.6). Latin American countries exports are, on average, relatively less diversified with a slight increase in concentration over a large part of the period for many countries. Colombia, Argentina, Brazil and, more importantly, Venezuela have followed this trajectory (IMF, 2017b).

Conversely, exports from sub-Saharan African countries are the most concentrated and the increase in the index shows an intensification of concentration throughout the period, as in the case of the major countries of the zone such as Angola, Nigeria, Republic of the Congo and Ghana (see Appendix 2.B, Figure 2.6).

Figure 2.1 – Export diversification by region over time (1995-2015)

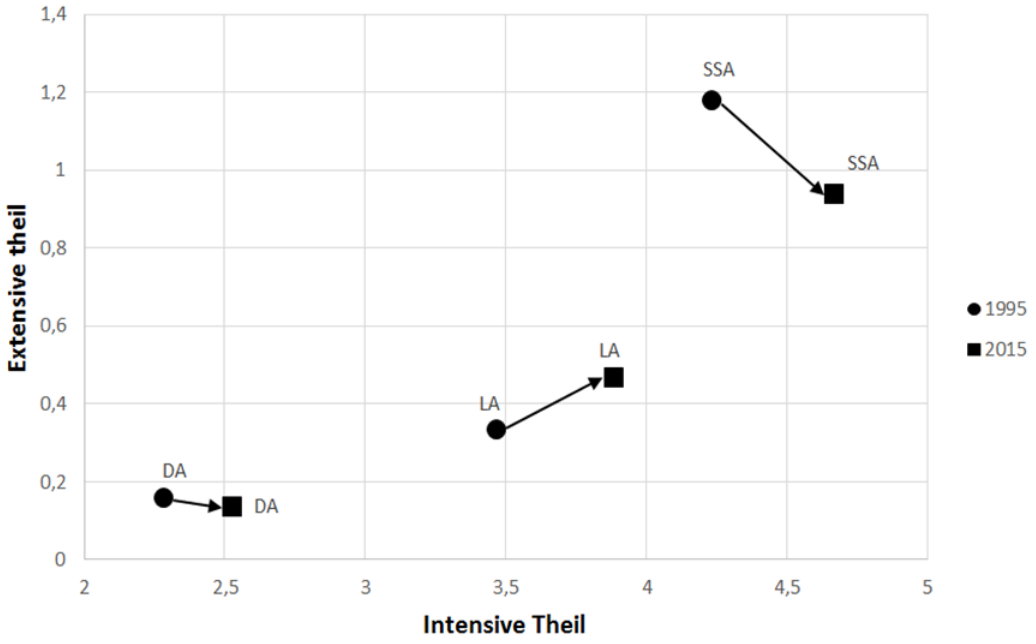


Source: Weighted average, author's calculations from BACI database, 2017.

Now, for each region, we can describe more precisely how export structures have

evolved by looking more closely at the decomposition of export diversification at the extensive and intensive margins. Figure 2.2 shows the average extensive and intensive levels of countries' Theil indices in the three regions at the beginning and end of the period.

Figure 2.2 – Extensive vs. intensive margins in 1995 and 2015



Source: Weighted average, author's calculations from BACI database, 2017.

First of all, Figure 2.2 supports the previous observation: over the period 1995-2015, the DA region, located in the South-West zone of the figure, is the most diversified, followed by the LA region; the SSA region is the most concentrated.

Developing Asia's economies achieved spectacular export performance and became tremendous international competitors by transforming their export structure jointly across extensive margin diversification and intensive margin concentration. In order to understand these two contrary trends, it should be noted that in this region, unlike in the others, there is a great heterogeneity of trajectories that can be analyzed by attributing the evolution of the intensive margin to advanced countries (China, India, Thailand and Malaysia) and the evolution of the extensive margin to the latecomers (Vietnam, Cambodia or Laos) (see Appendix 2.B, Figure 2.7). These two trends are in fact complementary: the decrease in the intensive margin reflects the fact that the region's most advanced countries concentrated their exports around more sophisticated existing products while at the same time ceding their labor-intensive activities to the latecomers, thereby enabling the latter to di-

versify their exports at the extensive margin (Papageorgiou & Spatafora, 2012; Asian Development Bank, 2014). For example, the Chinese export growth is mainly explained by the change in the intensive margin (Amiti & Freund, 2010). More precisely, for the last decade the country has been moving up the value chain, abandoning the labor-intensive sectors (where they have a comparative disadvantage because of rising wages) in favor of sectors with higher value-added. This evolution has benefitted China's less advanced neighboring countries (Cambodia, Laos, Myanmar and especially Vietnam), which are very strongly open to international trade and have taken over these export sectors, which produce goods that are labor-intensive or form part of a low value-added regional assembly process (Mathai et al., 2016). Indeed, compared to the rest of the world, latecomers are today countries most strongly integrated into the GVC. For example, according to the OECD Trade in Value Added (TiVA) database, Cambodia's GVC participation index is 45 percent of its total gross export in 2015 with an increase in GVC participation of 8.4 percent per year over the period 2005-2015. Comparatively, for developing countries, these figures are respectively 41.4 percent for the GVC participation index and an annual increase of 6.5 percent on average over the period 2005-2015. The example of Vietnam is even more remarkable since nowadays the country is one of the most strongly integrated into the GVC: Vietnam's GVC participation index is 55.6 percent (14 points more than the average for developing countries) with an average increase in GVC participation of 16.4 percent per annum over the period 2005-2015 (10 points higher than the average for developing countries). Hence, GVCs managed by multinational firms divide the production of manufactured goods into production stages distributed among several countries in the region. Specialization is no longer based on countries' comparative advantages in a final good but on the comparative advantage of the "tasks" that they perform at a specific stage of the GVC. Moreover, the integration of the latecomers into GVCs has led to the export of new goods and therefore to a diversification at the extensive margin, leading in turn to a massive growth in their exports. For example, during the observation period, Vietnam achieved its meteoric diversification with a very high probability of survival for the new varieties by joining GVCs in several product categories through its export of new goods, especially in the electronics sector (IMF, 2014a,b) (see Extensive Margin of Developing Asia in Appendix 2.B, Figure 2.7). However, while the latecomers' integration into GVCs has enabled them rapidly to diversify their exports at the extensive margin, these new exports have a high import content, which is characteristic of specialization in assembly and finishing activities (Mathai et al., 2016). Ultimately, the joint evolution of the extensive and intensive margins of exports for the DA countries

characterizes the GVCs in the region: the region's more advanced countries have refocused their activities by abandoning the labor-intensive sectors (concentration at the intensive margin) to the region's least developed countries, which have thus been able to diversify their trade through the extensive margin.

For the SSA, concentration at the intensive margin can be observed during the observation period, accompanied by a diversification at the extensive margin. The export-led growth boom in Asian countries contributed to a massive increase in the world demand for inputs of primary products (agricultural and mining). This was a windfall that SSA countries were able to exploit; encouraged by the advantageous trend in commodity prices during the 2000s, they concentrated their exports around primary products (represented by a decrease at the intensive margin in Figure 2.7 in Appendix 2.B). Thus, the pattern of trade between developing Asian countries and SSA, which saw a 40-fold increase in volume over the period 1995-2015, reflects the traditional pattern of international specialization: the African continent imports a wide range of manufactured goods from Asia in exchange for primary products or products based on natural resources (IMF, 2017b). As a result, countries in the sub-Saharan region remain the least specialized in manufactured goods (IMF, 2015). Thus, since the countries of the region have a very limited basket of export products, any attempt at diversification is made at the extensive margin.

Similarly, in the LA region, the rise in world demand for primary products (particularly from Asia) and the soaring prices for these products led to a refocusing of Latin America's exports on raw materials. At the same time, the countries experienced strong competition from Asian manufactured goods, which severely undermined their exports in these sectors (IMF, 2017a). This combination of supply (Asian competition) and demand (rising global demand for primary products) shocks explains the joint concentrations at the intensive and extensive margins in the LA region (De La Torre et al., 2015). The growth in exports of Chinese manufactures characterized by strong price competitiveness negatively affected Latin American exports, from Honduras and Mexico, for example. At the same time, the growth in Chinese imports of agricultural and mining products strongly boosted exports of agricultural products from other countries in the region (Paraguay, Argentina and Brazil) as well as mining products (Brazil, Peru and Venezuela) (Artuç et al., 2015).

In order to put these facts into perspective, we present in the following section a theoretical framework that can be used to assess the impact of these changes in export composition on the productive structure of each of these regions.

2.3 Balance of Payments Constrained Growth Theory and export diversification

2.3.1 The theoretical framework

The Balance of Payments (BoP) constrained growth model rewrites both the Keynesian precepts of demand-led growth and the teachings from structuralist economists about the interaction between economic development and structural changes in an economy's productive capacities. In our paper, we propose to amend Thirlwall (1979)'s canonical model. The original insight of Thirlwall (1979) is that an economy's external constraint reflects the quality of its productive structure in the long run. Our purpose is to analyze the impact of export diversification on a developing economy's long-run sustainable growth path: the criterion of sustainability refers to a non-explosive external debt on the stationary growth path.

We make an initial modification to Thirlwall's model. We consider that the level of an economy's export diversification influences its export performance by taking into account, firstly, a direct effect: the level of export diversification, as well as the economy's price competitiveness and the level of world demand, determines the economy's export volume.

Taking a traditional export function as a starting point, the amended version will be written:

$$X = (\frac{P_d}{P_f})^{\phi} Z^{\varepsilon} DIV^{\lambda} \tag{2.1}$$

where X is the volume of exports; P_d/P_f is the relative domestic and foreign prices measured in a common currency; Z is the level of world income; DIV is the level of export diversification; $\phi(< 0)$ is the price elasticity of demand for exports; $\varepsilon(> 0)$ is the income elasticity of demand for exports and λ is the export diversification elasticity of demand for exports. The sign of this elasticity is *a priori* indeterminate: according to traditional international trade theories, if the export concentration in line with comparative advantages improves export performance, the sign will be negative; conversely, if export diversification improves export performance, the sign will be positive.

In a second step, we also consider that export diversification affects the income elasticity of exports by modifying the country's productive structure. This indirect effect captures the impact on export performance of the structural changes induced by export diversification. This structural effect is written:

$$\varepsilon = \varepsilon(DIV) \text{ where } \varepsilon' \lesseqgtr 0 \tag{2.2}$$

Taking as our starting point the same arguments advanced for the direct effect, the sign of the impact of diversification on the income elasticity of exports (ε') is *a priori* undetermined: concentration, as well as export diversification, can induce structural changes that improve export performance through an increase in the income elasticity of exports.

A second modification we bring to Thirlwall (1979) model is to consider that an economy's export diversification is likely to change its import volume. The argument is twofold:

— on the one hand, export diversification may be a substitute for imports, in which case an increase in export diversification will be accompanied by a decrease in the import volume;

— on the other hand, export diversification may be characterized by a high import content, hence increasing the country's "appetite for imports".

Viewed alongside each other, these two arguments indicate that the impact of export diversification on a country's import volume is ambiguous. As with the export function, we consider that this linkage can be disaggregated into a direct effect and a structural effect that impact on the income elasticity of imports. With the direct effect, the import function will be written:

$$M = \left(\frac{P_f}{P_d}\right)^{\psi} Y^{\pi} DIV^{\tau} \tag{2.3}$$

where M is the volume of imports; Y, the domestic income; $\psi(< 0)$, the price elasticity of imports; $\pi(> 0)$, the income elasticity of imports and $\tau(\lesseqgtr 0)$ the elasticity of import demand relative to export diversification.

For the indirect effect, export diversification, by modifying the country's productive structure, changes the income elasticity of imports. It is written:

$$\pi = \pi(DIV) \text{ where } \pi' \lesseqgtr 0 \tag{2.4}$$

For reasons of analytical convenience, relations 2.2 and 2.4 are expressed in linear functional forms:

$$\varepsilon = \bar{\varepsilon} + \alpha DIV \text{ where } \alpha \lesseqgtr 0 \tag{2.5}$$

$$\pi = \bar{\pi} + \beta DIV \text{ where } \beta \lesseqgtr 0 \tag{2.6}$$

Taking logs, the export and import functions are written thus:

$$log(X) = \phi log\left(\frac{P_d}{P_f}\right) + \bar{\varepsilon} log(Z) + \alpha DIV log(Z) + \lambda log(DIV) \tag{2.7}$$

$$log(M) = -\psi log\left(\frac{P_d}{P_f}\right) + \bar{\pi} log(Y) + \beta DIV log(Y) + \tau log(DIV) \tag{2.8}$$

Beside the various elasticities discussed above, the parameters α and β capture the interaction effect of diversification on the income elasticities of exports and imports respectively.

Referring to Thirlwall & Hussain (1982), the balance of payments equilibrium condition is written:

$$P_d X + P_d F = P_f M \tag{2.9}$$

where $F(> 0)$ is the current deficit in real terms or the net financial inflows in real terms.

With lower-case letters standing for the growth rates of variables, condition 2.9 implies:

$$x\omega + f(1-\omega) = m + p_f - p_d \tag{2.10}$$

$\omega = X/(X+F) = (P_d X)/(P_f M)$ is the share of export earnings in total real foreign exchange earnings or the share of total imports that are paid for with exports.

Differentiating equations 2.7 and 2.8 with respect to time and incorporating the export and import growth rate expressions in equation 2.10, we deduce the income growth rate compatible with the BoP equilibrium:

$$y_{BoP} = \frac{(p_d + p_f)(1 + \omega\phi + \psi) + \omega z(\bar{\varepsilon} + \alpha DIV) + f(1-\omega) + div(\omega\alpha DIV log(Z) + \omega\lambda - \beta DIV log(Y) - \tau)}{\bar{\pi} + \beta DIV} \tag{2.11}$$

2.3.1.1 The stationary state and the definition of the long-run sustainable growth path

To define the long-run sustainable growth path, we refer to Thirlwall's Law, which postulates that an economy cannot finance its growth indefinitely out of a growing inflow of foreign capital, as this will lead to unsustainable foreign debt accumulation. Thirlwall's Law is expressed in these terms: *"In the long run, no country can grow faster than the rate consistent with the balance of payments equilibrium on the current account unless it can finance an ever growing deficit which, in general, it cannot."*.

In other words, in the long run, an economy's external debt cannot grow indefinitely and must therefore be stabilized. The need to satisfy the external constraint in the long run sets an upper limit to growth given by y_{BoP}. If a country's growth rate is lower than y_{BoP}, the country will accumulate trade surpluses and become a net capital exporter. Conversely, if its actual growth exceeds y_{BoP}, the current account will deteriorate, and the country will become a net capital importer. However, this cannot continue indefinitely.

Two conditions verified in the long run determine the stationary state of an economy:

— on the one hand, the relative purchasing power parity (RPPP) attains in the long run: $p_d - p_f = 0$;

— on the other hand, the export productive structure of our economy is stabilized: $dDIV/dt = 0$.

In the stationary state[8], the growth rate compatible with the equilibrium of the BoP is therefore written:

$$y_{BoP} = \frac{\omega z(\bar{\varepsilon} + \alpha DIV) + f(1-\omega)}{\bar{\pi} + \beta DIV} \tag{2.12}$$

In our model, the economic growth sustainability condition implies a null growth rate of the current deficit in the long run ($f = 0$). The last condition implies as a corollary (for $x > 0$) that $\omega = \frac{X}{X+F} = \frac{1}{1+F/X} \to 1$. From equation 2.12, we therefore obtain the expression of the growth rate compatible with the equilibrium of the BoP in the stationary state, what we call the long-run sustainable growth rate[9]:

$$y_{sust} = \frac{\bar{\varepsilon} z + \alpha z DIV}{\bar{\pi} + \beta DIV} \tag{2.13}$$

We recognize the originality of Thirlwall's law which, by studying the impact of international trade on the long-run sustainable economic growth, compares the positive impact of an increase in the income elasticity of exports ($\bar{\varepsilon}$) to the negative impact of an increase in the income elasticity of imports ($\bar{\pi}$). In the post-Keynesian literature, the two elasticities are a function of each economy's specific productive structure. In our augmented version (expression 2.13), the same is true for export

8. Note that within a Ricardian model *à la* Dornbusch, Fischer and Samuelson (Dornbusch et al., 1977), the two conditions defining the stationary state are tautological since by definition $dDIV/dt = -(p_d - p_f)$: an economy's export diversification is determined by its price competitiveness.

9. A less restrictive condition leading to the same expression of the long-run sustainable growth rate would be to write the identity $f = x$. When the relationship is verified, growth remains sustainable because external debt is perpetually financed by exports (Setterfield, 2011).

diversification (DIV), which appears simultaneously in the numerator and the denominator. Thus, the differences in export diversification (DIV) between countries explain their differences in terms of sustainable growth rate.

2.3.1.2 The impact of export diversification on the sustainable growth rate

As already observed, export diversification changes a country's productive structure by simultaneously impacting the income elasticity of exports (measured by the parameter α) and the income elasticity of imports (measured by the parameter β). The first remark that emerges from the observation of equation 2.13 is that only the indirect effect of the impact of export diversification, on export performance and import demand respectively, influences the definition of the long-run sustainable growth rate. In other words, only changes in the productive structure caused by export diversification and measured by the α and β parameters are likely to shift the long-run sustainable growth path. The direct effects of diversification on import and export volumes (measured by the elasticities λ and τ respectively), and consequently on the current account equilibrium, are limited to the theoretical transitional dynamics; these effects will fade at the stationary state once the productive structure of exports is stabilized.

Analytically, the impact of diversification is given by the following expression:

$$\frac{\partial y_{sust}}{\partial DIV} = \frac{z(\alpha\bar{\pi} - \beta\bar{\varepsilon})}{(\bar{\pi} + \beta DIV)^2} \tag{2.14}$$

From this last expression, it appears that the sign of the relation is ambiguous:

$$\frac{\partial y_{sust}}{\partial DIV} \lessgtr 0 \Longleftrightarrow \alpha\bar{\pi} \lessgtr \beta\bar{\varepsilon} \tag{2.15}$$

For given income elasticity values of imports and exports $(\bar{\varepsilon}, \bar{\pi})$ the sign of the relation will be a function of a relative comparison of the values of α and β. For example, structural changes that strongly improve export performance (positive and high α) will increase the probability of a favorable impact of diversification on the long-run sustainable growth. Conversely, an export diversification characterized by a high import content (positive and high β) will have a negative impact on the sustainable growth rate and inversely if export diversification is substituted for imports (β negative). It follows for example that export diversification, while having a positive impact on export performance ($\alpha > 0$), may have a negative impact on sustainable economic growth because of the high import content of the diversification ($\beta > \alpha\bar{\pi}/\bar{\varepsilon}$). In this case, and more generally when the sign of the expression 2.15

is negative, export diversification is described as "bad" diversification in terms of productive transformation. Conversely, export diversification is described as "good" diversification when it allows the external constraint of the economy to be relaxed by jointly improving export performance and reducing (or curbing the rate of increase of) the appetite for imports ($\beta < \alpha\bar{\pi}/\bar{\varepsilon}$). In that case, the sign of expression 2.15 will be positive.

The two possible configurations formulated by expression 2.15 can be represented in a diagram $(DIV; y_{sust})$ (Figure 2.3). In case (a), the relationship between the sustainable growth rate and the level of diversification is positive ($\alpha\bar{\pi} > \beta\bar{\varepsilon}$). The opposite case is represented in case (b) ($\alpha\bar{\pi} < \beta\bar{\varepsilon}$).

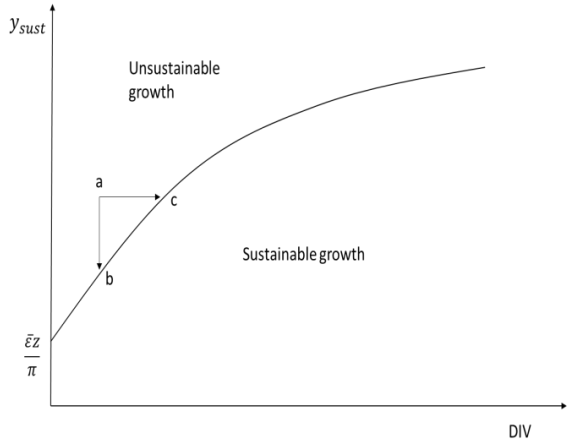
In both cases, the expression 2.13 delimits the sustainable growth zone of an economy according to its level of diversification. Indeed, the curve represents the growth rate of an economy associated with a balanced current account in the long run ($f = 0$ and $\omega = 1$). Above the curve, growth will be described as unsustainable: it will be accompanied by an explosive growth of external indebtedness ($f > 0$). Conversely, below the curve, the economy will accumulate current account surpluses ($f < 0$).

For an economy that is located on a growth path above the long-run sustainable growth rate, the implications in terms of diversification policy are radically different depending on the sign of the relationship. In the case of a positive linkage between diversification and sustainable growth (case (a)), the economy will have two possibilities. It can pursue a recessionary policy in order to restrict the growth of imports and thereby restore the current account balance (shifting from point a to point b). Conversely, it can diversify its exports while maintaining its productive capacity (shifting from point a to point c). In the case of a negative relationship, the recession option is still a solution (moving from point a' to point b'). However, in terms of export diversification, the recommendations are reversed: the economy will have to concentrate its export structure on the most competitive sectors in order to ensure current account equilibrium in the long run (moving from point a' to point c').

2.3.2 Estimation issues

To determine the impact of export diversification on the long-run sustainable growth rate, we need to estimate the parameters $(\alpha, \bar{\pi}, \beta, \bar{\varepsilon})$ that identify the sign of the expression 2.14. To that end, we will estimate the export and import functions (equations 2.7 and 2.8) by making two modifications to their theoretical expression. First, we introduce a time lag on the variable DIV in equations 2.5 and 2.6: the

(a) $(\alpha\bar{\pi} > \beta\bar{\varepsilon})$



(b) $(\alpha\bar{\pi} < \beta\bar{\varepsilon})$

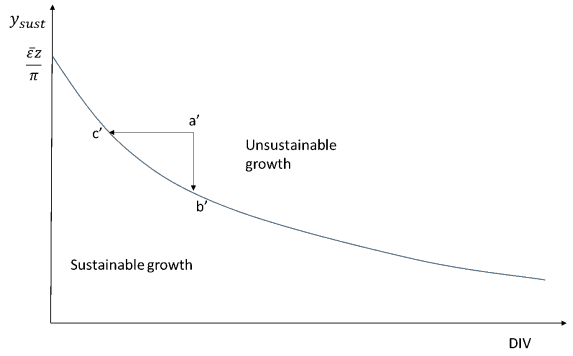


Figure 2.3 – The relationship between export diversification and sustainable growth

Note: The function 2.13 is represented by the curves in case (a) and case (b) and the derivative of the function (expression 2.14) gives the sign of the relation.

argument is that the effects of export diversification on income elasticities (ε, π) are related to structural changes that do not manifest themselves immediately. Second, we assume that it takes time for exports and imports to adjust to the desired level, so that we have a dynamic specification for estimation. The adjustment to the equilibrium specification enables us to distinguish short and long-run elasticities (Santos-Paulino & Thirlwall, 2004). The estimated equations for imports and exports are then:

$$logX_{it} = a_1 logX_{it-1} + a_2 log\left(\frac{P_d}{P_f}\right)_{it} + a_3 logZ_{it} + a_4 logDIV_{it} + a_5 DIV_{it-1} logZ_{it} + e_{it} \tag{2.16}$$

$$logM_{it} = b_1 logM_{it-1} + b_2 log\left(\frac{P_d}{P_f}\right)_{it} + b_3 logY_{it} + b_4 logDIV_{it} + b_5 DIV_{it-1} logY_{it} + e_{it} \tag{2.17}$$

where $1 - a_1$ and $1 - b_1$ are the adjustment coefficients and the other coefficients are the elasticities or the short-run coefficients. Long-run elasticities are obtained by dividing each of the respective coefficients by $(1 - a_1)$ for the export function and by $(1 - b_1)$ for the import function. For example, the short-run income elasticities are a_3 and b_3 respectively, while the long-run income elasticities are $a_3/(1 - a_1)$ and $b_3/(1 - b_1)$ respectively. Finally, e_{it} gives the error term.

The variable DIV is the value of the degree of product diversification, as measured by the overall Theil, the extensive Theil and intensive Theil indices. Thus, to analyze the direct and indirect impact of a change in the export structure, each equation comes in three variants. Moreover, the strong collinearity between $logDIV_{it}$ and $DIV_{it-1} logZ_{it}$ and $DIV_{it-1} logY_{it}$ respectively constrains us to estimate the direct effect and the structural effect of export diversification separately. [10] So, for each region, there are six estimated equations for export functions, as well as import functions.

In order to address endogeneity issues, we use a dynamic panel data model based on the generalized method of moments (GMM) model of Arellano & Bond (1991). The GMM-difference estimator controls for the endogeneity of the explanatory variables where the instruments are based on lagged values of the variables. We compute robust standard errors to solve heteroskedasticity problem.

For our three samples, we estimate the two equations in panel data covering the period 1995-2015. Annual data on exports (X) and imports (M) as well as national income (Y) and foreign income (Z) are at constant 2010 USD and were taken from the World Bank Indicator (WDI) database. The relative price $(\frac{P_d}{P_f})$, defined by the ratio between the domestic price and the foreign price, is approximated by the country GDP deflator divided by the world GDP deflator which are also taken from the WDI database.

2.4 Results

Our estimation results on the import and export equations for the three samples are reported in the Appendix [11] (see Appendix 2.C). Looking first at the price elas-

10. The correlation coefficients are respectively 0.97 and 0.93.

11. In addition to the GMM estimates, we also run long-run dynamic fixed-effect estimates for robustness checks and found similar results. We do not report the results, but they are available

ticity estimates, we can see that they are relatively weak. For the coefficients of the export functions, the price elasticities are always significant and have the expected negative sign for DA and LA; they appear to be non-significant for SSA (see Exports results respectively in Tables 2.8, 2.12 and 2.10 of Appendix 2.C). For imports, theoretically, we expect a positive sign. This result is observed significantly for LA and SSA coefficients, while DA estimates appear significant but with a negative sign. Although our study of the impact of export diversification on long-run sustainable growth does not involve price elasticities, we note that this "price elasticity pessimism" characterizes developing countries in many econometric studies (Olofin & Babatunde, 2009; Chassem, 2011; Bagnai et al., 2016). It can be learned from these studies that for the import side, the low level of price elasticity or a negative sign reflects developing countries' dependence on imports of capital goods and equipment. For the export side, the non-significant estimates for SSA reflect an export structure based mainly on primary goods, exports of which are not price-sensitive (Baumeister & Peersman, 2013).

Secondly, the short-run income elasticities are very significant and do have the expected positive sign, which enables us to calculate the long-run income elasticity values for our three samples ($\bar{\varepsilon}(LT), \bar{\pi}(LT)$). The same is true of the long-run coefficients associated with the direct impact and the indirect impact of the level of diversification on the volumes of imports and exports ($\lambda(LT), \tau(LT), \alpha(LT), \beta(LT)$) (Table 2.5).

First, we find that the estimates of the long-run income elasticities of exports ($\bar{\varepsilon}(LT)$) and imports ($\bar{\pi}(LT)$) are relatively robust. Their values for the three samples are barely affected by the diversity of the measurements of diversification, whether for the direct or indirect effect. The main distinction between the three groups of countries is to be found in the value of the income elasticity of exports (columns (1) and (5)). These estimates reflect specific aspects of the international specialization models of our country groups. The DA countries specialize mainly in manufactured goods and their income elasticity of exports is relatively high (between 2.716 and 3.749). Compared to the other two regions, this result confirms the success of their international integration scheme (Diaw et al., 2012; Papageorgiou et al., 2015; Mathai et al., 2016). Conversely, for the LA region and especially for the SSA region, exports of natural resources play a major role in their specialization models (Lederman et al., 2009; IMF, 2017b). However, the literature on growth and structural change points out that such a specialization scheme is weakened by a relatively low level of income elasticity of exports (Dosi et al., 1990). This observation is reinforced

upon request.

Table 2.5 – Direct and indirect effects of export diversification

	Direct Effect				Indirect Effect				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	**(9)**
Theil	$\bar{\varepsilon}$(LT)	$\bar{\pi}$(LT)	λ(LT)	τ(LT)	$\bar{\varepsilon}$(LT)	$\bar{\pi}$(LT)	α(LT)	β (LT)	**Impact**
Developing Asia									
Overall	3.370	1.760	NS	NS	3.433	1.643	NS	NS	**NS**
Intensive	3.124	1.697	1.078	NS	3.046	1.537	0.016	NS	+
Extensive	3.749	1.726	-0.681	-0.381	2.716	1.568	-0.027	-0.028	+
Sub-Saharan Africa									
Overall	1.797	1.329	NS	1.428	1.764	1.327	NS	NS	**NS**
Intensive	1.302	1.198	2.334	1.275	2.085	1.172	NS	NS	**NS**
Extensive	1.591	1.318	-0.921	NS	1.992	1.501	NS	0.011	**-**
Latin America									
Overall	1.747	1.185	NS	0.73	1.761	1.159	NS	0.005	**-**
Intensive	1.685	1.225	NS	NS	1.785	1.156	NS	0.005	**-**
Extensive	1.686	1.265	-0.433	0.374	1.669	1.226	-0.012	NS	**-**

NS: not significant

by our estimates: for SSA, the value is between 1.302 and 2.085, while for LA it is between 1.669 and 1.785.

To study the impact of export diversification on sustainable growth in our three country samples, we will proceed in two stages. Firstly, we analyze the direct impact of diversification on the volumes of imports and exports (Table 2.5, columns (1) to (4)) before going on, secondly, focus on the structural impact of diversification on income elasticities (of exports and imports respectively) (Table 2.5, columns (5) to (9)). With reference to our theoretical framework, column (9) calculates the sign of the relation 2.15 ($\alpha\bar{\pi} - \beta\bar{\varepsilon}$) that summarizes the object of our study, namely the impact of diversification on long-run sustainable growth.

As already noted, the Theil index is proportional to the level of export concentration. Thus, a negative sign of the coefficients associated with the indices shows a positive linkage between export diversification and the dependent variable (and vice versa). For the same reason, the sign of the impact of export diversification on the long-run sustainable growth rate has to be interpreted as the inverse of the theoretical model: a positive sign shows "bad" diversification in terms of productive transformation (and vice-versa).

In our comments on the evolution of the Theil indices in Section 2.2, we noted that export diversification trajectories in the DA region are very heterogeneous [12].

12. Given the heterogeneity of the developing Asian countries in the sample, in the published version of the paper, we integrated a dummy variable that enables us to distinguish the latecomer countries from the advanced countries in the region. To do so, we took as reference Vietnam's GDP

This heterogeneity becomes obvious if the evolution of the intensive margin is assigned to the advanced countries of the region (China, India, Thailand and Malaysia) and that of the extensive margin is assigned to the latecomers (Vietnam, Cambodia, Laos and Myanmar). More precisely, the regionalization of production resulting from GVC integration has been accompanied by a twofold shift: the most advanced countries in the zone have refocused their exports on the more sophisticated existing products (concentration at the intensive margin) while giving up their labor-intensive activities to the latecomer countries, thereby enabling the latter to diversify their exports through the extensive margin. These stylized facts enable us to interpret the export performance of the countries in the region. In the Direct Effect part of Table 2.5, the results show that the concentration of the most advanced countries in existing exporting sectors (intensive Theil) is associated with an improvement in their export performance (column (3)) without influencing their import volume (column (4)). More specifically, a 1 percent increase in the degree of concentration at the intensive margin induces a growth in exports of 1.078 percent. In addition, the coefficients reported in the Indirect Effect part of Table 2.5 show that the trend towards re-concentration also has a structural impact and strengthens the direct effect. It is accompanied by an increase in the income elasticity of exports in existing exporting sectors (column (7)) without impacting the income elasticity of imports (column (8)): the marginal effect of a concentration through the intensive margin on the income elasticity of exports is 0.016. For countries newly integrated into GVCs, the evolution of the export structure has an impact on export and import volumes. As expected, and in line with the stylized facts, diversification into new export sectors increases the export volume (column (3)): a 1 percent increase in the level of diversification at the extensive margin induces a growth in exports of 0.681 percent. Moreover, extensive margin has a positive impact on the income elasticity of exports (column (7)): the marginal effect is estimated at 0.027. Moreover, the export of new products is associated with both an increase in the volume of imports (direct effect, column (4)) and an increase in the income elasticity of imports (structural effect, column (8)): this increase in the level of diversification leads to a marginal increase in income elasticity of 0.028 points and the increase of the level of diversification of 1 percent leads to an increase in import volume of 0.381 percent. As a result, the latecomers benefit from the re-concentration of the most advanced countries in the region in terms of export diversification and a structural improvement in their competitiveness. However, the production pattern is characterized by a high import

per capita in 2015, which is the most advanced among the latecomer countries. The results do not differ from those in this analysis.

content, which increases their structural dependence on imported inputs [13].

Overall, the last column of Table 2.5 shows that for the most advanced countries in the zone (mainly concerned with the intensive Theil), the re-concentration of exports has a favorable impact on the long-run sustainable growth rate. In contrast, for the latecomers, extensive diversification has had a negative effect on the long-run sustainable growth rate because of its high import content. For the latter countries, integration into GVCs has certainly enabled them to diversify their exports rapidly, but it has not been followed by a sufficient modernization of their productive structure, which undermines the long-run sustainability of their growth path. The overall Theil interpretation sums up the two contradictory tendencies within the DA region: the non-significance of the coefficients shows that at the global level, the two opposite evolutions of the two margins are both important in terms of contribution.

For the SSA region, the situation in the various countries with regard to export diversification appears to be relatively more homogeneous. There is a general trend towards export concentration over the whole period caused by the concentration in existing sectors (intensive margin) and accompanied by diversification into new export sectors (extensive margin) (Figure 2.1 and Figure 2.2). Table 2.5 shows that the evolution of the overall Theil has not had any effect on export volume but has influenced positively the import volume (columns (3) and (4) respectively) because the concentration in existing sectors (intensive margin) is accompanied by an increase of import volume: 1 percent increase in the overall Theil index induces an augmentation of the volume of imports of 1.428 percent. For the export function, the non-significant result reflects two contradictory effects on export volumes. Concentration in existing sectors (intensive margin) is undoubtedly followed by an improvement in export performance (column (3)). This favorable effect of concentration is offset by the favorable effect of diversification in the new sectors (extensive margin, column (3)): an increase in the intensive Theil index and a decrease in the extensive Theil index of 1 percent lead to increases in export volumes of 2.334 percent and 0.921 percent respectively. For the import function, concentration of exports on existing primary products is likely to lead to an increase in import volume: for a 1 percent increase in intensive Theil index, the import volume rises of 1.275 percent. However, the most interesting results can be seen on the right-hand side of Table 2.5 (Indirect Effect). It shows that a change in the SSA export composition has had no structural impact on export and import performance (columns (7) and (8)). In other words, a change in export composition has had no influence on the long-run sustainable growth rate (column (9)). The only positive effect is observed at the diversification

13. A specific analysis of the case of Vietnam is presented in Bagnai et al. (2015).

into new sectors and has reduced the income elasticity of imports (the marginal effect is 0.011). Consequently, export diversification at the extensive margin impacts positively the long-run sustainable growth for SSA countries but the effect is too weak for a structural effect at the aggregated scale. Although SSA economies have experienced remarkable economic growth since the early 2000s, our results support the skepticism of some development economists about the structural changes that accompanied it (McMillan et al., 2014). Indeed, diversification into new sectors of primary goods had a direct impact on export volumes and an indirect effect on imports and therefore on economic growth but did not lead to the industrialization of their productive structures.

For LA countries, the concentration of exports on existing products (intensive margin) had no impact on either the volume of exports or the volume of imports (Direct Effect, columns (3), (4)). Conversely, concentration at the extensive margin weakened export performance and, at the same time, led to an increase of the import volume (column (3) and (4)): a 1 percent increase in the extensive Theil index generated a decrease of 0.433 percent in the volume of exports and an increase of 0.374 percent in the volume of imports. At the aggregate scale, the last effect predominates (overall Theil). Structurally (Indirect Effect), we observe that the concentration of exports of existing products (intensive margin) on commodities - fostered by increasing global demand - at the expense of manufactured goods, which are in competition with Chinese exports, has increased the income elasticity of imports (column (8)): the marginal effect is relatively low (0.005). This result shows that the restructuring of the productive structure has increased these countries' dependency on imports of foreign manufactured goods. As far as the external financing constraint is concerned, this change has had a negative impact on long-run sustainable growth (column (9)). At the same time, the narrowing of the export composition of new products (extensive margin) has reduced the income elasticity of exports (column (7)): the marginal effect is estimated at 0.012. At the aggregate scale, since the relatively small effect of intensive export concentration is predominant, diversification has had a low but negative overall impact because of a greater appetite for imports. Thus, for the LA countries, the structural transformation associated with the double export concentration has affected modestly but negatively the growth rate compatible with the BoP equilibrium.

2.5 Conclusion

There is a consensus in the recent economic literature on the virtues of an economic development strategy based on export diversification. Export diversification facilitates structural transformation and is conducive to development and economic growth through cross-sectoral technology spillover effects. The successful experience of the Asian NICs as well as numerous econometric studies show that export diversification contributes positively to economic growth in developing countries.

This new consensus confirms the earlier arguments advanced by the pioneers in development (Meier & Seers, 1984). However, not all export baskets have the same potential for growth and economic development. The quality of export diversification must therefore be assessed according to a country's capacity to develop its productive structure. Furthermore, the new firm internationalization strategies may affect the relationship between export diversification and economic growth. Indeed, there is a vertical fragmentation of production process on an international scale, with developing countries specializing in strictly delimited segments of the production processes. GVC integration enables countries to broaden their export composition and rapidly industrialize their economies but does not necessarily lead to transformation of the economic structure favorable to sustainable growth in the long run.

To specify the latter concept, we first developed an extended version of Thirlwall's Law in which the criterion of sustainability refers to the external financing constraint and therefore to the quality of a country's productive structure. The idea is that export diversification, by transforming national productive structure, modifies the export and import structures. The sustainable nature of this restructuring for long-run growth is assessed through the evolution of a country's external constraint. In the second stage of our analysis, we used the lessons from our model to estimate empirically the evolution of the export composition of three samples of developing countries over the period 1995-2015. For DA countries, our results enabled us to interpret the great heterogeneity of export diversification trajectories within the region. Thus, for the advanced countries of the zone, the strategy of reconcentrating exports on more sophisticated existing products has had a favorable impact on the long-run sustainable growth rate. This result confirms the beneficial nature of the transformation of their productive systems. The integration of latecomer countries into GVCs has enabled these countries to diversify their exports following the abandonment of labor-intensive activities by the most advanced countries in the region. However, the specialization of these countries in new activity segments has not been accompanied by sufficient structural changes, which weakens

the sustainability of their long-run growth path alarmingly. For SSA countries, our results support the skepticism of some development economists about their remarkable export performance. Our tests show that change in the export composition is limited to a transitory impact and thus on economic growth but does not lead to significant changes in their productive structures. The application of our model to LA countries shows that the structural change following the concentration of exports on existing commodities has led to a structural increase in these countries' dependency on imported manufactured goods. According to our results the phenomenon is relatively modest in scale but the tendency towards concentration of the overall export composition affect negatively the long-run sustainable growth path.

Appendix 2.A Countries by region

For our study, we selected 54 developing countries, which are divided by region into three samples. Depending on their income level (gross national income per capita), the developing countries are classified as low income (LI), lower-middle income (LMI) or upper-middle income (UMI) economies, as defined by the World Bank. We chose to use the country classification for the fiscal year 2016.

Developing Asia (17 countries):
Bangladesh (BGD) (LMI), Bhutan (BTN) (LMI), Cambodia (KHM) (LMI), China (CHN) (UMI), India (IND) (LMI), Indonesia (IDN) (LMI), Lao PDR (LAO) (LMI), Malaysia (MYS) (UMI), Mongolia (MNG) (LMI), Myanmar (MMR) (LMI), Nepal (NPL) (LMI), Pakistan (PAK) (LMI), Papua New Guinea (PNG) (LMI), Philippines (PHL) (LMI), Sri Lanka (LKA) (LMI), Thailand (THA) (UMI), Vietnam (VNM) (LMI).

Sub-Saharan Africa (21 countries):
Angola (AGO) (UMI), Burkina Faso (BFA) (LI), Cameroon (CMR) (LMI),Congo, Dem. Rep. (ZAR) (LI), Congo, Rep. (COG) (LMI),Cote d'Ivoire (CIV) (LMI), Ethiopia (ETH) (LI), Ghana (GHA) (LMI), Guinea (GIN) (LI), Kenya (KEN) (LMI), Madagascar (MDG) (LI), Mali (MLI) (LI), Mozambique (MOZ) (LI), Nigeria (NGA) (LMI), Senegal (SEN) (LI), South Africa (ZAF) (UMI), Sudan (SDN) (LMI), Tanzania (TZA) (LI), Uganda (UGA) (LI), Zambia (ZMB) (LMI), Zimbabwe (ZWE) (LI).

Latin America (16 countries):
Argentina (ARG) (UMI), Bolivia (BOL) (LMI), Brazil (BRA) (UMI), Colombia (COL) (UMI), Costa Rica (CRI) (UMI), Cuba (CUB) (UMI), Dominican Rep. (DOM) (UMI), Ecuador (ECU) (UMI), El Salvador (SLV) (LMI), Guatemala (GTM) (LMI), Honduras (HND) (LMI), Mexico (MEX) (UMI), Panama (PAN) (UMI), Paraguay (PRY) (UMI), Peru (PER) (UMI), Venezuela, RB (VEN) (UMI).

Source: World Bank (World Development Indicators), 2016.

Appendix 2.B Export diversification in selected countries over time (1995-2015)

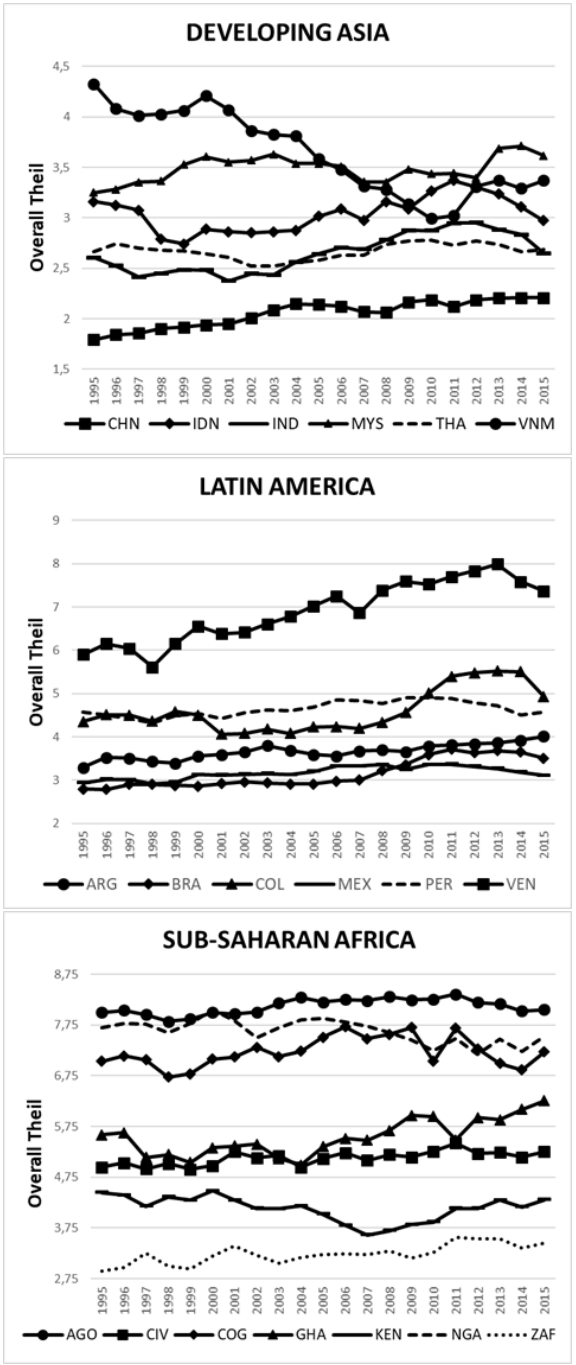


Figure 2.6 – Theil index in developing regions

Source: Authors' calculations using BACI database, 2017.

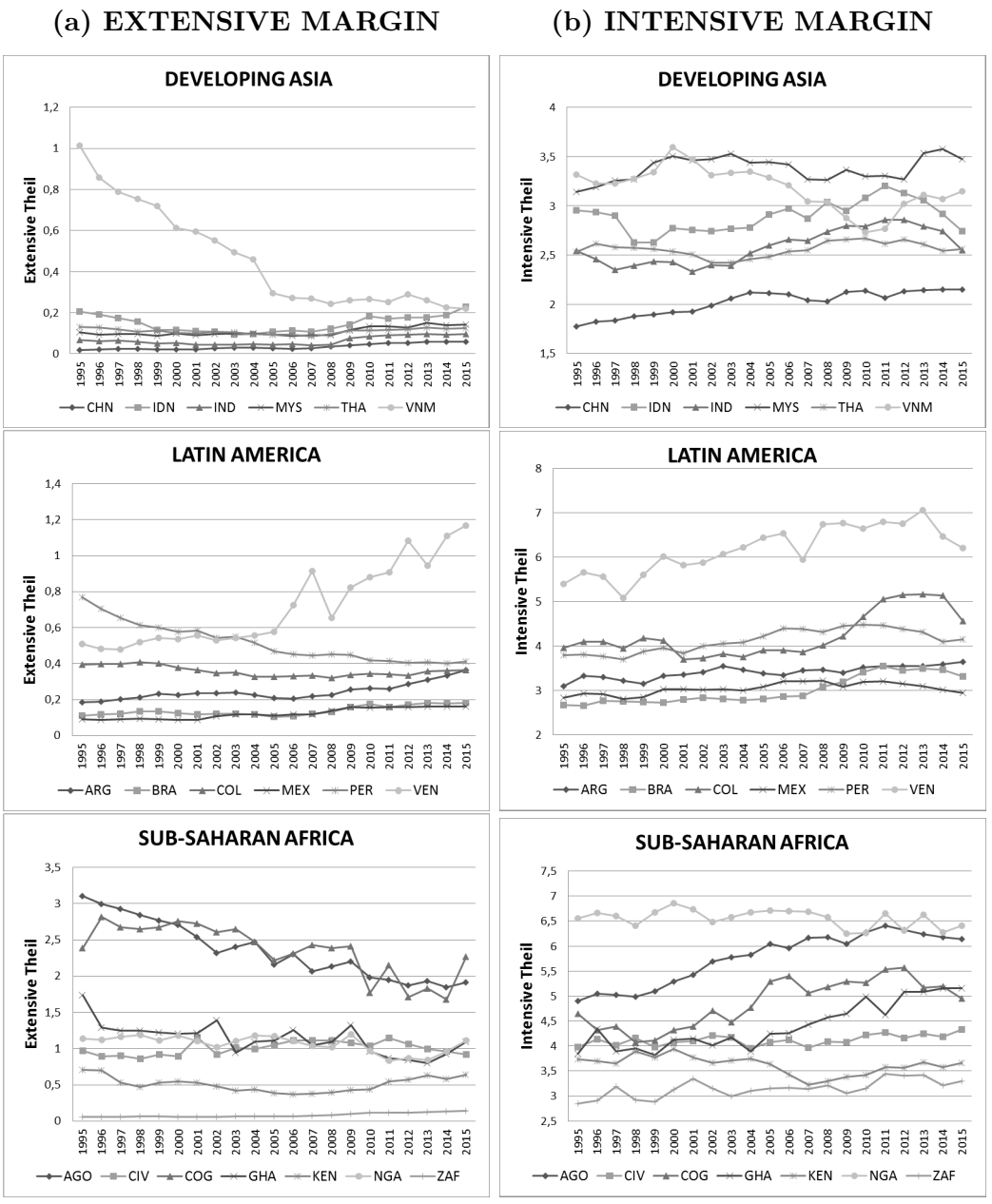


Figure 2.7 – Extensive and intensive Theil indices in developing regions

Source: Authors' calculations using BACI database, 2017.

Appendix 2.C Estimation results: impact of export product diversification in the 3 developing regions

Table 2.8 – Impact of export product diversification on Developing Asia (Export function)

	Exports in Developing Asia					
	Dependent variable: log Exports (logXit)					
Variables	Overall Theil		Extensive Theil		Intensive Theil	
logX(t-1)	0.587***	0.598***	0.782***	0.789***	0.570***	0.566***
	(0.070)	(0.100)	(0.081)	(0.039)	(0.068)	(0.099)
log(Pd/Pf)t	-0.301**	-0.345**	-0.225**	-0.069	-0.318**	-0.380***
	(0.132)	(0.144)	(0.101)	(0.054)	(0.122)	(0.113)
logZt	1.391***	1.381***	0.817**	0.573***	1.343***	1.323***
	(0.396)	(0.453)	(0.346)	(0.179)	(0.361)	(0.431)
logDIVt	0.300		-0.148**		0.463***	
	(0.276)		(0.060)		(0.146)	
*DIV(t-1)*logZ(t)*		0.003		-0.006*		0.007**
		(0.002)		(0.003)		(0.002)
Diagnostic statistics						
AR (1)	0.0031	0.0061	0.0020	0.0021	0.0026	0.0150
AR (2)	0.353	0.267	0.458	0.607	0.498	0.268
Hansen Test	1	1	1	1	1	1
F-test	0	0	0	0	0	0
Number of countries	17	17	17	17	17	17
Observations	306	306	306	306	306	306

Notes: Figures in () are robust standard errors and diagnostic statistics are p-values. ***, ** and * indicate that coefficient is significant at 1%, 5% and 10% respectively. We perform GMM-difference estimation (Arellano and Bond, 1991) and lags of dependent and independent variables are used as instruments. Results of the tests for AR(1) and AR(2) are the p-values of Arellano and Bond tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. F-tests give p-values for overall model fit.

Table 2.9 – Impact of export product diversification in Developing Asia (Import function)

	Imports in Developing Asia					
	Dependent variable: log Imports (logMit)					
Variables	Overall Theil		Extensive Theil		Intensive Theil	
logM(t-1)	0.498***	0.563***	0.570***	0.609***	0.475***	0.412***
	(0.105)	(0.097)	(0.094)	(0.094)	(0.096)	(0.113)
log(Pd/Pf)t	-0.263*	-0.234**	-0.241**	-0.176*	-0.303**	-0.395**
	(0.133)	(0.108)	(0.107)	(0.101)	(0.127)	(0.168)
logYt	0.884***	0.719***	0.742***	0.613***	0.891***	0.905***
	(0.181)	(0.160)	(0.141)	(0.139)	(0.190)	(0.215)
logDIVt	-0.426		-0.164***		0.160	
	(0.788)		(0.043)		(0.538)	
*DIV(t-1)*logY(t)*		0.004		-0.011**		0.0107
		(0.003)		(0.005)		(0.0078)
Diagnostic statistics						
AR (1)	0.0651	0.0520	0.0399	0.0239	0.0590	0.0353
AR (2)	0.191	0.211	0.233	0.238	0.222	0.215
Hansen Test	1	1	1	1	1	1
F-test	0	0	0	0	0	0
Number of countries	17	17	17	17	17	17
Observations	306	306	306	306	306	306

Notes: Figures in () are robust standard errors and diagnostic statistics are p-values. ***, ** and * indicate that coefficient is significant at 1%, 5% and 10% respectively. We perform GMM-difference estimation (Arellano and Bond, 1991) and lags of dependent and independent variables are used as instruments. Results of the tests for AR(1) and AR(2) are the p-values of Arellano and Bond tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. F-tests give p-values for overall model fit.

Table 2.10 – Impact of export product diversification on sub-Saharan Africa (Export function)

	Exports in sub-Saharan Africa					
	Dependent variable: log Exports (logXit)					
Variables	Overall Theil		Extensive Theil		Intensive Theil	
logX(t-1)	0.802***	0.797***	0.753***	0.628***	0.787***	0.668***
	(0.087	(0.091)	(0.108)	(0.084)	(0.072)	(0.076)
log(Pd/Pf)t	0.012	0.013	0.003	0.002	0.008	0.006
	(0.016)	(0.016)	(0.014)	(0.020)	(0.016)	(0.016)
logZt	0.356*	0.359*	0.393*	0.742***	0.277*	0.693***
	(0.191)	(0.205)	(0.209)	(0.200)	(0.156)	(0.197)
logDIVt	-0.019		-0.227**		0.497**	
	(0.296)		(0.105)		(0.205)	
*DIV(t-1)*logZ(t)*		0.001		-0.002		-0.000
		(0.002)		(0.002)		(0.001)
Diagnostic statistics						
AR (1)	0.0026	0.0024	0.0021	0.0017	0.0017	0.0024
AR (2)	0.547	0.497	0.686	0.613	0.668	0.585
Hansen Test	1	1	1	1	1	1
F-test	0	0	0	0	0	0
Number of countries	21	21	21	21	21	21
Observations	378	378	378	378	378	378

Figures in () are robust standard errors and diagnostic statistics are p-values. ***, ** and * indicate that coefficient is significant at 1%, 5% and 10% respectively. We perform GMM-difference estimation (Arellano and Bond, 1991) and lags of dependent and independent variables are used as instruments. Results of the tests for AR(1) and AR(2) are the p-values of Arellano and Bond tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. F-tests give p-values for overall model fit.

Table 2.11 – Impact of export product diversification in sub-Saharan Africa (Import function)

	Imports in sub-Saharan Africa					
	Dependent variable: log Imports (logMit)					
Variables	Overall Theil		Extensive Theil		Intensive Theil	
logM(t-1)	0.480***	0.460***	0.543***	0.434***	0.496***	0.516***
	(0.127)	(0.083)	(0.126)	(0.080)	(0.114)	(0.123)
log(Pd/Pf)t	0.070**	0.060**	0.063**	0.071***	0.061**	0.057**
	(0.028)	(0.024)	(0.025)	(0.018)	(0.026)	(0.023)
logYt	0.691***	0.717***	0.603***	0.849***	0.603***	0.568***
	(0.176)	(0.138)	(0.194)	(0.155)	(0.160)	(0.160)
logDIVt	0.742*		-0.026		0.642**	
	(0.396)		(0.116)		(0.246)	
*DIV(t-1)*logY(t)*		0.002		0.006**		0.005
		(0.001)		(0.003)		(0.003)
Diagnostic statistics						
AR (1)	0.0042	0.0089	0.0075	0.0118	0.0015	0.0046
AR (2)	0.405	0.458	0.405	0.459	0.367	0.459
Hansen Test	1	1	1	1	1	1
F-test	0	0	0	0	0	0
Number of countries	21	21	21	21	21	21
Observations	378	378	378	378	378	378

Notes: Figures in () are robust standard errors and diagnostic statistics are p-values. ***, ** and * indicate that coefficient is significant at 1%, 5% and 10% respectively. We perform GMM-difference estimation (Arellano and Bond, 1991) and lags of dependent and independent variables are used as instruments. Results of the tests for AR(1) and AR(2) are the p-values of Arellano and Bond tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. F-tests give p-values for overall model fit.

Table 2.12 – Impact of export product diversification in Latin America(Export function)

	Exports in Latin America					
	Dependent variable: log Exports (logXit)					
Variables	Overall Theil		Extensive Theil		Intensive Theil	
logX(t-1)	0.483**	0.569***	0.530***	0.567***	0.304*	0.460**
	(0.170)	(0.123)	(0.093)	(0.072)	(0.170)	(0.182)
log(Pd/Pf)t	-0.208***	-0.161***	-0.127***	-0.138***	-0.313***	-0.210***
	(0.031)	(0.041)	(0.037)	(0.025)	(0.077)	(0.051)
logZt	0.904***	0.759***	0.792***	0.723***	1.173***	0.964***
	(0.309)	(0.232)	(0.194)	(0.154)	(0.365)	(0.323)
logDIVt	0.127		-0.203**		0.561	
	(0.142)		(0.088)		(0.351)	
*DIV(t-1)*logZ(t)*		-0.000		-0.005*		0.000
		(0.001)		(0.003)		(0.001)
Diagnostic statistics						
AR (1)	0.1340	0.0725	0.0866	0.0957	0.0939	891
AR (2)	0.999	0.921	0.798	0.615	0.573	0.950
Hansen Test	1	1	1	1	1	1
F-test	0	0	0	0	0	0
Number of countries	16	16	16	16	16	16
Observations	288	288	288	288	288	288

Notes: Figures in () are robust standard errors and diagnostic statistics are p-values. ***, ** and * indicate that coefficient is significant at 1%, 5% and 10% respectively. We perform GMM-difference estimation (Arellano and Bond, 1991) and lags of dependent and independent variables are used as instruments. Results of the tests for AR(1) and AR(2) are the p-values of Arellano and Bond tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. F-tests give p-values for overall model fit.

Table 2.13 – Impact of export product diversification in Latin America (Import function)

	Imports in Latin America					
	Dependent variable: log Imports (logMit)					
Variables	Overall Theil		Extensive Theil		Intensive Theil	
logM(t-1)	0.266***	0.436***	0.272***	0.376***	0.317***	0.335***
	(0.061)	(0.066)	(0.058)	(0.078)	(0.090)	(0.087)
log(Pd/Pf)t	0.066	0.042	0.060	0.104**	0.089**	0.085*
	(0.045)	(0.038)	(0.049)	(0.046)	(0.041)	(0.043)
logYt	0.869***	0.654***	0.921***	0.766***	0.836***	0.768***
	(0.109)	(0.115)	(0.112)	(0.118)	(0.139)	(0.145)
logDIVt	0.536*		0.272**		0.177	
	(0.305)		(0.105)		(0.248)	
*DIV(t-1)*logY(t)*		0.003**		0.000		0.003*
		(0.001)		(0.005)		(0.002)
Diagnostic statistics						
AR (1)	0.0173	0.0177	0.0207	0.0293	212	0.0294
AR (2)	0.228	0.135	0.214	0.223	0.234	0.164
Hansen Test	1	1	1	1	1	1
F-test	0	0	0	0	0	0
Number of countries	16	16	16	16	16	16
Observations	288	288	288	288	288	288

Notes: Figures in () are robust standard errors and diagnostic statistics are p-values. ***, ** and * indicate that coefficient is significant at 1%, 5% and 10% respectively. We perform GMM-difference estimation (Arellano and Bond, 1991) and lags of dependent and independent variables are used as instruments. Results of the tests for AR(1) and AR(2) are the p-values of Arellano and Bond tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. F-tests give p-values for overall model fit.

Chapter 3

Export diversification, export sophistication and the actuality of Kaldor-Verdoorn's Law in Sub-Saharan Africa, Developing Asia and OECD countries

Abstract

This chapter examines the role of export diversification and export sophistication as engines of economic growth and economic development in sub-Saharan Africa (SSA). We investigate the relationship through an expanded version of Kaldor-Verdoorn's Law, where the evolution of export structure can impact not only productivity growth, but also the degree of returns to scale. Empirical analysis is conducted for three samples, namely SSA countries, Developing Asian countries and founder OECD members, over the period 1995-2017 in order to make a comparison. The findings show heterogeneity across samples. More specifically, they suggest that export concentration, as a transitional step, should be favored only in the very first stage of economic development. Our results show that afterwards export diversification and sophistication are drivers of virtuous economic growth through increasing returns to scale. [14]

Keywords: export diversification, export sophistication, productivity, increasing returns, economic growth.

JEL codes: F43, O11, O47, O57.

14. This chapter is a personal and original contribution of the author. A shorter version of this chapter is currently submitted to a journal.

3.1 Introduction

One of the most important issues in economic development is to determine how developing countries might converge economically with developed ones. Recently, a consensus has emerged around an export-led growth strategy based on export diversification as a means of tackling poverty (UN, 2011; IMF, 2014b; Lopez-Calix, 2019). Governments of developing economies in sub-Saharan Africa have received several policy recommendations from international organizations about an economic development strategy based on economic and export diversification. Export diversification has attracted tremendous interest from researchers as the economic advantages of export diversification in terms of products and destination have been acknowledged in the economic debates, partly because of the successful economic growth of Asian economies over decades. Indeed, the development literature highlights the contrasting growth experiences of sub-Saharan Africa and Developing Asia. The two regions have taken divergent path in terms of structural transformation: while Africa has accumulated external debt and experienced failure of its export-led growth policies because of its specialization in low productivity exports, the East and South-East Asia have succeeded in implementing a spectacular export-led growth strategy Akyüz & Gore (2001). In addition, numerous papers have empirically highlighted the positive impact of export diversification in fostering productivity, export performance and economic growth (Feenstra & Kee, 2008; Basile et al., 2018; Abreha et al., 2020). Logically, therefore, trade integration through export diversification would enable African countries to improve their development trajectory (Berthélemy & Soderling, 2001; Nicita & Rollo, 2015; Didier, 2017). The positive linkage between export diversification and economic development is now unequivocal. However, despite the wide range of existing studies, the mechanism that governs the relationship remains a black box. It is still unclear how and through which channels an economy's diversification causes an increase in its income per capita.

To open the black box, in this paper, we use Kaldor-Verdoorn's Law (hereinafter KVL) to propose a re-examination of the relationship between export diversification and productivity growth as a driver of economic development for sub-Saharan African countries. KVL states that economic growth arises from the interaction between productivity growth and demand growth (Kaldor, 1966). Our analysis goes further than looking at the effect of export diversification on productivity growth. We identify how change in a country's export structure acts as a driver of economic development by increasing the returns to scale. Indeed, in citing Hausmann et al. (2007) on "What You Export Matters" in his tribute to Kaldor, Thirlwall (2017) concludes in his paper that the success of exports as an engine of growth depends on

the technology (in other words, the complexity) embedded in manufactured goods as it is associated with high levels of income, which are fostered by diversification.

Our contribution is threefold. First, we want to contribute to the literature on the export diversification-economic growth nexus by proposing new insights from different approaches. For instance, in the previous chapter (chapter 2), we assess the quality of export diversification by comparing it with the evolution of external constraint, obtaining heterogeneous results for samples of developing countries. We propose in this paper a complementary argument by focusing on the productivity growth mechanism. Second, we want to contribute to the literature on African countries in terms of policy implications by investigating how a change in export composition enables the catching-up phenomenon. Third, the KVL has been widely tested on developed countries over the years, but few studies have been conducted on African countries. Thus we aim to update the Law by comparing the Kaldor-Verdoorn (hereafter KV) coefficients of developed and developing economies.

Our empirical analysis covers the period 1995-2017 for three samples of countries: sub-Saharan African (SSA) countries, Developing Asian (DA) countries and Western European and North American countries that were founder members of the OECD. We compare the results of SSA economies with those of the two other groups. We find that the impact of export diversification on productivity growth is heterogenous, but that an overall pattern is emerging. In general, for SSA, export concentration favors productivity growth. However, further investigations show that the latter finding is valid solely for low-income countries, while middle-income economies in that region are gaining higher degree of returns to scale from an increase in export diversification and sophistication. In addition, our findings highlight the undeniable economic performance of Asian economies induced by export diversification and sophistication and the specialization of OECD countries in the most sophisticated goods, which may illustrate their competitiveness in complex goods as high-income economies.

In the following sections, we will first develop our approach by explaining how KVL can be leveraged to respond to two major limitations in the existing literature on the quality of export diversification as a development strategy. Second, we present our extended model involving export diversification. Then, we empirically investigate the KVL in sub-Saharan Africa by conducting a comparison between the three samples and conclude with some final remarks.

3.2 Export diversification and Kaldor-Verdoorn's Law: an alternative approach

3.2.1 Export diversification and Kaldor-Verdoorn's Law: a literature review

Low-income countries are characterized by their dependence on primary commodities and natural resources, which are sources of volatility in export earnings and vulnerability to external shocks (IMF, 2014b), so that production and export diversification have been recommended as the basis for a growth strategy. As far as theory is concerned, the debate is not new since the traditional trade theories, namely the Ricardian and Heckscher-Ohlin-Samuelson models, which advocate the gains to be made from trade through specialization according to comparative advantage, did not manage to explain the failure of trade to boost economic growth in developing countries. Indeed, in the 1950s, proponents of structuralism pointed out that, due to specialization, the declining terms of trade for primary product exporters (Prebisch (1950) and Singer (1950) hypothesis) was one of the main issues that developing countries had faced for decades because free trade generated an "immiserizing growth", where the intensification of exports of products in which they had a comparative advantage reduced the countries' real income (Bhagwati, 1958). The debate has been revived recently with the New New Trade Theory and the New Structural Economics. On the one hand, the "new new trade theory", initiated by Melitz (2003), shows that, due to a selection effect, a rise in export diversification generates an increase in aggregate productivity in a monopolistic-competition model. On the other hand, the New Structural Economics emphasizes the central role of governments in addressing market failure in order to help industries to develop and find new opportunities and thereafter to diversify the country's production along the development path (Lin & Monga, 2010). Although there is a divergence in the two approaches, indeed the former advocates a reduction in trade costs whereas the latter recommends state intervention, they do not differ in their purpose, since trade intensification should lead to export diversification in order to generate economic growth.

On an empirical level, there is a consensus on the benefits of export diversification and the harm of specialization for developing countries. First of all, a set of studies report the "natural resources curse" from which resource-rich countries specialized in primary commodities suffer because of slow growth (Auty, 1993; Humphreys et al., 2007). In addition, as stated by Daruich et al. (2019) using data from 1998 to

2010, hyper-specialization of exports is a source of instability because they are not persistent over time. Furthermore, on the one hand, Asian economies (NIC) have experienced spectacular economic growth and export performance by defying their comparative advantages since the 1970s (World Bank, 1993); on the other hand, the seminal article by Imbs & Wacziarg (2003) shows that production concentration and economic development have a U-shaped relationship. More explicitly, along the development path, the authors show that in the early stage of its development, a country's increase in income per capita is accompanied by diversification of its production until it reaches a threshold income per capita. Thereafter, in a second stage, the increase in per capita income is associated with a concentration of production, with richer countries specializing in products with higher value-added. Subsequently, several authors have confirmed the same pattern for export concentration and economic development (Klinger & Lederman, 2004, 2006; Cadot et al., 2011, 2013). In that wave of studies, it is shown that, for developing countries, export diversification is positively linked to economic development.

These major trends encouraged international organizations to emphasize the benefits of economic and export diversification as a key strategy for economic growth and development (IMF, 2014b, 2016, 2017b; OECD/WTO, 2019). Indeed, it has been argued that structural transformation through export diversification brings macroeconomic stability, notably due to reduced volatility in export earnings, helps resource-dependent and commodity-dependent economies to be more resilient to external shocks and generates technology spillover that can benefit other sectors of the economy. de Piñeres & Ferrantino (2000) present these benefits for Latin American countries.

Specifically, Cadot et al. (2013) emphasize the impact of trade diversification on productivity at firm and industry level in their survey of the empirical literature on trade diversification and growth. Feenstra & Kee (2008) show in a monopolistic competition model that an increase in export variety was accompanied by a 3.3% increase in productivity from 1980 to 2000. In the same vein, Rath & Akram (2017) conduct an empirical study of the South Asian region and find that export diversification creates an increase in productivity.

Thereafter, numerous empirical studies have focused on the determinants of export diversification, as well as on the relationship between diversification and export performance at a country level and firm level (Balavac & Pugh (2016); Basile et al. (2018); Djimeu & Omgba (2019); Abreha et al. (2020); among others). Moreover, in the era of globalization, the quality of the export basket matters, and countries are likely to develop when they upgrade the quality of their exported products and

export more sophisticated goods, (IMF, 2014b; Lall et al., 2006; Hausmann et al., 2007).

However, according to the World Development Report (World Bank, 2020b), since 1990, the face of global trade has changed such that half of its component includes participation in global value chains (GVCs). The division of the production process for a single good among several countries, which is the very definition of GVC, leads Lederman & Maloney (2012) to draw attention to how goods are produced rather than what is produced. In terms of policy recommendations, they question the relevance of a good as a unit of analysis and emphasize the nature of the tasks performed that have externality potential. Although quality upgrading and export sophistication are identified as inevitable steps in establishing sustained growth, overall, another crucial limitation that should be emphasized is that the existing literature has been focused exclusively on supply side constraints and seems to neglect the crucial role of demand constraints, as far as developing countries are concerned (Kaldor, 1970; Thirlwall, 2002b). Indeed, in order to distinguish good from bad diversification in terms of structural transformation, the nature of export diversification must be adapted to demand constraints. A good diversification strategy would lead to economic development by increasing productivity and enhancing economic growth in the long run.

Taking these two major arguments into account, Nicholas Kaldor's emphasis on the central role of manufacturing sector in economic development and his demand-led growth approach provide a framework for assessing the quality of sectoral diversification. Indeed, as mentioned earlier, although the diversification phenomenon is widely discussed in the existing literature, the mechanism through which it affects economic development remains a black box. Kaldor-Verdoorn's Law will enable us to identify the channel through which a change in export composition may affect a country's economic performance by looking closely at how diversification directly impacts the growth of productivity via technological progress, on the one hand, and how it structurally impacts economic growth in the long run through economies of scale, on the other hand.

Kaldor (1975) was strongly critical of neoclassical general equilibrium theory, which had not succeeded in modelling growth and development since the latter depend on the development path and is demand constrained. He was also very critical of the use of aggregate production function to explain economic growth as it divides the increase in production into the growth of factor inputs and exogenous technical change and does not consider capital accumulation as an investment that can improve the method of production. Indeed, the Cambridge capital theory controversies

in the 60s and 70s and the aggregation problem show that the aggregated production function does not exist because it suffers from fallacy in the measurement of capital and from accounting identity (Felipe & McCombie, 2013). In the light of these comments, Kaldor (1957) developed his approach using the concept of the technical progress function. He posits the existence of increasing returns to scale in some sectors, and hence the importance of sectoral production structure, to explain the income gap and difference in growth rates between countries and consequently to show why convergence still does not happen. Indeed, in a demand-constrained approach, Kaldor (1966) conducted empirical tests based on the study by Verdoorn (2002) in 1949 to demonstrate the existence of increasing returns to scale in the manufacturing sector and, therefore, to explain the slowdown in the United Kingdom's economic growth. Verdoorn's Law, as Kaldor named it, is defined as the long-run relationship between the growth of labor productivity in manufacturing and the growth of production and is interpreted by Kaldor as a production relationship because it shows that a rapid growth in production generates faster growth in productivity. It was originally expressed as follows:

$$p = a + bq$$

p is the growth of labor productivity in manufacturing sector, q is the growth of manufacturing output and b is the Kaldor-Verdoorn coefficient. For Kaldor (1966), in order to attest the evidence of a dynamic economy of scale, the coefficient should be statistically different from zero and less than unity. He attaches great importance to the dynamic nature of that structural relationship. Indeed, McCombie's estimation results show the existence of constant returns to scale when variables are in level (static version); whereas the presence of increasing returns to scale is shown when using growth rate variables (dynamic version) (McCombie, 1982). Thus, in the mid-1960s, Verdoorn's Law was renamed the Kaldor-Verdoorn Law or Kaldor's second Law (McCombie et al., 2002). In addition, the above specification obeys Kaldor's stylized fact assuming that, in the long run, capital and output grow at the same rate, or in other words, the capital-output ratio is constant (Kaldor et al., 1961). The relaxation of this assumption has led to the integration of the capital accumulation in specifications derived from Cobb-Douglas production function in empirical studies. Thus, the KVL was widely extended to Total Factor Productivity (TFP) despite the debate and criticism in the literature concerning the place of capital in the productive function of economic growth theory (Wolfe, 1968; Kaldor, 1968; Jefferson, 1988; Felipe & McCombie, 2007, 2013).

However, McCombie & Spreafico (2016) highlight a paradox in the utilization

of aggregate production function, such as the Cobb-Douglas function, to formulate Kaldor's technical progress function and Verdoorn's Law. They show that, with a common intercept and if the coefficients are not interpreted as separate contributions of the factors, the same approach makes it possible to express Verdoorn's Law as a behavioral relationship that fits with Kaldor's insights. Thus, Kaldor-Verdoorn's Law is not betrayed by being expressed in terms of a Cobb-Douglas function. Angeriz et al. (2008), McCombie & Spreafico (2016), as well as Romero & Britto (2017), revisited the Verdoorn's Law that can be derived from an aggregate Cobb-Douglas production function:

$$Y = A_0 e^{gAt} K^{\gamma\alpha} L^{\gamma(1-\alpha)} \tag{3.1}$$

Y is total value added, K is stock of capital, L is labour, A_0 is a constant and g_A is the rate of technological progress. $\gamma\alpha$ and $\gamma(1-\alpha)$ are output elasticities of capital and labor respectively. γ is a measure of the degree of static returns to scale. Indeed, if $\gamma = 1$, there are constant returns to scale whereas if $\gamma > 1$, there are static increasing returns to scale. α and $(1-\alpha)$ are, respectively, the share of capital and labor in total value-added.

It is assumed in the Kaldorian approach that the growth in factor inputs is generated by demand growth. Then, since the growth in demand determines technical progress, the growth rate of technical progress is determined by the growth of factor inputs. The relationship is expressed as:

$$g_A = \varphi + \eta[\alpha\hat{K} + (1-\alpha)\hat{L}] \tag{3.2}$$

g_A is the rate of technological progress, φ is the exogenous technical progress, $\hat{K}$ and $\hat{L}$ are the growth rates of capital and labor respectively and η is the elasticity of induced technological progress with respect to weighted input growth.

Taking the logarithm of equation 3.1, differentiating with respect to time and replacing the rate of technological progress with expression 3.2 gives:

$$\hat{Y} = \varphi + (\gamma + \eta)[\alpha\hat{K} + (1-\alpha)\hat{L}]$$

$\hat{Y}$ is the growth rate of output and $\gamma + \eta = \nu$ is a measure of the degree of static and dynamic returns to scale respectively. Moreover, since the growth rate of Total Factor Inputs (TFI) mathematically equals the weighted sum of the growth rate of capital and labor (*i.e.* $\hat{TFI} \equiv \alpha\hat{K} + (1-\alpha)\hat{L}$), the growth rate of Total Factor Productivity (TFP) is defined as $\hat{TFP} \equiv \hat{Y} - \hat{TFI}$.

Hence, rearranging the above expression gives the dynamic Kaldor-Verdoorn

Law:

$$T\hat{F}P = \left(\frac{\varphi}{\nu}\right) + \delta\hat{Y} \tag{3.3}$$

$\delta = 1 - \frac{1}{\nu}$ is the static-dynamic Kaldor-Verdoorn (KV) coefficient. As mentioned above, the degree of encompassing returns to scale ν is the sum of the static (γ) and the dynamic (η) returns to scale. Hence, on the one hand, if $\gamma > 1$, there is a static increasing returns to scale and, on the other hand, $\eta > 0$ implies a dynamic increasing returns to scale. The increasing returns to scale are observed when $\gamma > 1$, or $\eta > 0$, or both, which corresponds to a positive value of the KV coefficient ($\delta > 0$). By definition, the existence of increasing returns to scale implies that the coefficient is strictly positive and less than unity: $0 < \delta < 1$. It should be noted that the interpretation of the coefficient is similar to the original one in Kaldor (1966).

To sum up, the Kaldorian approach considers only the demand-side in attempting to explain economic growth and the Kaldor-Verdoorn Law is its empirical application. It emphasizes the importance of the sectoral structure of manufacturing that has increasing returns to scale and thus boosts economic growth. In the following section, we develop an expanded model of KVL in which it is assumed that export diversification and export sophistication are determinants of technological progress and reinforce the impact of output growth on productivity growth.

3.2.2 The expanded version of the Kaldor-Verdoorn Law

To examine thoroughly the impact of export diversification on productivity growth, we follow Romero & Britto (2017)'s work, in which they examine the impact of output growth and research intensity on productivity growth by combining the bases of the models developed by Kaldor and Schumpeter. They investigate whether research intensity impacts the value of the returns to scale. In this paper, our purpose is to determine the role of export diversification and export sophistication in a country's economic performance by examining their impact on the growth rate of total factor productivity and their effect on returns to scale.

In a first step, we amend the model by enriching the definition of technical progress. Indeed, technical progress comes not only from the capital and labor factors, but also from the knowledge integrated into the productive structure, namely the capabilities that can be built up through the learning process by producing new goods and diversifying exports. Akyüz et al. (1998) and Akyüz & Gore (2001) are agreed that the successful East Asian experience stems from the countries' ability to acquire capacities from learning processes and their involvement in a virtuous

circle of rising rates of savings, investments and exports. As far as exporting activity is concerned, the learning by exporting hypothesis has been widely discussed in the literature. For instance, Fernandes & Isgut (2015) investigate the hypothesis for Colombian manufactures over the period 1981-1991 and find evidence of positive learning-by-exporting and diminishing returns to export experience. Indeed, Arrow (1962) reports that the learning process is subject to diminishing returns when it is associated with repetition. However, Romer (1986) points out that increasing returns to scale are found at country level as they originate in externalities generated by knowledge. In addition, de Piñeres (1996) states that the increase in exports induces positive technological externalities and then improves productivity. These arguments suggest that, in order to increase economic performance, countries should constantly find opportunities to export, especially new products, and sectors should generate externalities. Hence a successful diversification strategy would lead to an accumulation of new capabilities. Furthermore, for an economy, a new technology is assimilated even more rapidly when the existing knowledge is abundant and complex. It can be said that the productivity of an economy depends on the diversity of its capabilities and their complexity and hence on its capacity to export a wide range of goods and sophisticated products.

In terms of impact on productivity growth, the literature suggests that export composition can be expected to evolve in one of two directions. An increase in productivity growth could be driven by either export concentration or, conversely, export diversification. Our argument developed above, the learning by exporting process and the accumulation of capabilities support the idea that export diversification impacts productivity growth positively. Conversely, however, traditional trade theories state that the comparative advantage from specialization should also be followed by productivity growth. For instance, as shown by Mayer et al. (2014), competition in global markets may affect the economy and production concentration by selection effect would increase firms' productivity. The two variations of export composition (diversification and concentration) may therefore impact positively on technological progress.

Thus on the basis of these explanations, it is deduced that export diversification (or concentration) and sophistication are fundamental determinants of technological progress.

$$g_A = \varphi + \eta[\alpha\hat{K} + (1-\alpha)\hat{L}] + \mu DIV \tag{3.4}$$

where DIV is the degree of export diversification (or concentration) and sophistication. It follows that the learning effects from diversification (and sophistication) or,

conversely, concentration, has an impact on productivity growth. The productivity growth function then becomes:

$$\hat{TFP} = \left(\frac{\varphi}{\nu}\right) + \delta\hat{Y} + \left(\frac{\mu}{\nu}\right) DIV \tag{3.5}$$

In a second step, it is assumed that the diversity and complexity of exported goods are closely linked to economic development. The more diversified the exports are, the more the growth in productivity at country level is sensitive to demand growth. In other words, there is a virtuous circle of economic growth, and hence sustained growth, generated by export diversification and sophistication through the externalities and the learning process which occurs through increasing returns to scale. This impact is structural as it persists in the long run. Thus, in order to capture the increasing returns to scale driven by export diversification, we consider that the Verdoorn coefficient depends on the level of diversification. As we argued earlier, export concentration can also be expected to impact the degree of returns to scale. Assuming that the relationship is linear, we can write:

$$\delta = \rho + \sigma DIV \tag{3.6}$$

As defined before, it is assumed that $0 < \rho + \sigma DIV < 1$. Finally, the function of the productivity growth rate becomes:

$$\hat{TFP} = \left(\frac{\varphi}{\nu}\right) + \rho\hat{Y} + \sigma DIV\hat{Y} + \left(\frac{\mu}{\nu}\right) DIV \tag{3.7}$$

3.3 Data used and Stylized Facts

3.3.1 Data description

In order to carry out a thorough analysis of the impact of export diversification on the KV coefficient for sub-Saharan African (SSA) countries and to compared it with the experience of other countries, we conduct our empirical investigation on three groups of countries, namely SSA countries, Developing Asian (DA) countries and founder members of the Organisation for Economic Co-operation and Development (OECD), which are Western European and North American countries (see Table 3.11 in Appendix 3.A for country list), over the period 1995-2017. Indeed, it would be interesting to highlight these three regions' characteristics as, overall, Asian governments have succeeded in implementing an export-led strategy with spectacular economic growth over recent decades. As far as the Verdoorn coefficient and increa-

sing returns to scale (hereafter IRS) are concerned, previous empirical works have mostly focused on developed countries and have found that the Law is robust. For instance, Knell (2004) examines the Law for European Union and Eastern Europe, the United States and Japan during the 1990s. Millemaci & Ofria (2012)'s findings validate the existence of the KVL in some advanced countries, namely Western European countries, Australia, Canada, Japan and the United States, for the period 1973-2006. More specifically, several studies have focused on OECD countries (Kaldor, 1966; Michl, 1985; Romero & Britto, 2017). It is worthwhile, therefore, adding the OECD group to our study, in order, on the one hand, to make a comparison with the two other regions and, on the other, to update the Law for developed countries. Conversely, with the exception of a few studies such as Wells & Thirlwall (2003), the literature on testing the Kaldor-Verdoorn Law on African countries remains scarce.

The Kaldor-Verdoorn coefficient is estimated using panel data on the growth of total factor productivity (TFP) from the Penn World Table version 9.1 (Feenstra et al., 2015), where country and time coverages are extensive and where the capital stock is calculated using the perpetual inventory method; which is found to be more appropriate according to McCombie & Spreafico (2016). For the output variable, we use data on manufacturing value-Added in constant 2010 USD from UNIDO's MVA Database that is described as the total estimate of net output of all resident manufacturing activities. The TFP from the Penn World Table is the total factor productivity in total output approximated by the gross domestic product. There are two main reasons for this choice. The first is the scarcity of available data, especially for Africa, and in order to ease the comparison between samples, homogeneity in the dataset is required. For instance, Wells & Thirlwall (2003), in assessing the Verdoorn Law for African countries, use productivity in industry that includes other activities such as construction and transports, instead of productivity in manufacturing because of the lack of data on labor employment in the manufacturing sector. Therefore, several studies have been conducted at regional level with regional data. Second, the diversification variable takes into account all products regardless of the type of product. In order to assess its impact on the increasing returns to scale of the total output, the corresponding TFP in total output should be used. In addition to the fact that the two economic quantities, namely gross domestic product (GDP) and manufacturing value-added (MVA), are very closely and positively correlated (in the sample, the correlation between GDP in constant 2010 USD and MVA is 0.91), our interpretation of the estimated K-V coefficient remains quite similar to the traditional KVL in the sense that the increase in productivity growth in the manufacturing sector generated by growth in manufacturing value-

added mathematically augments the output productivity growth at the aggregated level but to a lesser extent, all other things being equal. Additionally, according to Kaldor's first law, the growth rate of an economy is positively related to the growth rate of its manufacturing sector, and the third law stipulates that productivity in the non-manufacturing sector increases as the rate of growth of manufacturing output increases Wells & Thirlwall (2003). Hence, the estimated increasing returns to scale fostered by the growth rate of manufacturing impacts not only the manufacturing sector but also the entire economy (manufacturing and non-manufacturing sectors), which is exactly what we intend to measure. Thus, our specification is still in line with Kaldor's view.

As we want to assess the impact of export diversification and export sophistication on productivity growth, we consider some indicators of export diversification and export sophistication. Two types of diversification indicators are utilized in this paper and are calculated from export data in CEPII's BACI database that gives bilateral trade flows for approximately 5000 products from more than 200 countries (Gaulier & Zignago, 2010). First, one of the most frequently used diversification indicators in development literature is the Herfindahl-Hirschman (HH) product concentration index, which measures dispersion across existing exported products. To obtain HH index values, we follow the World Bank definition from the World Integrated Trade Solution (WITS) for the mathematical expression:

$$HH_{index} = \frac{\sum_{k=1}^{n_i}(\frac{x_k}{X_i})^2 - (\frac{1}{n_i})}{1 - \frac{1}{n_i}}$$

X_i is the total value of exports of country i, x_k is the value of exports of product k of i, and n_i is the number of products exported by country i. The index value is between 0 and 1 and a higher value indicates a more concentrated composition of exports around a small number of products. A major limitation of the Herfindahl-Hirschman index is that it gives the degree of diversification at the intensive margin, which means that a lower value indicates more balanced export shares amongst products that have been already exported, and therefore, the index does not take into account the prospect of diversification based on the export of new products. In order to consider the extensive margin of export diversification, we introduce a second diversification indicator into our analysis, namely the Theil index, which is also a measure of export concentration. We follow the IMF (2014b) and Cadot et al. (2011) expression. Hence, the Theil index is calculated as:

$$Theil_{index} = \frac{1}{n}\sum_{k=1}^{n}\frac{x_k}{\mu}\ln\left(\frac{x_k}{\mu}\right)$$

with $\mu = \frac{1}{n}\sum_{k=1}^{n} x_k$.

n is the number of products exported in the world, around 5000 products at 6-digits of disaggregation in the Harmonized System (HS) classification, and x_k is the export value of product k.

In trade literature, as we have briefly emphasized above, the quality of exported goods through export sophistication and the complexity of production is discussed along with export diversification as they are linked with the stages of economic development. For instance, Felipe et al. (2012) find that sophisticated (or more complex) goods are exported by high-income countries, whereas less complex goods are generally exported by low-income countries. In the same vein, Ferrarini & Scaramozzino (2016) show that the augmentation in complexity impacts positively on economic growth via human capital. In order to capture the information about the complexity of the capabilities that an economy held, Hausmann & Hidalgo (2010) used available trade data to develop a measure known as the Economic Complexity Index (ECI). For these authors, economic complexity is assessed through the mix of products that the economy is capable of manufacturing: the more the knowledge in interaction, namely the capabilities, are diversified, the more an economy produces complex goods. The fact that this index incorporates the idea of sophistication in addition to diversification convinced us to use it in our analysis. Compiled by Hausmann et al. (2014), the ECI database is available on Harvard University's Atlas of Economic Complexity Dataverse (The Growth Lab at Harvard University (2019), http://www.atlas.cid.harvard.edu) and is calculated from disaggregated trade data in SITC and HS codes. We choose ECI from HS codes for the study because of its contemporary classification of goods. We will refer to the ECI as a measure of export sophistication.

A limitation of this index is the method of measurement itself. The ECI assesses the relative level of sophistication of an economy's exports as it measures the relative complexity and relative diversity of an economy's export basket compared to that of other countries by attributing a degree of complexity to each product, namely the Product Complexity Index (PCI), for each year. Since a product's PCI value varies from one year to another, it follows that the value of a country's ECI is impacted because the latter's range of variation changes from one year to another. Therefore, for any given year, the ECI is a good indicator for international cross-country comparison, but an interpretation of the index for a given country in time series between period t and period t+1 seems less obvious, since the index may not vary to the same extent as the actual evolution of economic sophistication. To deal with this limitation, we normalize the ECI index between 0 and 1 as follows:

$$ECI_{it} = \frac{ECIval_{it} - ECImin_t}{ECImax_t - ECImin_{it}}$$

where $ECIval$ is the given value of the Economic Complexity Index for country i in year t, $ECImax_t$ and $ECImin_t$ are respectively the maximum value and the minimum value of ECI for the year t among all reported countries. Here, we could have approximated the normalized ECI (ECI_{it}) with the rank of countries in terms of ECI because the use of the ECI rankings is a possible alternative [15]. However, in our opinion, the normalized value of economic complexity may provide supplementary information about the actual level of export sophistication, since the rankings may not capture the distance in economic complexity between two given countries. The summary statistics of variables for each group are available in Table 3.12 in Appendix 3.B.

3.3.2 Stylized facts

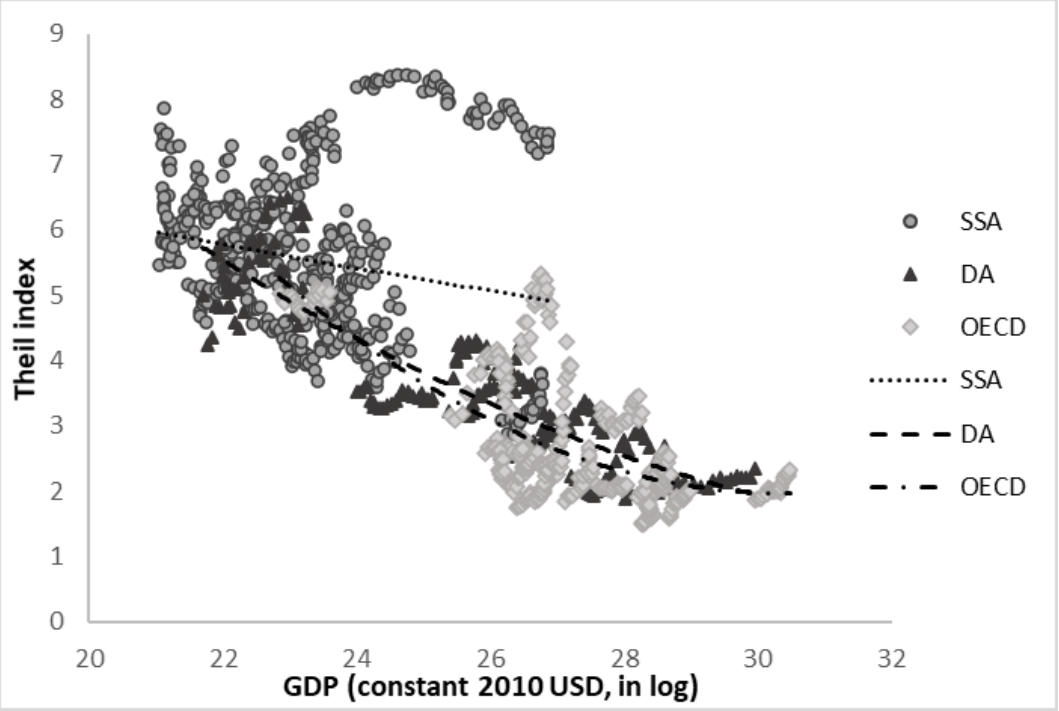
In this section, we present graphically how the relationship between export diversification and economic development in the three regions behaves. The selected countries in the three groups have their own characteristics in terms of income level, as observed in Table 3.11 of Appendix 3.A. The SSA group includes mostly low-income and middle-income economies, all the DA countries are middle-income economies and all selected OECD members are categorized as high-income economies.

Figure 3.1 presents a scatter plot that compares the scale of economic activity, approximated by the gross domestic product (GDP) in real terms, with export diversification, as measured by the Theil index, over the period 1995-2017 for the three groups of countries. The Theil index measures export concentration: the higher the index value, the more concentrated exports are. We observe that overall, the SSA countries are the most specialized in terms of exports and have the lowest level of real GDP. The values for the DA economies are to be found along the graph in terms of economic activity, which likely indicates an improvement in economic performance in this region over the period and the trend clearly shows a positive linkage between the scale of economic activity and export diversification. The OECD countries, largely located on the lower right corner of the scatter chart, are relatively diversified with higher levels of GDP. Trends for each country group show a positive linkage and, on average, a higher level of GDP is associated with a greater degree of export

15. In our sample, the normalized ECI is strongly correlated with the ECI rankings (correlation$= -0,98$).

diversification. Taken as a whole, the scatter plot shows a monotonical relationship between the level of economic activity and the diversification of exported products.

Figure 3.1 – Linkage between level of gross domestic product in real terms and product export diversification (1995-2017)

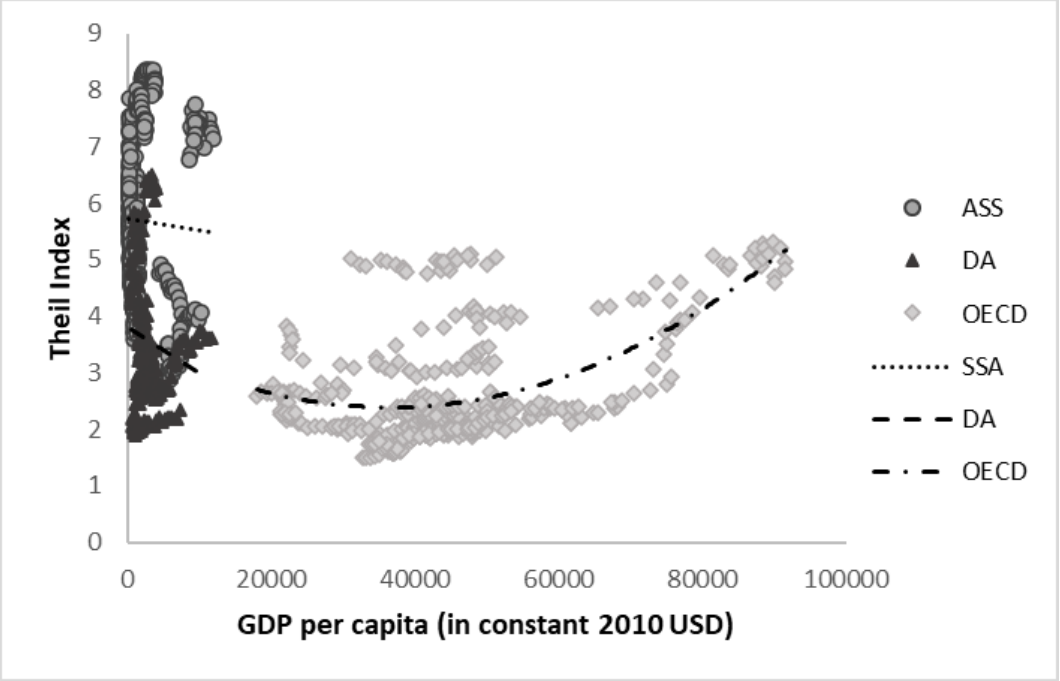


Source: Theil index calculation from BACI database and GDP in constant 2010 USD from World Bank Indicators database.

Focusing now on the relationship between the level of income per capita and export concentration in terms of products, Figure 3.2 depicts a U-shaped pattern. This stylized fact is well known in the empirical literature. Imbs & Wacziarg (2003), using employment and value-added data, show a U-shaped relationship between sectoral concentration and the level of income per capita and identify the minimum level of concentration at around 9000 USD. Their findings hold robustly for OECD countries, as well as for the sub-Saharan African and Southeast Asian samples. A similar pattern has been found for trade. IMF (2014b) find a turning point at around 25000-30000 USD, as do Cadot et al. (2011). A comparison between the three regions enables us to locate the stylized fact along the development path: positioned in the upper left corner of the figure, SSA countries are at their earliest stage of development with the most concentrated exports and seem to begin a timid stage of de-specialization, then DA economies seem to have a marked phase of diversification, and finally OECD countries, taken as a whole, present a general stage of specialization. Graphically, the threshold income is roughly located around 20000

and 40000 USD. These observations show that, on average, African exports are the most concentrated. Indeed, it is well-known that Africa's export structure is specialized in primary products (Wood & Mayer, 2001). Then, followed by the Asian economies, OECD members have the most diversified export basket.

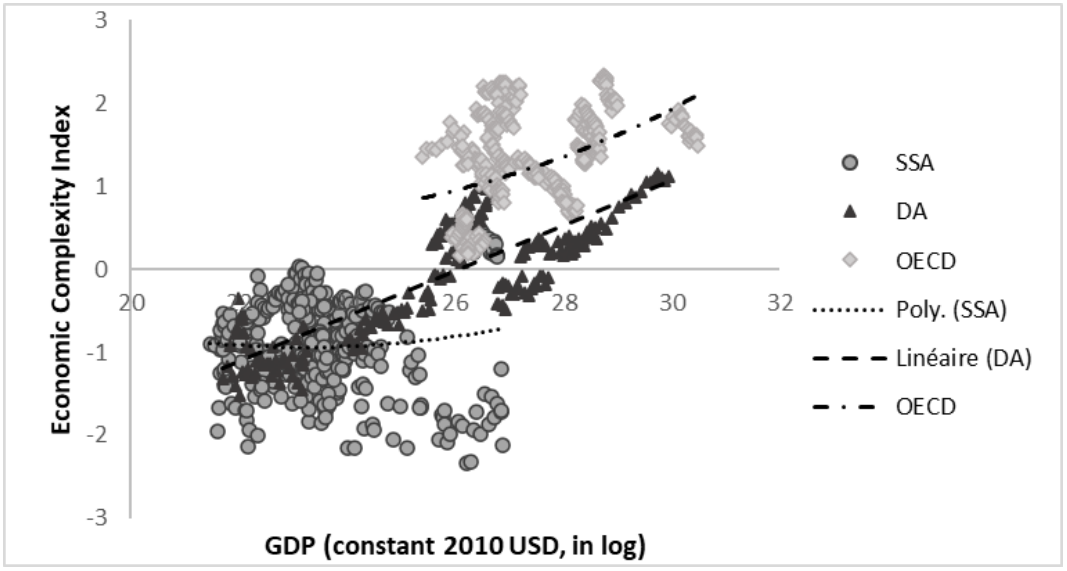
Figure 3.2 – Linkage between level of income and product export diversification (1995-2017)



Source: Theil index calculation from BACI database and GDP per capita in constant 2010 USD from World Bank Indicators database.

Regarding export sophistication as measured by the Economic Complexity Index, the comparisons with the scale of economic activity and the level of income per capita seem to portray a specific stylized fact. Figure 3.3 reveals a linear relationship between the gross domestic product in real terms and export sophistication on average. African economies export the least sophisticated products, Asian exports seem to follow a distinct linear trend and OECD countries have the most sophisticated export baskets. In other words, for DA, the higher the level of output, the more sophisticated the exported goods are. Indeed, referring to GVC, the World Development Report (World Bank, 2020b) emphasizes these characteristics. They reflect the deep involvement of African countries in commodities. Moreover, they show that the booming exports in Developing Asian countries is accompanied by a switch from exporting commodities to exporting basic manufactured goods using imported inputs, and furthermore, they highlight the specialization of high-income countries in complex tasks by producing advanced manufactures.

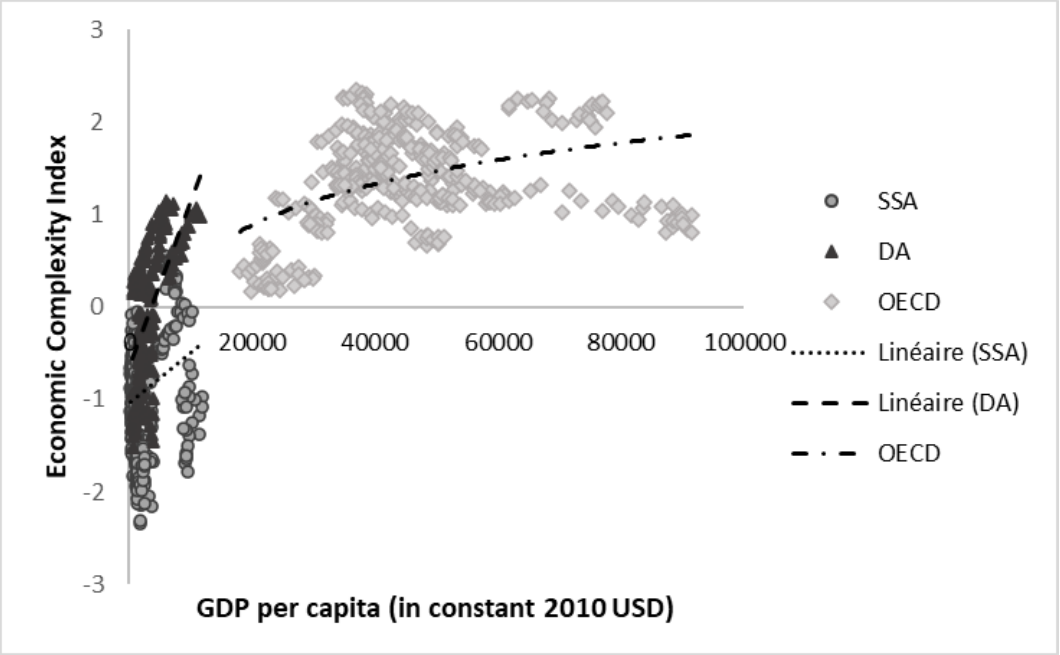
Figure 3.3 – Linkage between level of gross domestic product and export sophistication (1995-2017)



Source: Economic Complexity Index from Atlas of Economic Complexity Dataverse and GDP in constant 2010 USD from World Bank Indicators database.

In Figure 3.4, examination of the scatter plot representing the linkage between per capita income and economic complexity shows that a lower level of income per capita is associated with a lower value for economic complexity. However, when the value of the index is positive, it is scarcely possible to identify a general trend from the scatter plot. In other words, there is a wide range of income levels for the same level of economic complexity. This general observation can be broken down by looking at the behavior of the variables for each group of countries. We note that African countries export the least complex products and are characterized by relatively low incomes. It appears that the least diversified region, namely the SSA, has the least complex exported goods. The lack of sophistication that characterizes the exported goods is confirmed by Abdon & Felipe (2011), who analyze the structural transformation of SSA. For Asian countries which are characterized by a good export performance, a sharply positive and linear trend is observed: the higher the income is, the more sophisticated the exported products are. Finally, for the OECD countries, the complexity of exports varies little with per capita income, although they are characterized by substantial income disparity.

Figure 3.4 – Linkage between income and export sophistication (1995-2017)



Source: Economic Complexity Index from Atlas of Economic Complexity Dataverse and GDP per capita in constant 2010 USD from World Bank Indicators database.

3.4 Specification and empirical methodology

3.4.1 Empirical specifications

The specifications for the econometric estimations are derived from equations 3.3, 3.5 and 3.7 and are given with the following regression equations at country level:

$$tfp_{it} = a_0 + a_1 y_{it} + e_{it} \tag{3.8}$$

$$tfp_{it} = a_0 + a_1 y_{it} + a_2 DIV_{it} + e_{it} \tag{3.9}$$

$$tfp_{it} = a_0 + a_1 y_{it} + a_3 DIV_{it} y_{it} + e_{it} \tag{3.10}$$

$$tfp_{it} = a_0 + a_1 y_{it} + a_2 DIV_{it} + a_3 DIV_{it} y_{it} + e_{it} \tag{3.11}$$

Total factor productivity (tfp) and output (y) variables for country i at year t are in growth rate in order to capture the static-dynamic increasing returns to scale

(IRS). The degree of export diversification (DIV) is measured by the Herfindahl-Hirschman (HH) and the Theil indices, and the degree of sophistication of exports is assessed through the Economic Complexity (ECI) Index. e_{it} is the error term. In equations 3.8 and 3.9, increasing returns to scale (IRS) are obtained from the estimated KV coefficient a_1 and in regression equations 3.10 and 3.11, the value of KV coefficient depends on export diversification effect as it is expressed in equation 3.6.

A comprehensive analysis will be conducted in the following sections by proceeding in two steps. First, we will compare the SSA results with those of the two other groups, namely Developing Asia and OECD economies. Our purpose is to assess the heterogeneity of the impact of export diversification in the three samples and to understand the channel through which increasing returns to scale occurs. In a second step, for a deeper analysis, we divide the SSA sample by income level into two sub-groups in order to assess whether the impact of export diversification and sophistication differs along the development path. But before proceeding to estimations, we first run preliminary tests in order to investigate cross-sectional dependence and stationarity in the variables.

3.4.2 Preliminary tests and econometric methodology

The statistics are reported in Table 3.5. Cross-sectional dependence tests are performed using the Pesaran (2004) CD test, which investigates whether there is interdependence between individuals in panel time-series data under the null hypothesis of cross-sectional independence. Statistics show that, except for variables tfp, y, HH and $Theil$ for the SSA sample, the null hypothesis of no cross-sectional dependence is strongly rejected. In other words, all variables in the two other samples (Asia and OECD) are cross-sectionally correlated.

To test for stationarity, we execute three types of unit root tests. Assuming that all panels have the same autoregressive parameter, the Levin et al. (2002) (LLC) statistic tests the null hypothesis of unit root against the alternative hypothesis indicating that the panels are stationary. In addition, we run the Maddala & Wu (1999) (MW) test that allows for heterogeneity in the autoregressive coefficient of the Dickey-Fuller regression. These first two tests do not assume for cross-dependence across panels. Hence, we implement a third unit root test, the Pesaran (2007) (CIPS) test, allowing for cross-sectional dependence in form of a single unobserved common factor and where the null implies that series are $I(1)$. We report these tests in Table 3.5 for each country group. The LLC, MW and CIPS tests for the SSA sample strongly reject the null of unit root. For the DA sample, similar results are observed for the

Table 3.5 – Preliminary tests

		Unit root tests		
	CD test	**LLC**	**MW**	**CIPS**
Sub-Saharan Africa (SSA)				
tfp	0.82	-5.8245***	341.801***	-10.678***
y	-0.30	-6.2130***	317.577***	-10.648***
theil	1.12	-2.2045**	69.121***	-1.106
HH	0.62	-2.5983***	89.613***	-3.498***
ECI	14.72***	-4.3236***	167.703***	-3.615***
Developing Asia (DA)				
tfp	6.34***	-4.6931***	142.086***	-7.587***
y	7.01***	-7.5915***	143.487***	-6.941***
theil	8.49***	-1.0168	23.959	-2.115**
HH	7.57***	-0.8332	29.735**	-0.833
ECI	15.33***	-1.1518	63.864***	-1.134
OECD				
tfp	23.07***	-7.8017***	257.279***	-8.945***
y	30.16***	-10.2588***	294.820***	-10.260***
theil	21.59***	-3.2631***	43.093	-1.214
HH	10.13***	-3.1617***	47.327*	-1.625*
ECI	28.71***	-4.5595***	146.753***	-2.743***

tfp and output y variables. Moreover, the CIPS test shows stationarity for the Theil variable and the MW statistics show that the null hypothesis of unit root is strongly rejected for the HH and ECI variables in the DA sample. For the OECD group, the tests on tfp, y, HH and ECI show stationarity of variables. The CIPS reports poor statistic for the $Theil$ variable, however, the LLC favors stationarity. Hence, the results for the unit root tests confirm that the variables in the three samples do not possess unit root. In other words, we observe that all variables in each sample are stationary. These results enable us to skip the cointegration procedure and to use the linear estimation method to investigate the long-run relationship between productivity growth and the growth of output, diversification and sophistication.

Equations 3.8, 3.9, 3.10 and 3.11 are estimated using Generalized Least Square that is suitable for panel data with long T and small N. The econometric method allows for estimation in the presence of heteroskedasticity, first-autocorrelation within panels and heteroskedasticity with cross-sectional dependence in its error structure. To choose the appropriate model, specification with panel-level heteroskedasticity is preferred after running a Likelihood-Ratio (LR) test. Moreover, we use the Wooldridge (2002) test to verify for first autocorrelation in panel-data model, and when the null of no serial correlation is rejected, we correct the model from the first auto-

correlation by using the AR1 autocorrelation structure. Last, when cross-sectional dependence is detected in the error structure after testing the residuals with the Pesaran (2004) CD test, we specify the model accordingly. A final limitation related to our equation specifications is that the presence of an interaction variable could generate structural multicollinearity. We have centered the independent variables (y and DIV indices) in order to remove, or at least to reduce, structural multicollinearity when using their interaction terms [16]. To do so, for each sample, we standardize the variables by subtracting the mean from all observed values before proceeding to estimation. The interpretation of the estimated coefficient remains the same but, in this case, the constant represents the predicted value of the dependent variable when explanatory variables are at their means.

3.5 Results and Discussions

In the following tables, the estimated coefficients related to regression equations 3.8, 3.9, 3.10 and 3.11 are reported in columns (i), (ii), (iii) and (iv) respectively. In addition, we give the estimated increasing returns to scale (IRS) corresponding to each estimated equation. For equations 3.8 and 3.9, the IRS is obtained with the following formula: $IRS = 1/(1 - a_1)$. In equations 3.10 and 3.11, after we report the nature of the impact of a change in export composition on IRS (namely diversification, concentration or sophistication), the latter is calculated with the following expression: $IRS = 1/(1 - (a_1 + a_3 DIV))$. Here $a_1 + a_3 DIV$ is the long-term Kaldor-Verdoorn coefficient in equation 3.6 from the expanded model involving the degree of diversification or sophistication, which is approximated by the mean value of the variable in the sample. As we use three types of indicator, equation 3.6 shows that the level of the estimated degree of returns to scale is conditioned by the type of diversification indicator used. Thus it would be inconsistent to comment on the level of IRS itself or to make a comparison of the IRS impacted by diversification that is assessed using different indicators. What is important is to observe in the three regions how a change in export composition impacts the IRS for each type of indicator, by making a hierarchy of the calculated IRS for the three regions. Therefore, considering these elements, we choose to present the results by the type of indicator. Moreover, we normalize the Theil index value between 0 and 1 before proceeding to IRS calculation so that the restriction related to the Kaldor coefficient ($0 < a_1 + a_3 DIV < 1$) is respected. In the following paragraphs, we will first

16. The correlation matrices of the variables before and after standardization are available upon request.

discuss the Kaldor-Verdoorn law in its basic form, then we will see the impact of diversification and sophistication on the Law. In a second step of our analysis, we will divide the sub-Saharan African sample into two groups according to income level for further investigation.

3.5.1 Impact of export diversification and sophistication in Sub-Saharan Africa: a comparative analysis

First, Table 3.6 reports the main results of the regression of equation 3.8 on the three samples, which is the expression of the basic Kaldor-Verdoorn (KV) Law. Our findings validate the existence of increasing returns to scale for the three regions, namely sub-Saharan Africa (SSA), Developing Asia (DA) and OECD members. More specifically, for SSA, the Kaldor-Verdoorn coefficient is positive ($a_{1ASS} = 0.115$) and shows that there are increasing returns to scale whether small ($IRS = 1/(1 - a_1) = 1.13$). In fact, Wells & Thirlwall (2003) corroborate these results and show some support for Kaldor's second law in Africa. Comparatively, for the DA sample, the KV coefficient is substantially higher ($a_{1DA} = 0.187$): the static-dynamic increasing returns to scale is 1.23. This initial comparative result reflects the success in growth performance in that region. Finally, the KV coefficient for OECD countries is slightly higher than that of DA with a degree of returns to scale of 1.24, which is the highest value in the three regions and may emphasize the source of developed countries' perpetual competitiveness. Subsequently, these initial results highlight the divergence in economic development paths followed by the two developing regions. Indeed, countries in sub-Saharan Africa seem to lag behind with low economies of scale, whereas developing Asian countries are economically almost as effective as the most developed OECD countries. Kaldor-Verdoorn's Law has been investigated in several studies for developed countries, especially for the OECD members. For instance, sectoral studies, as well as country-level analyses, have been conducted and validate the existence of dynamic increasing returns to scale. Angeriz et al. (2008) and Romero & Britto (2017) estimated the KVL respectively for EU regional manufacturing sectors and OECD industry sectors and found substantial static-dynamic increasing returns to scale.

Second, looking now at the impact of export diversification as measured by the Herfindahl-Hirschman index (HH), the estimated coefficients of the three remaining regression equations are shown in Table 3.7. Overall, the estimated coefficients related to output growth (y) are consistent with the previous results. The estimated coefficients of the output growth variable and diversification variable are robust to

Table 3.6 – Kaldor-Verdoorn's Law in Sub-Saharan Africa, Developing Asia, and OECD

	Dependent variable: *tfp*		
	ASS	DA	OECD
Variables	*(i)*	*(i)*	*(i)*
y	0.1149***	0.1865***	0.1926***
	(0.0213)	(0.0200)	(0.0038)
Constant	0.0048***	0.0096***	0.0031***
	(0.0013)	(0.0015)	(0.0002)
Observations	460	207	414
Number of i	20	9	18
Likelihood-Ratio test	488.2***	59.10***	165.6***
AR test (p-value)	0.306	0.456	0.120
CD test	-0.302	7.013***	30.16***
IRS	1.13	1.23	1.24

Notes: *, ** and *** are respectively 10%, 5% and 1% significance, and figures in parentheses are standard errors. Likelihood-ratio tests give Chi2 statistics that test for heteroskedasticity and show that we can reject the null hypothesis of homoskedasticity for each regression. AR tests give p-values of Wooldridge test for first order autocorrelation and figures do not allow to reject the null of no first-order autocorrelation. CD tests are Pesaran (2004) cross-sectional dependence tests (CD tests) on residuals and show that the null hypothesis of cross-sectional independence is favored for SSA sample, and cross-sectional dependence is favored for DA and OECD samples. IRS is the estimated increasing returns to scale ν.

any change in specification for the three samples. As we mentioned in the data description section, the HH concentration index measures the intensive margin part of export diversification. Put differently, a lower value of the index indicates a more equal dispersion of export shares among the existing products. Hence, a negative sign of the associated coefficient indicates a positive impact of export diversification. A first glance enables us to observe the heterogeneous effects of export diversification on productivity in the three samples. For SSA, export concentration generates a higher growth rate in total factor productivity (columns (ii) and columns (iv)), but does not influence the returns to scale (columns (iii) and (iv)): for instance, the estimates

in column (ii) indicate that an increase in the HH index of one standard deviation (= 0.241) will lead to an increase in productivity growth rate of 0.007, which is small. As mentioned earlier, the Asian export structure is relatively diversified. Furthermore, for DA results, surprisingly, estimates associated with HH strongly show that a change in composition does not have any direct impact on productivity growth but export diversification impacts the KV coefficient positively (see columns (iii) and (iv)): on average, the long-term KV coefficient induced by diversification, measured by the mean of the HH index, is 0.29. These estimation results are in line with the economic literature that emphasizes the central role of trade integration and manufacturing sector in structural transformation and rapid economic growth in DA countries (World Bank, 1993, 2020b; Rath & Akram, 2017). The regression results for OECD countries in the three last columns are robust to modifications in the regression specification. We note that a change in shares of goods in the export basket, as defined by the HH index, does not have any impact on productivity growth for developed countries. This finding shows that OECD economic competitiveness is mainly based on its demand growth.

Table 3.7 presents some interesting information about the three regions in terms of sustained growth driven by export diversification. It appears that only the DA countries benefit structurally from an increase in diversification. More importantly, when the diversification effect is taken into account (columns (iii) and (iv)), we find that the degree of returns to scale is highest in DA, followed by the OECD countries and finally by SSA. This hierarchization highlights, firstly, the great economic emergence of Asian countries driven by the accumulation and the economies of scale generated by diversification. Secondly, it accentuates the contrasting experiences with the implementation of a development model in the two regions: on the one hand, the spectacular dynamism of the Asian countries that have adopted a diversification strategy and, on the other hand, the transitory impact on productivity of sub-Saharan Africa's concentration on export commodities.

Focusing now on Table 3.8, we use the second diversification measure, namely the Theil concentration index. In addition to the intensive margin, the Theil index captures the extensive margin by integrating diversification in new exports and then allows for additional information to explain the impact of a variation in an export basket. Overall, the estimated coefficients show similar effects, except for the OECD countries. Indeed, in the first three columns (SSA), the estimated coefficient of output is still relatively low and export concentration has a direct impact on productivity: the positive sign of the estimated coefficients indicates that an increase in export concentration is likely to lead to higher productivity growth (see columns (ii)

Table 3.7 – Impact of export diversification (measured by HH index) and expanded Kaldor-Verdoorn's Law

	Dependent variable: tfp								
Variables	SSA *(ii)*	SSA *(iii)*	SSA *(iv)*	DA *(ii)*	DA *(iii)*	DA *(iv)*	OECD *(ii)*	OECD *(iii)*	OECD *(iv)*
y	0.1095***	0.1213***	0.1159***	0.1869***	0.2301***	0.2308***	0.1922***	0.1932***	0.1931***
	(0.0211)	(0.0237)	(0.0240)	(0.0201)	(0.0203)	(0.0203)	(0.0039)	(0.0048)	(0.0049)
HH	0.0275***		0.0268**	-0.0006		0.0173	0.0010		0.0001
	(0.0103)		(0.0104)	(0.0282)		(0.0311)	(0.0063)		(0.0063)
*HH*y*		0.0789	0.0480		-1.2436***	-1.2531***		-0.1882	-0.1824
		(0.1481)	(0.1491)		(0.3491)	(0.3495)		(0.1431)	(0.1492)
Constant	0.0073***	0.0046***	0.0071***	0.0096***	0.0100***	0.0104***	0.0033***	0.0031***	0.0033***
	(0.0018)	(0.0013)	(0.0018)	(0.0016)	(0.0014)	(0.0015)	(0.0003)	(0.0002)	(0.0003)
Observations	460	460	460	207	207	207	414	414	414
Number of i	20	20	20	9	9	9	18	18	18
Likelihood-Ratio test	484.5***	488.1***	483.2***	59.23***	48.25***	48.43***	165.6***	165.4***	165.3***
AR test (p-value)	0.280	0.409	0.387	0.388	0.627	0.715	0.126	0.114	0.109
CD test	0.185	-0.288	0.466	7.003***	6.267***	6.266***	30.19***	30.15***	30.20***
Mean Indice					0.046	0.046			
Nature of the impact		NI	NI		Div.	Div.		NI	NI
Long-term coef.	0.1095	0.1213	0.1159	0.1869	0.287	0.289	0.1922	0.1932	0.1931
IRS	1.12	1.14	1.13	1.23	1.40	1.41	1.24	1.24	1.24

Notes: *, ** and *** are respectively 10%, 5% and 1% significance and figures in parentheses are standard errors. Chi2 statistics of Likelihood-ratio test show that panels are heteroskedastic. P-values of Wooldridge test for first order autocorrelation (AR tests) allow us to not reject the null of no first-order autocorrelation for all estimated equations. Cross-sectional dependence tests (CD tests) of Pesaran (2004) on residuals show that the null hypothesis of cross-section independence is rejected for DA and OECD samples, except for SSA sample. The nature of the impact could be a diversification (Div.) or a concentration (Conc.). NI stands for No Impact of the change in export structure on the degree of increasing returns to scale (IRS).

and columns (iv)). For instance, in column (ii), an increase in the Theil index of one standard deviation (1.267) will lead to an increase in productivity growth rate of 0.003. The impact is still small. For Developing Asia, the estimated coefficients are robust as they do not change from previous results. Export diversification generates increasing returns to scale and in column (iv), the estimated long-term KV coefficient is about 0.28. The last three columns give the results for the OECD countries. Although the impact is very weak, the Theil index shows that export concentration increases the productivity growth rate. This significant difference from the previous estimation results may have an explanation. Indeed, the two indices do not have the same mathematical definition: unlike the HH index, the Theil index takes into account the diversification (or the concentration) at the extensive margin. It means that for the OECD countries, a concentration on smaller products would increase the productivity growth rate via technical progress. These findings are interesting because it reflects the inverted U-shaped relationship pattern between export diversification and level of development, where developing countries would diversify their exports and the most developed countries would concentrate their exports along the development path. Interestingly, the findings in Table 3.8 corroborate the previous comments in terms of the IRS hierarchy after considering the impact of export diversification (columns (iii) and (iv)) and reflect the difference in the paths taken by the two developing regions. Thus it demonstrates the robustness of our results.

To sum up, the estimated coefficients associated with the output growth variable (y) are robust to any change in specification and any change in diversification measure. All the estimated coefficients associated with the output are statistically different from zero and less than unity. It means that there are static-dynamic economies of scale in our three samples. In addition, our investigation based on the comparison of the results between Developing Asia and sub-Saharan Africa prompts us to make a few remarks. In contrast to Asia, the change in export composition does not generate any structural transformation in SSA because even if its effect (*i.e.* concentration) on technical progress is positive, it remains a transitory effect and does not increase the effect of output growth. In other words, it does not generate externalities to the whole economy. One could say that the diversification strategy is a priori a better growth strategy because it produces sustained economic growth through increasing returns to scale.

Thirdly, we investigate the role of export sophistication on economic growth via a transitory effect, namely the growth in productivity, and a more structural effect, namely its impact on the degree of increasing returns to scale. In this study, we choose to mobilize the Economic Complexity Index taken from the Atlas of

Table 3.8 – Impact of export diversification (measured by Theil index) and expanded Kaldor-Verdoorn's Law

	Dependent variable: tfp								
Variables	SSA *(ii)*	SSA *(iii)*	SSA *(iv)*	DA *(ii)*	DA *(iii)*	DA *(iv)*	OECD *(ii)*	OECD *(iii)*	OECD *(iv)*
y	0.1091***	0.1143***	0.1102***	0.1870***	0.2943***	0.2500***	0.1903***	0.1939***	0.1891***
	(0.0213)	(0.0228)	(0.0227)	(0.0202)	(0.0250)	(0.0264)	(0.0032)	(0.0045)	(0.0042)
Theil	0.0026**		0.0026**	-0.0001		0.0014	0.0007**		0.0007**
	(0.0012)		(0.0013)	(0.0012)		(0.0015)	(0.0003)		(0.0003)
*Theil*y*		-0.0127	-0.0037		-0.1051***	-0.0999***		-0.0009	0.0020
		(0.0220)	(0.0231)		(0.0214)	(0.0211)		(0.0041)	(0.0036)
Constant	0.0064***	0.0048***	0.0062***	0.0096***	0.0104***	0.0108***	0.0033***	0.0031***	0.0033***
	(0.0017)	(0.0014)	(0.0017)	(0.0016)	(0.0018)	(0.0014)	(0.0005)	(0.0002)	(0.0005)
Observations	460	460	460	207	207	207	414	414	414
Number of i	20	20	20	9	9	9	18	18	18
Likelihood-Ratio test	487.3***	488.4***	486.8***	59.13***	39***	39.84***	165.1***	165.5***	165.1***
AR test (p-value)	0.305	0.393	0.390	0.443	0.590	0.630	0.0689	0.130	0.0803
CD test	0.0665	-0.234	0.148	7.036***	5.554***	5.529***	30.05***	30.16***	30.05***
Mean Indice					3.56	3.56			
Normalized index					0.3	0.3			
Nature of the impact		NI	NI		Div.	Div.		NI	NI
Long-term coef.	0.1091	0.1143	0.1102	0.1870	0.326	0.280	0.1903	0.1939	0.1891
IRS	1.12	1.13	1.12	1.23	1.48	1.39	1.24	1.24	1.23

Notes: *, ** and *** are respectively 10%, 5% and 1% significance and figures in parentheses are standard errors.Chi2 statistics of Likelihood-ratio test of null hypothesis of homoskedasticity can be reject for each regression. AR tests allow us to not reject the null of no first-order autocorrelation for SSA and DA samples, except for OECD sample where the AR tests reject the null in columns (ii) and (iv) at 10%. CD tests on residuals show that the null hypothesis of no cross-section dependence is favored for SSA sample and rejected for DA and OECD samples. The nature of the impact could be a diversification (Div.) or a concentration (Conc.). NI stands for No Impact of the change in export structure on the degree of increasing returns to scale (IRS).

Economic Complexity. The corresponding results are presented in Table 3.9 for all the regression equations[17]. Overall, an increase in the sophistication of exported goods generates better performance in productivity growth. However, the channel of its impact differs according to the region. For the two developing regions, the positive sign of the estimated coefficient related to the interaction variable in columns (iii) and (iv) implies that an improvement in sophistication is definitely accompanied by increasing returns to scale, but for DA, the long-term coefficient is more than twice as high as that of SSA. More precisely, when comparing the level of IRS in columns (ii) and (iii) in each sample, the regression results show that the impact of an increase in sophistication is stronger for developing Asia than for sub-Saharan Africa on average. Since, on average, SSA exported goods are less complex than those that of DA, it would seem that, as far as developing countries are concerned, a higher degree of sophistication implies a higher degree of impact. For the OECD countries, the results show that an increase in complexity of exported goods, hence a concentration in more complex goods if the previous findings are considered, would induce higher productivity growth: in column (ii), an increase of one standard deviation in the ECI ($= 0.116$) generates an increase in the productivity growth rate of 0.002.

To sum up, economies in SSA have low increasing returns to scale and the results for export diversification and sophistication provide some explanations. Firstly, the growth rate of total factor productivity can be increased through a concentration in goods, but the effect is small. However, an increase in returns to scale is associated with an increase in economic complexity, which is what we expected: an accumulation of the capabilities required in the manufacturing sector to produce and export more complex goods is likely to generate externalities that boost other sectors' productivity on a country level. In addition, in all three regions, the impact of export diversification and sophistication on the productivity growth rate is very heterogeneous, but it enables us to explain the difference in economic performance. Notably, for DA countries, the effect of output growth on productivity growth is intensified by export diversification and sophistication. Moreover, the OECD founder member economies increase their productivity growth rate when they improve the concentration and sophistication of their export baskets, even if the impact is transitory. It emerges from these findings that on average, the Western European and North American OECD members are reaping the gain from trade by being competitive in complex and sophisticated goods, and hence by concentrating their exports in these kinds of products.

17. We also use the ECI rankings to investigate the impact of export sophistication, and the results are similar. The latter are available upon request.

Table 3.9 – Impact of export sophistication and expanded Kaldor-Verdoorn's Law

	Dependent variable: tfp								
Variables	SSA (ii)	SSA (iii)	SSA (iv)	DA (ii)	DA (iii)	DA (iv)	OECD (ii)	OECD (iii)	OECD (iv)
y	0.0956***	0.0754***	0.0807***	0.1881***	0.2146***	0.2155***	0.1939***	0.1968***	0.1951***
	(0.0234)	(0.0239)	(0.0244)	(0.0203)	(0.0198)	(0.0198)	(0.0048)	(0.0052)	(0.0055)
ECI	-0.0089		-0.0038	0.0113		0.0109	0.0131***		0.0132***
	(0.0115)		(0.0121)	(0.0091)		(0.0085)	(0.0032)		(0.0033)
*ECI*y*		0.4883**	0.4742**		0.6335***	0.6152***		0.0167	0.0383
		(0.2055)	(0.2173)		(0.1408)	(0.1413)		(0.0530)	(0.0533)
Constant	0.0038**	0.0045***	0.0042**	0.0096***	0.0097***	0.0095***	0.0025***	0.0026***	0.0025***
	(0.0016)	(0.0015)	(0.0017)	(0.0015)	(0.0013)	(0.0014)	(0.0003)	(0.0003)	(0.0003)
Observations	345	345	345	207	207	207	391	391	391
Number of i	15	15	15	9	9	9	17	17	17
Likelihood-Ratio test	438.1***	446.7***	445.3***	58.55***	50.12***	50.33***	123.3***	116.9***	123.4***
AR test (p-value)	0.218	0.160	0.198	0.443	0.918	0.922	0.0623	0.0229	0.0473
CD test	0.938	-0.262	0.217	7.110***	6.365***	6.756***	30.21***	30.67***	30.32***
Mean Indice		0.268	0.268		0.450	0.450			
Nature of the impact		Soph.	Soph.		Soph.	Soph.		NI	NI
Long-term coef.	0.0956	0.206	0.208	0.1881	0.50	0.492	0.1939	0.1968	0.1951
IRS	1.11	1.26	1.26	1.23	2.00	1.97	1.24	1.25	1.24

Notes: *, ** and *** are respectively 10%, 5% and 1% significance and figures in parentheses are standard errors.Likelihood-ratio tests reject the null hypothesis of homoskedasticity for each regression. AR tests allow us to favor the null of no first-order autocorrelation except for OECD regressions in columns (ii) and (iv). CD tests on residuals show that the null hypothesis of cross-section independence is not rejected for SSA regressions, and the hypothesis of cross-sectional dependence is favored for DA and OECD. The nature of the impact is export sophistication (Soph.). NI stands for No Impact of the change in export structure on the degree of increasing returns to scale (IRS).

3.5.2 A comparison within the Sub-Saharan African region

In a second step of our empirical analysis, we examine the role of export diversification and sophistication in different stages of development for SSA countries. As we mentioned in the data description section, African countries are relatively less advanced. Following the World Bank classification, we divide our sample into two subgroups according to their income level: middle-income SSA countries (MI SSA) and low-income SSA countries (LI SSA). We report our results in Table 3.10 for the traditional specification of KVL (in columns (i)), and the specifications with the Theil index and ECI for the two sub-samples (in columns (ii) and (iii)). When we compare the two samples, initial observation shows that in columns (i), the low-income countries have a greater KV coefficient and hence higher returns to scale: IRS are 1.12 and 1.18 for middle-income and low-income countries respectively.

As far as the Theil index is concerned, the estimation results for the two subgroups show divergence in terms of the trajectory of export composition. However, the division of countries by income level enables us to better understand the previous results. The results in Tables 3.7 and 3.8 support the argument that export concentration impacts positively on productivity growth. The current findings in Table 3.10 go further by showing that the positive effect of concentration is observed only in the low-income economies. Moreover, for the SSA countries taken as a whole, a change in export composition does not affect the economies of scale. In fact, on a disaggregated level, the "no-impact" conceals two contradictory phenomena. For LI SSA countries, concentration in exported goods leads to higher productivity growth and more structurally is conducive to increasing returns to scale. MI SSA countries, conversely, benefit from export diversification as it contributes positively to the effect of output growth on productivity growth. These results, although unexpected, require attention. The positive structural impact of specialization in the LI economies is relatively strong: in absolute terms, the coefficient associated with the interaction variable and the change in the IRS after taking the impact into account are higher for the LI sample than for the MI sample. It seems that, on average, low income countries still have advantages from specialization in spite of its volatility and its unsustainability as a development strategy in the long run. Indeed, comparison of the values of returns to scale (IRS) in Table 3.10, firstly in columns (i) and secondly in columns (ii) and (iii) of the Theil index, where IRS for low-income countries are higher than those for middle-income countries, calls for some remarks. It seems that low-income economies are taking full advantage of export concentration within a traditional development model and are benefiting from the accumulation and economies of scale already implemented for a long time. Conversely, when it comes to

Table 3.10 – Middle-income and Low-income countries in sub-Saharan Africa

	Dependent variable: tfp									
VARIABLES	MI SSA (i)	LI SSA (i)	THEIL MI SSA (ii)	THEIL LI SSA (ii)	THEIL MI SSA (iii)	THEIL LI SSA (iii)	ECI MI SSA (ii)	ECI LI SSA (ii)	ECI MI SSA (iii)	ECI LI SSA (iii)
y	0.1064***	0.1510***	0.1044***	0.1307***	0.0869**	0.1384***	0.1159***	0.0571**	0.0852***	0.0723***
	(0.0292)	(0.0229)	(0.0290)	(0.0326)	(0.0355)	(0.0312)	(0.0297)	(0.0285)	(0.0324)	(0.0278)
index			0.0011	0.0070**			-0.0068	0.0111		
			(0.0016)	(0.0028)			(0.0134)	(0.0314)		
*index*y*					-0.0690**	0.1929***			0.7288***	-0.3642
					(0.0305)	(0.0440)			(0.2585)	(0.2934)
Constant	0.0040**	0.0035	0.0041*	0.0087***	0.0050***	0.0083***	0.0034	0.0046	0.0046**	0.0043
	(0.0016)	(0.0021)	(0.0024)	(0.0024)	(0.0018)	(0.0022)	(0.0021)	(0.0029)	(0.0018)	(0.0041)
Observations	253	207	253	207	253	207	253	92	253	92
Number of i	11	9	11	9	11	9	11	4	11	4
L.-R. test	353.1***	96.87***	351.2***	100.7***	362.8***	98.83***	350.7***	35.01***	361.6***	30.76***
AR test (p-value)	0.193	0.774	0.204	0.769	0.354	0.757	0.243	0.179	0.143	0.0788
CD test	0.0299	-2.019**	-0.00225	-1.607	0.219	0.0207	0.488	-2.656***	0.497	-1.737*
Mean Indice					5.57	5.83			0.28	
Normalized ind.					0.59	0.63				
Nature of the imp.					Div.	Conc.			Soph.	NI
Long-term coef.	0.1064	0.1510	0.1044	0.1307	0.128	0.260	0.1159	0.0571	0.286	0.0723
IRS	1.12	1.18	1.12	1.15	1.15	1.35	1.13	1.06	1.40	1.08

Notes: *, ** and *** are respectively 10%, 5% and 1% significance and figures in parentheses are standard errors. Likelihood-ratio tests show that we can reject the null hypothesis of homoskedasticity for all regressions. AR tests allow us to not reject the null of no first-order autocorrelation for regressions except for the last column. CD tests show that the null hypothesis of cross-section independence is favored except for regressions in the second column and the las two columns.

middle-income economies, with low economies of scale, it seems that diversification is only now under way and that the switch to a diversification strategy generates transaction costs. For MI economies, the positive structural impact of diversification is similar to that of DA countries, although the impact is weaker ($a_{3MIASS} = -0.069$ and $a_{3DA} = -0.105$). Again, it shows that, as the MI SSA countries have just started the diversification process, they do not fully capture yet the full benefits of diversification in terms of economies of scale. More specifically, as far as the impact of export diversification measured by the Theil index is concerned, the low value of IRS in MI SSA compared to that of DA shows a difference in the stage of diversification and the economies of scale: developing Asian countries, as we have mentioned above, are at a stage of fully benefiting from the diversification process with a higher accumulation dynamic, whereas the diversification model has only recently been implemented in the middle-income SSA economies and initially generates only low economies of scale. Finally, we find that export sophistication is significant only for middle-income countries and the estimated value of the long-term KV coefficient is 0.29. Regarding the DA results in previous Tables and those of the MI SSA, it seems that the positive effect of export sophistication on productivity goes hand in hand with the positive effect of export diversification, which corroborates the existing literature (Hausmann & Hidalgo, 2010; Felipe et al., 2012; IMF, 2014b). In short, the division of the sample into two subgroups gives supplementary information. The low-income economies are taking full advantage of export concentration but when it comes to middle-income economies, improvement in economic performance by increasing the returns to scale is possible only through export diversification and sophistication.

To sum up, our empirical analysis enables us to investigate the impact of export diversification and sophistication on economic development through the Kaldor-Verdoorn Law. In terms of economies of scale, ideally, according to Kaldor (1966), the Kaldor-Verdoorn coefficient should be close to 0.5. The level of the coefficient was determined after he showed that, from the end of the ninetieth century to the beginning of the twentieth century, the United States and Germany had grown to catch up with the United-Kingdom with a KV coefficient of 0.42 and 0.49 respectively. However, recent decades have seen, on the one hand, the astonishing growth of Developing Asian countries, especially China and its leading role in global trade, and, on the other, a sub-Saharan Africa that has failed to implement successful policies for economic development and therefore lags behind the Asian countries. Moreover, the founder members of OECD have always been remarkable examples of developed countries. To assess whether export diversification is a good strategy for countries in sub-Saharan Africa, comparison of the impact of export composition

in the three regions would enable us to make some recommendations in terms of structural transformation and to ascertain how a change in export structure affects sustained economic growth. It would seem that, for developing countries, export sophistication only has a positive impact when it is accompanied by export diversification, and that export concentration is maybe an effective strategy but solely at a very early stage of development, namely at the low-income stage, in order to initiate diversification.

3.6 Concluding Remarks

The economic development of countries in sub-Saharan Africa has been the subject of several policy recommendations in recent decades. In particular, there is a consensus in the economic literature on the virtues of export diversification strategy. In this paper, our purpose has been to assess the role of export diversification and export sophistication as engines of growth by endogenizing Kaldor-Verdoorn's Law in a comparative analysis. Put differently, we go further than investigating its effect on productivity growth. The quality of export diversification is investigated through its impact on the degree of increasing returns to scale. For our empirical study, we compare the results of three samples of countries, namely SSA countries, Developing Asian countries, and the founder member countries of the OECD.

The results of the regressions from different samples are heterogeneous but seem to form an overall pattern. For the basic Kaldor-Verdoorn's Law, we find that the KV coefficient for SSA is relatively low with respect to that of DA group and OECD group. Moreover, we find that for low-income countries in SSA, export concentration has a positive impact on productivity growth and a relatively stronger effect on the degree of returns to scale. The latter highlights a traditional model of concentration in which economies of scale has been fully exploited. Conversely, for Developing Asian countries and middle-income SSA economies, export diversification generates positive effects on increasing returns to scale although the effect is much stronger in DA. These findings emphasize the fact that the diversification process is at its very beginning in MI SSA, whereas in DA countries, the economies of scale are being fully exploited as the emerging economies are thoroughly involved in the diversification process along their development path. As far as export sophistication is concerned, we show that its impact on the Kaldor-Verdoorn coefficient is positive for middle-income economies in SSA and in DA. For the OECD countries, the drive to concentrate and increase the sophistication of their export baskets leads to a better performance in productivity which may characterize their competitiveness in more

complex goods and thus validates the U-shaped linkage between concentration and economic development.

In terms of policy implications, our findings give support to export diversification and export sophistication as drivers of sustained growth emerging from the interaction between demand and productivity. The diversification strategy is more likely to be effective in a second phase of economic development, namely after that the economy has taken full advantage of export concentration in a very early stage of its development path. As mentioned above, the export structure of sub-Saharan African countries is very concentrated in primary products and natural resources. The poorest economies could first favor these products in which they have a comparative advantage in the initial stage of development in order to be able to invest in infrastructure improvement and increase employment and human capital. Then, in a second stage, they should promote product and export diversification in order to foster a virtuous cycle of economic growth and development. Indeed, it is worth mentioning that concentration should be a transitory step as its long-run impact on economic growth is weak and volatile. For instance, in his article, Habiyaremye (2016) was concerned about the increasing trade expansion between China and Africa, where Africa mainly exports natural resources and raw materials. He argues that in addition to the human capital, by helping African countries building infrastructures, the resources-for-infrastructure swap deals with China gave the opportunity to acquire the capacity for greater diversification and structural change. Subsequently, throughout the development path, the benefits of export diversification go hand in hand with those of export sophistication and therefore, economic policies should be amended accordingly.

Appendix 3.A Country List

We list below the countries included in our study by group sample. Country name with an (*) indicates that the ECI variable is available for the period 1995-2017. We follow the World bank classification which categorize countries according to the level of Gross National Income per capita: Low-income countries (LI), Lower-middle-income countries (LMI), Upper-middle-income countries (UMI) and High-income countries (HI).

Appendix 3.B Summary Statistics

Table 3.11 – Country list

	Sub-Saharan Africa			**Developing Asia**			**OECD**	
ISO	Country Name		ISO	Country Name		ISO	Country Name	
AGO	Angola*	LMI	CHN	China*	UMI	AUT	Austria*	HI
BDI	Burundi	LI				BEL	Belgium*	HI
BEN	Benin	LI	IDN	Indonesia*	LMI	CAN	Canada*	HI
BFA	Burkina Faso*	LI	IND	India*	LMI	CHE	Switzerland*	HI
CAF	Central African Rep.	LI	LAO	Lao People's DR*	LMI	DEU	Germany*	HI
CIV	Côte d'Ivoire*	LMI	LKA	Sri Lanka*	UMI	DNK	Denmark*	HI
CMR	Cameroon*	LMI	MNG	Mongolia*	LMI	ESP	Spain*	HI
GAB	Gabon*	UMI	MYS	Malaysia*	UMI	FRA	France*	HI
KEN	Kenya*	LMI	PHL	Philippines*	LMI	GBR	United Kingdom*	HI
MOZ	Mozambique*	LI	THA	Thailand*	UMI	GRC	Greece*	HI
MRT	Mauritania*	LMI				IRL	Ireland*	HI
MUS	Mauritius*	UMI				ISL	Iceland	HI
NER	Niger	LI				ITA	Italy*	HI
NGA	Nigeria*	LMI				NLD	Netherlands*	HI
RWA	Rwanda	LI				NOR	Norway*	HI
SEN	Senegal*	LMI				PRT	Portugal*	HI
TGO	Togo*	LI				SWE	Sweden*	HI
TZA	Tanzania*	LI				USA	United States*	HI
ZAF	South Africa*	UMI						
ZWE	Zimbabwe*	LMI						

Source: World Bank, June 2019

Table 3.12 – Summary statistics

Sub-Saharan Africa (SSA)					
Variable	N	Mean	Standard Deviation	Min	Max
tfp	460	0.007	0.0698	-0.359	0.630
y	460	0.044	0.083	-0.191	0.544
HH	460	0.237	0.241	0.0144	0.953
Theil	460	5.688	1.267	2.866	8.371
ECI	345	0.268	0.138	0	0.602
Developing Asia (DA)					
Variable	N	Mean	Standard Deviation	Min	Max
tfp	207	0.01	0.028	-0.158	0.085
y	207	0.062	0.067	-0.191	0.366
HH	207	0.046	0.057	0.003	0.277
Theil	207	3.560	1.195	1.887	6.505
ECI	207	0.450	0.163	0.0798	0.758
OECD					
Variable	N	Mean	Standard Deviation	Min	Max
tfp	414	0.003	0.018	-0.06	0.185
y	414	0.022	0.067	-0.196	0.945
HH	414	0.026	0.0413	0.002	0.231
Theil	414	2.671	0.984	1.5	5.319
ECI	391	0.772	0.116	0.476	0.973

Chapter 4

Export diversification and CO2 emissions: an augmented environmental Kuznets curve

Abstract

The mitigation of global warming by reducing greenhouse gas emissions has been the objective of successive negotiations and agreements between nations. At the same time, there is a consensus on the virtues of export diversification for the development of less advanced countries. This chapter investigates the effect of export diversification on CO2 emissions in the context of an environmental Kuznets curve hypothesis in 98 developed and developing countries during the period 1995-2013. Using short-run (system GMM) and long-run (PMG) estimation methods, we find that the environmental Kuznets curve is valid, and that export diversification has a positive effect on CO2 emissions. [18]

Keywords: Export diversification, pollution, CO2 emissions, Environmental Kuznets Curve hypothesis, economic development.

JEL codes: F.18, O.13, Q.53, Q.56, C.33.

18. This chapter is a personal and original contribution of the author. It has been accepted for a presentation at the 6th annual conference of the FAERE (French Association of Environmental and Resource Economists), Rennes (29-30 August,2019). A version of this chapter has been published in the Journal of International Development with citation "Mania, E., 2020. Export diversification and CO2 emissions: an augmented environmental Kuznets curve. *Journal of International Development* 32(2), 168-185. DOI: 10.1002/jid.3441".

4.1 Introduction

Over the past twenty years, tackling environmental degradation and economic development challenges are two of the greatest concerns in economic debates. Since the beginning of the new millennium, countries have found themselves in a new global context in which the preservation of environmental quality and the fight against climate change and global warming have become priorities. A willingness to reduce greenhouse gas emissions in order to mitigate global warming is the objective of successive negotiations and agreement between UN member states (Kyoto Protocol, COP21 Paris Agreement). However, the ambitious goal may hamper latecomer countries in developing and following the same path as those already developed. To respond to development concerns, international organizations, primarily the International Monetary Fund (IMF) and World Bank, are now agreed on the virtues of economic and export diversification. For instance, they recommend low-income countries to diversify their exports in order to reduce dependency on commodity exports and to stabilize export earnings. However, the consequences of such an export diversification strategy may conflict with environmental priorities. The economic growth strategy for developing countries may or may not conflict with the objective of environmental preservation. This context leads us to question whether such a growth strategy is good or bad for the environment. Thus, in this paper, our purpose is to investigate the impact of export diversification on the environmental quality.

On the one hand, some responses to these environmental concerns may be found in the environmental and economic literature. Environmental degradation seems to follow an inverted U-shaped relationship with economic development. Numerous studies, based on the environmental Kuznets curve (EKC) [19] concept, have followed in the wake of the pioneering studies by Grossman & Krueger (1993) on the environmental impact of the North American Free Trade Agreement (NAFTA) and Shafik & Bandyopadhyay (1992) background study for the World Development report. These studies use various indicators of environmental degradation, such as deforestation, air and water quality and sanitation. More specifically, the EKC hypothesis suggests that, in the early stages of economic development, pollution increases with economic activity until a threshold income is reached; this rise in income is followed by a demand for environmental quality. The income turning point is then mostly given. For Shafik & Bandyopadhyay (1992), the turning point income for local air pollutant concentration is 3000 USD and 4000 USD, while Panayotou (1993)'s turning point income for sulphur dioxide emissions is between 3800 USD and 5500 USD and for

19. The EKC is named for Kuznets (1955) who suggested that inequality rises and falls as an economy follows its development path.

Grossman and Krueger (1995) the turning point income for different pollutants is less than 8000 USD. For CO2 emissions, which is one of the main greenhouse gases, large-scale empirical studies have been conducted, whether by country, region or on a global scale (Apergis & Payne (2009); Guangyue & Deyong (2011); among others).

The increase in economic scale has two sources: economic growth itself and trade (Copeland & Taylor, 2004). Antweiler et al. (2001) show that the EKC hypothesis is valid for countries following trade liberalization by attributing the rise in the curve to economic growth driven by capital accumulation and the fall to technological progress. Moreover, the theoretical model and empirical studies divide income growth and trade impacts on pollution into scale, technique and composition effects, as established by other studies (Copeland & Taylor, 1994, 2004; Hettige et al., 2000). The scale effect, which is the consequence of a simple increase in economic activity, increases pollution levels proportionally. The technique effect appears later, when the economy is performing better and leads to greater technological progress by improving environmental quality. The composition effect, finally, reflects the composition of production in the economy, which has a more ambiguous impact on pollution. For a country opened up to trade, there can be two possible impacts of the trade-induced composition effect on the concentration of pollution, depending on the country's comparative advantages as determined by its factor endowment and pollution policy (Antweiler et al., 2001). The factor endowments hypothesis postulates that a high-income country with sufficiently abundant capital will have a comparative advantage in exporting dirty (polluting) goods (Mani & David, 1998). Conversely, the pollution haven hypothesis suggests that, after trade liberalization, the difference in income between two countries leads to a configuration in which the poorer country will have the comparative advantage in the production of dirty goods because of lax pollution policy (Low & Yeats, 1992; Wagner, 2010). This last concept should be differentiated from the pollution haven effect, which stipulates that stronger pollution regulation in a country impacts the choice of location and the trade flows of polluting industries (Copeland & Taylor, 2004; Levinson & Taylor, 2008). In a North-South configuration with capital mobility and trade costs, Rieber & Tran (2009) add a relocation effect for polluting industries and discuss the efficiency of unilateral or harmonized environmental regulation for global welfare.

On the other hand, trade liberalization as experienced by some developing countries has in recent decades given rise to unwanted consequences. Declining terms of trade (Prebisch, 1950; Singer, 1950), the natural resources curse (Auty, 1990; Sachs & Warner, 2001) and the volatility of export earnings (IMF, 2014b) are discussed in the development literature. A solution has been put forward in a number of empirical

studies and recommended by the leading international organizations (IMF, 2014b): export diversification could, it is suggested, stabilize export earnings and contribute to a better macroeconomic equilibrium. Imbs & Wacziarg (2003), who originally conducted the study, show that there is a robust non-linear relationship between production diversification and economic development. More specifically, there is an initial stage in which a country begins to develop and diversify across sectors until a threshold income is reached, at which point the country starts the second stage of specialization. The study has been extended logically to export diversification by others (Cadot et al. (2013); IMF (2014b); Klinger & Lederman (2004); among others) and the U-inverted relationship still holds. The turning point has been located at 22500 USD by Klinger & Lederman (2006) and at 25000 USD by Cadot et al. (2013).

Therefore, export diversification, at the same level as trade openness, might have consequences for environmental quality. Indeed, as already noted, international trade has an impact on environmental quality. Moreover, various studies have considered international trade as a determinant of pollution in the context of an EKC (Ben Jebli & Ben Youssef, 2015a,b; Ben Jebli et al., 2016; Cole, 2003). Recently, in the international trade literature, the focus is more on the diversification of the export basket. Then, export diversification could be an important determinant of pollution. For instance, Shahbaz et al. (2019) investigate the effect of export diversification on energy demand, which is a main driver of carbon emissions. More specifically, a small number of studies have started investigating the effect of export diversification on CO2 emissions within the EKC. Gozgor & Can (2016) analyze the impact of Turkish export diversification on its CO2 emissions and show a positive relationship. Apergis et al. (2018), in a study of 19 developed countries, found that export concentration leads to a reduction in CO2 emissions.

In the light of these considerations and in line with the EKC literature, our aim in this paper is to examine the impact of export diversification on CO2 emissions in developed and developing countries for the period 1995-2013 within the context of the EKC hypothesis. To the best of our knowledge, no study has yet examined the effect of export diversification on a large group of developed and developing countries. The question is whether the recommendations of international organizations conflict with the objectives of environmental preservation. Indeed, there would be some economic interest in analyzing the relationship between export diversification or concentration and CO2 emissions.

As stylized facts, in the empirical literature, export diversification variable and carbon emission variable have an inverted U-shaped relationship with economic de-

velopment. As far as export structure is concerned, countries in the early stages of development will diversify their exports; then, once a threshold income has been reached, the country will begin specializing in specific export products. As far as pollution levels are concerned, the first stage of development is accompanied by an increase in pollution; in the second stage, the country begins to decrease its pollution as it follows its development path. It can be presumed that export diversification is accompanied by an increase of pollution and that export concentration is accompanied by a fall in pollution volume. In both cases, we expect a monotonical relationship for the whole sample: a positive relationship between CO2 emissions and export diversification, or in other words, a negative relationship between CO2 emissions and export concentration. It seems, however, that the two directions of changes in export structure are the outcomes of two different forces. Export diversification leads to composition and scale effects in which, apparently, developing countries invest in dirty industries. Conversely, export concentration for developed countries would give rise to composition and technique effects, with firms specializing in goods that use cleaner technologies.

To investigate the facts, this manuscript seeks to contribute to the debate by analyzing the effect of export diversification or concentration on greenhouse gas emissions for countries at different income levels in the context of an EKC. Going deeper, our contribution to the existing literature is twofold. Firstly, by taking the CO2 emissions as an indicator of the greenhouse gas emissions, we attempt to verify the validity of the environmental Kuznets curve hypothesis as shown by numerous previous studies in environmental literature. Secondly, our findings will contribute to export diversification literature by analyzing whether, for poorer and developing countries, a growth strategy such as export diversification, although recommended by international organizations for its benefits, would increase negative externalities such as environmental degradation and air pollution. Indeed, research questions related to economic growth in recent studies are increasingly focused on the diversification of export basket, for example in its role in energy demand (Shahbaz et al., 2019) or in effects of diversification on the quality upgrading of exports (Can & Gozgor, 2018).

By putting all the countries into a single sample, our aim is to derive a more general relationship. The idea is that we will augment the Kuznets curve by taking into account the level of diversification. The augmented environment Kuznets curve will serve as the basis for an empirical model that can be used to analyze the impact of economic development and export diversification on CO2 emissions. More specifically, given that we want to investigate the whole of the EKC, we will empi-

rically analyze the impact of export diversification on the volume of CO2 emissions using data from 98 developing and developed countries for the period 1995-2013. To do so, we answer the research question with an empirical analysis in two stages: first by checking the validity of the EKC hypothesis and, second, by adding export diversification as a determinant of CO2 emissions. After applying preliminary tests as cross-sectional dependence, unit root and cointegration tests, we use short-run (one-step and two-step system GMM) and long-run (PMG) estimation methods to investigate the impact of export diversification on CO2 emissions within the context of EKC. We find that the environmental Kuznets curve hypothesis is valid, and moreover, the effect of export diversification on the volume of CO2 emissions per capita is positive and robust. More precisely, referring to the stylized facts, our results show that, for the less developed countries, export diversification leads to an increase in CO2 emissions; conversely, for the developed countries, export concentration leads to a decrease in the level of CO2 emissions.

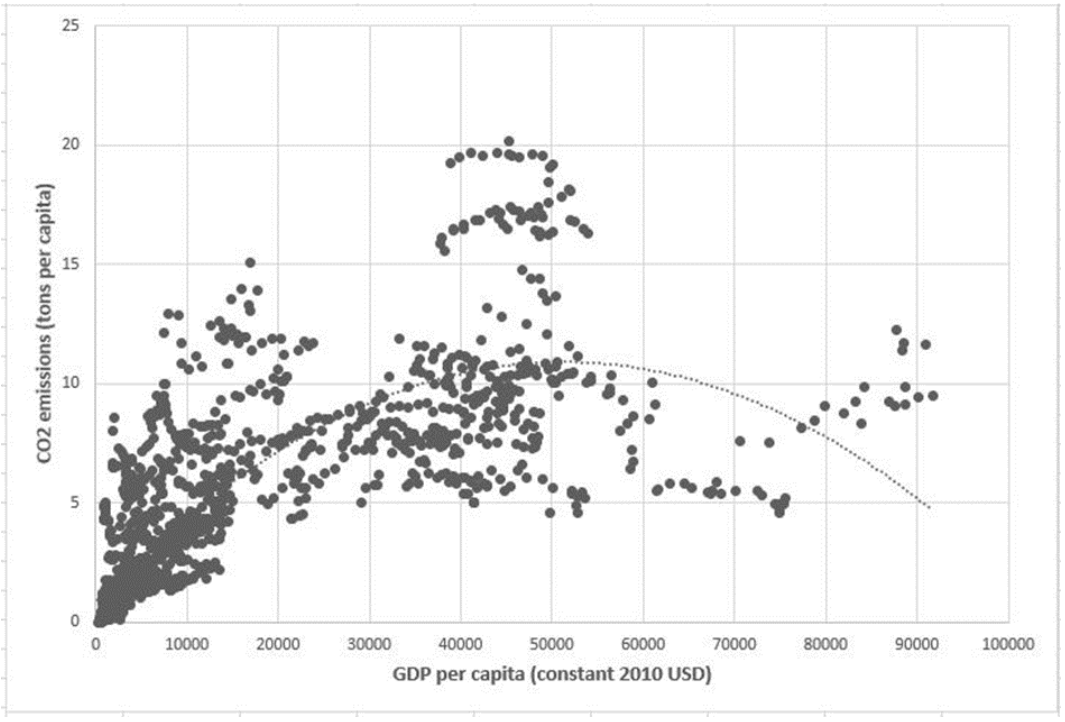
The article is organized as follows. The second section will briefly present the stylized facts. In the third section we will outline the data and methodology used, followed by the empirical results. The final section offers some concluding remarks.

4.2 Stylized facts

In this section, we briefly present the stylized facts pertaining to export structure and CO2 emissions. The environmental Kuznets curve hypothesis, which links environmental degradation, in the case of CO2 emissions, to economic development, might be highlighted in our first figure. Figure 4.1 presents our data from 98 countries over the period 1995-2013 and the scatter plot displays values for the level of the CO2 emission in tons per capita and the gross domestic product (GDP per capita in constant 2010 USD).

Economic development, approximated by GDP per capita, and CO2 emissions per capita are matched graphically for selected country-year observations that we will use later for the empirical analysis, with the addition of a quadratic trend. The inverted U-shaped relationship is observed. In the first stage, economic development is associated with increasing CO2 emissions per capita; a second stage then starts in which an increase in GDP per capita is linked with reduced CO2 emissions. The turning point income seems to be around 40000 USD. This figure seems to be consistent with the EKC hypothesis. Indeed, in the EKC literature, many studies have focused on the CO2 emissions as an indicator of environmental degradation and have shown that the inverted U-shaped relationship between economic development and

Figure 4.1 – Relationship between economic development and CO2 emissions (1995-2013)



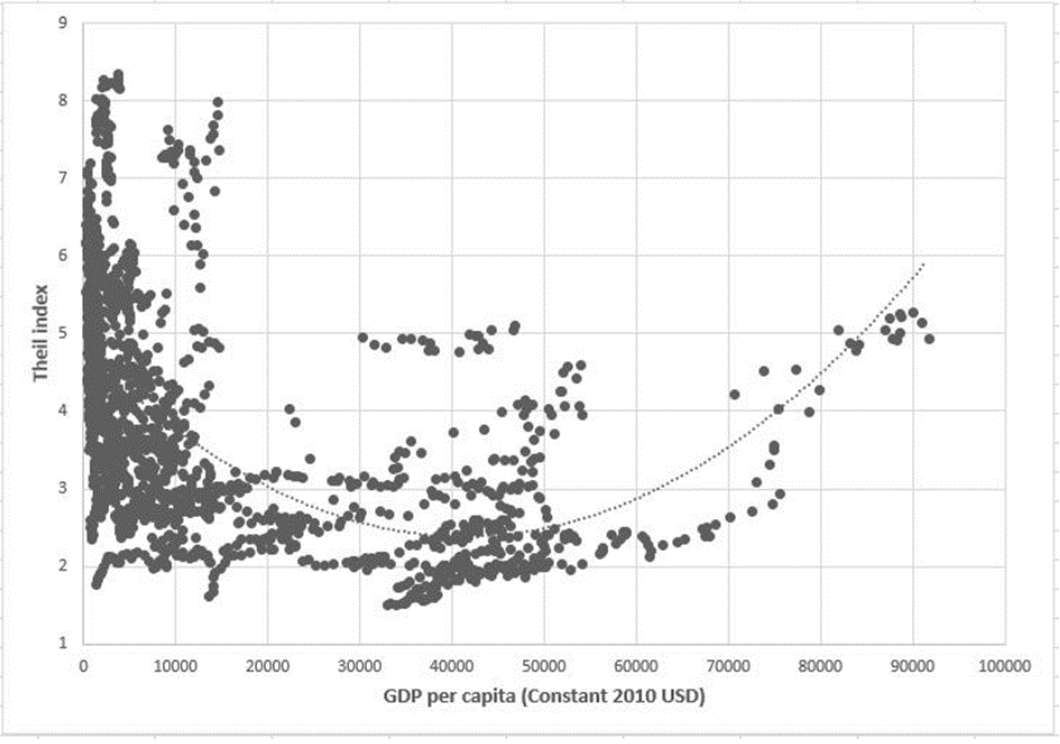
Source: Author's calculations using WDI database (with quadratic trend).

the carbon dioxide is verified. Most of these studies attempt to identify the effects of various variables such as energy consumption, trade and urbanization within an environmental Kuznets Curve context (Ben Jebli & Ben Youssef (2015b); Ben Jebli & Ben Youssef (2015a); Ben Jebli et al. (2016); Bilgil et al. (2016); Cole (2003); Gozgor (2017); Schmalensee et al. (1995); Wang et al. (2015); among others). Douglas & Selden (1995) emphasize a nuanced result in their study: they show that as the country get richer, there is a diminishing marginal propensity to emit carbon dioxide, however, the global emissions of carbon dioxide keeps growing at an annual rate of 1.8 percent. In the empirical literature, the EKC has been tested for different pollutants and greenhouse gas emissions, as noted in the introduction, and turning points are found (Grossman & Krueger, 1995; Panayotou, 1993; Shafik & Bandyopadhyay, 1992). More specifically, emissions of sulfur dioxide are the other commonly used indicator for measuring air pollution: a wide range of empirical studies finds that the EKC hypothesis hold for the Organisation for Economic Cooperation and Development (OECD) countries (Cole et al. (1997); Selden & Song (1994); Stern & Common (2001); among others).

Focusing now on export structure, numerous empirical studies show a robust inverted U-shaped relationship between economic development and export diver-

sification (Cadot et al., 2011, 2013; IMF, 2014b; Klinger & Lederman, 2004). To measure export diversification, we choose to calculate the Theil index for every single country-year observation due to its widespread use (Apergis et al., 2018; Can & Gozgor, 2018; Gozgor & Can, 2016; Shahbaz et al., 2019). The Theil index is a concentration index; consequently, it is inversely proportional to the degree of export diversification. In other words, for a given country and year, a lower level of the Theil index indicates a higher level of export diversification and, conversely, a higher level of the Theil index shows a weaker level of export diversification. Figure 4.2 shows a non-monotonic relationship between export diversification and economic development. More specifically, the U-shaped relationship between export concentration and economic development is observed. We can observe the two stages: an initial phase of diversification for the less advanced countries until a threshold income is reached, and a second phase of concentration for the more advanced countries. The turning point income is located at approximately 40000 USD.

Figure 4.2 – Relationship between economic development and export diversification (1995-2013)



Source: Author's calculations using WDI database for GDP per capita and BACI database for Theil index (with quadratic trend).

When the two curves are put together, it can be seen that export diversification occurs when CO2 emissions are increasing, and that export concentration coincide

with a decrease in pollution. From a comparison of the two curves, we can deduce, a priori, a positive relationship between export diversification and CO2 emissions. In the next sections, to test the relationship, we will analyze the effect of export diversification and concentration on CO2 emissions for developed and developing countries in the context of an Environmental Kuznets Curve hypothesis, which we call the augmented environmental Kuznets curve hypothesis. Our purpose is to ascertain whether the strategy of export diversification, on which there is a consensus in economic development literature, conflicts with the environmental priorities set by nations. For our study, we will analyze the impact of export diversification (or concentration) on CO2 emissions for 98 countries over the period 1995-2013.

4.3 Data, specification and methodology

4.3.1 Data

For our analysis, we use annual data from the 98 developed and developing countries listed in Table 4.3 Following the World Bank classification of countries by income, we selected countries from each group in order to analyze a generalized relationship between CO2 emissions and export structure. Our study covers the period 1995-2013.

The variables used are the following: carbon dioxide emissions (CO2; metric tons per capita); real GDP per capita (GDP, approximated by the GDP per capita in constant 2010 USD). The data comes from the World Bank's World Development Indicator (WDI). In our study, the CO2 emissions data is limited to the year 2013 because of the availability in the WDI database. To measure export diversification, we use the Theil indexes (DIV), which measure the concentration of exports. Thus, a positive impact of export diversification on CO2 emissions will imply a negative sign for the Theil index coefficient. They are calculated annually for each country from the export lines of trade data taken from the CEPII's BACI database. The BACI database gives bilateral trade flows using the Harmonized System of 6-digit disaggregation and begins at the year 1995, which is the lower limit of our study period. Thus, our study period is limited by the availability of our data. Furthermore, the highly disaggregated data gives us a better measure of the degree of export concentration. The descriptive statistics are reported in Table 4.4.

Table 4.3 – List of countries

Group	List of countries
HIC (33 countries)	Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Rep., Latvia, Lithuania, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States, Uruguay.
UMIC (26 Countries)	Albania, Argentina, Bosnia and Herzegovina, Brazil, Bulgaria, China, Colombia, Costa Rica, Croatia, Cuba, Dominican Republic, Ecuador, Gabon, Jamaica, Macedonia, FYR, Malaysia, Mauritius, Mexico, Panama, Paraguay, Peru, Romania, South Africa, Thailand, Turkey, Venezuela, RB.
LMIC (29 countries)	Angola, Armenia, Bangladesh, Bolivia, Cambodia, Cameroon, Congo, Rep., Cote d'Ivoire, El Salvador, Georgia, Ghana, Guatemala, Honduras, India, Indonesia, Kenya, Kyrgyz Republic, Morocco, Myanmar, Nicaragua, Nigeria, Pakistan, Philippines, Sri Lanka, Tajikistan, Tunisia, Ukraine, Vietnam, Zambia.
LIC (10 countries)	Benin, Congo, Dem. Rep., Ethiopia, Mozambique, Nepal, Senegal, Tanzania, Togo, Uzbekistan, Zimbabwe.

Source: World bank, country classification for the 2018 fiscal year.

Notes: To select developed and developing countries, we refer to the classification of the countries as defined by the World Bank: HIC or high-income countries have a GNI per capita of 12236 USD or more in 2016; UMIC or upper-middle-income countries have a GNI per capita between 3956 USD and 12235 USD; LMIC or lower-middle-income countries have a GNI per capita between 1006 USD and 3955 USD; and finally, LIC or low-income countries are defined as economies with a GNI per capita of 1005 USD or less.

4.3.2 Equation Specification

Our objective is to assess the impact of export diversification in a context of EKC. By matching the two stylized facts, we expect the relationship between export diversification and CO2 emissions to be positive. Our analysis is performed in two stages.

We first check for the existence of the environmental Kuznets curve and then we investigate whether export diversification has an impact on CO2 emissions. To

Table 4.4 – Summary of descriptive statistics and sources

Variable	Data source	Observation	Mean	Standard-Deviation	Min.	Max.
log(CO2)	World Bank, WDI	1 862	0.728	1.427	-4.058	3.006
log(GDP)	World Bank, WDI	1 862	8.530	1.516	5.139	11.43
log(DIV)	Author's calculations; CEPII, BACI	1 862	1.300	0.376	0.421	2.123

check the validity of the EKC hypothesis, we follow the model traditionally used in empirical EKC studies:

$$log(CO2)_{it} = a_0 + a_1 log(GDP)_{it} + a_2 (log(GDP)_{it})^2 + e_{it} \quad (4.1)$$

t is the time period ($t = 1, ..., T$) and i is the cross-section unit of the panel ($i = 1, ..., N$). a_0 is the constant. The variables are transformed into the natural logarithm form. e_{it} is the error term. We expect the coefficient a_1 to be positive in order to demonstrate a positive relationship between income and CO2 emissions and the coefficient a_2 to be negative, to verify the nonlinear and inverted U-shaped relationship, according to the EKC hypothesis.

Secondly, we introduce the export diversification variable (DIV) into the equation:

$$log(CO2)_{it} = a_0 + a_1 log(GDP)_{it} + a_2 (log(GDP)_{it})^2 + a_3 log(DIV)_{it} + e_{it} \quad (4.2)$$

We expect the sign of the coefficient a_3 to be positive, thus showing a positive relationship between CO2 emissions and export diversification.To measure the relationship and estimate the coefficients, we use various estimation methods.

4.3.3 Methodology

Taking into account the endogeneity problems that might exist between the variables, we apply the one-step system GMM estimator of Arellano & Bover (1995) and Blundell & Bond (1998) for a linear estimation in dynamic panel data. Indeed, the system GMM addresses the problem of endogeneity by treating each variable as endogenous, which instrumentalizes the variables by their own lag and relaxes

the assumptions of heteroscedasticity and serial correlation. The consistency of the GMM estimator is verified by the Hansen J test for the validity of the overidentifying restriction and the Arellano-Bond tests for first-order AR(1) and second-order AR(2) autocorrelation in first differences: the null hypothesis for zero autocorrelation at AR(1) should be rejected and the null hypothesis for zero autocorrelation at AR(2) should not be rejected. The estimator is more efficient when $T < N$. The GMM model is presented in the autoregressive form:

$$y_{it} = \alpha y_{it-1} + \beta_1' x_{it} + \beta_2' x_{it-1} + \eta_i + \nu_{it} \tag{4.3}$$

We apply the panel unit root tests and cointegration tests and if the long-run relationship is observed, we run the pooled mean-group (PMG) Pesaran et al. (1999) model which is based on an ARDL (Autoregressive distributed lag) model and estimates long-run coefficients when the variables are cointegrated. The PMG estimator constrains the long-run coefficients to be equal across the panel but allows the short-run coefficients to be specific to each group. The PMG model is written as:

$$\Delta y_{it} = \theta_i(y_{i,t-1} - \beta' x_{i,t-1}) + \sum_{j=1}^{p-1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{q-1} \gamma_{ij}' \Delta x_{i,t-j} + \mu_i + e_{it} \tag{4.4}$$

θ_i is the error correction speed of the adjustment parameter, $x_{i,t-1}$ are explanatory variables, β' is the estimated long-term parameter, γ_{ij} are parameters p to estimate, γ_{ij}' are parameters q to estimate, μ_i are fixed effects and e_{it} are the error terms.

As a robustness check, we perform the two-step system GMM, which is asymptotically more efficient, with the Windmeijer (2005) robust standard errors by using the command *xtabond2* Roodman (2009) in Stata. We also provide the Hansen J test and the Arellano-Bond tests for AR(1) and AR(2) autocorrelations. Moreover, by performing a specification test, we arbitrate between a traditional fixed-effect or random-effect model. After applying a preliminary test of cross-section dependence Pesaran (2004), we also apply the fixed-effect model with the standard-errors of Driscoll-Kraay (Driscoll & Kraay, 1998), which is suitable for panels in macroeconomics and international economics and makes it possible to take into account spatial cross-section dependence by using a non-parametric technique.

4.3.4 Preliminary tests

Cross-sectional dependence in macro-panel data is a type of correlation that highlights the interdependence between individuals. It can, for example, come from a common shock suffered by all countries with heterogeneous effects or spillover effects between countries.

We implement the test of cross-sectional dependence proposed by Pesaran (2004) in panel time-series data to investigate cross-sectional dependence in log CO2 emissions, log gross domestic product per capita and log export diversification. It is based on the pair-wise correlation coefficients and can be computed as:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right) \longrightarrow N(0,1) \tag{4.5}$$

where $\hat{\rho}_{ij}$ is the estimated correlation coefficient between the time-series for country i and j. Under the null hypothesis of no cross-sectional dependence, the statistics are normally distributed for T and N sufficiently large and robust in non-stationarity.

Table 4.5 – Pesaran (2004) cross-sectional dependence test and unit root tests

Variables	CD-test	Unit root tests		
	(1)	LLC (2)	MW (3)	CIPS (4)
$log(CO2)$	15.46***	-0.73	178.7	-4.14***
$log(GDP)$	214.6***	-1.15	265.8***	1.26
$log(GDP)^2$	214.6***	-0.19	246.3***	1.68
$log(DIV)$	28.10***	-4.13***	323.5***	-4.39***

Notes: * Significance at 10 percent; ** significance at 5 percent; *** significance at 1 percent. For cross-sectional dependence (CD) test in column 1, the null hypothesis doesn't reject the cross-section independence (the test statistics are normalized to be distributed under N(0,1)): hence, the alternative hypothesis is in favor of a cross-section dependence for the dependent and the explanatory variables. The Levin Lin and Chu (2002), the Maddala and Wu (1999) and the Pesaran (2007) tests verify for the panel unit root (respectively in columns (2), (3) and (4)) and the null hypothesis does not reject the existence of a unit root.

In the first column of Table 4.5, the statistics show that the null hypothesis of cross-sectional independence is rejected at the 1 percent level of significance in our sample. Hence, cross-sectional dependencies exist in our data.

We also verify the stationarity of the variables with several tests of unit root hypothesis: the Levin-Lin-Chu (LLC) (Levin et al., 2002) test assumes that all panels have the same autoregressive parameter, the Maddala and Wu (MW) (Maddala & Wu, 1999) test gives a chi-squared statistic and allows for autoregressive parameters to be heterogeneous but ignores cross-sectional dependence. Consequently, we compute a third unit root test, the Pesaran (Pesaran, 2007) cross-sectional IPS (Im et al., 2003) test which allows for the presence of cross-sectional dependence. Results in the other columns of Table 4.5 (columns 2, 3 and 4) suggest that the variables could be stationary, depending on the test computed. However, a cointegration test is used to detect a long-run relationship. In order to examine the cointegration between the variables, we compute two groups of cointegration tests. The two types of tests are based on the null hypothesis of no cointegration among series, against the alternative that series are cointegrated. The first is the Pedroni's seven test statistics (Pedroni, 1999) which are four panels and three group mean cointegration statistics: panel-v, panel-rho, group-rho, panel-t (non-parametric), group-t (non-parametric), panel-adf (parametric t), and group-adf (parametric t). All test statistics are normalized to be distributed under N(0,1). The second is the Westerlund (2007) cointegration tests with bootstrap and reports test statistics of Ga, Gt, Pa and Pt. The evidence of cointegration will enable us to estimate a long-run relationship across variables. The results in Table 4.6 provide evidence of a long-run relationship among variables for equation 4.1 and 4.2. For the Pedroni statistics, the non-parametric tests of Pedroni reject the null of no integration. All Westerlund tests are very significant and reject the null of no integration.

Table 4.6 – Cointegration tests

		Equation (1)	Equation (2)
Pedroni	Panel v	2.28**	0.68
	Panel-Rho	-2.35***	0.09
	Panel-PP	-7.63***	-7.75***
	Panel-ADF	1.06	0.86
	Group-Rho	1.12	3.69
	Group-PP	-7.40***	-8.36***
	Group-ADF	0.37	2.22
Westerlund	Gt	-2.04***	-2.25***
	Ga	-5.66***	-5.91**
	Pt	-21.50***	-19.13***
	Pa	-6.02***	-5.85***

Notes: * Significance at 10 percent; ** significance at 5 percent; *** significance at 1 percent. Pedroni's panel cointegration and Westerlund's panel cointegration tests are computed on Stata with the commands *xtpedroni* and *xtwest*. The lags in the Pedroni's tests are automatically determined while there are no lags in the Westerlund tests. Robust critical values are obtained through bootstrapping for Westerlund's panel cointegration tests. The null hypothesis for both group of cointegration tests is for no cointegration.

4.4 Empirical results

Table 4.7 reports our main empirical results for equation 4.1 and equation 4.2. Focusing first on equation 4.1, we examine the validity of the EKC hypothesis. To do so, we regress the CO2 emissions on the GDP per capita and the squared GDP per capita and we expect that the coefficient of the GDP (a_1) will be positive, and the coefficient of the squared GDP (a_2) will be negative. We compute first the one-step system GMM to solve the problem of endogeneity by considering each variable as endogenous and the results give short-run estimates.

Table 4.7 – Main estimation results

	Dependent variable: log(CO2)			
	One-Step System GMM		**PMG**	
	Short-run estimates		Long-run estimates	
Variables	(1)	(2)	(1)	(2)
$L.log(CO2)$	1.01***	0.96***		
	(0.021)	(0.019)		
$log(GDP)$	0.16*	0.30***	6.51***	2.90***
	(0.088)	(0.096)	(0.31)	(0.22)
$log(GDP)^2$	-0.010**	-0.017***	-0.34***	-0.14***
	(0.004)	(0.005)	(0.02)	(0.01)
$log(DIV)$		-0.15***		-0.31***
		(0.047)		(0.05)
Constant	-0.57	-1.01**		
	(0.412)	(0.414)		
Observations	1764	1764	1764	1764
Number of i	98	98	98	98
Number of t	18	18	18	18
Hansen statistics	0.527	0.990		
AR(1) test	0.000	0.000		
AR(2) test	0.307	0.317		

Notes: * Significance at 10 percent; ** significance at 5 percent; *** significance at 1 percent. Number of i is the number of countries, number of t is the number of years. The standard errors of the one-step system GMM estimations are robust. For the one-step system GMM estimations, lags of dependent and independent variables are used as instruments. For the diagnostic statistics, p-values are given. Hansen J statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. Results of the tests for AR(1) and AR(2) are the p-values of tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of no second-order serial correlation AR(2) is not rejected.

The results are given in column (1) and show that coefficient a_1 is significant and positive (0.16) and that coefficient a_2 is significant and negative (-0.01). Indeed, as we expected, the empirical findings show that the CO2 emissions have an inverted U-shaped relationship with GDP per capita. After we tested for cointegration of the variables, we find that the variables are cointegrated and thus there is a long-run relationship. In other words, in the long run, economic development will have an effect on CO2 emissions. The PMG estimation enables us to provide the long-run coefficients. Our results in column (1) show that the environmental Kuznets curve

hypothesis is still valid, however, for long-run estimation, the figures are higher ($a_1 = 6.51$ and $a_2 = -0.34$).

Focusing now on the empirical results of equation (2) in columns (2), we intend to verify if the augmented EKC hypothesis is valid. More precisely, we want to verify if the coefficient of the GDP per capita variable is still positive, the coefficient of the squared GDP per capita variable still has a negative sign and, in addition, if the export diversification impact positively the CO2 emissions as we expect. The estimates show that the environmental Kuznets curve hypothesis for CO2 emissions is still verified for the one-step system GMM method and the coefficients do not seem to change much: the GDP per capita coefficient is highly significant and positive ($a_1 = 0.30$) and the coefficient associated with the squared GDP per capita is significant and negative ($a_2 = -0.17$). Thus, the results show a non-linear relationship between CO2 emissions and GDP per capita. Moreover, the findings suggest that the added variable, the measure of export diversification, is a highly significant determinant of CO2 emissions. It should be remembered that the Theil index is a concentration index. Thus, a positive relationship between export diversification and CO2 emissions will be indicated by a significant and negative sign of the Theil index coefficient, and conversely, a negative relationship between export concentration and CO2 emissions will be indicated by the same negative sign. As we expected, the coefficient of the variable (a_3) is highly significant and has a negative sign: a 1 percent increase in export diversification as measured by the Theil index leads to an increase of 0.15 percent in CO2 emissions (in metric tons per capita). In the long run, the augmented EKC is still verified. For a long-run relationship, the PMG estimates give similar results but the estimated coefficient of GDP per capita and squared GDP per capita in logarithm are reduced because, in the long run, it is partly captured by the diversification effect. In other words, export diversification is a significant determinant of CO2 emissions in the long run: the 1 percent increase in export diversification, measured by the Theil index, would generate an increase of 0.31 percent in CO2 emissions (in metric tons per capita).

In addition to the main results, we make some robustness checks with other estimation methods presented in Table 4.8. The fixed effects method with the robust standard errors are performed and the Driscoll-Kraay standard errors are given in addition to assume the cross-sectional dependence. Furthermore, the two-step system GMM with the Windmeijer (2005) robust standard errors gives a robustness check to the one-step system GMM because it is more asymptotically efficient.

Table 4.8 – Results for robustness check estimations

	Dependent variable : $log(CO2)$					
	Fixed-Effects				**Two-Step**	
	Robusts standard-errors		Driscoll-Kraay standard-errors		**System GMM**	
Variables	(1)	(2)	(1)	(2)	(1)	(2)
L.$log(CO2)$					1.01***	0.96***
					(0.02)	(0.02)
$log(GDP)$	1.88***	1.69***	1.88***	1.69***	0.16*	0.29***
	(0.49)	(0.47)	(0.12)	(0.07)	(0.089)	(0.098)
$log(GDP)^2$	-0.08***	-0.07**	-0.08***	-0.07***	-0.011**	-0.017***
	(0.03)	(0.03)	(0.01)	(0.00)	(0.005)	(0.005)
$log(DIV)$		-0.37***		-0.37***		-0.14***
		(0.13)		(0.07)		(0.047)
Constant	-9.04***	-7.91***	-9.04***	-7.91***	-0.589	-0.962**
	(2.11)	(2.03)	(0.47)	(0.30)	(0.41)	(0.43)
Observations	1862	1862	1862	1862	1764	1764
Number of i	98	98	98	98	98	98
Number of t	19	19	19	19	18	18
R-squared	0.39	0.41	0.39	0.41		
Sargan-Hansen Stat.	0.000	0.000				
Hansen statistics					0.527	0.990
AR(1) test					0.000	0.000
AR(2) test					0.305	0.315

Notes: * Significance at 10 percent; ** significance at 5 percent; *** significance at 1 percent. Number of i is the number of countries, number of t is the number of years. For the diagnostic statistics, p-values are given. The Sargan-Hansen statistics test the overidentifying restriction which is a fixed vs random effects specification test when the robust standard-error is used. The p-values show that the alternative hypothesis is not rejected, and the fixed-effects estimators are favored over the random effect estimators. The standard errors of the fixed-effect and the two-step system GMM estimations are robust. Additionally, we compute the Driscoll-Kraay (Driscoll and Kraay, 1998) standard-errors with the fixed-effects in order to take into account cross-sectional dependence. For the two-step system GMM estimations, lags of dependent and independent variables are used as instruments: Hansen J statistics are tests of overidentifying restrictions and show that the instruments are valid by not rejecting the null hypothesis. Results of the tests for AR(1) and AR(2) are the p-values of tests for first and second-order autocorrelation in first differences: the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected.

The three outcomes in columns (1) are consistent with the EKC hypothesis: estimated coefficients associated with the GDP per capita are significant and positive (for fixed-effects, $a_1 = 1.88$ and for two-step system GMM, $a_1 = 0.16$) and estimated coefficients associated with the squared GDP per capita are significant and negative (for fixed-effects, $a_2 = -0.08$ and for two-step system GMM, $a_2 = -0.011$). They show a non-linear effect of the economic development (GDP per capita) on the CO2

emissions. The difference between the coefficient results is due to the fact that for the two-step system GMM, the lagged dependent variable partially captures the endogeneity of the explanatory variables.

The three results in columns (2) are also in line with the principal findings. GDP per capita estimated coefficients are significant and positive (for fixed effects estimates, $a_1 = 1.69$ and for two-step system GMM estimates, $a_1 = 0.29$), squared GDP per capita coefficients are significant and negative (for fixed effects estimates, $a_2 = -0.07$ and for two-step system GMM estimates, $a_2 = -0.017$), and moreover, estimated coefficients a_3 are significant and negative and show a positive effect of export diversification on CO2 emissions (for fixed effects estimates, $a_3 = -0.37$ and for two-step system GMM estimates, $a_3 = -0.14$). The results show inverted U-shaped relationship between CO2 emissions and the economic development, measured by GDP per capita, and, in addition, export diversification, measured by the Theil index, has a positive effect on CO2 emissions for countries at any level of economic development. Therefore, the augmented EKC is still valid.

As we observed in the stylized facts and as numerous empirical studies show (Cadot et al., 2011, 2013; IMF, 2014b; Klinger & Lederman, 2004), countries in the first stages of development diversify their export basket until a threshold level of income is reached and then begin to concentrate their exports. For CO2 emissions, the relationship with economic development is also non-linear and follow an inverted U-shaped as shown in the EKC literature. The first part of the development process is characterized by an increase in emissions until a certain point, after which the second part of the development process sees a reduction in CO2 emissions. In this contribution, we seek to investigate the impact of the export diversification and concentration on air pollution in the process of economic development at country level. Analysis of the empirical findings enables us to make strong interpretations of the impact of export diversification or concentration on CO2 emissions when we compare the environment literature with that on export diversification.

It should be remembered that the changes in export structure can be two directions, depending on the country's level of development. Less advanced countries would diversify their exports and more advanced countries would concentrate their export basket. Thus, our results show that, for the less developed countries, export diversification leads to an increase in CO2 emissions; conversely, for the developed countries, export concentration leads to a decrease in the level of CO2 emissions. As export diversification (or concentration) measures the changes in the export sectoral structure in the most highly disaggregated line, its evolution will implicitly show a country's preferential composition of factors in accordance with its comparative

advantage. Furthermore, in the literature, poorer countries are characterized by lax pollution regulation, while richer countries are more stringent in environmental regulation (Antweiler et al., 2001; Rieber & Tran, 2009). Given the results, it appears that developing countries, by diversifying their exports, invest in new goods in polluting industries and that the increase in export activity increases their pollution levels: here, the composition effect is accompanied by a scale effect. Conversely, developed countries, by concentrating their exports, will select the sectors in which there is a comparative advantage and specialize in goods with cleaner technologies, thereby bringing about a reduction in their emissions: the composition effect is followed by a technique effect. Thus, as we noted in the introduction, for poorer countries, a development strategy based on export diversification leads to a deterioration in environmental quality.

4.5 Concluding remarks

In a global context in which global warming is increasingly threatening and there is unanimous agreement on the benefits of an export diversification strategy for poorer economies, this article has attempted to assess the impact of export diversification and concentration on levels of greenhouse gas emissions (CO2) in the context of an environmental Kuznets curve. With system GMM, PMG and robustness estimations, in order to obtain a generalized relationship, we have analyzed 98 developing and developed countries within the period 1995-2013.

Our first results tended to show the validity of the environmental Kuznets curve hypothesis. In a second stage, as we expected, the environmental Kuznets curve is still valid and, in addition, we found that export diversification has a positive effect on CO2 emissions. More precisely, export diversification generates an increase in CO2 emissions per capita for the less developed countries, which emphasizes the dominance of composition and scale effects, while export concentration leads to a decrease of CO2 emissions per capita for advanced economies, which is led by composition and technique effects. The impact is highly robust.

In terms of policy implications, the policy goal of reducing pollution directly concerns pollution regulation or trade costs, but the outcomes are said to be limited in terms of welfare in the literature (Copeland & Taylor, 1994; Rieber & Tran, 2009). However, our results enable us to provide some policy implications for developing countries in the early stages of development in terms of CO2 emissions reduction. Indeed, development strategy based on export diversification should be accompanied by an active environmental policy. As CO2 emissions are global air

pollution, developed countries should then participate in this environmental effort by facilitating the transfer of cleaner technologies toward developing countries (Rieber & Tran, 2009). Moreover, since pollution is closely linked to energy demand and ultimately to economic growth, human capital could mitigate the energy demand (Salim et al., 2017; Shahbaz et al., 2019). Therefore, our results lend support to the policy implication that investing and financing in cleaner technological progress and human capital will help to develop and enhance the technique effect and thus favors a reduction in pollution.

Our results are in line with the findings of the other two studies (Apergis et al., 2018; Gozgor & Can, 2016). Gozgor & Can (2016) found that, in the long run, greater export diversification across products generates higher CO2 emissions for Turkey. In our sample, Turkey is an upper middle-income economy and is therefore classified as a developing country. Apergis et al. (2018) demonstrate that concentration of export products for developed countries causes a decrease in CO2 emissions. From the environmental Kuznets curve augmented by export diversification, our study generalized the results by putting developed and developing countries in the same sample, thereby producing a more general relationship: we call it the augmented EKC. Further research should examine whether export diversification could have the same impact on other types of greenhouse gas emissions and environmental degradation. Our study has focused on a very aggregated level of export structure. Therefore, another possible direction for future research should be an investigation of environmental impacts at a sectoral level through a sectoral differentiation analysis.

Chapter 5

Trade and the environment: assessing the effect of export diversification on pollution emissions

Abstract

We investigate in this chapter the impact on pollution emissions of export diversification following an improvement in price competitiveness. We develop a theoretical framework that isolates the scale, composition and technique effects. We find that the terms of trade effect should be taken into account along with the export diversification effect. Moreover, we show that the composition effect and price competitiveness are two of the channels through which the export diversification effect on pollution is transmitted. We then examine the theory through an empirical study performed on a sample of 135 countries covering the period 2000-2014. The estimation results provide strong evidence of a positive impact of export diversification on CO2 emissions. A division of our sample into two subgroups reveals that only the scale effect occurs for less advanced countries; conversely, for more developed countries, an increase in export diversification generates a rise in CO2 emissions. [20]

Keywords: International trade, pollution, environment, export diversification, terms of trade.

JEL codes: F.14, F.18, O.50, Q.53, Q.56.

20. This chapter is a personal and original contribution of the author. It has been accepted for a presentation at the 36th "journées du développement de l'Association Tiers-Monde" conference, LiRIS and ESO, University of Rennes 2 (27-28-29 May, 2020), Rennes. Due to Covid-19 pandemic, the conference was postponed for Autumn 2020. A version of this chapter is currently submitted to a journal with "under review" status.

5.1 Introduction

There is increasing interest in economic development and growth strategies based on international trade and its environmental outcomes. A seminal empirical study was conducted by Grossman & Krueger (1993) who, against the background of the North American Free Trade agreement, broke down the impact of trade liberalization on the environment into three components, namely scale, the technique and composition effects (or the SCT effects). The scale effect comes with the increase in economic activity and increases pollution, the technique effect appears with cleaner production methods and improves environmental quality, and the composition effect depends on the comparative advantage. Consequently, numerous empirical studies have investigated the relationship between trade and environmental quality (Kleemann & Abdulai (2013); Kim et al. (2019); Chang et al. (2014); Grether & Mathys (2013); Le et al. (2016); among others); others, more specifically, have assessed the existence of SCT effects (Grether et al. (2009); Mohapatra et al. (2016); Liobikiene & Butkus (2019); among others).

Specifically, trade-induced composition effects may, on the one hand, depend on the difference in income and hence the demand for environmental quality, as hypothesized by the pollution haven hypothesis, where relatively low-income countries will become dirtier by exporting polluting goods. Or, on the other hand, trade-induced composition effect, as suggested by the factor endowment hypothesis, may be determined by a new configuration in which polluting sectors are reallocated to capital-intensive countries (mostly developed countries) (Antweiler et al., 2001; Cole & Elliott, 2003). However, the pollution haven hypothesis should be distinguished from the pollution haven effect that questions whether more stringent regulations affect the comparative advantage (Copeland & Taylor, 2004; Levinson & Taylor, 2008; Anouliès, 2016; Cherniwchan et al., 2017).

Thus, Copeland & Taylor (1994) developed a model of North-South trade in order to study the international trade-environment nexus by separating the SCT effects of international trade on pollution. They show that environmental quality could be affected differently in the context of a free trade than in autarky through the composition effect. Antweiler et al. (2001) give theoretical model and empirical examination of the SCT effects by using sulfur dioxide concentration data and find that trade generates small changes in pollution through the composition effect and, therefore, show that trade is good for the environment. Furthermore, a number of theoretical studies have focused on the impact of international trade on environmental quality (Copeland & Taylor, 2004; Cherniwchan et al., 2017).

Moreover, trade integration is considered to be one of the main determinants

of economic growth, for instance through the export-led growth strategy. In fact, export diversification has recently attracted increasing attention in the literature as a growth and development strategy for developing countries (IMF, 2014b). Indeed, there are many advantages for a low-income country in diversifying its export basket. Less volatile export earnings, an increase in export growth and economic growth, and macroeconomic stability are some of the known benefits of an expanding export basket (Papageorgiou et al., 2015; Brenton & Newfarmer, 2007). Furthermore, a debate is emerging on the place of export diversification in environmental concerns. Empirical studies are beginning to reveal the environmental consequences of export diversification in the case of CO2 emissions (Gozgor & Can, 2016; Apergis et al., 2018). However, theoretically, to the best of our knowledge, no study has yet explicitly developed an environmental model that takes into account the importance of export diversification because a change in product composition has been treated implicitly as a change in the number of products (and hence as a change in number of exported products in the case of free trade).

To that end, our purpose in this paper is to theoretically and empirically investigate the impact of export diversification on pollution emissions. In the first part of our study, we develop a theoretical basis that integrates export diversification and clarifies its role in determining environmental quality by decomposing the trade effect into scale, technique, composition and diversification effects. Thus, we develop a simple model by following and revisiting Antweiler et al. (2001) model and introduce a multi-good framework with two types of goods: a homogeneous good Y and heterogeneous X_i goods according to their pollution intensity. The originality of our approach is the dissociation between composition effect, which is the environmental consequence of a change in the composition of domestic production, and diversification effect, which we describe as the environmental impact of an increase in the number of exported products. To construct our multi-good framework, we follow Falvey & Kierzkowski (1987)'s approach by introducing vertical differentiation into national products. In developing the model, we find that the effect of the terms of trade must be taken into consideration along with diversification. That outcome is not surprising as export diversification is a consequence of a country's improved export performance. Moreover, in the development literature, the deterioration in the terms of trade has been widely debated by the proponents of structuralism. For them, specialization based on comparative advantage, which is recommended by the traditional international trade theories, would be disadvantageous for developing countries (Prebisch, 1950, 1959; Singer, 1950; Auty, 2000, 2001). We show from the model that export diversification effect is derived from two channels: the

composition effect and the country's price competitiveness.

In the second part of the paper, we investigate the phenomenon empirically using the lessons to be drawn from the model. Our aim is to examine the impact of various effects (scale, composition, technique, terms of trade and export diversification) on CO2 emissions. A review of previous empirical studies based on SCT effects enable us to construct our variables. We measure export diversification, which is defined as the number of goods exported by a country, by means of the Theil index, which is a concentration index. More precisely, we use the extensive margin component of the Theil index to assess the evolution of the number of goods exported, following Cadot et al. (2011), Cadot et al. (2013) and the IMF (2014b) definition and decomposition. Data from UNCTAD, the BACI database and the Penn World Table 9.0 are collected in order to construct our variables covering 135 countries for the period 2000-2014. Our cross-country analysis is performed in two stages. Firstly, we construct a global picture of the five effects at world level by pooling all the countries in one sample. Secondly, we split the countries into two groups, one containing the more advanced countries, the other the less advanced countries. As expected, we find that the scale and technique effects generate an increase and a decrease respectively in CO2 emissions. Furthermore, the composition effect is not significant. Finally, the terms of trade and export diversification impact positively on CO2 emissions. For the less developed country subsample, it appears that only the scale effect occurs. Conversely, in the case of the more developed countries, the various effects are significant and more importantly, an increase in export diversification leads to an increase in CO2 emissions.

Thus, the present study contributes theoretically and empirically to the debate on the trade-environment relationship with the identification of the scale, composition and technique effects by introducing a novelty into the differentiation between composition and the number of goods, which is not precisely identified in other models.

The remainder of the paper is as follows. In the second section, we develop the model that links export diversification to pollution emissions. In the third section we apply the lessons learned from the model empirically by identifying the variables and samples, identify the estimated equation and analyze the econometric results, and in the last section, we conclude with some remarks.

5.2 The theoretical model

5.2.1 The model

In order to analyze the impact of export diversification on pollution emissions, we follow Antweiler et al. (2001)'s initial approach by considering a country, Home, with the following characteristics: an open economy with a population of N agents, a constant return to scale with two primary factors (capital K and labor L) and full employment ($L = N$). We then introduce a many-good framework. It is assumed that there are two types of goods: a homogeneous good Y and diversified goods X_i. Good X_i is relatively capital intensive and generates pollution, while good Y is relatively labor intensive and does not pollute.

There are m finite number of goods $X_i (i = 1, 2, 3, ..., m)$ in the world. Goods X_i are heterogeneous in the units of factor K required. Conversely to good Y, the production of each X_i is polluting and requires a fixed capital-labor ratio. For simplicity and clarity's sake, one unit of good X_i requires α_i units of capital, which generates α_i units of pollution.

For our many-good framework, we follow the specifications given by Falvey & Kierzkowski (1987), which are well suited to our model. The authors construct an international trade model in which constant returns to scale technologies prevail and two types of goods coexist. On the one hand, there is a homogenous good which is modelled along Ricardian lines: in our case, it is the good Y. On the other hand, there are heterogenous goods with vertical differentiation which follows Heckscher-Ohlin (H-O) modelling, which in our case is the good X_i. We can rank goods X_i according to quality (as in Falvey & Kierzkowski (1987)) and pollution intensity α_i from less to more polluting. Indeed, the quality of the good X_i depends on the units of capital used to produce it, and hence also on the pollution emissions produced. In other words, the higher α_i is, the higher the quality and pollution intensity generated by the production are also. We can write:

$$\alpha_1 < \alpha_2 < ... < \alpha_n < ... < \alpha_m \tag{5.1}$$

For analytical convenience, it is assumed that $0 < \alpha_i < 1$. Finally, among the existing range m of goods X_i, Home country produces and exports only n number of goods X_i (with $n \leq m$) among the number m of existing products in the world. It means that Home will import the remaining range of goods $m - n$.

5.2.1.1 The pollution emissions

As noted above, the good Y, as a labor-intensive good, is produced with relatively clean production technology and does not pollute. Consequently, pollution is exclusively emitted by the production of various goods X_i. x_i is the amount of output X_i. For a given base level of pollution B_i by sector, the amount of pollution abated A_i is given by the function $\lambda A_i(a_i x_{ai}, B_i)$, where $a_i x_{ai}$ is the volume of resources allocated to abatement and λ is a common parameter that may be affected by technological change.

Following Antweiler et al. (2001), the pollution emissions for each good (sector) X_i is given by B_i minus A_i :

$$e_i = [\alpha_i x_i - \lambda A_i(\alpha_i x_{ai}, x_i)] \tag{5.2}$$

For each good X_i, $A_i(\alpha_i x_{ai}, x_i)$ is linear and homogeneous, increasing and concave in $\alpha_i x_{ai}$ and x_i.

$$A_i(\alpha_i x_{ai}, x_i)] = x_i d_i(\theta_i) \tag{5.3}$$

$\theta_i = \frac{x_{ai}}{x_i}\alpha_i = \theta\alpha_i$, x_{ai} is weighted by α_i which is specific to each sector. Indeed, we assume that the effectiveness of the volume of resources allocated to abatement is affected by the pollution intensity: the higher the sector's pollution intensity is, the greater the amount of resources needed to meet the environmental standard is. Thus θ_i is also specific to each sector. On a country level, let us define an abatement threshold $\theta = \frac{x_{ai}}{x_i}$ which is a constant and common to all the sectors of the country's economy. Furthermore, at a sectoral level, pollution emission is expressed by:

$$e_i = x_i[\alpha_i - \lambda_i d_i(\theta_i)]$$

We can write the total pollution emissions in the country Home as:

$$z = \sum_{i=1}^{n} e_i = \sum_{1}^{n} x_i[\alpha_i - \lambda d_i(\theta_i)] \tag{5.4}$$

5.2.1.2 Producers

From the constant return to scale assumption, $C^{xi}(w, r)$ and $C^{y}(w, r)$ are the unit cost functions describing X_i and Y production technology respectively. Let C_w^{xi} be the number of labor units required to produce one unit of good X_i and C_r^{xi} be the number of capital units needed to produce any good X_i, and so on. Thus, we have for X_i and Y:

$$\frac{C_r^{xi}}{C_w^{xi}} > \frac{C_r^y}{C_w^y} \Leftrightarrow \frac{\alpha_i}{C_w^{xi}} > \frac{C_r^y}{C_w^y} \quad \forall i \quad i = 1, 2, ..., m.$$

The capital-labor ratio is higher for good X_i. Let Y be the numeraire, thus $p_y = 1$. Another important change from the original model is that we do not take into account the government's role. As our main purpose is to assess the role of export diversification, environmental regulations are determined exogenously in our model. As in other theoretical models, we assume that the government does not tax pollution emissions, but firms in the sectors are obliged to meet the environmental standard (Rieber & Tran, 2009). Equation 5.2 therefore gives the amount of pollution emitted by each sector in accordance with the environmental standard.

Consequently, each sector's profit π^{xi} is explained by its revenue minus production and abatement costs:

$$\pi^{xi} = p_i x_i - c^{xi}(w, r)x_i - p_i \theta_i x_i \tag{5.5}$$

The prices of goods X_i depend on the volume of factor capital used. Thus, we can write:

$$p_i = p_i(\alpha_i) \text{ with } \frac{\partial p_i}{\partial \alpha_i} > 0 \tag{5.6}$$

As mentioned earlier, $\alpha_1 < \alpha_2 < ... < \alpha_n < ... < \alpha_m$. This implies that the greater the volume of capital used is, the higher the price is. The prices can be ranked in ascending order depending on pollution intensity: $p_1(\alpha_1) < p_2(\alpha_2) < ... < p_n(\alpha_n) < ... < p_m(\alpha_m)$. The full employment condition is given by:

$$\sum_{i=1}^{n} C_w^{xi} x_i + C_w^y y = L \tag{5.7}$$

$$\sum_{i=1}^{n} \alpha_i x_i + C_r^y y = K \tag{5.8}$$

5.2.2 Scale, technique and composition effects

For Home country, the characteristics of the scale, technique and composition effects are outlined below. As in Antweiler et al. (2001), we define the scale effect of economic activity as the environmental impact of a rise in economic activity. The economic activity is the economy's gross output and is written:

$$S = \sum_{i=1}^{n} x_i p_i + y \tag{5.9}$$

An improvement in technique is described as a change in technology that leads to cleaner production. Hence, the result of technique effect would be to mitigate the pollution emissions expressed in equation 5.4.

As stated in Cherniwchan et al. (2017): *"the composition effect reflects the changes in pollution due to changes in the composition of economic activity across industries"*. From that definition, let us introduce two types of composition effect: the aggregated composition effect, defined by the effect of aggregated changes in the relative amount of polluting goods at a country level, and the industry (or sector) level composition effect, that can be described as a disaggregated composition effect that measures the impact of the changes in the amount of polluting good relative to cleaner goods for a specific industry.

5.2.2.1 The aggregated composition effect

For the polluting goods n in the economy, the aggregated composition effect is generated by a change in the relative supply of polluting goods $\sum_{i=1}^{n} x_i$. It is functional to start by the following ratio: $\chi = \sum_{i=1}^{n} x_i/y$. From equations 5.7 and 5.8, we have (see Appendix 5.A.1 for detailed calculations):

$$\frac{\sum_{i=1}^{n} x_i}{y} = \frac{C_w^y K - C_r^y L}{-\bar{C_w^{xi}} K + \bar{\alpha_i} L} \Leftrightarrow \frac{\sum_{i=1}^{n} x_i}{y} = \frac{C_w^y \frac{K}{L} - C_r^y}{-\bar{C_w^{xi}} \frac{K}{L} + \bar{\alpha_i}}$$

$$\frac{\sum_{i=1}^{n} x_i}{y} = \frac{C_w^y k - C_r^y}{\bar{\alpha_i} - \bar{C_w^{xi}} k} \equiv \chi(k, \bar{p_i}) \tag{5.10}$$

$k = \frac{K}{L}$ is the capital-labor ratio for the economy. χ is increasing in k and $\bar{p_i}$. Changes in the economy that have consequences for $\chi(k, \bar{p_i})$ would create a composition effect.

5.2.2.2 The industry level composition effect

In our model, the composition effect produced by the change in each sector's share in the economy's final output could be formulated as the environmental consequence of the change in the relative supply of x_j: $\chi_j = x_j/y$ (see appendix 5.A.2 for detailed calculations). Thus, at the industry j level we have:

$$C_w^{xj} x_j + \sum_{i=1}^{j-1} C_w^{xi} x_i + \sum_{i=j+1}^{n} C_w^{xi} x_i + C_w^y y = L \text{ with } A = \sum_{i=1}^{j-1} C_w^{xi} x_i + \sum_{i=j+1}^{n} C_w^{xi} x_i$$

$$C_r^{xj}x_j + \sum_{i=1}^{j-1} C_r^{xi}x_i + \sum_{i=j+1}^{n} C_r^{xi}x_i + C_r^{y}y = K \text{ with } B = \sum_{i=1}^{j-1} C_r^{xi}x_i + \sum_{i=j+1}^{n} C_r^{xi}x_i$$

$$\frac{x_j}{y} = \frac{C_w^y(k-(B/L)) - C_r^y(1-(A/L))}{\alpha_j(1-(A/L)) - C_w^{x_j}(k-(B/L))} \tag{5.11}$$
$$\equiv \chi_j(k, p_j, p_1, p_2, ..., p_{j-1}, p_{j+1}, ..., p_n, x_1, x_2, ..., x_{j-1}, x_{j+1}, ..., x_n)$$

χ_j is increasing in k and the price of X_j and is decreasing in the prices and output volumes of the other industries, ceteris paribus. Rewriting the emission pollution in 5.4 yields (see appendix 5.B.1 for detailed calculations):

$$z = \frac{(1-\lambda d(\theta))\sum_{i=1}^{n}\chi_i\alpha_i}{\sum_{i=1}^{n} p_i\chi_i + 1}S \tag{5.12}$$

To obtain the decomposition, we fully differentiate 5.12 with respect to time to yield:

$$\hat{z} = \hat{S} + \sum_{i=1}^{n}\varphi_{yi}\hat{\chi}_i - \zeta\varepsilon_{d\theta}\hat{\theta} \tag{5.13}$$

When $\hat{}$ denotes percentage change ; φ_{yi} ($\varphi_{yi} = [\phi_i + \psi_i]$ and $\phi_i = \frac{x_i\alpha_i}{\sum\alpha_i x_i}$; $\psi_i = \frac{p_i x_i}{S}$) is the difference between the share of sector i's pollution intensity in the total volume of pollution emissions and the share of output value x_i in the value of gross product; $\zeta = \lambda d(\theta)\frac{\sum x_i\alpha_i}{z}$ is the ratio of abated pollution to actual pollution. $\varepsilon_{d,\theta}$ is the elasticity of d with respect to θ. The first term is the scale effect that implies that an increase in economic activity would increase pollution emissions proportionately, all other things remaining constant. The second term is the composition effect. It appears that the composition effect in the economy is determined by the sum of all industrial level composition effects. The last term is the technique effect and has a negative effect on pollution when it is increasing. For the sake of simplicity in resolving the model, symmetry of outputs is assumed.

5.2.2.3 Introduction of output symmetry

For simplicity's sake and given the large number of parameters, it seemed necessary to assume the symmetry of output X_i. In Falvey & Kierzkowski (1987), the unequal distribution of income plays a central role in explaining consumer taste and demand for differentiated products. Similarly, we assume that households have exogenous characteristics in terms of population (L) and income distribution. It is assumed that consumers have a taste for quality such that richer consumers would

prefer to consume goods of higher quality. Thus demand follows α_i distribution. In other words, the distribution of household income is unequal and follows the same formulation as α_i distribution so that each consumer consumes different quality of X_i. We then assume that the volumes of goods X_i produced in the economy are identical: $x_1 = x_2 = ... = x_n = x$.

Thus, we can reformulate the composition of the national production. For Home, the volume of output of polluting goods at a country level is $\sum_{i=1}^{n} x_i = nx$. In particular, each sector has the same volume of output, namely: $x/y = \chi_1 = \chi_2 = ... = \chi_n = \chi_x$. Furthermore, let $\bar{\alpha_i}$ be the mean pollution intensity at country level:

$$\bar{\alpha_i} = \frac{\sum_{i=1}^{n} \alpha_i x_i}{\sum_{i=1}^{n} x_i} = \frac{x \sum_{1}^{n} \alpha_i}{xn} = \frac{\sum_{1}^{n} \alpha_i}{n} \Leftrightarrow n\bar{\alpha_i} = \sum_{1}^{n} \alpha_i$$

The composition effect can be expressed as the environmental consequence of a change in the following ratio:

$$\frac{\sum_{i=1}^{n} x_i}{y} = \frac{nx}{y} = n\chi_x \equiv \chi(k, \bar{p_i}, n) \tag{5.14}$$

This means that the aggregated composition effect is equal to n times the composition effect at sectoral level. It increases with the K/L ratio, with the average price p_i and the number n of produced good X_i, *ceteris paribus*. From the symmetry of output assumption, expression 5.12 of pollution emissions becomes (see Appendix 5.B.2 for detailed calculations):

$$z = \frac{(1 - \lambda d(\theta))\chi\bar{\alpha_i}}{\bar{p_i}\chi + 1} S \tag{5.15}$$

We can rewrite the expression 5.15 in its growth rate after differentiation and obtain the decomposition into the three traditional effects:

$$\hat{z} = \hat{S} - \zeta\varepsilon_{d,\theta}\hat{\theta} + \varphi_y\hat{\chi} \tag{5.16}$$

$\zeta = \lambda d(\theta)\frac{\sum x_i\alpha_i}{z}$; $\varepsilon_{d,\theta}$ is the elasticity of d with respect to θ; and $\varphi_y = y/S$ is the share of good y in the value of gross output. After the output symmetry condition, from equation 5.16, we can observe that the composition effect is the consequence of a change in the aggregated relative supply of polluting goods.

5.2.3 The effect of export diversification on pollution emissions

5.2.3.1 Country characteristics

In order to be able to study the impact of export diversification on pollution emissions, country Home needs to trade with another country. Let us define a world with two countries, Home H and Foreign F, where there is no barrier to trade. In a trade liberalization context, Home exports and imports goods from country Foreign, and Foreign exports and imports goods from Home. Trade between Home and Foreign is determined by the assumption that there is similarity in domestic demand, as described by Linder (1961, chap. 3), and that there is a difference in factor endowments as suggested by the traditional H-O model.

First, as mentioned earlier, export diversification is the number of products exported by Home country H. For the sake of convenience, the economic variables of Foreign country will be annotated with an $*$ and in order better to assess the impact of export diversification on pollution, some assumptions are made:

1. Home and Foreign have similar characteristics in terms of population ($L = L^*$) and income distribution. There is an inequality in income between households and income distribution follows α_i $(i = 1, 2, ..., m)$ distribution. We choose to neutralize the demand effects by making income exogeneous, and then by neutralizing the effect of income difference. Our model does not allow us to test the pollution haven hypothesis because there is no income difference between the two countries. Moreover, it can be inferred that households in H and F have the same demand for each good in the world. Hence the exogenous nature of the demand enables us to assume that, overall, outputs X_i are of the same level. This can be expressed as follows:

$$x_1 + x_1^* = x_2 + x_2^* = ... = x_j + x_j^* = ... = x_m + x_m^*$$

2. There is no difference between Home and Foreign in the technology used to produce Goods X_i. However, it is assumed that each economy is endowed with fixed stocks of resources (capital and labor) and there is a factor endowment difference. Capital-labor ratio is inferior in Home country:

$$\frac{K}{L} < \frac{K^*}{L^*} \Leftrightarrow K < K^*$$

Moreover, the homogenous good Y has a better production technology in Foreign country. This means that as $L = L^*$, the Foreign wage rate exceeds the

Home wage rate ($w < w^*$). Consequently, Foreign country tends to export more Y because of the better technology, even at the same price. Thus, there are three cases:

(a) $y = y^* \Leftrightarrow (L - C_w^y y) = (L^* - C_{w*}^{y*} y^*)$: the two countries produce equal volumes of good Y;

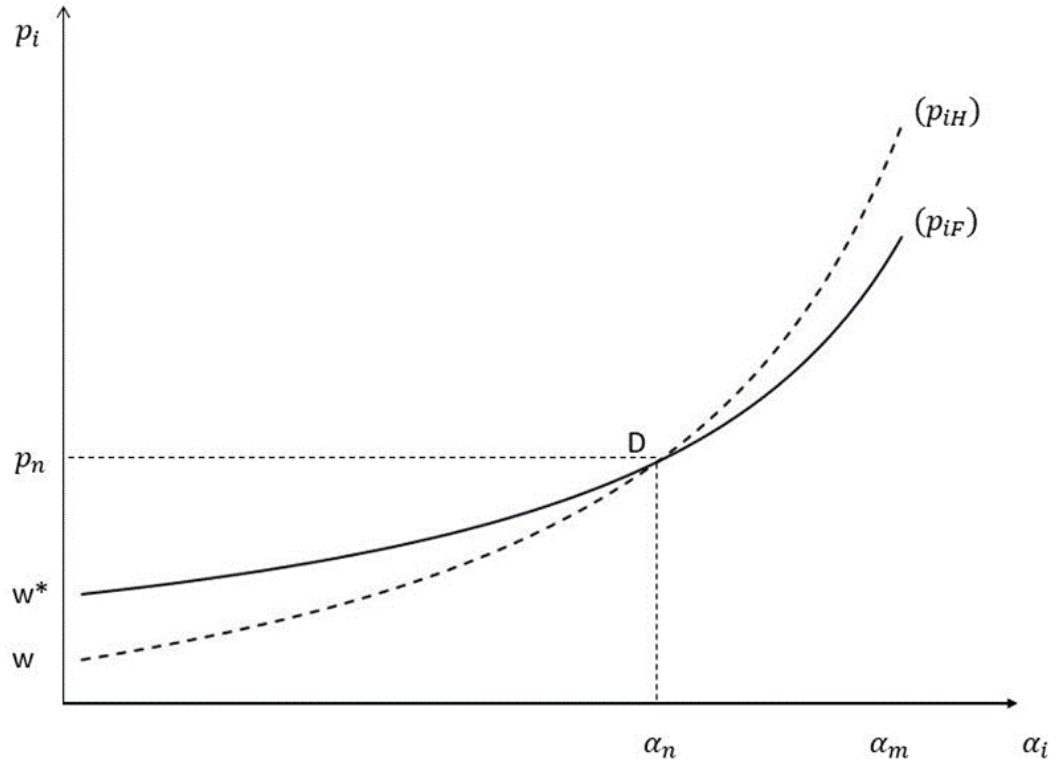
(b) $y < y^* \Leftrightarrow (L - C_w^y y) > (L^* - C_{w*}^{y*} y^*)$: Home country produces less of good Y. In this case, as the two countries have the same characteristics in terms of income distribution and population, we can assume that Home country imports good Y;

(c) Extreme case, Y is exported solely by Foreign country.

Focusing now on good X_i, as mentioned earlier, α_i is the number of units of emitted pollution or the pollution intensity (which also gives the amount of capital used) generated in producing X_i good. For our analysis, we rank it in ascending order: $\alpha_1 < \alpha_2 < ... < \alpha_j < ... < \alpha_m$ for all existing goods. Consequently, p_i is also increasing with the pollution intensity in both Home and Foreign countries. Specifically, for Home country, we can write : $p_{1H} < p_{2H} < ... < p_{jH} < ... < p_{mH}$ and $p_{iH} = p_i(\alpha_i)$ with $p_i'(\alpha_i) > 0$. The same applies to Foreign country. For each good X_i, the Foreign prices p_{iF} can also be classified in ascending order: $p_{1F} < p_{2F} < ... < p_{jF} < ... < p_{mF}$. The two countries' characteristics in terms of technology and factor endowments enable us to compare the price of each good, according to each α_i, in Home and Foreign, and to establish whether Home imports or exports each good X_i. The comparison is shown in the Figure 5.1. Good X_i is exported exclusively by Home country as long as $p_{iH} \leq p_{iF}$. From that observation, there is a threshold price p_{nH} for the good X_n where it is equal to the foreign price of good X_n : $p_{nH} = p_{nF}$. Thus the range of goods X_i cheaper than X_n will be produced and exported exclusively by Home country and the range of goods from X_n to X_m will be produced and exported only by Foreign country. In the world of free trade, the symmetrical output assumption, the two countries' identical characteristics in terms of population and factor endowments enable us to assume that the number of produced goods coincides with export diversification. For Home, outputs are such that: $x_1 = x_2 = ... = x_n = x$; and for Foreign, the volume of output is written as: $x_{n+1}^* = x_{n+2}^* = ... = x_m^* = x$.

Thus export diversification (and hence national product diversification) depends on the price competitiveness of Home country. Let us denote the threshold price (D on the figure) by p_n. We rewrite its expression as:

Figure 5.1 – The evolution of home and foreign prices as a function of polluting intensity



$$p_n = p_{nH} = p_{nF} \text{ if } p_n < p_m \tag{5.17}$$

An improvement in country Home's price competitiveness generates an increase in p_n, and at D, α_n gives the level of the country's export diversification. Moreover, the more the country Home has diversified its exports, the higher α_n is. We can then write: $\alpha_n = \alpha_n(n)$. Then, the threshold price can be expressed as a function of export diversification at point D:

$$p_n = p_n(n) \text{ with } \frac{\partial p_n}{\partial n} > 0$$

5.2.3.2 Impact of export diversification on pollution emissions

On the one hand, country Home can diversify its exports by improving its price competitiveness. From equation 5.17, we can compare the domestic price of other goods X_i with respect to the threshold price p_n:

$$p_n = p_{nH} = p_{nF} \Rightarrow p_i = \beta_i p_n \tag{5.18}$$

β_i is the ratio between the domestic price p_i of good X_i and the threshold world price that determines the number of the country's exported goods (*i.e.* the level of diversification):

$$\beta_i = \frac{p_i}{p_n} = \frac{p_i}{p_{nF}}$$

The definition of β_i recalls that of a country's terms of trade which is defined by the purchasing power that a country holds through its exports to buy its imports, and is usually calculated by the ratio of export prices to import prices. Thus, we can approximate this parameter by the terms of trade variable in the empirical analysis section. The average price of products in country Home can be expressed in function of the terms of trade:

$$\sum_{i=1}^{n} p_i = \sum_{i=1}^{n} \beta_i p_n \rightarrow \sum_{i=1}^{n} \frac{p_i}{n} = \sum_{i=1}^{n} \frac{\beta_i}{n} p_n \Rightarrow \bar{p_i} = \bar{\beta_i} p_n(n) \tag{5.19}$$

In the previous section, the price and number n of produced goods are fixed. Now, to assess export diversification through price competitiveness, we make a variation over time. The change in price competitiveness expressed in terms of change in export diversification in the economy is therefore:

$$\hat{p_n}(n) = \varepsilon_{pn,n} \hat{n} \tag{5.20}$$

On the other hand, the composition effect captures some of the diversification effect as expressed by equation 5.14. Hence, by differentiating it with respect to time, the expression of the composition effect growth rate becomes:

$$\hat{\chi} = \varepsilon_{\chi,k} \hat{k} + \varepsilon_{\chi,\bar{p_i}} \hat{\bar{p}}_i + \varepsilon_{\chi,n} \hat{n} \tag{5.21}$$

Moreover, the country's average pollution intensity can be expressed as an increasing function of $n : \bar{\alpha_i} = \bar{\alpha_i}(n)$ with $\frac{\partial \bar{\alpha_i}}{n} > 0$. Hence the growth rate of average pollution intensity induced by export diversification is:

$$\hat{\bar{\alpha}}_i = \varepsilon_{\bar{\alpha_i},n} \hat{n} \tag{5.22}$$

Thus, taking into account the change in average price over time, we differentiate expression 5.15. The pollution emission growth rate is then written:

$$\hat{z} = \hat{S} - \zeta \varepsilon_{d,\theta} \hat{\theta} + \hat{\chi} \left(\frac{Y}{S} \right) + \hat{\bar{\alpha}}_i - \hat{\bar{p}}_i \left(\frac{xn\bar{p}_i}{S} \right)$$

Introducing 5.21 and 5.22, which captures the composition effect, yields:

$$\hat{z} = \hat{S} - \zeta\varepsilon_{d,\theta}\hat{\theta} + \hat{k}\left(\frac{Y}{S}\varepsilon_{\chi,k}\right) + \hat{\bar{p}}_i\left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right) + \hat{n}\left(\frac{y}{S}\varepsilon_{\chi,n} + \varepsilon_{\bar{\alpha}_i,n}\right)$$

Finally, by introducing expressions 5.19 and 5.20 to take into account price competitiveness, the final expression of the pollution emission growth rate used for empirical analysis will be (see Appendix 5.C for calculation details):

$$\hat{z} = \gamma_1\hat{S} - \gamma_2\hat{\theta} + \gamma_3\hat{k} + \gamma_4\hat{\bar{\beta}}_i + \gamma_5\hat{n} \tag{5.23}$$

$\gamma_1 = 1$; $\gamma_2 = \zeta\varepsilon_{d,\theta}$; $\gamma_3 = \left(\frac{Y}{S}\varepsilon_{\chi,k}\right)$;$\gamma_4 = \left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right)$;$\gamma_5 = \left(\frac{y}{S}\varepsilon_{\chi,n} + \varepsilon_{\bar{\alpha}_i,n}\right) + \left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right)\varepsilon_{pn,n}$.

The determinants of the pollution emissions are: the scale effect ($\hat{S}$), the technique effect ($\hat{\theta}$), the composition effect ($\hat{k}$), the terms of trade effect ($\hat{\bar{\beta}}_i$) and the diversification effect($\hat{n}$).

We expect the scale effect on pollution emissions to be positive and the coefficient γ_1 to be close to 1. We expect the technique effect on pollution emissions to be negative ($\gamma_2 > 0$). We assume that the composition effect induced by a change in the capital-labor ratio to have a positive impact on pollution emissions. However, theoretically, the sign of the effect is ambiguous, and besides, it depends on the type of pollutants (Cole & Elliott, 2003). As discussed earlier, we separated the diversification effect from the composition effect. We demonstrated that the effect of a change in average price can be decomposed into the effect of changes in the terms of trade and in export diversification. The impact of the terms of trade (TOT) on pollution totally captures the impact of a change in the average domestic price and depends on the sign of the expression $\left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right)$. $\frac{xn\bar{p}_i}{S}$ is the share of capital-intensive goods in the total value of economic activity and can be interpreted as the price effect. $\frac{y}{S}\varepsilon_{\chi,\bar{p}_i}$ is the elasticity of the composition with respect to the average domestic price, weighted by the share of labor-intensive goods in the total value of economic activity and its sign is positive. If the change in composition induced by a change in domestic price outweighs the price effect itself, then the terms of trade have a positive impact on pollution emission.

Finally, export diversification, defined by the number of exported products, impacts positively or negatively on pollution emission: its environmental impact is described by the expression $\left(\frac{y}{S}\varepsilon_{\chi,n} + \varepsilon_{\bar{\alpha}_i,n}\right) + \left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right)\varepsilon_{pn,n}$. We can observe that the effect of export diversification on pollution emission occurs through, on the one hand, the price competitiveness given by the coefficient $\left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right)\varepsilon_{pn,n}$, and on the other hand, through the change in the composition effect ($\varepsilon_{\chi,n}$ and $\varepsilon_{\bar{\alpha}_i,n}$

which shows that the effect of export diversification depends partly on changes in composition.

5.3 Empirical Analysis

In this section, we empirically test the theoretical results by identifying each variable and its impact on CO2 emissions through estimation methods. CO2 is a greenhouse gas and is suitable for our analysis because of its widespread use in assessing environmental degradation. To do so, we describe in the first subsection the data calculations and sources; second subsection gives the estimation equations and addresses the empirical methodology adopted, while the third subsection shows the results and discussions.

5.3.1 Data calculations and sources

Each variable, namely pollution emissions, scale, composition, technique, terms of trade and export diversification, will be measured by appropriate data according to previous empirical studies. The data we use for the empirical analysis come from datasets of UNCTAD, the Penn World Table 9.0 version (by Feenstra et al. (2015)), World Development Indicators from the World Bank and the BACI database from CEPII. We collected data of 135 countries covering the period 2000-2014 (see Table 5.5 in Appendix 5.D). We describe the calculation of each variable below.

First of all, we chose CO2 emissions as world pollutant. It is a global pollutant and the most important greenhouse gas emission responsible for global warming and most of the environmental degradation. Moreover, data on CO2 emissions are widely used in the empirical literature to investigate the environmental degradation impacts of SCT and to verify the environmental Kuznets curve hypothesis (Apergis & Payne (2009); Mohapatra et al. (2016); Muhammad (2019); Kim et al. (2019) among others). Figures on CO2 emissions in tons per capita were obtained from the World Bank's World Development Indicator (WDI) database.

In empirical studies, the scale effect is captured by the scale of activity which is measured by the GDP per capita. However, in Antweiler et al. (2001), the scale effect is obtained from GDP per square kilometer in order to measure heterogeneity within the same country. In our case, the analysis is carried out at country level. Thus, we measure the scale effect by GDP per capita, noted GDP. GDP per capita (in constant 2010 USD) is also available in the WDI Database.

As in Antweiler et al. (2001), the technique effect is estimated from a moving

average of lagged income. Moreover, in the environmental Kuznets curve literature, squared GDP per capita is used to capture the technique effect (Cole & Elliott, 2003). For our analysis, we chose to combine the two definitions in order to measure the technique effect by using the square of the three-year average of lagged GDP per capita. For a given year t, the effect of a change in technique can be captured by the following variable:

$$GDP^2_{avt} = [(GDP_{t-1} + (GDP_{t-2} + (GDP_{t-3}/3]^2$$

The composition effect is proxied by the capital-labor ratio (K/L) as described by Antweiler et al. (2001). The capital stock data (in current PPPs) and labor data (measured by the number of people employed) were obtained from the Penn World Table (version 9.0) in Feenstra et al. (2015) and used to construct the capital-labor ratio, which is technically the capital stock per worker. For instance, Cole & Elliott (2003) use the physical capital stock per worker from the WDI Database to measure the capital-labor ratio.

Terms of trade can be obtained directly from the WDI and UNCTAD databases. However, given the missing data for some recent periods, terms of trade (TOT) are constructed following the definition and formula provided in the UNCTAD description:

$$TOT = \frac{\text{export unit value index}}{\text{import unit value index}}$$

The value of terms of trade is obtained from the ratio between the export unit value index and the import unit value index, and data are obtained from UNCTAD datasets. As noted earlier, export diversification is defined as the evolution of the number of different goods exported by a country each year. Given that definition, we choose to measure it by means of two indices. First, we use the Theil index, which is a concentration index. The Theil index can be disaggregated into two components: the extensive margin component (or the Extensive Theil DIV) and the intensive margin component. Extensive Theil is an appropriate index because its evolution measures changes in the number of exported goods as demonstrated by some empirical studies (Cadot et al., 2011, 2013; IMF, 2014b). Index values are constructed and calculated from export data taken from the CEPII's BACI database, which provides bilateral values of exports at the HS 6-digit product disaggregation for more than 200 countries. Second, for robustness checks, we use a direct measurement of export diversification, which is simply the number of exported products N. Data are provided by UNCTAD (see Table 5.6 in Appendix 5.E for summary statistics).

5.3.2 Estimation equations and empirical methodology

In order to assess the various effects on pollution emissions, namely the traditional SCT, the terms of trade and the diversification effects, we derive estimation equations from the theoretical approach. To do so, our analysis is carried out in two stages: we first verify the validity of the existence of the three SCT traditional effects with equation 5.16, and second, we empirically assess the impact of the terms of trade and, more importantly, export diversification through the equation 5.23.

In the first stage, we verify the existence of the three traditional effects on CO2 emissions according to the equation 5.16. From the theoretical specification, the scale (GDP), technique (GDP^2_{av}) and composition (K/L) effects are estimated with the following empirical specification derived from the equation 5.16:

$$CO2_{it} = a_1 GDP_{it} + a_2 GDP^2_{avit} + a_3 \left(\frac{K}{L}\right)_{it} + e_{it} \tag{5.24}$$

We expect that coefficient α_1 would be positive and close to 1 and that it would reveal an increase in CO2 emissions generated by increasing economic activity. Coefficient α_2 is expected to be negative, reflecting the negative impact of technique on CO2 emissions, and coefficient α_3 is expected to be positive, in line with the factor endowment hypothesis.

Then, in a second stage, we introduce the lessons learned from our model by estimating all the five effects according to equation 5.23. The terms of trade (TOT) are added to the specification as a determinant of CO2 emissions. In addition, we measure export diversification by means of two indexes: the Extensive Theil (DIV) and the number of exported products (N) for robustness checks. We then have:

$$CO2_{it} = b_1 GDP_{it} + b_2 GDP^2_{avit} + b_3 \left(\frac{K}{L}\right)_{it} + b_4 TOT_{it} + b_5 DIV_{it} + e_{it} \tag{5.25}$$

$$CO2_{it} = b_1 GDP_{it} + b_2 GDP^2_{avit} + b_3 \left(\frac{K}{L}\right)_{it} + b_4 TOT_{it} + b_5 N_{it} + e_{it} \tag{5.26}$$

Equations 5.24, 5.25 and 5.26 are thus estimated by various estimation methods and across a large sample of countries. After specification tests, as the number of countries is much larger than the number of periods, we find it suitable to use fixed effects with robust standard errors (FE). Taking into account the problems of endogeneity that may exist between variables, we also apply one-step difference GMM and two-step difference GMM by Arellano & Bond (1991).

5.3.3 Results and discussions

Our analysis covers 135 countries during the period 2000-2014. It is conducted initially on the whole sample in order to derive a generalized relationship. Furthermore, the World Bank classifies countries by income level. In a second stage, the sample is divided into two groups for a more in-depth analysis: the more developed ones (or advanced countries) and the less developed ones (or less advanced countries) (see Table 5.5 in Appendix 5.D). In the first subsection we focus on the all country analysis, then in a second subsection, we disaggregate the sample into two subgroups, and in a third subsection we make some robustness checks by using an alternative export diversification index.

5.3.3.1 All country analysis

Estimation results for the whole sample are reported in Table 5.2. Columns (1) give the estimated coefficients from equation 5.24 and columns (2) report the coefficients for equation 5.25.

Table 5.2 shows that, in general, the estimated coefficients are consistent and robust and do not change substantially from one estimation method to another. We expect the coefficient of the scale effect (GDP) to be positive and the coefficient of the technique effect (GDP^2_{av}) to be negative. Although we expected the sign of the composition effect, which is captured by the capital-labor ratio, to be being positive, in the literature the sign of the composition effect is ambiguous both theoretically and empirically. In columns 1, the estimated coefficients from fixed effects (FE), one-step and two-step GMM generate similar results, which substantiates our interpretations. In line with the theory detailed in previous sections, the scale of economic activity as measured by Gross Domestic Product per capita (GDP) has a positive effect on CO2 emissions and its coefficient is quite close to 1. Indeed, the fixed effect estimates show that an increase of 1 percent in GDP per capita would lead to an increase of 1.03 percent in CO2 emissions. Similarly, an improvement in technique (GDP^2_{av}) would lead to a decrease in CO2 emissions. For instance, the GMM estimates indicate that a 10 percent growth in technique would cause a decline of 0.3 percent in CO2 emissions. However, surprisingly, the impact of a change in composition as measured by the evolution of the capital-labor ratio seems to be strongly not significant.

Table 5.2 – Estimation results for all countries

	Dependent variable: CO2					
	FE		GMM		GMM TWO STEP	
Variables	(1)	(2)	(1)	(2)	(1)	(2)
L.CO2			0.69***	0.61***	0.69***	0.61***
			(0.14)	(0.08)	(0.14)	(0.08)
GDP	1.03***	0.89***	0.74***	0.64***	0.74***	0.65***
	(0.14)	(0.15)	(0.21)	(0.14)	(0.21)	(0.14)
GDP_{av}^2	-0.02***	-0.02**	-0.03***	-0.03***	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
K/L	-0.03	-0.03	-0.03	-0.02	-0.03	-0.02
	(0.05)	(0.05)	(0.03)	(0.02)	(0.03)	(0.03)
TOT		0.13**		0.07**		0.07**
		(0.06)		(0.03)		(0.03)
DIV		-0.12***		-0.04**		-0.05**
		(0.03)		(0.02)		(0.02)
Constant	-6.19***	-6.07***				
	(0.77)	(0.81)				
Observations	1965	1965	1703	1703	1703	1703
Number of i	131	131	131	131	131	131
Number of t	15	15	13	13	13	13
R-squared	0.34	0.37				
Sargan-Hansen st.	0.000	0.000				
Hansen st.			0.132	1	0.132	1
AR(2)			0.487	0.491	0.507	0.498
AR(1)			2.97e-05	1.04e-07	4.56e-05	1.14e-06

Notes: Robust standard errors are in parentheses. * Significance at 10 percent; ** significance at 5 percent; *** significance at 1 percent. Sargan-Hansen statistics give specification tests in case of using robust standard error, and the rejection of null hypothesis shows that fixed-effect estimators are favored over the random-effect estimators. The p-values of Arellano and Bond tests AR(1) and AR(2), respectively for first and second-order autocorrelation in first differences, show that the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and do not reject the null hypothesis, which show that the instruments are valid.

On the one hand, our theoretical model demonstrates that the composition effect is partially captured by the terms of trade and export diversification. Hence the pure

capital-labor ratio effect might be not significant. On the other hand, as shown by Cole & Elliott (2003), the impact on CO2 emissions of composition as measured by capital per worker is sometimes not significant. For instance, Mohapatra et al. (2016) do not empirically test the impact of the composition effect on greenhouse gas emissions due to its ambiguous theoretical effect. Nor do Liobikiene & Butkus (2019) find any composition effect in their empirical investigation of the impact of the SCT effects on CO2 emissions.

Focusing now on columns (2) of Table 5.2, the significance and size of the SCT coefficients are similar to the previous findings. However, the impact of scale activity is less strong: according to the fixed effect estimates, an increase of 1 percent in the scale of economic activity leads to an increase of 0.89 percent in CO2 emissions. This result is quite logical, as the effects are partially captured by other determinants. And indeed, the impacts of the terms of trade and diversification are highly significant. As observed in the theoretical model, the consequences of the terms of trade (TOT) for pollution depend on the contradictory effects of the elasticity of composition with respect to the average domestic price and price effect. Figures enable us to show that terms of trade have a positive effect on CO2 emissions: according to the GMM estimates, a 10 percent increase in terms of trade would lead to a rise in CO2 emissions of 0.7 percent. These results indicate that composition elasticity outweighs domestic price effects. Export diversification (DIV) is described as the number of products exported and is measured by a concentration index: the extensive margin of the Theil index. A positive relationship would then be expressed by a negative sign of the associated coefficient. Theoretically, its consequence for pollution is the result of the combination of composition effect and price competitiveness. In our results, the coefficients are significant and the one-step GMM estimates show that an increase of 10 percent in the number of exported products would increase CO2 emissions by 0.4 percent.

Finally, from the three estimation methods, we find that the results are very robust. However, a deeper analysis enables us to observe how differently the five variables would affect pollution emissions along the development path. To that end, we break down the countries into two subgroups: the more advanced countries and the less advanced countries.

5.3.3.2 More advanced countries versus less advanced countries

For a more comprehensive analysis, we decompose the sample of countries into two subsamples according to the World Bank classification (see Table 5.5 in Appendix 5.D). We call the more developed (or advanced) countries those categorized as

upper middle income (UMI) and high income (HI). The second subsample includes the lower middle-income (LMI) countries and the low-income countries (LI), namely the less advanced countries (or the less developed countries).

Table 5.3 provides the findings for the estimated equation 5.25 and shows heterogeneity between the two groups. Focusing first on the less developed countries on the left-hand side of Table 5.3, the figures show that only a change in scale would affect CO2 emissions: the GMM estimates indicate that an increase in economic activity of 1 percent would increase CO2 emissions by 0.38 percent. The other coefficients remain strongly not significant despite the slight significance (at 10 percent) of the terms of trade coefficient in the case of the two-step GMM results.

These observations are in line with several empirical studies such as those in the environmental Kuznets curve literature. The environmental Kuznets curve hypothesis emphasizes the fact that countries at the first stage of development are characterized by a strictly positive relationship between development and environmental degradation, until a threshold income is reached, at which point the rise in economic development is accompanied by a demand for environmental quality. Hence, we conclude that only the scale effect occurs at the early stage of development and, above all, a change in the number of exported products might not have any impact on pollution for the less developed countries.

Focusing now on the right-hand side of Table 5.3, for the more advanced countries, CO2 emissions have various determinants and the findings seem to be consistent. An increase in economic activity would cause an increase in CO2 emissions: a 1 percent increase in scale would lead to an increase of 0.62 percent in CO2 emissions, according to the GMM estimates. We can see from a comparison of estimates of the GDP coefficient for the two groups that the scale effect is weaker for less developed countries: for this group, the GMM estimates show that a 1 percent increase in economic activity leads to an increase of 0.38 percent in CO2 emissions. Moreover, the technique effect is negative, as expected: indeed, an improvement of 10 percent in technique would reduce pollution emissions by 0.2 percent. Referring to our earlier comment on the composition effect, we stated that, theoretically, its effect is partially captured by the terms of trade and diversification and moreover, its sign is theoretically ambiguous. These observations are quite well reflected in our results. The estimated coefficients of composition and terms of trade are weakly significant. While the coefficient of the terms of trade is significant and positive for the fixed-effect estimation, the composition coefficient is less significant and negative for the one-step and two-step GMM estimations. More importantly, the export

Table 5.3 – Estimation results for less advanced countries and more advanced countries

	Dependent variable: CO2					
	Less advanced countries			More advanced countries		
Variables	FE	GMM	GMM TWO STEP	FE	GMM	GMM TWO STEP
$L.CO2$		0.70***	0.70***		0.44***	0.45***
		(0.06)	(0.09)		(0.09)	(0.09)
GDP	0.65**	0.38***	0.37*	0.80***	0.62***	0.61***
	(0.29)	(0.14)	(0.21)	(0.20)	(0.17)	(0.16)
GDP^2_{av}	0.01	-0.01	-0.01	-0.02*	-0.02**	-0.02**
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
K/L	0.00	0.03	0.02	-0.07	-0.05*	-0.05*
	(0.08)	(0.04)	(0.04)	(0.05)	(0.03)	(0.03)
TOT	0.09	0.06	0.09*	0.17**	0.04	0.04
	(0.08)	(0.04)	(0.05)	(0.09)	(0.07)	(0.08)
DIV	-0.13	-0.03	-0.04	-0.09***	-0.05**	-0.05**
	(0.09)	(0.05)	(0.07)	(0.03)	(0.02)	(0.02)
$Constant$	-6.18***			-4.70***		
	(1.02)			(1.33)		
Observations	855	741	741	1110	962	962
Number of i	57	57	57	74	74	74
Number of t	15	13	13	15	13	13
R-squared	0.41			0.35		
Sarg.-Hans. st.	0.000			0.000		
Hansen st.		1	1		1	1
AR(2)		0.745	0.737		0.144	0.161
AR(1)		0.000	9.94e-05		5.79e-05	0.00023

Notes: Robust standard errors are in parentheses. * Significance at 10 percent; ** significance at 5 percent; *** significance at 1 percent. Sargan-Hansen statistics give specification tests in case of using robust standard error, and the rejection of null hypothesis shows that fixed-effect estimators are favored over the random-effect estimators. The p-values of Arellano and Bond tests AR(1) and AR(2), respectively for first and second-order autocorrelation in first differences, show that the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and do not reject the null hypothesis, which show that the instruments are valid.

diversification coefficient is highly significant and shows that an increase in diversification of 10 percent would generate an increase in pollution of 0.5 percent. Thus we can confirm that, for the more advanced countries, the diversification effect, defined as the rise in the number of exported products, impacts positively on pollution emissions. Generally, we then find that the diversification effect occurs later in a country's development process. In other words, diversifying exports for these more advanced countries exposes them to higher CO2 emissions.

5.3.3.3 Robustness checks

In a third and final step, we verify the robustness of our analysis by implementing a second measure of diversification which is simply the number of exported products. We estimated the equation 5.26 and results for the global sample and the two subsamples are reported in Table 5.4 following the one- step and two-step GMM. First, in comparing the figures in Tables 5.2 and 5.3 with those in Table 5.4, it is comforting to observe that, for all three samples, the SCT effects and the terms of trade effect are strongly similar whether export diversification is measured by the extensive Theil or by the number of products (respectively equation 5.25 and equation 5.26). The difference in scale effect between the two subsamples is still noticeable. The scale effect is weaker for the less developed countries than for the more advanced countries: for the one-step GMM estimates, an increase of 1 percent in economic activity leads to a growth in CO2 emissions of 0.33 and 0.67 percent respectively. The effect of a change in capital-labor ratio still affects negatively in the case of more advanced countries, but the coefficients are more significant. The positive effect of terms of trade on the greenhouse gas emission occurs solely in the global sample (Whole countries). Finally, for more developed countries, export diversification has a positive effect on CO2 emissions, and conversely, for less advanced countries, export diversification is not a determinant of pollution emissions. The positive sign of the estimated coefficient for the global sample seems to highlight its average effect: for instance, for whole country on average, a 10 percent increase in the number of exported products would generate a 0.01 percent increase in CO2 emissions. These observations are strongly robust, as the results are the same as in the previous tables (Table 5.2 and Table 5.3) and show the same phenomenon. As mentioned earlier, in the early stage of development, only the scale activity affects the level of CO2 emissions. Then, following its development path, when the country reaches a higher income level, the scale effect gets stronger, the technique effect occurs and export diversification effect on CO2 emissions is positive. However, given our main results, the effect of terms of trade seems to be visible solely when all countries are taken

into account and change in capital-labor ratio in the economy has ambiguous effect.

Table 5.4 – Estimation results for robustness checks

	Dependent variable : $CO2$					
	Whole countries		More advanced countries		Less advanced countries	
Variables	GMM	GMM TS	GMM	GMM TS	GMM	GMM TS
$L.CO2$	0.6056***	0.6059***	0.2745***	0.4700***	0.7030***	0.6917***
	(0.0817)	(0.0820)	(0.0646)	(0.0911)	(0.0622)	(0.0849)
GDP	0.5779***	0.5749***	0.6745***	0.5783***	0.3295**	0.3726**
	(0.1282)	(0.1244)	(0.1712)	(0.1518)	(0.1354)	(0.1727)
GDP^2_{av}	-0.0238***	-0.0236***	-0.0117	-0.0187**	-0.0106	-0.0112
	(0.0062)	(0.0061)	(0.0103)	(0.0076)	(0.0072)	(0.0081)
K/L	-0.0331	-0.0347	-0.1899***	-0.0844**	0.0314	0.0267
	(0.0241)	(0.0242)	(0.0703)	(0.0339)	(0.0367)	(0.0451)
TOT	0.0648*	0.0642*	0.1452	0.0471	0.0491	0.0224
	(0.0340)	(0.0344)	(0.0983)	(0.0574)	(0.0385)	(0.0758)
N	0.0010**	0.0010**	0.0017**	0.0009*	0.0006	0.0006
	(0.0005)	(0.0005)	(0.0009)	(0.0005)	(0.0004)	(0.0006)
Obs.	1703	1703	962	962	741	741
Numb. of i	131	131	74	74	57	57
Numb. of t	13	13	13	13	13	13
Hans. st.	1	1	0.632	1	1	1
AR (2)	0.350	0.358	0.0912	0.147	0.845	0.874
AR (1)	1.83e-07	1.15e-06	0.00106	0.000166	2.76e-06	0.000152

Notes: Robust standard errors are in parentheses. * Significance at 10 percent; ** significance at 5 percent; *** significance at 1 percent. The p-values of Arellano and Bond tests AR(1) and AR(2), respectively for first and second-order autocorrelation in first differences, show that the null hypothesis of absence of first-order serial correlation AR(1) is rejected and the null hypothesis of zero second-order autocorrelation AR(2) is not rejected. Hansen statistics are tests of overidentifying restrictions and do not reject the null hypothesis, which show that the instruments are valid.

5.4 Conclusion

Our aim in this paper has been to investigate the impact of export diversification on pollution emissions in the context of the existence of the scale, composition and technique effects. We developed a theoretical model inspired by the Antweiler et al. (2001) approach and introduced a many-good framework based on Falvey & Kierzkowski (1987)'s model. We find that the effect of the terms of trade must be distinguished from the export diversification effect and, more importantly, that the export diversification effect is observed while Home country is gaining in price competitiveness. Actually, export diversification impacts on pollution emissions through two channels, namely the composition and price competitiveness. Our theoretical model enables us to analyze empirically the traditional SCT effects along with the terms of trade and export diversification effects by converting the theoretical specifications into estimated equations. The empirical investigation was conducted in two stage by assessing first the effects of scale, composition, technique, terms of trade and diversification on CO2 emissions in a sample of countries in order to derive a generalized relationship. And in a second stage, with a view to refining our interpretation, we disaggregated the countries into two subgroups according to their income level. We find that, generally, the increase in scale and technique effects would, as expected theoretically, generate an increase and a decrease in CO2 emissions respectively. However, we observe that the change in composition of production has no impact on pollution. The terms of trade have a positive effect and export diversification would generate an increase in CO2 emissions. For less advanced countries, only the scale effect is significant, but the impact is weak. Conversely, for the more advanced ones, the scale and technique effects occur, and moreover, export diversification generates more pollution. For the scale and technique effects, these findings do not differ from other findings in previous studies. Specifically, the ambiguous result for the composition effect is discussed in the literature. A stylized fact has been shown on the nexus between export diversification and economic development (Cadot et al., 2013). Indeed, there is a U-shaped relationship between export concentration and the level of development: along the development path, countries follow a pattern of diversification until a development threshold is reached and then begin a trajectory towards concentration. Thus, more advanced countries, in their export concentration trajectory, would a priori be able to mitigate adverse environmental impacts. Future research should focus on the role of export diversification by including consumer tastes and demand for environmental quality in the theoretical model.

Appendix 5.A The Composition Effect definition

As mentioned in the theoretical model section, $C^{xi}(w,r)$ and $C^{y}(w,r)$ are respectively the capital and labor unit costs, and $C_w^{xi} \equiv \frac{\partial C^{xi}}{\partial w}$ is the unit labor requirement in X_i. Recall the full employment condition in equation 5.7 and 5.8.

5.A.1 The aggregated composition effect

From 5.7 and 5.8, the aggregated composition effect is the environmental consequence of the change in the relative output of aggregated polluting goods $\frac{\sum_{i=1}^{n} x_i}{y}$. Then:

$$\frac{-\sum_{i=1}^{n} C_w^{xi} x_i}{C_w^y} + \frac{\sum_{i=1}^{n} C_r^{xi} x_i}{C_r^y} = \frac{K}{C_r^y} - \frac{L}{C_w^y}$$

Let us note $\bar{C_w^{xi}}$, the average number of unit labor to produce a good X_i in the economy: it depends of the number of sectors and the volume of output in each sector. Similarly, let's define $\bar{C_r^{xi}}$, the average number of capital unit to produce the good X_i:

$$\bar{C_w^{xi}} = \frac{\sum_{i=1}^{n} C_w^{xi} x_i}{\sum_{i=1}^{n} x_i} \text{ and } \bar{C_r^{xi}} = \frac{\sum_{i=1}^{n} C_r^{xi} x_i}{\sum_{i=1}^{n} x_i}$$

then

$$\sum_{i=1}^{n} x_i = \frac{C_w^y K - C_r^y L}{(-C_r^y \bar{C_w^{xi}} + C_w^y \bar{C_r^{xi}})}$$

and

$$y = \frac{-\bar{C_w^{xi}} K + \bar{C_r^{xi}} L}{(-C_r^y \bar{C_w^{xi}} + C_w^y \bar{C_r^{xi}})}$$

finally

$$\frac{\sum_{i=1}^{n} x_i}{y} = \frac{C_w^y k - C_r^y}{\bar{\alpha_i} - \bar{C_w^{xi}} k} \equiv \chi(k, \bar{pi})$$

With $k = K/L$ is the capital-labor ratio of the economy.

5.A.2 The disaggregated composition effect

Given the definition above, for the industry i, the industry level relative supply is:

$$\frac{x_j}{y} = \chi_j$$

Given that $\sum_{i=1}^{n} C_w^{wi} x_i + C_w^y y = L$ and $\sum_{i=1}^{n} C_r^{xi} x_i + C_r^y y = K$, once the factor used to produce goods in industry j is isolated, above equations can be rewritten as:

$$C_w^{xj} x_j + \sum_{i=1}^{j-1} C_w^{xi} x_i + \sum_{i=j+1}^{n} C_w^{xi} x_i + C_w^y y = L \text{ with } A = \sum_{i=1}^{j-1} C_w^{xi} x_i + \sum_{i=j+1}^{n} C_w^{xi} x_i$$

$$C_r^{xj} x_j + \sum_{i=1}^{j-1} C_r^{xi} x_i + \sum_{i=j+1}^{n} C_r^{xi} x_i + C_r^y y = K \text{ with } B = \sum_{i=1}^{j-1} C_r^{xi} x_i + \sum_{i=j+1}^{n} C_r^{xi} x_i$$

Then x_j, y and x_j/y can be obtained:

$$y = \frac{-C_r^{xj}(L - A) + C_w^{xj}(K - B)}{C_w^{xj} C_r^y - C_r^{xj} C_w^y}$$

and

$$x_j = \frac{-C_r^{y}(L - A) + C_w^{y}(K - B)}{C_r^{xj} C_w^y - C_w^{xj} C_r^y}$$

finally,

$$\frac{x_j}{y} = \frac{-C_r^{y}(L - A) + C_w^{y}(K - B)}{C_r^{xj}(L - A) - C_w^{xj}(K - B)}$$

then

$$\frac{x_j}{y} = \frac{C_w^{y}(k - (B/L)) - C_r^{y}(1 - (A/L))}{\alpha_j(1 - (A/L)) - C_w^{x_j}(k - (B/L))}$$

An environmental impact following a change in χ_j generates the industry composition effect. It increases on K/L, and on price p_j and decreases in the price and the output volume of other industries, *ceteris paribus*.

Appendix 5.B The Emission Pollution expression

5.B.1 The emission pollution before symmetry assumption

Recall that: $z = \sum_{i=1}^{n} e_i = \sum_{1}^{n} x_i[\alpha_i - \lambda d_i(\theta_i)]$

$$z = \frac{\sum_{i=1}^{n} x_i(\alpha_i - \lambda d_i(\theta_i))}{\sum_{i=1}^{n} p_i x_i + y} S$$

θ_i is specific to each sector because $\theta_i = \frac{x_{\alpha i}}{x_i}\alpha_i$, and we assume that $\frac{x_{\alpha i}}{x_i}$ is constant. For d_i linear and concave in α_i, we can write: $d(\theta_i) = d(\theta)\alpha_i$. Then:

$$z = \frac{\sum_{i=1}^{n} x_i\alpha_i - \lambda d(\theta)\sum_{i=1}^{n} x_i\alpha_i}{\sum_{i=1}^{n} p_i x_i + y} S$$

$$z = \frac{\frac{\sum_{i=1}^{n} x_i\alpha_i}{y}(1 - \lambda d(\theta))}{\frac{\sum_{i=1}^{n} p_i x_i}{y} + 1} S$$

$$z = \frac{\sum_{i=1}^{n} \chi_i\alpha_i(1 - \lambda d(\theta))}{\sum_{i=1}^{n} p_i\chi_i + 1} S$$

To obtain the decomposition, totally differentiate equation 5.12 to yield:

$$logz = log\left(\frac{\sum_{i=1}^{n} \chi_i\alpha_i(1 - \lambda d(\theta))}{\sum_{i=1}^{n} p_i\chi_i + 1} S\right)$$

$$logz = logS + log\left(\sum_{i=1}^{n} \chi_i\alpha_i\right) + log(1 - \lambda d(\theta)) - log\left[\left(\sum_{i=1}^{n} p_i\chi_i + 1\right)\right]$$

with $\frac{\partial(log(1-\lambda d(\theta)))}{\partial t} = \lambda\alpha(\theta)\varepsilon_{\alpha,\theta}\frac{\sum x_i\alpha_i}{z}\hat{\theta}$;

$$\frac{\partial log(\sum_{i=1}^{n} \chi_i\alpha_i)}{\partial t} = \sum_{i=1}^{n} \frac{\hat{\chi}_i x_i\alpha_i}{\sum \alpha_i x_i} = \sum_{1}^{n} \phi_i\hat{\chi}_i$$

$$\frac{\partial log(\sum_{i=1}^{n} p_i\chi_i + 1)}{\partial t} = \sum_{i=1}^{n} \frac{\hat{\chi}_i x_i p_i}{S} = \sum_{1}^{n} \psi_i\hat{\chi}_i$$

The growth rate of pollution emission is therefore:

$$\hat{z} = \hat{S} + \sum_{1}^{n} \hat{\chi}_i[\phi_i - \psi_i] - \lambda\alpha(\theta)\varepsilon_{\alpha,\theta}\frac{\sum x_i\alpha_i}{z}\hat{\theta}$$

$$\hat{z} = \hat{S} + \sum_{1}^{n} \hat{\chi}_i\varphi_{yi} - \zeta\varepsilon_{\alpha,\theta}\hat{\theta}$$

5.B.2 pollution emission expression after symmetry assumption

We assume that the volumes of output of goods X_i in the economy are identical: $x_1 = x_2 = ... = x_n = x$. From the equation 5.12, we assess the new expression of pollution emissions:

$$z = \frac{(1 - \lambda d(\theta)) \sum_{i=1}^{n} \chi_i \alpha_i}{\sum_{i=1}^{n} p_i \chi_i + 1} S$$

with $\sum_1^n \alpha_i = n\bar{\alpha_i}$ and $\sum_1^n p_i = n\bar{p_i}$

$$z = \frac{(1 - \lambda d(\theta)) \chi_x n\bar{\alpha_i}}{\chi_x n\bar{p_i} + 1} S$$

Note that $n\chi_x = \chi$

$$z = \frac{(1 - \lambda d(\theta)) \chi\bar{\alpha_i}}{\bar{p_i}\chi + 1} S$$

Totally differentiate:

$$logz = log\left[\frac{(1 - \lambda d(\theta)) \chi\bar{\alpha_i}}{\bar{p_i}\chi + 1} S\right]$$

with $\frac{\partial[log(\bar{p_i}\chi+1)]}{\partial t} = \hat{\chi}\left(\frac{xn\bar{p_i}}{S}\right)$

$$\hat{z} = \hat{S} - \zeta\varepsilon_{\alpha\theta}\hat{\theta} + \frac{S}{s}\hat{\chi} - \frac{xn\bar{p_i}}{S}\hat{\chi}$$

The growth rate of pollution emissions after symmetry assumption is then:

$$\hat{z} = \hat{S} - \zeta\varepsilon_{\alpha\theta}\hat{\theta} + \varphi_y\hat{\chi}$$

where $\varphi_y = y/S$, the share of good y in the value of gross output.

Appendix 5.C The effect of export diversification on pollution emissions

Prices and the number of goods produced were fixed in the previous sections. In order to assess the effect of induced export diversification of price competitiveness, we vary prices and the number of goods over time. By taking again the expression of the emission of pollutions in eq 5.15:

$$z = \frac{(1 - \lambda d(\theta))\chi\bar{\alpha_i}}{\bar{p_i}\chi + 1} S$$

$$logz = log\left(\frac{(1 - \lambda d(\theta))\chi\bar{\alpha_i}}{\bar{p_i}\chi + 1} S\right)$$

With $\frac{\partial[log(\bar{p_i}\chi+1)]}{\partial t} = \hat{\chi}\frac{xn\bar{p_i}}{S} + \hat{\bar{p}_i}\frac{xn\bar{p_i}}{S}$

The expression of the growth rate of pollution emissions is :

$$\hat{z} = \hat{S} - \zeta\varepsilon_{\alpha\theta}\hat{\theta} + \hat{\chi} + \hat{\bar{\alpha}} - \hat{\chi}\frac{xn\bar{p_i}}{S} - \hat{\bar{p}_i}\frac{xn\bar{p_i}}{S}$$

$$\hat{z} = \hat{S} - \zeta\varepsilon_{\alpha\theta}\hat{\theta} + \hat{\bar{\alpha}} + \hat{\chi}\frac{y}{S} - \hat{\bar{p}_i}\frac{xn\bar{p_i}}{S}$$

On the one hand, recall the expression of aggregated composition after symmetry assumption: $\chi = \chi(k, \bar{p_i}, n)$

It gives therefore:

$$\frac{\partial[log\chi(k, \bar{p_i}, n]}{\partial t} = \frac{\partial[log\chi(k)]}{\partial t} + \frac{\partial[log\chi(\bar{p_i})]}{\partial t} + \frac{\partial[log\chi(n)]}{\partial t}$$

$$\hat{\chi} = \varepsilon_{\chi,k}\hat{k} + \varepsilon_{\chi,\bar{p_i}}\hat{\bar{p}}_i + \varepsilon_{\chi,n}\hat{n}$$

And, on the other hand, with the symmetry assumption, the average pollution intensity depends solely on the number of products in the economy: $\bar{\alpha_i} = \bar{\alpha_i}(n) \rightarrow \frac{\partial[log\bar{\alpha_i}]}{\partial t} = \frac{\partial[log\bar{\alpha_i}(n)]}{\partial t}$.

The average pollution intensity in the country can be expressed as increasing function of n: $\bar{\alpha_i} = \bar{\alpha_i}(n)$ with $\frac{\partial\bar{\alpha_i}}{\partial n} > 0$

Proof: when α_i are ranked in increasing order, we can we can assimilate $\sum_1^n \alpha_i$ to the sum of an arithmetic sequence $\sum_1^n \alpha_i = n\frac{2\alpha_1+b(n-1)}{2}$

Then : $\bar{\alpha_i} = \sum_1^n \frac{a_i}{n} = \frac{2\alpha_1+b(n-1)}{2} \Rightarrow \bar{\alpha_i} = \bar{\alpha_i}(n)$ with $\frac{\partial\bar{\alpha_i}}{\partial n} > 0$.

Therefore, the growth rate of pollution emissions is written:

$$\hat{z} = \hat{S} - \zeta\varepsilon_{\alpha,\theta}\hat{\theta} + \frac{y}{S}\varepsilon_{\chi,k}\hat{k} + \left(\frac{y}{S}\varepsilon_{\chi,\bar{p_i}} - \frac{xn\bar{p_i}}{S}\right)\hat{\bar{p}}_i + \left(\frac{y}{S}\varepsilon_{\chi,n} + \varepsilon_{\bar{\alpha_i},n}\right)\hat{n}$$

Recall that $\bar{p_i} = \bar{\beta}p_n(n)$ and $\hat{p_n(n)} = \varepsilon_{pn,n}\hat{n}$

The final expression used for empirical analysis is therefore:

$$\hat{z} = \gamma_1 \hat{S} - \gamma_2 \hat{\theta} + \gamma_3 \hat{k} + \gamma_4 \hat{\bar{\beta}}_i + \gamma_5 \hat{n}$$

$\gamma_1 = 1$; $\gamma_2 = \zeta \varepsilon_{d,\theta}$; $\gamma_3 = \left(\frac{Y}{S}\varepsilon_{\chi,k}\right)$;$\gamma_4 = \left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right)$;$\gamma_5 = \left(\frac{y}{S}\varepsilon_{\chi,n} + \varepsilon_{\bar{\alpha}_i,n}\right) + \left(\frac{y}{S}\varepsilon_{\chi,\bar{p}_i} - \frac{xn\bar{p}_i}{S}\right)\varepsilon_{pn,n}$.

Appendix 5.D List of countries

Appendix 5.E Summary statistics

Table 5.5 – List of countries

More developed countries				Less developed countries			
Country	Inc.	Country	Inc.	Country	Inc.	Country	Inc.
Albania	UMI	Hungary	HI	Angola	LMI	Kyrgyz Republic	LMI
Algeria	UMI	Iceland	HI	Bangladesh	LMI	Lao PDR	LMI
Argentina	HI	Ireland	HI	Benin	LI	Liberia	LI
Armenia	UMI	Israel	HI	Bhutan	LMI	Madagascar	LI
Australia	HI	Italy	HI	Bolivia	LMI	Malawi	LI
Austria	HI	Jamaica	UMI	Burkina Faso	LI	Mali	LI
Azerbaijan	UMI	Japan	HI	Burundi	LI	Mauritania	LMI
Bahamas, The	HI	Kazakhstan	UMI	Cabo Verde	LMI	Mongolia	LMI
Bahrain	HI	Korea, Rep.	HI	Cambodia	LMI	Morocco	LMI
Barbados	HI	Latvia	HI	Cameroon	LMI	Mozambique	LI
Belarus	UMI	Lebanon	UMI	Central African Republic	LI	Myanmar	LMI
Belgium	HI	Lithuania	HI	Chad	LI	Nepal	LI
Belize	UMI	Malaysia	UMI	Comoros	LI	Nicaragua	LMI
Bosnia and Herzegovina	UMI	Malta	HI	Congo, Dem. Rep.	LI	Niger	LI
Brazil	UMI	Mauritius	UMI	Congo, Rep.	LMI	Nigeria	LMI
Brunei Darussalam	HI	Mexico	UMI	Côte d'Ivoire	LMI	Pakistan	LMI
Bulgaria	UMI	Netherlands	HI	Djibouti	LMI	Philippines	LMI
Canada	HI	New Zealand	HI	Egypt, Arab Rep.	LMI	Rwanda	LI
Chile	HI	Norway	HI	El Salvador	LMI	Senegal	LI
China	UMI	Oman	HI	Ethiopia	LI	Sri Lanka	LMI
Colombia	UMI	Panama	HI	Gambia, The	LI	Tanzania	LI
Costa Rica	UMI	Paraguay	UMI	Georgia	LMI	Togo	LI
Croatia	HI	Peru	UMI	Ghana	LMI	Tunisia	LMI
Cyprus	HI	Poland	HI	Guinea	LI	Uganda	LI
Czech Republic	HI	Portugal	HI	Guinea-Bissau	LI	Ukraine	LMI
Denmark	HI	Romania	UMI	Honduras	LMI	Uzbekistan	LMI
Dominican Republic	UMI	Singapore	HI	India	LMI	Vietnam	LMI
Ecuador	UMI	South Africa	UMI	Kenya	LMI	Zambia	LMI
Equatorial Guinea	UMI	Spain	HI			Zimbabwe	LI
Estonia	HI	Sweden	HI				
Fiji	UMI	Switzerland	HI				
Finland	HI	Thailand	UMI				
France	HI	Trinidad and Tobago	HI				
Gabon	UMI	Turkey	UMI				
Germany	HI	United Kingdom	HI				
Greece	HI	United States	HI				
Guatemala	UMI	Uruguay	HI				

Note: High Income (HI) ; Upper middle income (UMI); Lower middle income (LMI); Low income (LI)

Table 5.6 – Summary statistics

Whole countries					
Variable	Obs	Mean	Standard Deviation	Minimum	Maximum
CO2	1965	4.29	5.16	0.02	36.09
GDP	1965	12628.68	17357.56	193.87	91594.18
K/L	1965	110875.5	121549.1	1323.09	605906.2
TOT	1965	111.13	32.92	21.40	290.93
N	1965	174.28	73.10	5	260
DIV	1965	0.999	0.915	0.010	4.207
More developed countries					
Variable	Obs	Mean	Std. Dev.	Min	Max
CO2	1110	6.97	5.41	0.66	36.09
GDP	1110	21396.7	18869.54	1404.32	91594.18
K/L	1110	177828.3	123876.9	13102.47	605906.2
TOT	1110	110	32.03	50.19	290.93
N	1110	209.75	54.01	16	260
DIV	1110	0.546	0.612	0.010	4.036
Less developed countries					
Variable	Obs	Mean	Std. Dev.	Min	Max
CO2	855	0.81	1.30	0.02	13.51
GDP	855	1245.64	926.52	193.87	4265.15
K/L	855	23954.38	25671.54	1323.09	160419.7
TOT	855	112.59	34.01	21.40	250.99
N	855	128.22	68.87	5	256
DIV	855	1.588	0.908	0.041	4.207

Chapter 6

Vietnam's trade-led growth, balance of payments and macro resilience

Abstract

Vietnam is following the successive waves of rapid industrialization in Asia by conducting an export-oriented growth strategy. As trade representing a share of 208.3 percent of GDP in 2018, the country is strongly integrated in the global value chains, one of the prominent features of trade globalization. However, a key concern is whether such trade-led growth is sustainable in the long run and resilient to global shocks. Drawing on a multi-country balance-of-payments-constrained growth model, our objective in this chapter is threefold. Firstly, we examine Vietnam's growth performance over the past 30 years of transition and integration efforts. More specifically, we measure the respective contribution of partner areas to its external constraint. Secondly, we analyze how and through which transmission channels the changing geography of international trade has impacted the balance-of-payments-constrained growth rate before and after Vietnam joined the WTO in 2007. A decomposition of the external constraint in different factors from different sources is proposed in order to assess the outcomes of WTO accession. Lastly, we assess the country's ability to face global shocks like the current Covid-19 pandemic. Given its deep integration into the global economy, the geography of trade relations is critical in determining Vietnam's vulnerability, corroborating recent development studies that make a case for partner diversification and growth re-orientation to build macro resilience. [21]

Keywords: Balance-of-payments-constrained growth model, Trade inter-linkages,

21. This chapter is a first version of an original paper, co-authored with Rieber Arsène (LASTA, University of Rouen Normandy, France) and Tran Thi Anh-Dao (IRASEC-CNRS, Vietnam and LASTA, University of Rouen Normandy, France). Results in this chapter will be part of findings in the AFD project : General Monetary and Multisectoral Macrodynamics for the Ecological Shift Project (GEMMES Vietnam) under WP5.2 sub-package "Measuring the impact of climate change on Vietnam's international trade position".

East and Southeast Asia, Macro resilience.
JEL codes: E12, E62, E64, F43, F45.

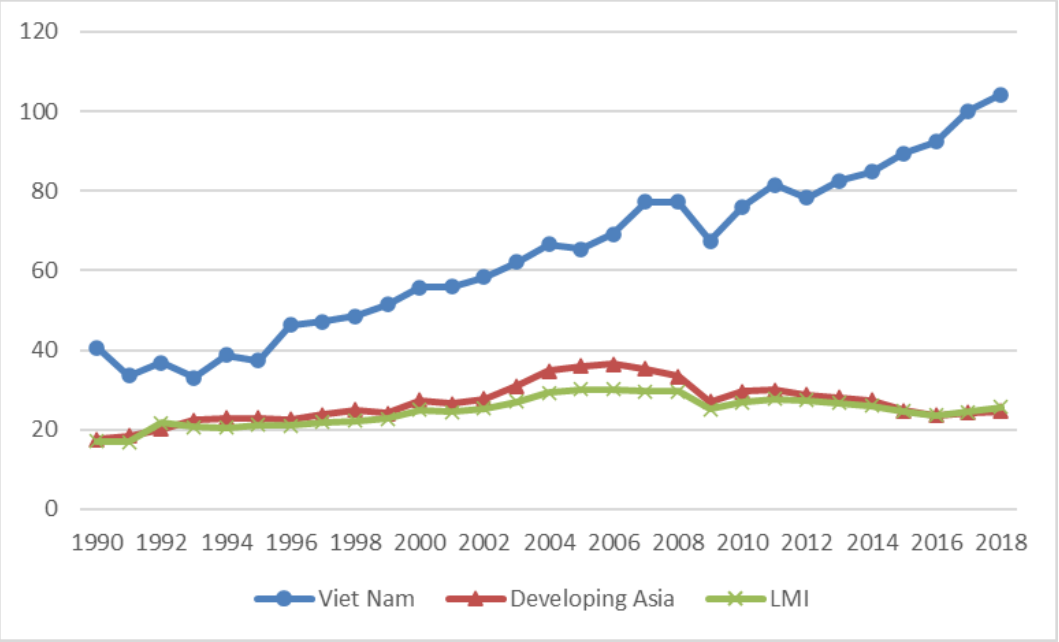
6.1 Introduction

Since 1986, Vietnam has gone through a far reaching transformation from an inward-looking planned economy to one that is globalized and market-based. Turning to the Asian region first by joining the Association of Southeast Asian Nations (ASEAN) in 1995, followed by the Asia-Pacific Economic Cooperation (APEC) in 1998, the country has drawn his own path to become the 6th largest economy in the sub-region. The real GDP grew by about 7% in the last two years, one of the fastest growth rates in East Asia and in the developing world. The country is now entering a new phase of national development and the government has set up an ambition to become a high-income country by 2045 in compliance with the 10-year Socio-Economic Development Strategy (SEDS) for 2021-2030 and an accompanying Socio-Economic Development Strategy Plan (SEDP) 2021-2025 which outlines the mid-term priorities of the country (World Bank, 2020a).

Behind the story, integration into the world economy has been the key driver of Vietnam's economic and social outstanding outcomes. Since the implementation of the Doi Moi policy, the evidence is overwhelming that it has resisted both the collapse of the former Soviet bloc and the US embargo (which was only lifted in 1994). After the US-Vietnam bilateral trade agreement in 2001, the country formally completed WTO accession in 2007, culminating a long process of efforts to integrate the national economy into global markets. Two new Free Trade Agreements (FTAs) have recently come into force, namely: the Comprehensive and Progressive Trans-Pacific Partnership (CPTPP) in 2019, and the EU-Vietnam bilateral agreement (EVFTA) in 2020. Successive reforms have also enabled the country to cope with a series of external shocks, e.g. the East Asian crisis of 1997 and the global crisis of 2008.

For many Developing Countries (DCs), export performance has become crucial in order to make international integration an efficient instrument for development. To this end, Vietnam is following the successive waves of rapid industrialization in East and Southeast Asia by conducting an export-oriented growth strategy. The country is one of the most open economies in the world (Figure 6.1) with high annual growth rates of exports and imports (an average of respectively 4.3% and 3.4% during the period 1990-2018). Moreover, fueled by the arrival of foreign investors, the country

Figure 6.1 – Trade openness in % of GDP for Vietnam, Developing Asia and LMI group (1990-2018)



Source: World Bank's World Development Indicators (WDI). Notes: 'Developing Asia' defines East Asia and Pacific (excluding high income) and 'LMI' Low and Middle Income. Trade openness is measured here by $(exports + imports)/2GDP$ **and expressed in %.**

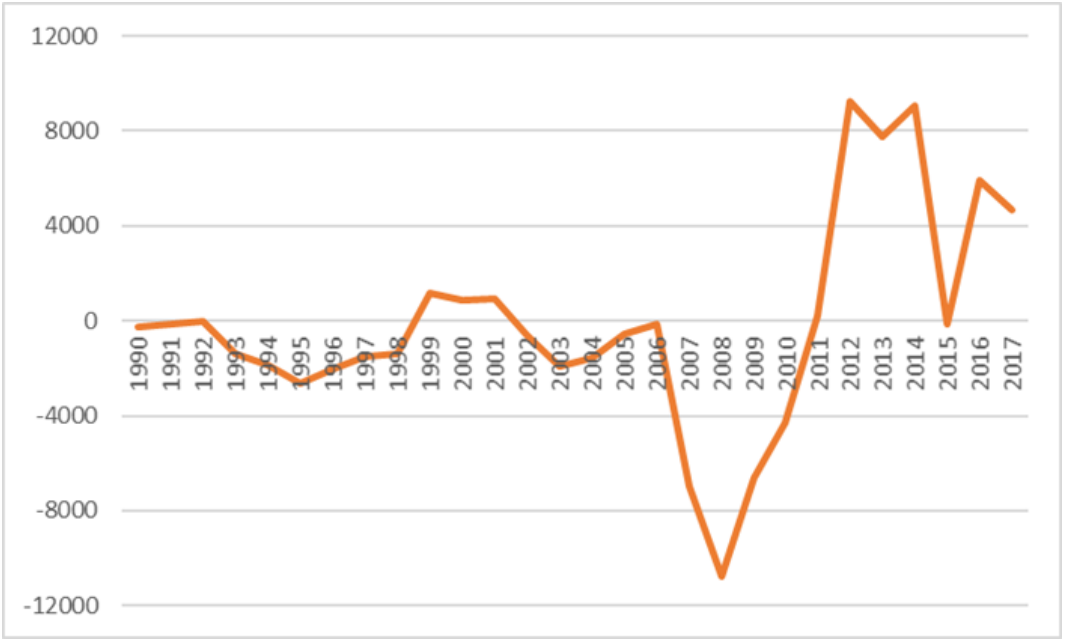
is deeply integrated in the Global Value Chains (GVCs), one of the prominent features of trade globalization. Today, electronics account for half of Vietnam's exports (World Bank, 2020a).

Because of geographic proximity and involvement in FTAs, Vietnam's neighbors aptly illustrate how important the choice of trading partners is. As noted by Kowalski et al. (2015), Vietnam is among DCs where the gap in the number of exported products and markets served has been bridged. Trade statistics from the World Integrated Trade Solution (WITS, World Bank) report that in 2017, the country exported 3831 products at HS6-digit to 143 destinations while it imported 4399 products from 141 countries. Though, 46 percent of the country's exports go to East Asia (19 percent to the US and 21 percent to Europe) while 79 percent of its import purchases come from the same area. Moreover, Vietnam is one of the most strongly integrated economies in the GVCs. According to measures of GVC participation such as the OECD-WTO Trade in Value Added (TiVA) database, Vietnam's GVC participation index is 55.6 percent of total gross exports in 2015 (14 points above the average rate for DCs) with an average growth rate of 16.4 percent per year over the period 2005-2015 (10 points higher than the one for DCs).

Export-oriented manufacturing clearly supports the country's economy. Heavily embedded in strong trade inter-linkages within the region and between geographical areas, GVC integration may however increase its economic vulnerability through tighter external constraint and weaker macroeconomic resilience to any potential shocks. A key concern then is whether Vietnam's trade-led growth is sustainable in the long run and whether it is resilient to global external shocks.

In light of this, the objective in the present paper is threefold. Firstly, we examine the country's growth performance over the past 30 years in reference to the Balance-of Payments-Constrained Growth (BPCG) model originally developed by Thirlwall (1979). More specifically, we measure the respective contribution of Vietnam's trading partners to its BPCG rate. To do this, we use the disaggregated Thirlwall's law proposed by Bagnai et al. (2016) who examined Vietnam's growth in a multi-country level with annual data from 1985 to 2010. The present paper conducts the analysis over a more recent period 1990-2017: first, although Vietnam officially embraced Doi Moi in 1986, there is a common consensus among researchers that 1989 marks the emergence of the country's "socialist-oriented market economy". Second, we update the investigation by considering a longer time span after 2007, when Vietnam became a WTO member.

Figure 6.2 – Vietnam's current account balance in current USD millions (1990-2017)



Source: International Monetary Fund

Secondly, this multi-country setting allows us to analyze how, and through which

transmission channels, the changing geography of international trade has impacted the evolution of Vietnam's external constraint before and after WTO accession. Figure 6.2 depicts the evolution of Vietnam's current account balance from 1990 to 2017. While external trade was relatively balanced during the first years of transition reforms, 2007 marked a break when the accession to WTO was accompanied by a large deficit followed by a surplus. From that year onwards, Vietnam experienced macroeconomic turbulence. Given its heavy reliance on foreign-based determinants, a decomposition of the external constraint in different factors from different sources aims at addressing the post-WTO outcomes.

Lastly, our paper is a first attempt to assess the country's ability to face global external shocks like the current Covid-19 pandemic. Because it hits hard all countries across the world, the economic repercussion of the pandemic will clearly depend upon the extent to which trade reliance has ensured export-led growth in the emerging economies. Given its deep integration into the global economy, we will examine here how the geography of trade has become a key concern in determining Vietnam's vulnerability to unpredictable shocks, corroborating recent development studies that make a case for diversification (in exported products or in partner countries) and growth re-orientation to build macro resilience.

The remainder of this paper is organised as follows. Section 2 presents the BPCG model and the extension proposed in our study. Section 3 describes the general options of our econometric approach before we report and interpret our empirical findings in Section 4. Section 5 addresses the issue of macroeconomic resilience: it first develops a detailed analysis on how WTO accession has affected the country's external constraint. Considering the current global slowdown, it then presents some simulation exercises aimed at forecasting the impact of the Covid-19 shock on Vietnam's future growth. Section 6 summarizes our main results and concludes.

6.2 Research background

6.2.1 On the basic model

The BPCG model rewrites both the Post-Keynesian tenets of demand-led growth and the thoughts from Structuralism about the interaction between economic development and structural change. In contrast to the Neo-classical growth model, the original insight of the well-known Thirwall's law is that the Balance of Payments (BP) constraint limits a country's ability to raise its rate of economic growth in the long run, which is mainly determined by a qualitative evolution in the structure of

production and trade. In the author's view: *"the most important policy implication concerns a country's structure of production and trade because different goods have different production and demand characteristics"* (Thirlwall, 2019, p. 3).

Assuming the constancy of relative prices, Thirlwall's law postulates that the growth rate of an open economy which is consistent with its BP equilibrium (denoted here $\dot{Y}_{BP}$) is determined by the growth of its exports in volume ($\dot{X}$) divided by the income elasticity of demand for imports (π). To put it differently, the BP equilibrium growth rate depends on the growth of world income ($\dot{Z}$) and the relative size of the income elasticities of demand for exports (ε) and imports (π). This relation can be formulated as follows:

$$\dot{Y}_{BP} = \frac{\dot{X}}{\pi} = \frac{\varepsilon \dot{Z}}{\pi} \tag{6.1}$$

If the actual growth rate is lower than $\dot{Y}_{BP}$, the country will accumulate trade surpluses and become a net capital exporter. Conversely, if it exceeds $\dot{Y}_{BP}$, the current account worsens and the country will become a net capital importer, but this cannot continue indefinitely. An economy is "BP constrained" whenever its growth rate must adjust downwards to maintain the BP equilibrium. In the long run, $\dot{Y}_{BP}$ (or the BPCG rate) defines therefore the maximum rate that an economy can reach in compliance with its external equilibrium.

This original version provides a rationale for an export-led growth model because exports are the only component of demand whose growth simultaneously relaxes the BP constraint. To some extent, the latter measures a country's competitiveness *vis-à-vis* the rest of the world, which is expressed jointly in the income elasticity of exports (a positive effect on long-run growth) and the income elasticity of imports (a negative effect). Indeed, the changing composition of the export basket with, for example, a move towards new products with higher added value will result in an increase in the income elasticity of exports. By relaxing the external constraint, such structural transformation will affect positively the BPCG rate. Conversely, an increase in the income elasticity of imports will have the effect of tightening the BP constraint.

That is the reason why Thirlwall's law relates structural change in a country with its external constraint as the elasticity ratio is rooted in different patterns of production and trade. Accordingly, because they are both sides of the same coin, the expected outcomes of participation in GVCs should take into account not only the performance in exports but also the imported goods that are used to produce exports, *i.e.* a subsequent increase in the country's "appetite for imports" which is measured here by the income elasticity of imports (Bagnai et al., 2015). This implies

that an export-led growth with heavy reliance on foreign goods and services may be detrimental for long-run growth. The BPCG model has been applied in numerous DCs across the world and a detailed survey can be found in Thirlwall (Thirlwall, 2011, 2019). India (Razmi, 2005), China (Jeon, 2009) and Pakistan (Felipe et al., 2010) were the first attempts to conduct individual country studies in Asia. While the majority of empirics mainly emphasized Latin America and Africa, recent studies have applied the model to Indonesia (Felipe et al., 2019), Thailand (McCombie & Tharnpanich, 2013) and Vietnam (Bagnai et al., 2015). These studies update a previous one that were conducted by Ansari et al. (2000) in four Southeast Asian economies also known as the second-tier NICs, *i.e.* Indonesia, Malaysia, Thailand and the Philippines.

Studies of groups of countries with Asia were developed in a comparative perspective when the first attempts to extend the basic model emerged. Hussain (1999) fitted an extended model with capital flows to understand differences in the growth performance of a selection of African and Asian countries. Gouvea & Lima (2010) tested a multi-sectoral model for four Latin American countries (Argentina, Brazil, Colombia and Mexico) and four Asian countries (South Korea, Singapore, Malaysia and the Philippines), and compared their findings with the simple model. In contrast to Latin America, they found that the ratio of the sectorally-weighted income elasticities of exports and imports had risen in Asia, thereby impacting favorably on their BPCG rates. Drawing on an extended BPCG model, we conducted in the second Chapter a Structuralist approach that examines the impact of export diversification on economic growth for three samples of developing countries (Latin America, sub-Saharan Africa and Developing Asia).

Structural characteristics of developing countries are thus critical in tightening or loosening the external constraint, which is reflected here in the elasticity ratio. The need for structural change that Thirlwall (2019) consistently calls for provides theoretical insights for what New or Neo-structuralism has highlighted from the late eighties, *e.g.* North-South asymmetries are underpinned by the existence of endogenous and structural factors in patterns of production and trade, market structures and the evolving international context (Bresser-Pereira et al., 2014; Porcile & Yajima, 2019).

6.2.2 Our multi-country version of Thirlwall's law

In the basic model, the long-run economic growth of an open economy is determined by the growth of aggregate exports, which is in turn determined by the exogenously given growth of world income. In practice however, an individual coun-

try trades goods and services with a number of partner countries, and each bilateral trade relation may have different outcomes. Since the economic growth of one country depends on the growth rate of others through the external constraint, this mutual interdependence should be captured in a model with multilateral trade relations between the individual country and trading partners. By the same token, the import behavior should be differentiated among the selling countries in order to assess the critical role of geography in determining the import dependency.

A generalized model has been originally developed by Nell (2003), who disaggregates the world income growth variable into a multi-country setting. From an empirical standpoint, it allows to cope with the income elasticities of exports and imports to/from different partners. One drawback is that Nell (2003) assumes, rather than testing, the irrelevance of relative prices. However, recent studies on the BP-constrained approach have shown that relative prices matter in trade functions, with a likely impact on the BP constraint. Bagnai et al. (2016) solve this issue by allowing for a rigorous decomposition of the BP constraint to highlight asymmetries in relative price changes among partner areas. In view of this, we disaggregate the original Thirlwall's law while introducing a relative price term. It allows us to identify the role of structural parameters in determining BPCG rate predictions.

Our analytical extension assumes that a given country i has n trading partners. As a consequence, Equations 6.2 and 6.3 feature the conventional demand functions for imports and exports respectively, and Equation 6.4 sets an equilibrium condition for the current account as follows:

$$M_{ij} = \left(\frac{P_i}{E_{ij}P_j}\right)^{\psi_{ij}} Y_i^{\pi_{ij}} \tag{6.2}$$

$$X_{ij} = \left(\frac{E_{ij}P_j}{P_i}\right)^{\eta_{ij}} Y_j^{\varepsilon_{ij}} \tag{6.3}$$

$$P_i \sum_j X_{it} = \sum_j E_{ij}P_j M_{ij} \tag{6.4}$$

where P_i are country i export prices, X_{ij} is the real demand of partner j for country i exports, E_{ij} is the bilateral nominal exchange rate, P_j are export prices in j, and M_{ij} are country i imports from partner j, $\psi_{ij} > 0$ and $\pi_{ij} > 0$ are respectively the price and income elasticities of country i imports from partner j, $\eta_{ij} > 0$ and $\varepsilon_{ij} > 0$ are respectively the price and income elasticities of country i exports to partner j.

Taking the growth rates in 6.4, we obtain:

$$\dot{P}_i + \sum_j \nu_{ij}\dot{X}_{ij} = \sum_j \mu_{ij}(\dot{E}_{ij} + \dot{P}_j + \dot{M}_{ij}) \tag{6.5}$$

Where $\nu_{ij} = \frac{X_{ij}}{\sum_j X_{ij}}$ and $\mu_{ij} = \frac{E_{ij}P_jM_{ij}}{\sum_j E_{ij}P_jM_{ij}}$

ν_{ij} and μ_{ij} are respectively the market shares of partner j in country i total exports (in volume) and in country i total imports (in value). [22]

Solving for the growth rate of country i as before, and denoting $R_{ij} = P_i/(E_{ij}P_j)$ the bilateral relative price or Real Exchange Rate (RER, namely the ratio of domestic to foreign prices expressed in domestic currency), we obtain a multi-country version of Thirlwall's law:

$$\dot{Y}_{i,BP} = \frac{\sum_j \dot{R}_{ij}[\mu_{ij}(1-\psi_{ij}) - \nu_{ij}\eta_{ij}] + \sum_j \nu_{ij}\varepsilon_{ij}\dot{Y}_j}{\sum_j \mu_{ij}\pi_{ij}} \tag{6.6}$$

By allowing us to separately assess the contribution of each partner j to country i's predicted growth rate, our multi-country setting brings three main contributions to the basic model. Firstly, the numerator in equation 6.6 features both a relative price term and a volume term where the effects of the latter are easily identifiable, which is not the case of the former. On the one hand, the export volume term features a weighted sum of real export growth where the export market shares intertwine with the income elasticities to magnify trading partners' GDP growth. On the other hand, the relative price term is subject to behavioral parameters that enter into a bilateral Marshall-Lerner condition. A decrease in bilateral relative prices (*i.e.* a real depreciation, $\dot{R}_{ij} < 0$) has a positive effect on $\dot{Y}_{i,BP}$ provided the term in square brackets (whose sign depends on the trade-weighted price elasticities) is negative, that is: $\mu_{ij} - \mu_{ij}\psi_{ij} - \nu_{ij}\eta_{ij} < 0$. The denominator instead features a sum of bilateral income elasticities of imports weighted by the corresponding market shares that expresses country i appetite for imports $\pi = \sum_j \mu_{ij}\pi_{ij}$. In other words, the aggregate elasticity that plays a crucial role in the single country version of Thirlwall's law is nothing but a "black box" summarizing behavioral parameters that are likely be subject to changes.

A second important feature of our multi-country law is that it cannot be decomposed in bilateral terms. In fact, any bilateral deficit is not constrained *per se*, since in principle it could be financed by another bilateral surplus; as a consequence, the aggregate BP constraint cannot be expressed as an additive function of bilateral balances (Bagnai et al., 2015). However, as we will see, the extended law allows one

22. This asymmetric treatment of the market shares is a mathematical consequence of the fact that the summation in the left-hand side of the constraint 6.4 involves terms in volume, while the summation in the right-hand side involves terms in value.

to measure the contribution of partner j's variables to changes in the aggregate BP constraint of country i.

Lastly, under the assumption that relative prices are not trending, equation 6.6 becomes:

$$\dot{Y}^*_{i,BP} = \frac{\sum_{j=1}^{n} \nu_{ij} \varepsilon_{ij} \dot{Y}_j}{\sum_{j=1}^{n} \mu_{ij} \pi_{ij}} \tag{6.7}$$

which can be seen as a generalization of Perraton (2003)'s "strong" version of Thirlwall's law. The differences between equations 3.6 and 3.7 matter only to the extent that the strong hypothesis of relative price constancy is rejected. Otherwise, our full specification allows us to look into both changes in relative prices and in behavioral relations, and to assess their impact on the BP constraint in a unified framework.

This leads us to a key underlying premise of the basic model: an unimportant or neglected role of relative price (RER) in determining economic growth. A strand of literature in New Structuralism argues that not only the level of the RER, but also RER change affect export diversification and drive processes of import substitution (Porcile & Yajima, 2019). From a policy perspective, a real undervaluation is complement to industrial and macroeconomic policies that encourage economic diversification and structural change in the presence of market and institutional failures (Frenkel & Rapetti, 2014; Guzman et al., 2018). Applied to Thirlwall's law, the assertion is that *"levels of RERs can be important in tightening or loosening long-run BP constraints, even if rates of change in RERs are not"* (Blecker, 2016, p. 276). Even though the BPCG model is to be applied to the long run (in which case only the structural characteristics are crucial), this variable is particularly useful to explain growth deviations. Put together with the geography of trade (*i.e.* demand patterns of exports and imports), it means that a country's BPCG rate could be determined by other constraints than the productive structure and they could be more binding under certain conditions. What matters is a country's ability to exploit the benefits of keeping the prices of exportable products at competitive levels. In other words, the RER as a development-relevant policy tool is a necessary but not sufficient condition to support export-led growth.

The latter point is very appealing when applied to Vietnam. The country aptly illustrates a case of export-led growth strategy with full reliance on foreign-based determinants. While there is a potential channel for the RER to help structural change, the effect of upgrading the export structure however, may be small and ineffective when exports are intensive in imported inputs. In this respect, partners

matter. Therefore, we empirically test the model predictions for Vietnam.

6.3 Data and estimation issues

6.3.1 Data Analysis

In the empirical implementation of the model for the period 1990-2017, we consider Vietnam's ten key individual country or group of country partners and the 11th area will cover the rest of the world (Appendix 6.A presents the list of countries in each partner area). According to Comtrade statistics, these ten partner areas accounted in 2017 for respectively 90 percent and 91 percent of Vietnam's exports in volume and imports in value.

In a first step, the long-run elasticities featuring the BP constraint are estimated. Since Thirlwall's law deals with long-run growth, co-integration techniques were used. The long-run price and income bilateral elasticities are obtained through the following export and import functions:

$$m_{ijt} = \alpha_j + \psi_{ij} r_{ijt} + \pi_{ij} y_{it} + u_{jt} \ (j = A, B, C, D, E, F, G, H, I, J, K)$$

$$x_{ijt} = \beta_j - \eta_{ij} r_{ijt} + \varepsilon_{ij} y_{jt} + e_{jt} \ (j = A, B, C, D, E, F, G, H, I, J, K)$$

Lowercase letters denote variables in natural logs, then $r_{ijt} = p_{it} - e_{ijt} - p_{jt}$. u_{it} and e_{it} are error terms. ψ_{ij} and η_{ij} are respectively the long-run price-elasticities of imports and exports and π_{ij} and ε_{ij} are respectively the long-run income elasticities of imports and exports.

Descriptions about the data used for the analysis are detailed in Appendix 6.B. Before proceeding to estimation, we first test for the presence of unit root using Elder & Kennedy (2001) strategy. As reported in Appendix 6.C, all time-series have unit root except m_K (Vietnam's imports from the rest of the world) and x_J (Vietnam's exports to Latin America), which seem following a I(0). Taking into account these observations, co-integration techniques are used to estimate the long-run coefficients in trade functions.

When all variables in the equation are I(1), we test the existence of long-run relationship between variables with Engle & Granger (1987) co-integration residual augmented Dickey-Fuller (CRADF) test. If variables are co-integrated, the estimated coefficients are chosen as the long-run elasticities to calculate the BP-constrained

growth rate. Conversely, when co-integration test fails to reject the null of no co-integration, we suppose that the reason is the existence of a structural change in the long-run parameters. In order to consider that possibility, we apply Gregory & Hansen (1996) estimation for co-integration that account for structural breaks. Indeed, the authors propose some forms of models with "level" shift (a break in the intercept only) and trend or "regime" shift (a break in the intercept and in the slope). In the latter, the null hypothesis is no co-integration against the alternative that variables are co-integrated in the presence of a regime shift at an unknown date. Due to the small size of our sample, we consider the first case where the structural change is characterized by a break in the intercept only. To model breaks in intercepts, we generate a dummy variable $\varphi_{t\tau}$ defined as follows:

$$\varphi_{t\tau} = \begin{cases} 0 & \text{if } t \leq [T\tau] \\ 1 & \text{if } t > [T\tau] \end{cases}$$

Where T is the sample size, $\tau \in (0, 1)$ is the relative timing of the change point and [.] is the integer part. Thus, import and export functions become respectively:

$$m_{ijt} = \alpha_{j0} + \mu_{j0}\varphi_{t\tau} + \psi_{ij}r_{ijt} + \pi_{ij}y_{it} + u_{jt} \ (j = A, B, C, D, E, F, G, H, I, J, K)$$

$$x_{ijt} = \beta_{j0} + \mu_{j0}\varphi_{t\tau} - \eta_{ij}r_{ijt} + \varepsilon_{ij}y_{jt} + e_{jt} \ (j = A, B, C, D, E, F, G, H, I, J, K)$$

Where α_{j0} and β_{j0} are the intercepts before regime shift and $\alpha_{j1} = \alpha_{j0} + \mu_{j0}$ and $\beta_{j1} = \beta_{j0} + \mu_{j0}$ are the intercepts after regime shift. As this form of structural change affects solely the constant term, the variable coefficients, namely the long-run elasticities, are not impacted. If variables still appear not co-integrated, we apply Autoregressive distributed lag (ARDL) model suggested by Pesaran et al. (2001) which is appropriate for small samples (Tang, 2003) and can be applied regardless of whether variables are I(0) and I(1). Because of the latter argument, this last method is also used to estimate long-run elasticities for equations involving I(0) variables (*i.e.* m_K and x_J).

In regard to the import function, the ARDL (p1, p2, p3) model can be written in an error-correction form such as:

$$\Delta m_{ijt} = \alpha_0 - \alpha_1[m_{ijt-1} - \psi_{ij} r_{ijt} - \pi_{ij} y_{it}] + \sum_{k=1}^{p_1-1} \gamma_{1k} \Delta m_{ijt-k} + \sum_{k=1}^{p_2-1} \gamma_{2k} \Delta r_{ijt-k} + \sum_{k=1}^{p_3-1} \gamma_{3k} \Delta y_{it-k} + e_{jt}$$

Where α_1 is the adjustment term, ψ_{ij} and π_{ij} are the price and income elasticities respectively, and γ_{1k}, γ_{2k} and γ_{3k} are short-run parameters. Pesaran et al. (2001) propose bounds test procedure to observe whether there is a long-run relationship between variables. Critical values of t-statistic and F-statistic are compared with the upper and the lower bound p-values. The lower bound corresponds to the case where all variables in equation are I(0) and the upper bound correspond to the case where all variables are I(1). The null of no co-integration cannot be rejected if the two statistics are below the lower bound, and conversely, the null can be rejected if the values of the two statistics are higher than the upper bound. No decision can be made if the values are between the two bounds. Finally, if the two tests reject the null hypothesis, we accept the existence of a long-run relationship between the variables m_{ijt}, r_{ijt} and y_{it}. Export function parameters are estimated similarly.

6.3.2 Estimation results on the long-run elasticities

Due to limited space, we report in Appendix 6.D estimation results on the long-run elasticities for import (Tables 6.12 to 6.15) and export (Tables 6.16 to 6.20) demand functions. Table 6.3 summarizes trade elasticities that will be used to construct the BPCG rate. On the whole, the income elasticities for both exports and imports are found to be statistically significant with the relevant sign. They are higher on the export than the import side, with the largest ones that are featured in the US, Japan, and the EU (*i.e.* the Northern partners). Asymmetry in the income elasticities implies that with unchanged relative prices and market shares, GDP growth rates of these key partners will highly impact on the corresponding bilateral balance.

On the contrary, relative price elasticities are statistically significant only in few cases, with the largest number on the export side. In accordance with Bagnai et al. (2015), it is confirmed that price elasticities of Vietnam's bilateral imports are rather insignificant. Interestingly, they are statistically significant with a negative sign for China and Japan. This counter-intuitive sign is consistent with most recent findings on the Asian economies (Hooy et al., 2015; Phi & Tran, 2020). Garcia-Herrero & Koivu (2008) were the first to report a negative RER elasticity of China's imports as a direct consequence of Asia's vertical integration. Any real appreciation of the Renminbi (an increase in Chinese prices relatively to foreign ones) reduces both China's exports and imports that are directed to exporting. Following China's

Table 6.3 – A summary of the estimated elasticities

	Bilateral Imports		Bilateral Exports	
	Income	Prices	Income	Prices
CHN	1.758***	-3.148**	2.521***	1.158*
JPN	2.703***	-0.629***	10.567***	0.860***
KOR	2.756***	*ns*	3.813***	-0.734***
IND	3.402***	*ns*	4.566***	*ns*
RoA	2.370***	*ns*	2.026***	0.915***
USA	2.647***	*ns*	11.298***	0.721*
OTPP-HI	2.364***	0.778*	4.054***	1.947**
EU-28	1.891***	*ns*	8.556***	*ns*
AFR	3.539***	*ns*	3.743***	*ns*
LA	3.839***	*ns*	6.869***	*ns*
ROW	1.357***	*ns*	3.840***	*ns*

Notes: ns stands for not significant. ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10%

footsteps in the regional waves of export-led growth, Vietnam confirms a negative value of import price elasticities in bilateral trade with the main Asian players.

As far as the export equations are concerned, price elasticities are statistically significant and correctly signed with OTPP-HI partners, the US and most of Asian partners. Against all odds, it is significant but of negative sign for South Korea. When the bilateral RER appreciates, Vietnam's exports to South Korea increase rather than fall: a result which is hard to ascertain. In fact, a number of recent studies question the role of involvement in GVCs in determining the RER's impact on trade. Using a panel framework covering 46 countries over the period 1996-2012, Ahmed et al. (2017) analyse how the formation of GVCs has affected the exchange rate elasticity of exports over time and across countries. With a FTA which came into force in 2007, ASEAN has become an important trading partner for South Korea (the second largest one after China), with imports growing even faster than exports. By estimating South Korea's bilateral import demand functions from ASEAN, Ha et al. (2016) find a sign for the long-run RER elasticities which is against expectation for four countries, *i.e.* a real depreciation of the Korean won increases the country's imports. Our explanation relies on Gopinath et al. (2020) who define a "dominant currency paradigm" in considering GVC integration, *i.e.* the US dollar is the main currency of trade invoicing for the majority of exports around the world. Given

that the exchange rate pass-through into trade prices depends on how a country's currency fares against the US dollar, any competitive RER against the US dollar boosts South Korea's exports and the subsequent imports from where it sources inputs (here, Vietnam). Assuming a strong trade complementarity which characterizes South Korea and Vietnam in regional value chains, bilateral exchange rates have less explanative power.

6.4 The BP equilibrium growth rate

6.4.1 Overall analysis

In this part, we construct the average growth rates predicted by the BPCG model for Vietnam. A critical step consists in comparing our two variables from equations 6.6 and 3.7 with the actual rates ($\dot{Y}$): the purpose is to test whether or not the country's growth was BP constrained over the period from 1990 to 2017. Moreover, since Vietnam joined the WTO in 2007, we next examine separately the two sub-periods before and after the accession.

As shown in Table 6.4, the empirical results provide evidence that over the whole period, the Vietnamese economy grew slightly at a lower rate (6.83%) than the one predicted by the generalized BPCG model (6.96%). This result is consistent with stylized facts as the accumulated current account was close to balance during the period 1990-2017. Globally speaking, Vietnam was respecting its BP constraint and our generalized Thirlwall's law aptly predicts its long-run growth path. To deeper understand the meaning of this broad result, it is necessary to break down into the explanatory elements from equation 6.6. Accordingly, the last column in Table 6.4 reports the different terms by aggregating over partner j contribution.

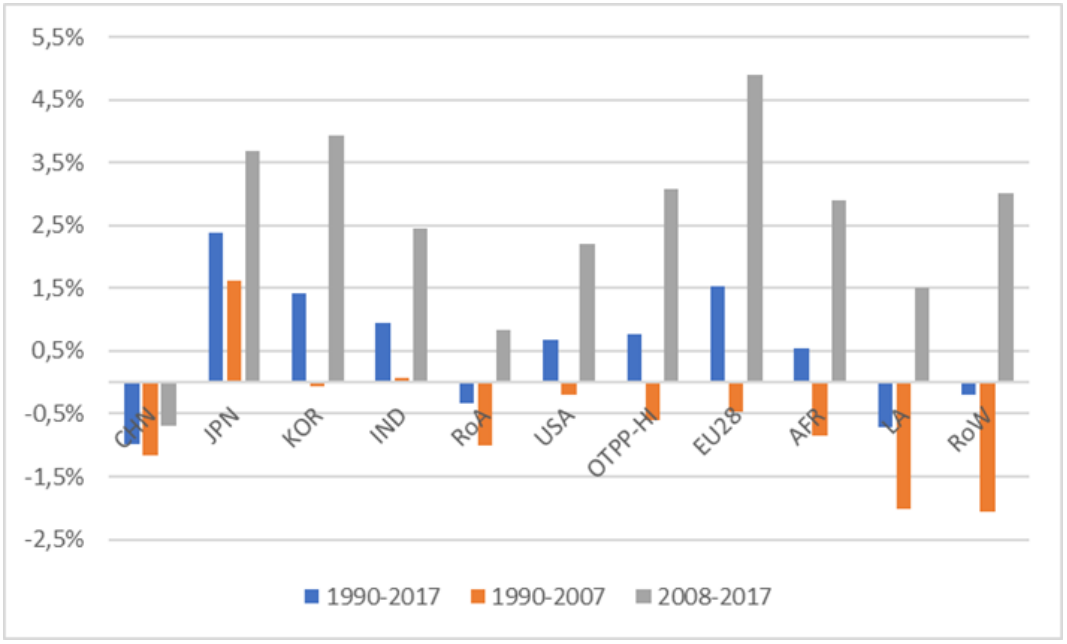
Though weak, relative prices have first to be considered as we can see that the strong law defined by equation 6.7 overvalues the constrained growth rate by about 0.22 percentage point (7.18% vs 6.96%). A negative sign in the first line, last column means that the relative price term tightened the BP constraint over the period considered and it was mainly explained by China (-0.007). In fact, Figure 6.5 plots favorable evolution in Vietnam's prices relatively to China, the rest of Asia, Latin America and to a lesser extent the rest of the world (the blue bars for the period 1990-2017). However, as the market-share-weighted Marshall-Lerner condition is not satisfied in the related cases, the subsequent real depreciation did not help to loosen the BP constraint. More generally, the Marshall-Lerner condition may no longer be verified as trade globalization gathers pace. It only holds when we consider either

Table 6.4 – Geographical breakdown of Vietnam's BoP constrained growth rate (1990-2017)

	CHN	JPN	KOR	IND	RoA	USA	OTPP	EU28	AFR	LA	RoW	Total
$\dot{R}_{ij}[\mu_{ij}(1-\psi_{ij}) - \nu_{ij}\eta_{ij}]$	-0.007	0.001	0.002	0	0	0	-0.001	0.002	0	0	0	-0.005
$\nu_{ij}\varepsilon_{ij}\dot{Y}_j$	0.025	0.019	0.006	0.003	0.015	0.034	0.006	0.034	0.002	0.004	0.009	0.157
$\mu_{ij}\pi_{ij}$	0.371	0.291	0.352	0.058	0.528	0.08	0.055	0.187	0.021	0.052	0.193	2.187
$\dot{Y}_{BP} = 6.96\%$												
$\dot{Y}*_{BP} = 7.18\%$												
$Y_{BP} = 6.83\%$												

the whole period or distinctive sub-periods for Vietnam's bilateral relations with the US and OTPP-HI partners, *i.e.* Canada, Australia and New Zealand.

Figure 6.5 – Average annual growth rates of relative prices by trading partner (in %)

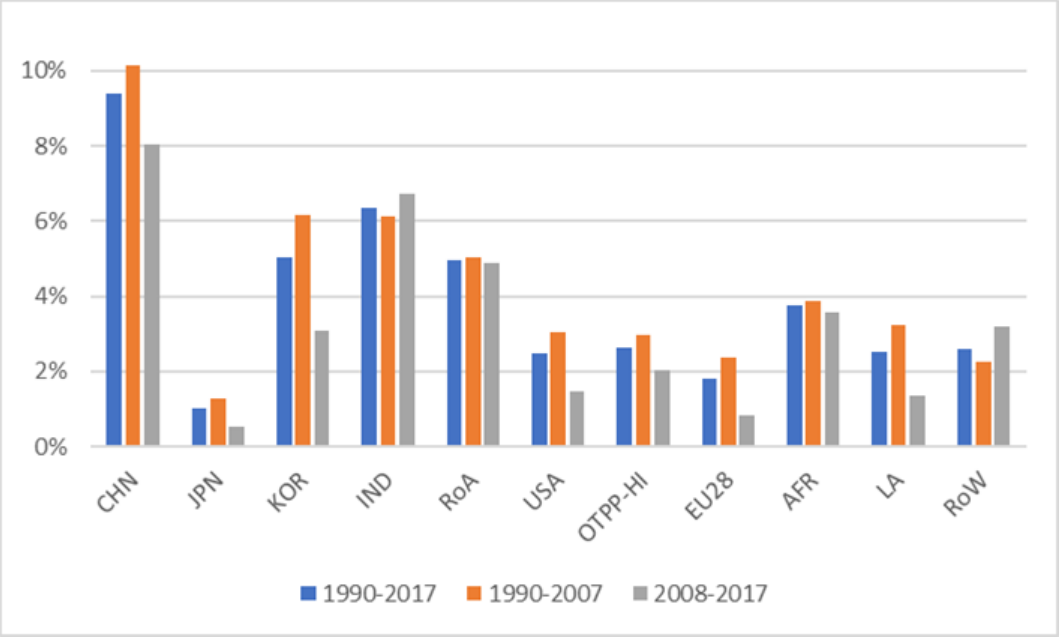


Source: Comtrade, Authors' calculations

Regarding the volume effect (a weighted sum of real export growth) in equation 6.6, four main partners played a crucial role over the period, namely: CHN, JPN, USA, and UE28. Income changes result from the interaction between partners' growth, the bilateral income elasticity and the market share of exports. In particular, the high income elasticity of exports explains a prominent role of USA, JPN, EU28 (Table 6.3) while it is mainly due to high GDP growth for CHN (Figure 6.6). Though, Figure 6.7 (a) depicts the evolving shares on different partner markets of Vietnam's total exports in volume. From 2000 to 2017, China and the US replaced the EU and Japan to become the leading export markets for the country. As the former are the two principal trading partners of most countries in Asia and the Pacific Rim, a favorable evolution in this behavioral parameter reveals that Vietnam has gained relative competitiveness *vis-à-vis* its main competitors on the Chinese and US markets.

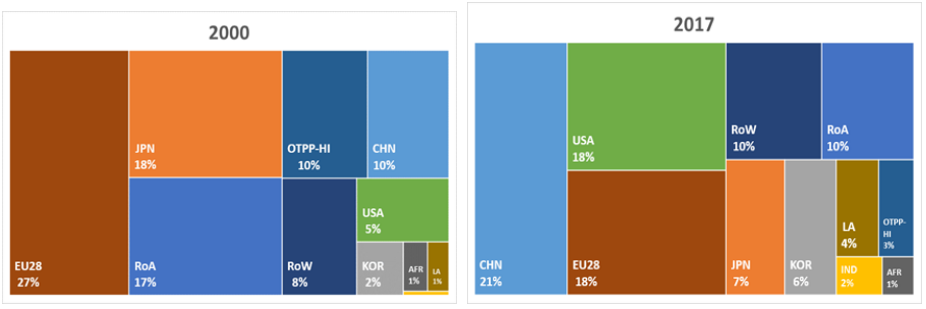
The denominator instead features a sum of bilateral income elasticities of imports weighted by the corresponding market shares in value. Unsurprisingly, the most significant contributions come from regional partners, namely: RoA, CHN and to a lesser extent KOR, JPN. By 2017, these partners accounted for the bulk of Vietnam's

Figure 6.6 – Average annual GDP growth rates for Vietnam's trading partners (in %)



Source: Comtrade, Authors' calculations.

(a) Exports in volume



(b) Imports in value

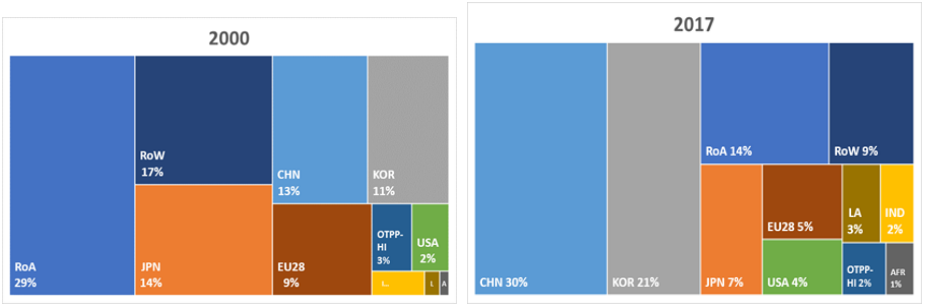


Figure 6.7 – Trade market shares (in %)

Source: Comtrade, Authors' calculations.

imports in value (Figure 6.7 (b)) and explained 70.5% of its appetite for imports.

6.4.2 An analysis by sub-period

Substantial differences emerge when we split the period considered before and after Vietnam's accession to the WTO. What the empirical results by sub-period reveal is that there are clearly two distinctive stages: the country was respecting its BP constraint during the sub-period 1990-2007 when the actual growth averaged 7.3%, while it grew above the BPCG rate after 2007 at an actual average rate of 6% (Table 6.8). Our evaluation across time provides information on the sustainability of growth because a comparison of the predicted rates shows that Vietnam's external constraint shifted downward, compelling the country to slow down its actual growth rate in order to maintain the BP equilibrium. The generalized BPCG as well as the actual growth rates both declined from 1990-2007 to 2008-2017, with a spread of respectively 1.7 and 1.3 percentage points. This gap is even worse when we take into account the strong law (first column), meaning that changes in the export volume term and in the appetite for imports were prevailing in the result.

Table 6.8 – Vietnam's BoP constrained and actual growth rates by sub-periods

	$\dot{Y}*_{BP}$	$\dot{Y}_{BP}$	$\dot{Y}$
1990-2017	7.20%	7.00%	6.80%
1990-2007	8.00%	7.50%	7.30%
2008-2017	5.60%	5.80%	6,00%
08-17/90-07 change	-2.4	-1.7	-1.3

In the first sub-period 1990-2007, the *Doi Moi* policy implied subsequent favorable bilateral prices relatively to all partner areas except Japan and in minor respects India (Figure 6.8). But against expectations, the relative price term in equation 6.6 tightened Vietnam's aggregate BP constraint, which is explained by the unfulfilled market-share-weighted Marshall-Lerner conditions. Only in the US and OTPP-HI cases this real depreciation intertwined positively with a negative Marshall-Lerner condition to improve bilateral balances. In the post-WTO accession era instead, relative prices were deteriorating with most partners except China (the grey bars in Figure 6.5) but their effect were very negligible. The BP constraint appeared to be binding and this is consistent with Figure 3.2 (in Introduction) where a slight surplus on the current account was registered first, then it turned out to be in turbulence after 2007.

Overall, Vietnam achieved rapid growth in recent years but it proved to be unsustainable and the macroeconomic stability was deteriorating consequently. One

wonders if this deceleration of the average growth rates predicted by the generalized Thirlwall's law is the result of WTO accession, in which case the integration process impacted on behavioral parameters. A matter of serious concern is the fact that the export volume effect and the appetite for imports both worsened after Vietnam joined the WTO. In the light of recent trends, the behavioral parameters associated with the two latter terms are especially worrisome as the Regional Comprehensive Economic Partnership (RCEP) is expected to deepen countries' involvement in regional supply chains. With the aim of boosting trade around Asia and the Pacific Rim, the RCEP negotiations bring together 16 countries (namely the 10 ASEAN members and the 6 countries that already have a bilateral FTAs with ASEAN [23]) to build up a regional FTA (Phi & Tran, 2020). This RCEP competes with the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP, also known as TPP-11), when the US withdrawal from the former Trans-Pacific Partnership (TPP) forced the remaining nations to renegotiate and sign a new agreement in 2018.

6.5 Trade-led growth and macroeconomic resilience

Vietnam's accession to the WTO paved its way into the global economy, with bilateral and multilateral FTAs. This membership opened a new chapter with growing FDI, expanding trade relations and deep integration efforts into the global economic map. As a result, trade (as the sum of exports and imports of goods and services) reached 208.3% of GDP in 2018 while separate exports and imports averaged respectively 84.1% and 85.7% of GDP [24] during the post-WTO sub-period. To get a sense of perspective, the same shares were only 28.8% and 26% for the developing Asia, and 26.3% and 26% for the whole DC group.

However, one wonders if this huge step forward explains build-up pressures on the country's macro resilience. Because of strong mutual interdependence within the region and between geographical areas, an export-oriented growth strategy may increase Vietnam's economic vulnerability through tighter external constraint and higher exposure to any exogenous shocks. To some extent, Vietnam's performance is nothing but a case study which brings back Structuralist thoughts about a systemic interdependent growth of the centre and the periphery. It questions the relevancy of trade-led growth strategy in breaking out economic dependency and the subsequent need to reformulate development models.

23. ASEAN's FTA partners are China, South Korea, Japan, India, Australia and New Zealand.
24. When otherwise mentioned, data come from the World Development Indicators database (WDI, World Bank).

Against this background, the objective here is twofold. Firstly, we examine how, and through which transmission channels, the WTO accession impacted the evolution of Vietnam's external constraint onwards. Secondly, we attempt to assess the country's ability to face global external shocks like the current Covid-19 outbreak. Because it hits hard all countries across the world, this question consists in evaluating the repercussion of this historically unprecedented event on long-run growth.

6.5.1 How WTO accession can explain the external constraint development ?

Because $\dot{Y}_{VN,BP}(1990-2007) > \dot{Y}_{VN,BP}(2008-2017)$, it means that Vietnam's BP constraint tightened after joining the WTO. This calls for further investigation on the channels through which deep integration with the world economy shifted the external constraint downward. As stressed in the extended model, the generalized law cannot be additively disaggregated. However, it still makes sense to analyze the contribution of each explanatory variable and/or partner area to the change in the BP constraint between the two sub-periods.

Owing to its structure, Eq 6.6 can be then decomposed linearly through a Taylor series expansion as follows:

$$\Delta\dot{Y}_{VN,BP} = \sum_j \left[\underbrace{\Delta\dot{Y}_j \frac{\partial\dot{Y}_{VN,BP}}{\partial\dot{Y}_j}}_{\text{partner growth}} + \underbrace{\Delta\nu_{ij} \frac{\partial\dot{Y}_{VN,BP}}{\partial\nu_{ij}}}_{\text{export market share}} + \underbrace{\Delta\mu_{ij} \frac{\partial\dot{Y}_{VN,BP}}{\partial\mu_{ij}}}_{\text{import market share}} + \underbrace{\Delta\dot{R}_{ij} \frac{\partial\dot{Y}_{VN,BP}}{\partial\dot{R}_{ij}}}_{\text{relative price}} \right] + R \tag{6.8}$$

Where Δ represents change in the variables between 1990-2007 and 2008-2017 sub-periods and the last term R is the remainder of the approximation.

It is then possible to disaggregate the BP constraint development into four components expressed in equation 6.8 . The following partial derivatives with respect to partner j's variables represent change relatively to the 2008-2017 sub-period:

$$\frac{\partial\dot{Y}_{VN,BP}}{\partial\dot{Y}_j} = \frac{\nu_{ij}\varepsilon_{ij}}{\sum_{j=1}^{11}\mu_{ij}\pi_{ij}}$$

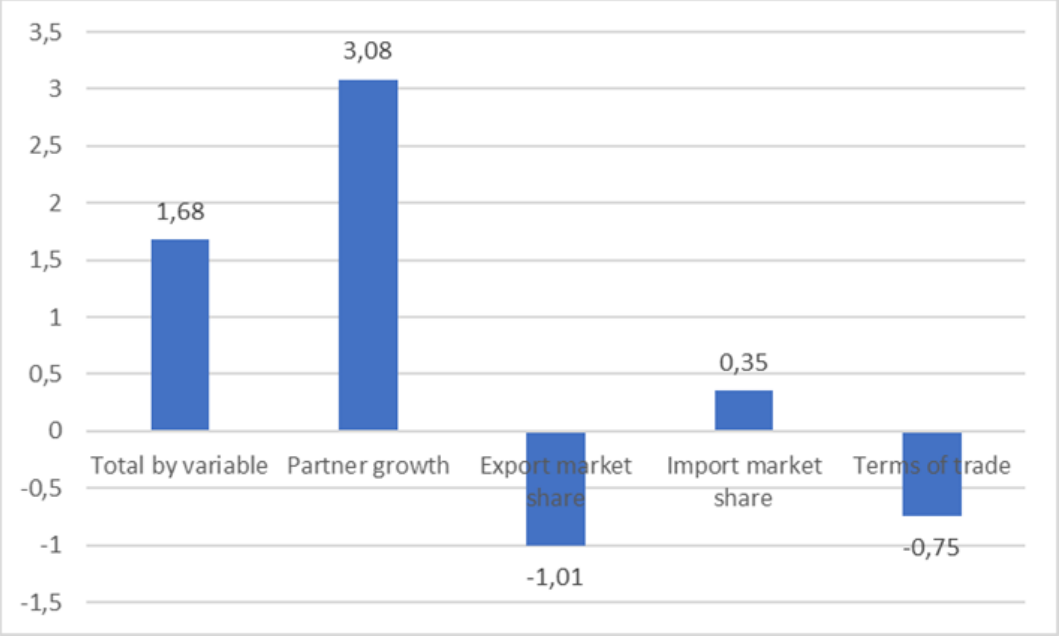
$$\frac{\partial\dot{Y}_{VN,BP}}{\partial\nu_{ij}} = \frac{\varepsilon_{ij}\dot{Y}_j - \dot{R}_{ij}\eta_{ij}}{\sum_{j=1}^{11}\mu_{ij}\pi_{ij}} = \frac{\dot{X}_{ij}}{\sum_{j=1}^{11}\mu_{ij}\pi_{ij}}$$

$$\frac{\partial\dot{Y}_{VN,BP}}{\partial\mu_{ij}} = \frac{\dot{R}_{ij}(1-\psi_{ij}) - \pi_{ij}\dot{Y}_{VN,BP}}{\sum_{j=1}^{11}\mu_{ij}\pi_{ij}}$$

$$\frac{\partial \dot{Y}_{VN,BP}}{\partial \dot{R}_{ij}} = \frac{\mu_{ij}(1-\psi_{ij}) - \nu_{ij}\eta_{ij}}{\sum_{j=1}^{11} \mu_{ij}\pi_{ij}}$$

Some major features in this disaggregation deserve mention by looking first at the broad breakdown in Figure 6.9. Recall that all the derivatives are evaluated in the last sub-period: assuming an overall decline of 1.68 percentage point in the predicted growth rates between 1990-2007 and 2008-2017 (equivalent to the spread of 1.7 in Table 6.8), a positive change associated with one component explains the overall decline in the BPCG rate. Conversely, a negative sign means that it mitigates the decrease. Aggregating over the four last bars (*i.e.* the four effects) will correspond to the total change (the first bar).

Figure 6.9 – Breakdown of the total tightening in Vietnam's BoP constraint between the two sub-periods 1990-2007 and 2008-2017



Source: Comtrade, Authors' calculations

The largest contribution to Vietnam's BP constraint development is partner growth effect. By neutralizing the three other effects, it means that the constraint tightening would have been 3.08 points if this isolated partner growth effect had occurred. As shown in Figure 6.6, all trading partners' growth decelerated after 2007 (lower grey bars) except India and the rest of the world. Another unfavorable effect is import market shares. According to Kowalski et al. (2015), Vietnam is an interesting example of rapid diversification in imports. To diversify risks, the average value of the number of imported products and the number of import sources were

larger than was the case for exports. In our view however, the heavier appetite for imports with export orientation is emphasized as an obstacle for achieving higher long-run growth.

The contribution of the two other effects (export market shares and relative price change) to the BP constraint tightening turned instead negative. When the WTO accession came into force, Vietnam benefited from better access to foreign markets and higher export market shares helped to counterbalance partially the unfavorable partner growth effect. The aggregate effect of relative price change depends instead upon whether the bilateral Marshall-Lerner condition is fulfilled or not. The grey bars in Figure 6.5 plot unfavorable change in relative prices between the two sub-periods; but the bilateral Marshall-Lerner conditions are unfulfilled in most cases, with the unexpected result of easing Vietnam's external constraint. This provides evidence that the RER variable is only one part of an export-led strategy so long as the effects of export and import market shares both enter into the BP constraint development.

Because the external constraint is one of the main obstacles for raising Vietnam's growth, we can see that the geography of trade clearly explains the problem. Therefore, we assess partner j contribution to the overall tightening between the two sub-periods. Table 6.10 reports the elements of the full breakdown by effect and by partner area. For the sake of simplicity, the various contributions are expressed as a percentage of the aggregate decrease in the BPCG rate after 2007. For instance, the different effects by aggregating over partner j contribution (last column of Table 6.10) are those depicted in Figure 6.9. The total partner growth effect (first line, last column) contributes to 181.3% (3.08/1.68) of the overall decrease. We have the same breakdown when we aggregate over the different effects by partner area (last line of Table 6.10).

Looking first at this bottom line allows us to understand how the changing geography of trade has constrained more or less Vietnam's BP equilibrium. The US, EU28 (and to a lesser extent, Japan) contributed the most to the overall downward shift whereas the rest of the world, the rest of Asia and South Korea contributed instead to the opposite. This line of interpretation sheds some light on trade diversification or conversely, increased dependence on specific foreign partners to explain Vietnam's macro resilience. We can observe that only the rest of the world (about 10% of Vietnam's total trade) contributes favorably in all disaggregated effects while bilateral trade with the other partner areas shows mixed results.

When crossing the partner/effect level, income changes clearly dominate the BP constraint development with the largest unfavorable effects resulting from GDP

Table 6.10 – A full breakdown of the total decrease in Vietnam's BoP-constrained growth rate between 1990-2007 and 2008-2017 by effect and by partner area (in %)

	CHN	JPN	KOR	IND	RoA	USA	OTPP	EU28	AFR	LA	RoW	**Total by effect**
Partner growth	16.8	17.9	12.1	-0.8	0.9	75.4	3.7	56.1	0.4	8.4	-7.8	183.1
Export market share	-27.8	6.2	-7.2	-3.9	8.4	-34.2	1.2	6.6	-0.8	-2.9	-5.3	-59.7
Import market share	36.2	-6.6	4.5	4.2	-18.9	4.9	-0.9	-7.2	1.4	7.4	-3.8	21
Relative prices	-10.7	-2.6	-15.3	-1.2	-2.8	5.1	6.8	-7.7	-0.7	-1.9	-13.5	-44.5
Total by area	14.4	14.9	-5.9	-1.8	-12.3	51.1	10.8	47.8	0.4	11	-30.4	100

growth in the US (+75.4%) and the EU (+56.1%) and import market share attributed to China (+36.2%). In other words, Vietnam was hit by sluggish growth in the two Northern partners with the highest income elasticities of exports (USA, EU28) while a heavier reliance on Chinese sales hampered the BP equilibrium after 2007. On the opposite, two favorable channels helped to attenuate the BP constraint tightening. First, growing export market shares in the case of China (−27.8%) and the US (−34.2%) means that Vietnam gained relative competitiveness on the two largest individual export markets (Figure 6.7 (a)). Second, Vietnam loosened its appetite for imports from the rest of Asia through lower import market shares (−18.9%). In fact, one suspects that the latter was counterbalanced by the heavier appetite *vis-à-vis* of China (+36.2%). In 2017, China and South Korea captured the lion's share for respectively 30% and 21% of Vietnam's imports in value at the expense of the other ASEAN members (Figure 6.7 (b)). Both countries are the most tangible aspects of Vietnam's integration into regional value chains (in electronics for example) and explain the counter-intuitive sign on the corresponding price elasticities (see Table 6.3).

The fact that the sign of the relative price change effect depends on two elements shows the conditions under which partner j contributes to improve or worsen Vietnam's constraint development. Firstly, bilateral relative prices consistently decreased only *vis-à-vis* of China ($\dot{R}_{ij} < 0$ in Figure 6.5), which is at odds with Japan. Vietnam has gained price competitiveness in exports specifically to China, the first and most important trading partner. However, the lower real depreciation after 2007 is associated with a bilateral Marshall-Lerner condition which is positive and greater than 1 to explain a favorable relative price contribution (−10.7 in Table 6.10). By contrast, a weighted Marshall-Lerner condition which only holds in the US and OTPP-HI cases implies that the increase in Vietnam's relative prices against those countries tightened the BP constraint. Lastly, according to our estimation results in Table 6.3, insignificant price elasticities in exports and imports imply that only the bilateral "pure terms of trade" effect (measured by μ_{ij}, *i.e.* the market share of partner j in Vietnam's total imports in value) plays a role in the specific cases of India, EU28, AFR, LA and the rest of the world. That is the reason why the relative price effect evolved favorably here.

All put together, a first worrisome matter deals with China, where Vietnam's growing export competitiveness is traded off by a higher appetite for imports. On average over the post-WTO sub-period, our data on China-Vietnam trade show that the import market share was twice the case for the export market share. A substitution effect occurs as China has replaced the rest of Asia (notably the ASEAN

members) in supplying Vietnam's imports.

A second worrying concern is about the extent to which a trade-led growth heavily depends on the structure of the multi-country BP constraint. Even if Vietnam wants to do well in terms of export performance, such a strategy is sustainable in the long run provided high income elasticities with relevant market shares on the export side interact with foreign demand growth. Unfortunately, sluggish growth in the Northern partners (the US, the EU and Japan) points out the fact that development in the centre is still decisive for the periphery. In addition to this export volume effect, Vietnam benefited from favorable change in relative prices in all partner areas except the US, Canada, Australia and New Zealand. In brief, high-income countries that are out of the Asian area have become "bad" partners by worsening the external constraint both in price and export volume terms.

6.5.2 Trade-led growth and balance of payments constraint in the face of global shocks

In a joint report published by the World Bank and the Ministry of Planning and Investment (World Bank & Ministry of Planning and Investment of Vietnam, 2016), the Vietnamese government set the goal of achieving an annual per capita GDP growth rate of 7% (equal to a $7\% - 8\%$ GDP growth rate for the period 2011-2020). This goal was very ambitious because it is by far higher than the country's growth rate in the past and only few countries in the world managed to achieve this. This growth rate would help the country to become an upper middle-income country by 2035 and a high-income one by 2045, the level that South Korea reached during the last decade of the 20th century.

The matter however is that the Covid-19 pandemic has come to hit hard all countries across the world. So far, the economic impact of the ongoing COVID-19 crisis is hard to predict, given the uncertainty surrounding its magnitude and duration. Vietnam's GDP growth rate is projected to fall but thanks to strong fundamentals and proactive measures at the national and subnational levels, and assuming relative control of the COVID-19 pandemic in the country, the economy should rebound in 2021. The World Bank (2020a) forecasts GDP growth rate at 2.8% in 2020 and expects the economy to resume faster in 2021 with 6.7%. Yet, the upcoming economic crisis stresses challenges that continue to confront the government, notably the need for structural transformation to drive economic growth.

This last part aims to measure the medium-term repercussion of the Covid-19 shock on Vietnam's future. To do this, we compare the growth rates predicted by

our model with those published by the IMF. A baseline scenario is set up from growth projections for the 2018-2024 period that were published in October 2019, *i.e.* just before the covid-19 crisis (IMF, 2019). This scenario therefore constitutes a growth scenario without the impact of Covid-19 on Vietnam's and trading partners' GDP growth. It will be confronted with updated projections revised by the IMF in June 2020 amid the pandemic (IMF, 2020). The latter scenario, called thereafter the Covid-19 scenario, is very optimistic as it assumes the pandemic to end in the second part of 2020 without any rebound in the spread of the virus, allowing for a gradual lifting of containment measures. In this optimistic scenario, the global recession would be of 4.9% in 2020 followed by a gradual recovery at 5.4% in 2021. In the specific case of Vietnam, the IMF forecasts an annual growth rate to slow down at 2.7% in 2020 in the worst circumstances, in contrast to 6.5% pre-crisis projections.

Departing from these two growth scenarios, we calculate the BPCG rate for Vietnam over the period 2018-2024 by considering that all behavioral parameters are kept unchanged. Moreover, because the relative price effect is negligible at the aggregate, we neglect it in our simulations. By allowing us to gauge the relative importance of different channels of transmission, the targeted research framework provides evidence on the important role of trade geography in the multi-country BP constraint.

Table 6.11 presents our results on the BP equilibrium growth rate predictions. The first two columns depict growth projections for trading partners published by the IMF respectively before (October 2019) and from the Covid-19 shock onwards (June 2020). The third column shows the percentage change in growth projections between the two scenarios while the last one expresses the various contributions of partners' GDP growth as a percentage of the overall change in the BPCG rate, *i.e.* $\dot{Y}_{VN,BP}(baseline) - \dot{Y}_{VN,BP}(Covid-19)$.

In 2020, the IMF forecasts that the economic slowdown would be much stronger in Northern countries than in emerging and developing countries, respectively around -8.0% (-8.0% in the US, -10.2% in the EU) and -3%. In the latter group, the countries most affected would be in Latin America (-9.4%) while those in Asia would experience a recession of around 0.8%. With extension of growth forecasts over the period 2018-2024, the IMF projects that the advanced countries will be seriously impacted by the Covid-19 pandemic. In the medium term, Japan is hit by a 104.1% drop in its average GDP growth, the EU by 64%, the US by 52.9%, and the other OTPP-HI partners (Australia, Canada, New Zealand) by 43.7%. Among emerging and developing countries, Latin America is the region that registers the

Table 6.11 – Some projections on Vietnam's economic growth (2018-2024)

Partners' growth	Baseline: IMF projections before Covid-19 pandemic	Covid-19 shock: updated IMF projections	Difference (% change)	Contribution (in%)
CHN	5.9	5.5	-6.1	3.3
JPN	0.6	0.0	-104.1	8.1
KOR	2.6	2.0	-22.3	2.4
IND	7.1	5.2	-26.1	2.4
RoA	4.8	4.0	-15.1	2.6
USA	2.0	0.9	-52.9	37.8
OTPP	2.1	1.2	-43.7	2.0
EU28	1.7	0.6	-64.0	28.5
AFR	3.6	2.9	-21.0	0.6
LA	2.0	0.5	-72.9	6.3
RoW	1.9	1.0	-47.6	6.1
$\dot{\boldsymbol{Y}}_{\boldsymbol{BP}}$	**6.2**	**3.6**	**-41.1**	**100**
VN	6.6	6.1	-7.2	

Sources: IMF(2019, 2020), author's calculations

worst recession (-72.9%). Conversely, it deserves mention that the Asian countries (with the exception of Japan) are relatively spared by the Covid-19 repercussion.

Unsurprisingly, since all countries across the world are affected by economic slowdown, the Covid-19 shock strongly tightens Vietnam's external constraint as the BPCG rate drops from 6.2% before the crisis to 3.6% thereafter (*i.e.* 2.6 point or 41.1%). In reference to the associated derivative that we developed previously, the partner growth effect is isolated here. It depends on three elements which show how partner j contributes more or less to worsen Vietnam's constraint tightening: the magnitude of the Covid-19 shock on j's income growth, Vietnam's share on j's export market and the income elasticity of j's demand for Vietnam's exports.

Vietnam is heavily affected by deep economic slowdown in the two destinations with the highest income elasticities of exports, *i.e.* USA and EU28. In total, these two Northern partners explain 66% of deterioration in Vietnam's BP constraint. Conversely, although China represents the first export market, it slightly contributes to this constraint tightening (3.3%) because the country is relatively spared by the global shock and the related income elasticity is rather low.

Lastly, we observe that the IMF forecasts a relatively weak impact of the Covid-19 shock on Vietnam's average growth rate for the period 2018-2024 as it only drops from 6.6% to 6.1% (*i.e.* 0.5 point or -7.2%). While the growth projections without

the Covid-19 crisis are relatively in line with the BPCG prediction (6.6% compared to 6.2%), the revised IMF projections are much higher (6.1% vs 3.6%). Yet, because the domestic growth will be constrained by foreign demand growth, the country will not respect its BP constraint. While the projected growth rate marginally exceeds the BP-constrained one in the baseline scenario, the spread is far higher in the Covid-19 scenario. If the latest IMF projections hold true, our results forecast that Vietnam will be exposed to a persistent current account deficit in the medium term. The country will then be forced to adjust its actual growth rate downwards to comply with the BP equilibrium.

6.6 Conclusion

For more than three decades, Vietnam's remarkable achievements in economic growth and poverty reduction have been overwhelmingly analyzed. It is broadly pointed out that this successful development results from an export performance which is largely driven by the FDI sector in export-oriented manufacturing (accounting for more than 70% of total exports). Drawing on a BPCG model, our study examines Vietnam's growth performance by measuring the respective contribution of different partner areas. In addition to behavioral parameters (*i.e.* market shares) revealed by bilateral trade statistics, we use the estimated price and income elasticities of exports and imports to show how structural change in the multi-country BP constraint impacts the maximum growth rate that the economy can reach.

Against all odds, we find that Vietnam's imports (respectively, exports) from China and Japan (South Korea) are negatively affected by real depreciation. This is a direct result of Asia's vertical integration, since a sizeable part of commerce with those countries is used to produce goods for re-export on global markets, making their trade patterns more complementary than substitutive. Most importantly, the market-share-weighted Marshall-Lerner condition may no longer be verified as trade globalization gathers pace. Our empirical results show that whatever the time span covered, the well-known condition is only fulfilled in bilateral relations with the US, Canada, Australia and New Zealand. By allowing the country to respond differently to RER movements, diversifying trading partners can then affect the sensitivity of Vietnam's imports and exports to changes in relative prices (the volume effect in the Marshall-Lerner condition).

Once constructed the average growth rates predicted by the BPCG model, a decomposition of the external constraint development in different factors from different sources is then proposed to assess the outcomes of WTO accession after 2007.

Lastly, we attempt to measure the medium-term repercussion of the Covid-19 shock on Vietnam's external constraint and the related growth predictions.

Globally speaking, Vietnam was respecting its BP constraint over the whole period considered and the predictions validate compliance with our generalized Thirlwall's law. First, albeit weak, an improvement in the relative price term (real depreciation) tightens the BP constraint and it is mainly explained by China. Second, a favorable income effect is attributed to high income elasticity of exports from JPN, USA, EU28 on the one hand, and to high GDP growth from China on the other. However, while Vietnam has gained relative competitiveness *vis-à-vis* its main competitors on the two largest individual export markets that are China and the US, the behavioral parameters associated with the appetite for imports are a matter of great concern, and it worsened after the country joined the WTO. In the post-WTO sub-period, the country appeared to be BP constrained while its external constraint was tightening. A decomposition of the BP constraint development into four components shows that the higher import dependency in the regional value chains is emphasized as an obstacle for achieving higher growth, with notably increasing appetite for imports attributed to China and South Korea. In the same vein, the largest unfavorable effects are sluggish growth in the US and the EU. A main implication from this study is that the geography of trade relations may help to understand growth deviations from the BPCG rate predictions.

Relying on the structure of the multi-country BP constraint, we finally measure the medium-term repercussion of the Covid-19 shock on Vietnam's external constraint. Again, we show that Vietnam is heavily affected by deep economic slowdown in the two export destinations with the highest income elasticities (USA, EU28). If the latest IMF projections hold true, our results show that Vietnam will be exposed to a persistent current account deficit in the medium term. A state of continuous dependence underlies trade-led growth strategy, which is a source of various vulnerabilities. In this respect, the choice of trading partners (and access to growth markets) is a key factor in the country's ability to relax the most binding constraints on the development of exports and the import dependency.

In some aspects, the Covid-19 shock is a historically unprecedented event which clearly highlights the risk of excessive reliance on export-led growth and FDI as a development strategy. It then corroborates Neo-structuralist idea that South's macro resilience deals with asymmetric impacts of global shocks, and the crucial role of geography of trade is prominently underlined in our multi-country setting. Indeed, our findings are consistent with Prebisch's idea that cycles in the periphery are tied to external conditions. As Bárcena & Prado (2016) note: *"While aggregate*

demand fluctuations in the past were often due to fiscal deficits financed through money creation, generally speaking, it may be stated that more recent variations have been due to external shocks." (p. 55).

In other words, though the export sector is a source of stimulus for aggregate demand, its contribution to a country's long-run growth may turn negative while the external constraint remains unsolved. Firstly, the economic performance of latecomers like Vietnam is largely determined by the architecture of international finance and trade. As Vietnam's manufacturing exports increase to generate GDP growth, the appetite for imports grows even more. Secondly, the countries are not isolated from unpredictable shocks. To some extent, the Covid-19 pandemic undermines further the basic tenets of globalization. It questions the relevancy of trade-led growth strategy in breaking out economic dependency and raises the need to reformulate development models. With its high exposure to global uncertainty, the country would be otherwise vulnerable to GVC disruptions and FDI outflows, challenging the viability of the current model to turn back to "export pessimism".

The good news for Vietnam is that, with an emergent middle class and an economic basis of viable size, the development of domestic markets could partially complement or even counterbalance its reliance on external trade and global markets (World Bank, 2020a). With the government's new strategy for the next 10 years, strategic plans aimed at linking the export-oriented manufacturing with the rest of the domestic economy will allow the country to strengthen spillover effects and build resilient growth. The push toward a qualitative rather than quantitative growth model also calls for further attention on more reliable domestic sectors, on the emergence of new activities in personal services (health care, tertiary education and skills development) and environmental sustainability, as Vietnam is one of the worst-affected countries by climate change. In other words, it is time now for Vietnam to build up specific pillars to such structural change in order to avoid the middle-income trap.

Appendix 6.A Vietnam's trading partner groups

Group A (China, CHN): China (including Hong-Kong, SAR).

Group B (Japan, JPN): Japan.

Group C (Korea, KOR): Korea.

Group D (India, IND): India.

Group E (Rest of Asia, RoA): Bangladesh, Bhutan, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Macao SAR, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand.

Group F (USA): United State of America.

Group G (Other Trans-Pacific Partnership-High Income countries, OTPP-HI): Australia, Canada, New Zealand.

Group H (European Union, EU-28): Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom.

Group I (Africa, AFR): Algeria, Angola, Burkina Faso, Cameroon, Dem. Rep. of Congo, Rep. of Congo, Cote d'Ivoire, Arab Rep. of Egypt, Ethiopia, Ghana, Guinea, Kenya, Libya, Madagascar, Mali, Morocco, Mozambique, Nigeria, Senegal, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe.

Group J (Latin America, LA): Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Venezuela RB.

Group K (RoW): Rest of the World.

Appendix 6.B Data sources and definitions

We use Comtrade database to construct Vietnam's bilateral trade flows, namely bilateral exports and bilateral imports in USD current prices. We cover the period 1990-2017 for each partner except for USA where the period 1994-2017 is selected because the embargo was only lifted in 1994. If data were missing, we reconstruct it from its "mirror". When a trade flow is reported by Vietnam and has at the same time its "mirrored" value, we calculate a weighted average (export flow weights for one third and import flow for two thirds).

The Rest of the World (RoW) series are deducted from difference between the total trade flow and the sum of partners' bilateral trade flows. Thus, to build our database, bilateral import volumes are calculated by deflating import series with

partner j's aggregated export deflator and bilateral export volumes are obtained by deflating export series with Vietnam's export deflator. We define the export deflator by the ratio of nominal to real exports in USD which are collected from the World Development Indicators (WDI) database.

Note that all real variables from WDI database are given in constant 2010 USD. Therefore, Vietnam's and its aggregated partners' real GDPs are directly extracted from the WDI database.

Relative prices are constructed as the ratio of domestic prices (expressed by Vietnam's export deflator) to foreign prices (defined by partner j's GDP deflator).

Appendix 6.C Unit root tests

To test variables for unit root, we follow Elder & Kennedy (2001) testing strategy that enhances the importance of the correct specification of the deterministic component of the time series. For macroeconomic data, it is important to identify the series' behavior first in order to eliminate unrealistic alternative hypothesis. Thus, by using a single test for unit root, this strategy allows to decide for the correct specification for the deterministic component.

By inspecting the plot, we verify if series are trending or nontrending. If series are trending, we apply an F-test for the null hypothesis $H_0 : \rho = 1, \beta = 0$ in the following model:

$$y_t = \alpha + \beta t + \rho y_{t-1} + \varepsilon_t$$

F-statistics non-standard distribution are compared with Φ_3 values of statistics in Dickey & Fuller (1981)'s Table IV. If test fails to reject the null, the series are I(1) with drift, otherwise, rejection of the null hypothesis indicate that variable is I(0) around a deterministic trend.

If series do not graphically follow a trending behavior, we perform the F-test for the null $H_0 : \rho = 1, \alpha = 0$ in the model:

$$y_t = \alpha + \rho y_{t-1} + \varepsilon_t$$

F-statistics are compared with Φ_1 Dickey & Fuller (1981) distribution. Failure to reject implies that the time series is I(1) without drift, conversely, rejection of the null hypothesis indicate that series are I(0) with unconditional mean different from zero.

We display the results in Table 6.13. We find that imports (m_{jt}), exports (x_{jt})

and income (y_{jt}) and (y_{it}) series follow a trending behavior, and relative price (r_{jt}) is graphically non-trending. Besides, these statements are in line with theoretical considerations. Lags of differenced dependent variables are added (with a maximum lag of 2) in order to whiten the residuals. All variables have unit root (I(1) except variables m_{Kt} and x_{Jt} which are I(0)).

Appendix 6.D Econometric estimates of trade elasticities

Starting from the import equations, Engle and Granger co-integration test (CRADF) fails to reject the null of no co-integration for imports coming from China, South Korea, India (Table 6.12). For the rest of the sample, the variables have a long run relationship and for most of them, price elasticity is statistically not significant. Gregory & Hansen (1996) estimates in Table 6.14 show that bilateral imports from South Korea and India possess structural breaks which shift the level upward after 2012 in the former case, and downward after 2011 in the latter case. In the first case, a structural break with upward level shift makes sense because the year 2012 corresponds to the start of trade negotiations between Vietnam and South Korea, the first bilateral FTA that Vietnam has ever signed with an individual partner after the *Doi Moi* policy. In the second case, India and Vietnam has strong bilateral relations which date back to the former centrally planned economic system. However, as the ASEAN-India FTA came into effect in 2010, a structural break with downward level shift marks the end of exclusive trade relations between the two countries. Lastly, Table 6.15 presents results for Pesaran et al. (2001) estimation. We re-estimate parameters of the bilateral import equations from China and from the rest of the world (RoW) because it involves a variable with I(0), namely m_K. Results show that variables are co-integrated and the price elasticity is only significant in the case of Vietnam's imports from China.

Tables 6.16 to 6.20 present the estimation results for the bilateral export functions. In Tables 6.16 and 6.17, Engle and Granger procedure rejects the null of no co-integration in the case of the EU, Africa and Latin America. However, price elasticities are not significant. Gregory and Hansen estimation results in Table 6.18 show that only the variables for exports to OTPP-HI partners are not co-integrated. Thus, we re-estimate the parameters of the latter equation with Pesaran et al. (2001) estimation. The same is true for LA equation as the variable x_{Jt} does not possess unit root. Results show that variables are co-integrated and therefore are selected to be our long-run coefficients.

Table 6.13 – Unit root test results

Var.	Behavior	F-stat	Lag	Decision	Var.	Behavior	F-Stat	Lag	Decision
$r_{A,t}$	nontrend.	0.56	1	I(1)	$y_{A,t}$	trending	3.37	0	I(1)
$r_{B,t}$	nontrend.	0.47	0	I(1)	$y_{B,t}$	trending	4.69	0	I(1)
$r_{C,t}$	nontrend.	2.34	1	I(1)	$y_{C,t}$	trending	3.10	1	I(1)
$r_{D,t}$	nontrend.	3.67	0	I(1)	$y_{D,t}$	trending	2.07	1	I(1)
$r_{E,t}$	nontrend.	3.32	0	I(1)	$y_{E,t}$	trending	1.80	0	I(1)
$r_{F,t}$	nontrend.	1.69	0	I(1)	$y_{F,t}$	trending	4.87	1	I(1)
$r_{G,t}$	nontrend.	1.81	0	I(1)	$y_{G,t}$	trending	0.56	0	I(1)
$r_{H,t}$	nontrend.	1.81	0	I(1)	$y_{H,t}$	trending	1.27	0	I(1)
$r_{I,t}$	nontrend.	1.86	0	I(1)	$y_{I,t}$	trending	3.61	2	I(1)
$r_{J,t}$	nontrend.	2.07	1	I(1)	$y_{J,t}$	trending	1.37	0	I(1)
$r_{K,t}$	nontrend.	2.09	0	I(1)	$y_{K,t}$	trending	4.97	2	I(1)
$x_{A,t}$	trending	4.63	0	I(1)	$m_{A,t}$	trending	4.08	1	I(1)
$x_{B,t}$	trending	4.82	0	I(1)	$m_{B,t}$	trending	6.69	0	I(1)
$x_{C,t}$	trending	4.92	1	I(1)	$m_{C,t}$	trending	3.42	2	I(1)
$x_{D,t}$	trending	3.92	0	I(1)	$m_{D,t}$	trending	2.22	0	I(1)
$x_{E,t}$	trending	2.37	0	I(1)	$m_{E,t}$	trending	5.47	2	I(1)
$x_{F,t}$	trending	3.03	2	I(1)	$m_{F,t}$	trending	4.19	1	I(1)
$x_{G,t}$	trending	6.24	1	I(1)	$m_{G,t}$	trending	5.31	2	I(1)
$x_{H,t}$	trending	4.70	2	I(1)	$m_{H,t}$	trending	6.39	0	I(1)
$x_{I,t}$	trending	1.54	2	I(1)	$m_{I,t}$	trending	3.85	2	I(1)
$x_{J,t}$	trending	10.28	2	I(0)	$m_{J,t}$	trending	4.99	2	I(1)
$x_{K,t}$	trending	2.78	0	I(1)	$m_{K,t}$	trending	16.20	0	I(0)
					$y_{i,t}$	trending	6.17	0	I(1)

Notes: For a sample size equals to 25, in Dickey and Fuller (1981), the 5% critical value for Φ_3 test is 7.24 for trending series and for non-trending series, the 5% critical value for Φ_1 test is 5.18.

Table 6.14 – Results for import equations with Gregory and Hansen (1996) estimation

	Dependent variable: m_{ijt}								
	Sample	α_{j0}	μ_{j0}	ψ_j	π_j	$\bar{R}^2$	DW	ADF	Break
CHN	1990-2017	-14.45***	0.46*	-0.33	2.06***	0.96	0.90	-2.71	2002
		(2.42)	(0.25)	(0.77)	(0.22)				
CHN	1990-2017	-14.90***	0.51**		2.10***	0.96	0.94	-2.88	2002
		(2.14)	(0.21)		(0.20)				
KOR	1990-2017	-22.69***	0.27*	0.92	2.74***	0.95	0.48	-4.85*	2012
		(1.43)	(0.16)	(0.30)	(0.13)				
KOR	1990-2017	-22.88***	0.28*		2.76***	0.98	0.47	-4.77**	2012
		(1.25)	(0.16)		(0.11)				
IND	1990-2017	-32.55***	-0.51***	0.51	3.47***	0.98	1.09	-5.92***	2011
		(1.49)	(0.17)	(0.38)	(0.13)				
IND	1990-2017	-31.79***	-0.42**		3.40***	0.98	0.96	-5.89***	2011
		(1.40)	(0.16)		(0.13)				

Notes : α_{j0} is the intercept and μ_{j0} is the shift in the intercept. Standard errors are reported in parentheses. DW is the statistic of Durbin Watson test, ADF statistic reports the Granger and Hansen cointegration test for the null of no cointegration. Break gives the year of changing regime. ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that ADF statistic rejects the null hypothesis of no cointegration at respectively 1%, 5% and 10%.

Table 6.15 – Results for import equations with Pesaran, Shin and Smith (2001) estimation

	Dependent variable : m_{ijt}					
	Sample	ψ_j	π_j	$t-stat$	$F-stat$	Conclusion
CHN	1990-2017	-3.148**	1.758***	-3.35*	8.53***	Cointegrated
		(1.263)	(0.390)			
RoW	1990-2017	0.741	1.508***	-4.80***	12.20***	Cointegrated
		(0.642)	(0.251)			
RoW	1990-2017		1.357***	-4.67***	17.39***	Cointegrated
			(0.242)			

Notes: ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that t-stat and F-stat reject the null hypothesis of no cointegration at respectively 1%, 5% and 10%.

Table 6.16 – Results for export equations with Engle and Granger (1987) estimation

	Dependent variable : x_{ijt}						
	Sample	β_j	η_j	ϵ_j	$\bar{R}^2$	DW	CRADF
CHN	1990-2017	-18.195***	1.780***	1.756***	0.980	0.997	-2.66
		(1.600)	(0.505)	(0.104)			
JPN	1990-2017	-170.432***	0.219	11.534***	0.940	1.015	-3.01
		(12.284)	(0.229)	(0.791)			
JPN	1990-2017	-161.748***		10.975***	0.940	1.058	-3.05
		(8.241)		(0.531)			
KOR	1990-2017	-46.807***	-0.536	3.960***	0.970	0.681	-2.73
		(2.241)	(0.330)	(0.163)			
KOR	1990-2017	-48.760***		4.097***	0.968	0.575	-2.31
		(1.950)		(0.144)			
IND	1990-2017	-36.020***	2.943**	2.985***	0.725	0.653	-2.47
		(5.282)	(1.383)	(0.378)			
RoA	1990-2017	-32.903***	0.103	2.886***	0.926	0.347	-1.58
		(2.526)	(0.554)	(0.174)			
RoA	1990-2017	-33.115***		2.900***	0.929	0.345	-1.57
		(2.210)		(0.154)			
USA	1994-2017	-170.179***	0.908**	10.868***	0.965	0.973	-3.21
		(7.053)	(0.409)	(0.429)			
OTPP-HI	1990-2017	-76.490***	0.321	5.709***	0.850	0.376	-3.30
		(7.155)	(0.674)	(0.485)			
OTPP-HI	1990-2017	-77.487***		5.775***	0.854	0.391	-3.18
		(6.739)		(0.458)			

Notes : Standard errors are reported in parentheses. DW is the statistic of Durbin Watson test, CRADF is the Engle and Granger cointegration test. ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that CRADF test rejects the null hypothesis of no cointegration at respectively 1%, 5% and 10%.

Table 6.17 – Results for export equations with Engle and Granger (1987) estimation(continued)

	Dependent variable : x_{ijt}						
	Sample	β_j	η_j	ϵ_j	$\bar{R}^2$	DW	CRADF
EU-28	1990-2017	-131.230***	-0.465	8.471***	0.947	0.528	-4.33**
		(6.536)	(0.331)	(0.395)			
EU-28	1990-2017	-132.648***		8.556***	0.945	0.404	-4.02**
		(6.578)		(0.398)			
AFR	1990-2017	-47.662***	-0.307	3.816***	0.906	1.77	-4.53**
		(3.835)	(0.586)	(0.270)			
AFR	1990-2017	-46.595***		3.743***	0.909	1.70	-4.37***
		(3.206)		(0.227)			
LA	1990-2017	-102.546***	2.109	7.164***	0.834	1.583	-7.80***
		(13.377)	(1.832)	(0.868)			
LA	1990-2017	-112.541***		7.803***	0.832	1.59	-8.81***
		(10.242)		(0.673)			
RoW	1990-2017	-71.701***	-0.666	5.106***	0.814	0.301	-2.76
		(8.608)	(0.844)	(0.549)			
RoW	1990-2017	-67.636***		4.850***	0.817	0.275	-2.61
		(6.850)		(0.440)			

Notes : Standard errors are reported in parentheses. DW is the statistic of Durbin Watson test, CRADF is the Engle and Granger cointegration test. ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that CRADF test rejects the null hypothesis of no cointegration at respectively 1%, 5% and 10%.

Table 6.12 – Results for import equations with Engle and Granger (1987) estimation

		Dependent variable : m_{ijt}						
		Sample	α_j	ψ_j	π_j	$\bar{R}^2$	DW	CRADF
A	CHN	1990-2017	-16.402***	-1.040	2.260***	0.953	0.718	-2.95
			(2.272)	(0.693)	(0.199)			
A	CHN	1990-2017	-19.299***		2.512***	0.951	0.718	-2.76
			(1.229)		(0.109)			
B	JPN	1990-2017	-22.413***	-0.629***	2.703***	0.982	2.291	-5.93***
			(1.158)	(0.214)	(0.102)			
C	KOR	1990-2017	-23.902***	0.155	2.854***	0.973	0.439	-2.40
			(1.283)	(0.309)	(0.111)			
C	KOR	1990-2017	-24.279***		2.885***	0.974	0.408	-2.29
			(1.023)		(0.091)			
D	IND	1990-2017	-29.404***	0.087	3.181***	0.972	0.727	-2.28
			(1.191)	(0.403)	(0.105)			
D	IND	1990-2017	-29.362***		3.178***	0.973	0.725	-2.29
			(1.153)		(0.103)			
E	RoA	1990-2017	-17.118***	-0.566	2.316***	0.854	0.308	-5.25***
			(2.374)	(0.920)	(0.207)			
E	RoA	1990-2017	-17.784***		2.370***	0.857	0.348	-5.13***
			(2.088)		(0.186)			
F	USA	1994-2017	-22.091***	0.578*	2.590***	0.952	1.70	-4.03*
			(1.477)	(0.335)	(0.129)			
F	USA	1994-2017	-22.802***		2.647***	0.947	1.53	-3.69**
			(1.481)		(0.130)			
G	OTPP-HI	1990-2017	-19.935***	0.778*	2.364***	0.939	1.22	-4.50**
			(1.326)	(0.379)	(0.117)			
H	EU-28	1990-2017	-12.777***	0.446	1.849***	0.931	1.08	-4.02*
			(1.159)	(0.304)	(0.103)			
H	EU-28	1990-2017	-13.263***		1.891***	0.928	0.95	-3.64**
			(1.135)		(0.101)			
I	AFR	1990-2017	-36.804***	1.343	3.718***	0.884	1.606	-4.25**
			(3.139)	(0.918)	(0.276)			
I	AFR	1990-2017	-34.658***		3.539***	0.879	1.447	-3.86**
			(2.836)		(0.252)			
J	LA	1990-2017	-37.323***	0.032	3.843***	0.912	1.935	-5.87***
			(3.304)	(1.389)	(0.284)			
J	LA	1990-2017	-37.276***		3.839***	0.915	1.93	-5.87***
			(2.520)		(0.224)			
K	RoW	1990-2017	-14.679***	0.511	2.071***	0.836	0.450	-4.18**
			(2.294)	(0.614)	(0.200)			
K	RoW	1990-2017	-13.595***		1.980***	0.838	0.441	-4.14**
			(1.876)		(0.167)			

Note: Standard errors are reported in parentheses. DW is the statistic of Durbin Watson test, CRADF is the Engle and Granger cointegration test. ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that CRADF test rejects the null hypothesis at respectively 1%, 5% and 10%.

Table 6.18 – Results for export equations with Gregory and Hansen (1996) estimation

	Dependent variable: x_{ijt}								
	Sample	β_{j0}	μ_{j0}	η_j	ϵ_j	$\bar{R}^2$	DW	ADF	Break
CHN	1997-2017	-29.533***	-0.726***	1.158*	2.521***	0.976	1.942	-4.83*	2005
		(3.357)	(0.193)	(0.595)	(0.225)				
JPN	1990-2017	-155.703***	0.566***	0.860***	10.567***	0.981	1.857	-5.12**	2007
		(7.192)	(0.076)	(0.155)	(0.464)				
KOR	1995-2017	-44.868***	0.506***	-0.734***	3.813***	0.985	1.241	-4.78*	2014
		(1.908)	(0.112)	(0.186)	(0.139)				
IND	1990-2017	-54.196***	-2.832***	1.133	4.445***	0.912	2.373	-6.26***	1994
		(3.863)	(0.383)	(0.817)	(0.291)				
IND	1990-2017	-55.875***	-2.991***		4.566***	0.909	2.401	-6.47***	1994
		(3.735)	(0.372)		(0.282)				
RoA	1990-2017	-21.193***	0.923***	0.915***	2.026***	0.986	2.007	-5.13**	1996
		(1.590)	(0.090)	(0.256)	(0.113)				

Notes: β_{j0} is the intercept and μ_{j0} is the shift in the intercept. Standard errors are reported in parentheses. DW is the statistic of Durbin Watson test, ADF statistic reports the Granger and Hansen cointegration test for the null of no cointegration. Break gives the year of changing regime. ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that ADF statistic rejects the null hypothesis of no cointegration at respectively 1%, 5% and 10%.

Table 6.19 – Results for export equations with Gregory and Hansen (1996) estimation (continued)

	Dependent variable: x_{ijt}								
	Sample	β_{j0}	μ_{j0}	η_j	ϵ_j	$\bar{R}^2$	DW	ADF	Break
USA	1994-2017	-177.160***	-0.339	0.721*	11.298***	0.967	1.127	-4.95**	2013
		(8.290)	(0.226)	(0.416)	(0.506)				
OTPP-HI	1990-2017	-52.190***	1.272***	1.293**	3.992***	0.897	0.896	-4.52	1994
		(9.062)	(0.359)	(0.622)	(0.629)				
RoW	1990-2017	-56.026***	1.439***	-0.462	4.026***	0.937	1.295	-6.86***	1994
		(5.481)	(0.204)	(0.492)	(0.354)				
RoW	1990-2017	-53.096***	1.450***		3.840***	0.937	1.255	-5.68***	1994
		(4.495)	(0.203)		(0.294)				

Notes: β_{j0} is the intercept and μ_{j0} is the shift in the intercept. Standard errors are reported in parentheses. DW is the statistic of Durbin Watson test, ADF statistic reports the Granger and Hansen cointegration test for the null of no cointegration. Break gives the year of changing regime. ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that ADF statistic rejects the null hypothesis of no cointegration at respectively 1%, 5% and 10%.

Table 6.20 – Results for export equations with Pesaran, Shin and Smith (2001) estimation

	Dependent variable : x_{ijt}					
	Sample	η_j	ϵ_j	$t-stat$	$F-stat$	Conclusion
OTPP-HI	1990-2017	1.947**	4.054***	-3.90**	9.00***	Cointegrated
		(0.817)	(0.710)			
LA	1990-2017	-0.390	6.974***	-9.48***	32.06***	Cointegrated
		(1.062)	(0.493)			
LA	1990-2017		6.869***	-9.65***	49.82***	Cointegrated
			(0.397)			

Notes: ***, ** and * indicate that coefficients are significant respectively at 1%, 5% and 10% and that t-stat and F-stat reject the null hypothesis of no integration at respectively 1%, 5% and 10%.

General Conclusion

As part of our doctoral thesis in economics, this manuscript gathers together our studies in the research areas of macroeconomics, international economics and development economics. Over the past four years, we have sought to understand the heterogeneous experience of developing countries and to identify the economic issues in the context of contemporary globalization.

Recent economic literature and major international organizations are agreed on the virtues of diversification as a development strategy. The successful experience of the Asian NICs and the numerous empirical studies that emphasize the positive impact of export diversification on economic growth are the two main sources of this consensus. However, the deep integration of developing countries into the global economy characterized by a vertical fragmentation of production processes may interfere with the established relationship between export diversification and economic growth. Furthermore, increasing concerns on environmental issues induce developing economies to jointly face the challenge of finding greener paths to economic development. Considering these new arguments, this thesis aimed to re-explore the relationship between export diversification and economic development in developing countries and presents the following main findings throughout the chapters.

First of all, the second chapter reexamines the relationship between export diversification and economic growth in a post-Keynesian balance of payments constrained growth (BOPC) model. This framework enabled us to assess the quality of a country's productive structure by comparing the structural transformation of its productive capacities that accompanies export diversification with the evolution of the current account balance. The findings from the empirical studies on three samples, namely developing Asia, sub-Saharan Africa and Latin America, suggest heterogeneous patterns among the three regions. The developing Asian region presents two trends according to the level of development: concentration of exports for the advanced countries impacts positively the growth rate compatible with the balance of payments equilibrium, whereas export diversification for latecomer countries integrated into the GVCs is accompanied by a worsening of their external constraint. It

confirms the existence of the "middle-income trap". For sub-Saharan African countries, changes in export structure did not have any impact on their long-run sustainable growth rate. The "no effect" may support the skepticism of some development economists about their recent improvement in export performance. Finally, our results suggest that the change in export composition for Latin American countries has led to an increase in their dependence on imported manufactured goods. In the third chapter, we investigate the role of export diversification and export sophistication as engines of sustained economic growth through their impact on productivity growth and the increasing returns to scale in sub-Saharan Africa. We utilized the Kaldor-Verdoorn Law in an empirical study and make a comparison between three samples, namely sub-Saharan Africa, developing Asia and OECD countries. Our findings indicate that export concentration in low-income economies in sub-Saharan Africa is conducive to higher productivity and higher increasing returns of scale. Conversely, for middle-income economies in that region, export diversification and sophistication are emerging and seem to impact positively on the returns to scale. As far as developing Asia is concerned, export diversification and sophistication strongly foster increasing returns to scale. Findings for OECD countries suggest that export concentration and sophistication entail better performance with higher productivity for developed countries.

The forth and fifth chapters emphasize another challenge that should concern developing nations, that is the global warming associated with CO2 emissions. The question of the compatibility of export diversification strategy with the mitigation of global warming arises. Our results show that export diversification generates an increase in CO2 emissions. For a thorough analysis, we thereafter develop a theoretical framework that isolates the scale, composition, technique and export diversification effects. Here the effect of diversification is described as the impact of an increase in the range of exported products on CO2 emissions induced by an improvement in price competitiveness. We find that overall, export diversification leads to a rise of CO2 emissions and further examination shows that the effect is solely significant for higher income countries.

Finally, the sixth chapter presents a country case study on Vietnam. The existing literature records the success story. The country followed the successive waves of rapid industrialization in Asia by conducting an export-led strategy and was resilient to the regional Asian crisis in 1997 and to the global economic crisis in 2007-2008. We examine Vietnam's growth performance over the past 30 years of transition and integration efforts. Overall, Vietnam has respected its balance of payments constraint. The contribution of trading partners to its external constraint after joining the WTO

in 2007 and its macroeconomic resilience in the face of the Covid-19 pandemic are both studied. Our analysis emphasizes that trading partners diversification through its integration into the WTO has tightened its external constraint. In addition, the impact of the external shock (Covid-19 pandemic) on Vietnam's external constraint shows its dependency on some trading partners and questions the relevancy of a development model based on international trade.

These main findings show the vulnerability of developing economies following an export diversification strategy, in both terms of macroeconomic and environmental levels.

Our research work emphasizes the need for diversity of development models according to the characteristics of each economy on the one hand, and draws a lesson on the importance of historical context on the other. The successful experiences of Asian NICs in the 1950s evidenced the virtues of export diversification as shown by the structuralist economists. However, the context of contemporary globalization, characterized by the GVCs, no longer allows us to reach the same conclusion. The developing countries deeply integrated into the world economy may undergo vulnerability facing external shocks and be stuck in an "under-industrialization trap". The case study of Vietnam supports these arguments. Vietnam's growing appetite for imports and its increasing dependence on international trade confirms the need for the country to implement a new development model. Indeed, a development model, even being successful, needs to be revised once it is fully exploited. Therefore, as far as developing countries are concerned, the inadequacy of considering a single approach to every situation and the necessity of having a diversity of development models according to country characteristics are in line with our main results in our second and third chapter. On the environmental level, our results suggest that a development strategy based on export diversification is in conflict with the mitigation of climate change, especially at a later stage of the development process. In other words, a development model based on export diversification in terms of products exposes these countries to a higher vulnerability in terms of air pollution. Government policies on pollution mitigation should therefore accompany economic policies.

Future research should focus on extended topics that have not been addressed in our research work. Firstly, multi-sectoral balance of payments constrained growth model should be proposed to identify the key sectors that are conducive to higher long-run growth rate compatible with balance of payments equilibrium, and therefore relaxing external constraint.
Secondly, import diversification deserves special attention. Literature on the role of

imports, especially import diversification, is still scarce. They emphasize a positive causation between productivity and import diversification and a positive impact of import diversification, notably in terms of intermediate inputs, on export diversification (Bas & Strauss-Kahn, 2014). Specifically, Parteka & Tamberi (2012) draw the joint evolution of import and export diversifications along the development path. The authors find that the evolution of import diversification is similar to that of export, showing that countries tend to diversify their imports as the level of income increases. Therefore it would be interesting to investigate the role of import diversification in structural change dynamics, in medium and long terms, and integrate it into a growth model that takes account of the interaction between export and import diversifications in the economic growth process.

Further research should be conducted on the role of the services sector. The services sector in the modern world economy is vital as it participates in the operation of trade and facilitates the GVCs. For instance, telecommunication, energy and transport are some key areas that are essential to overcome lack of competition in international markets. Therefore, the services sector is a crucial determinant for economic performance and economic growth. Over recent decades, the services sector has played an increasing role in trade and the structural transformation of low-income countries as its share in the total export value has increased. The share of the services sector in total exports for developing countries rose from 14 to 17 percent during the period 2005-2016 (UNCTAD, 2017). Another good example is the tourism market. UNCTAD (UNCTAD, 2017) forecasts that Africa and Asia will increase their share in world international tourist arrivals in the period 2016-2030. The sector is vital for some least developed countries: for example, the tourism and travel industry in Madagascar accounted for 17.6% of its total exports in 2018. Hence, on the one hand, their uniqueness of natural landscape, wildlife, culture and cuisine endow these countries with a comparative advantage in tourism. On the other hand, the existence of strong backward linkages, as it increases demand for other industries' output, such as food and beverages, transportation, construction and communications, would foster investments and promote diversification of the entire economy (UNCTAD, 2017). Thus, it would be interesting to focus on the services sector and to examine how the structure of services would interact with structural transformation.

References

Abdon, A. & Felipe, J. (2011). *The product space: what does it say about the opportunities for growth and structural transformation of Sub-Saharan Africa ?* Levy Economics Institute Working Papers 670.

Abreha, K. G., Smeets, V., & Warzynski, F. (2020). Coping with the crisis and export diversification. *The World Economy*, 43, 1452– 1481.

Agosin, M. R. (2007). *Export Diversification and Growth in Emerging economies*. Working Paper 233, Department of Economics, University of Chile Department of Economics, University of Chile, Chile.

Agosin, M. R., Alvarez, R., & Bravo-Ortega, C. (2012). Determinants of Export Diversification Around the World: 1962-2000. *The World Economy*, 35(3), 295–315.

Ahmed, S., Appendino, M., & Ruta, M. (2017). Global Value Chains and the Exchange Rate Elasticity of Exports. *The B.E. Journal of Macroeconomics*, 17(1), 1–24.

Akamatsu, K. (1962). A historical pattern of economic growth in developing countries. *The Developing Economies*, 1(s1), 3–25.

Akyüz, Y., Chang, H.-J., & Kozul-Wright, R. (1998). New perspectives on East Asian development. *The Journal of Development Studies*, 34(6), 4–36.

Akyüz, Y. & Gore, C. (2001). African economic development in a comparative perspective. *Cambridge journal of Economics*, 25, 265–288.

Amado, A. M. & Dávila-Fernández, M. (2016). Conciliating Prebisch-Singer And Thirlwall: An Assessment Of The Dynamics Of Terms-Of-Trade In A Bopc Growth Model. volume 075 of *ANPEC*.

Amiti, M. & Freund, C. (2010). The Anatomy of China's Export Growth. In R. Feenstra & S.-J. Wei (Eds.), *China's Growing Role in World Trade* (pp. 35–56). Chicago: University of Chicago press.

Amsden, A. H. (1989). *Asia's next giant: South Korea and late industrialization*. New York: N.Y.: Oxford University Press.

Amurgo-Pacheco, A. & Pierola, M. D. (2008). *Patterns of Export Diversification in Developing Countries: Intensive and Extensive Margins*. World Bank Policy Research Working Paper 4473, The World Bank.

Angeriz, A., McCombie, J. S. L., & Roberts, M. (2008). New estimates of returns to scale and spatial spillovers for EU regional manufacturing, 1986-2002. *International Regional Science Review*, 31(1), 62–87.

Anouliès, L. (2016). Are trade integration and the environment in conflict ? The decisive role of countries' strategic interactions. *International Economics*, 148, 1–15.

Ansari, M., Hashemzadeh, N., & Xi, Y. (2000). The Chronicle of Economic Growth in South East Asian Countries : Does Thirlwall's Law Provide an Adequate Explanation ? *Journal of Post Keynesian Economics*, 22(4), 573–588.

Antweiler, W., Copeland, B. R., & Taylor, M. S. (2001). Is free trade good for the environment ? *American Economic Review*, 91(4), 877–908.

Apergis, N., Can, M., Gozgor, G., & Lau, C. K. M. (2018). Effects of export concentration on CO2 emissions in developed countries: an empirical analysis. *Environmental Science and Pollution Research*, 25(14), 14106–14116.

Apergis, N. & Payne, J. E. (2009). CO2 emissions, energy usage, and output in Central America. *Energy Policy*, 37(8), 3282–3286.

Araujo, R. A. & Lima, G. T. (2007). A structural economic dynamics approach to balance-of payments-constrained growth. *Cambridge Journal of Economics*, 31, 755–74.

Arellano, M. & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58, 277–297.

Arellano, M. & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68, 29–51.

Arrow, K. J. (1962). The economic implications of learning by doing. *The Review of Economic Studies*, 29(3), 155–173.

Artuç, E., Lederman, D., & Rojas, D. (2015). *The Rise of China and Labor Market Adjustments in Latin America*. Policy Working Paper 7155, The World Bank, Washington, D.C.

Asian Development Bank (2014). *Asian Development Outlook 2014 Update: Asia In Global Value Chains*. Mandaluyong City, Philippines, asian development bank edition.

Auty, R. M. (1990). *Resource-based industrialization: sowing the oil in eight developing countries*. New York: Oxford University Press.

Auty, R. M. (1993). *Sustaining development in mineral economies: the resource curse thesis*. London and New York: Routledge.

Auty, R. M. (2000). How Natural Resources Affect Economic Development. *Development Policy Review*, 18, 347–364.

Auty, R. M. (2001). The Political Economy of Resource-Driven Growth. *European Economic Review*, 45, 839–846.

Bagnai, A., Rieber, A., & Tran, T. A.-D. (2015). Economic growth and balance-of payments-constraint in Vietnam. *Journal of Post-Keynesian Economics*, 38(4), 588–615.

Bagnai, A., Rieber, A., & Tran, T. A.-D. (2016). Sub-Saharan Africa's growth, South-South trade and the generalized Balance-of-payment constraint. *Cambridge Journal of Economics*, 40(3), 797–820.

Balavac, M. & Pugh, G. (2016). The link between trade openness, export diversification, institutions and output volatility in transition countries. *Economic Systems*, 40, 273–287.

Baldwin, R. (2012). *Global supply chains: Why they emerged, why they matter, and where they are going*. Centre for Economic Policy Research Discussion Papers 9103.

Bárcena, A. & Prado, A., Eds. (2016). *Neostructuralism and heterodox thinking in Latin America and the Caribbean in the early twenty-first century*. Santiago, December: United Nations, Economic Commission for Latin America and the Caribbean (ECLAC).

Bas, M. & Strauss-Kahn, V. (2014). Does importing more inputs raise exports ? Firm-level evidence from France. *Review of World Economics*, 150, 241–275.

Basile, R., Parteka, A., & Pittiglio, R. (2018). Export diversification and economic development: A dynamic spatial data analysis. *Review of International Economics*, 26, 634–650.

Baumeister, C. & Peersman, G. (2013). The role of time-varying price elasticities in accounting for volatility changes in the crude oil market. *Journal of Applied Econometrics*, 28, 1087–1109.

Ben Hammouda, H., Karingi, S., Njuguna, A., & Sadni Jallab, M. (2006). *Diversification: towards a new paradigm for Africa's development.* MPRA Paper 13359, University Library of Munich, Germany.

Ben Jebli, M. & Ben Youssef, S. (2015a). The Environmental Kuznets Curve, Economic Growth, Renewable and Non-Renewable Energy, and Trade in Tunisia. *Renewable and Sustainable Energy Reviews*, 47, 173–185.

Ben Jebli, M. & Ben Youssef, S. (2015b). Output, Renewable and Non-Renewable Energy Consumption and International Trade: Evidence from a Panel of 69 Countries. *Renewable Energy*, 83, 799–808.

Ben Jebli, M., Ben Youssef, S., & Ozturk, I. (2016). Testing Environmental Kuznets Curve Hypothesis: The Role of Renewable and Non-Renewable Energy Consumption and Trade in OECD Countries. *Ecological Indicators*, 60, 824–831.

Bernardin-Haldemann, V. (1974). L'idéologie de la CEPAL. *Études internationales*, 5(1), 123–142.

Berthélemy, J.-C. & Soderling, L. (2001). The role of capital accumulation, adjustment and structural change for economic take-off: empirical evidence from African growth episodes. *World Development*, 29(2), 323–343.

Bhagwati, J. (1958). Immiserizing Growth: A Geometrical Note. *The Review of Economic Studies*, 25(3), 201–205.

Bilgil, F., Kocak, E., & Bulut, U. (2016). The Dynamic Impact of Renewable Energy Consumption on CO2 Emissions: A Revisited Environmental Kuznets Curve Approach. *Renewable and Sustainable Energy Reviews*, 54, 838–845.

Blecker, R. A. (2016). The Debate Over "Thirlwall's Law": Balance of Payments Constrained Growth Reconsidered. *European Journal of Economics and Economic Policies: Intervention*, 13(3), 275–290.

Blundell, R. & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87, 115–143.

Bosker, M. & Garretsen, H. (2012). Economic Geography and Economic Development in Sub-Saharan Africa. *The World Bank Economic Review*, 26(3), 443–485.

Botta, A. (2010). Economic Development, Structural Change and Natural Resource Booms: A Structuralist Perspective. *Metroeconomica*, 61(3), 510–539.

Bravo-Ortega, C. & de Gregorio, J. (2007). The Relative Richness of the Poor ? Natural Resources, Human Capital, and Economic Growth. In D. Lederman & W. Maloney (Eds.), *Natural resources: Neither curse nor destiny*. The world bank edition.

Brenton, P. & Newfarmer, R. (2007). *Watching More Than The Discovery Channel: Export Cycles and Diversification in Development*. Policy Research Working Paper 4302, The World Bank.

Bresser-Pereira, L., Oreiro, J., & Marconi, N. (2014). A theoretical framework for a Structuralist Development Macroeconomics. In L. Bresser-Pereira, J. Kregel, & L. Burlamaqui (Eds.), *Financial Stability and Growth: Perspectives on Financial Regulation and New Developmentalism* (pp. 55–73). London: Routledge.

Cadot, O., Carrère, C., & Strauss-Kahn, V. (2011). Export diversification: what's behind the hump ? *The Review of Economics and Statistics*, 93, 590–605.

Cadot, O., Carrère, C., & Strauss-Kahn, V. (2013). Trade Diversification, Income, and Growth: What Do We Know ? *Journal of Economic Surveys*, 27(4), 790–812.

Cadot, O., de Melo, J., Plane, P., Wagner, L., & Woldemichael, M. T. (2016). Industrialisation et transformation structurelle : l'Afrique subsaharienne peut-elle se développer sans usines ? *Revue d'économie du développement*, 24(2), 19–49.

Can, M. & Gozgor, G. (2018). Effects of Export Product Diversification on Quality Upgrading: An Empirical Study. *Journal of International Trade and Economic Development*, 27(3), 293–313.

Chaney, T. (2008). Distorted Gravity: The Intensive and Extensive Margins of International Trade. *American Economic Review*, 98(4), 1707–1721.

Chang, D.-S., Yeh, L.-T., & Chen, Y.-F. (2014). The effects of economic development, international trade, industrial structure and energy demands on sustainable development. *Sustainable Development*, 22, 377–390.

Chaponnière, J.-R. & Lautier, M. (2013). La montée des échanges Sud-Sud dans le commerce mondial. In CEPII (Ed.), *L'Économie mondiale 2013*, Repères (pp. 91–103). Paris: La Découverte.

Chassem, N. P. (2011). *Long-run effects of real exchange rate on the nominal and real trade balance in African Franc zone.* Munich Personal RePEc Archive Paper 30252.

Cherniwchan, J., Copeland, B. R., & Taylor, M. S. (2017). Trade and the environment: new methods, measurements, and results. *The Annual Review of Economics*, 9, 59–85.

Cimoli, M., Fleitas, S., & Porcile, G. (2011). *Real Exchange Rate and the Structure of Exports.* MPRA Paper 37846.

Cimoli, M., Porcile, G., & Rovira, S. (2010). Structural Convergence and the Balance-of-Payments Constraint: Why Did Latin America Fail to Converge. *Cambridge Journal of Economics*, 34(2), 389–411.

Cole, M. A. (2003). Development, Trade, and the Environment: How Robust is The Environmental Kuznets Curve ? *Environment and Development Economics*, 8, 557–580.

Cole, M. A. & Elliott, R. J. R. (2003). Determining the tradeâ-environment composition effect: the role of capital, labor and environmental regulations. *Journal of Environmental Economics and Management*, 46, 363–383.

Cole, M. A., Rayner, A. J., & Bates, J. M. (1997). The Environmental Kuznets Curve: An Empirical Analysis. *Environment and Development Economics*, 2(4), 401– 416.

Collier, P. & Dehn, J. (2001). *Aid, Shocks, and Growth.* Policy Research Working Paper 2688, The World Bank, Washington, D.C.

Copeland, B. R. & Taylor, M. S. (1994). North-South trade and the environment. *The Quarterly Journal of Economics*, 109(3), 755–787.

Copeland, B. R. & Taylor, M. S. (2004). Trade, growth, and the environment. *Journal of Economic Literature*, 42(1), 7–71.

Daruich, D., Easterly, W., & Reshef, A. (2019). The surprising instability of export specializations. *Journal of Development Economics*, 137, 36–65.

De La Torre, A., Didier Brandao, T., Ize, A., Lederman, D., & Schmukler, S. L. (2015). *Latin America and the rising south : changing world, changing priorities*. Latin America and Caribbean Studies 2, World Bank Group, Washington, D.C.

de Piñeres, S. A. G. (1996). Externalities in the export sector and long-run growth rates. *Singapore Economic Review*, 41(1), 13–24.

de Piñeres, S. A. G. & Ferrantino, M. J. (1997). Export diversification trends: Some comparisons for Latin America. *The International Executive*, 39, 465–477.

de Piñeres, S. A. G. & Ferrantino, M. J. (2000). *Export Dynamics and Economic Growth in Latin America*. Burlington, Vermont, ashgate publishing ltd edition.

Dennis, A. & Shepherd, B. (2011). Trade Facilitation and Export Diversification. *The World Economy*, 34(1), 101–122.

Diaw, D., Rieber, A., & Tran, T. A.-D. (2012). International demand spillovers in South-South exports: Application to Sub-Saharan Africa and the Developing Asia. *Journal of Economic Integration*, 27(3), 410–436.

Dickey, D. A. & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, 49(4), 1057–1072.

Didier, L. (2017). South-South trade and geographical diversification of intra-SSA trade: evidence from BRICs. *African Development Review*, 29(2), 139–154.

Dixit, A. K. & Stiglitz, J. E. (1977). Monopolistic Competition and Optimum Product Diversity. *The American Economic Review*, 67(3), 297–308.

Djimeu, E. W. & Omgba, L. D. (2019). Oil windfalls and export diversification in oil producing countries: Evidence from oil booms. *Energy Economics*, 78, 494–507.

Dornbusch, R. W., Fischer, S. L., & Samuelson, P. A. (1977). Comparative Advantage, Trade and Payments in a Ricardian Model with a Continuum of Goods. *American Economic Review*, 67, 823–839.

Dosi, G., Pavitt, K., & Soete, L. (1990). *The economics of technical change and international trade*. Brighton, Wheatsheaf and New York, new york university press edition.

Douglas, H.-E. & Selden, T. M. (1995). Stoking the Fires ? CO2 Emissions and Economic Growth. *Journal of Public Economics*, 57(1), 85–101.

Driscoll, J. C. & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics*, 80, 549–560.

Easterly, W. & Levine, R. (1997). Africa's Growth Tragedy: Policies and Ethnic Divisions. *Quarterly Journal of Economics*, 112(4), 1203–1250.

Easterly, W., Reshef, A., & Schwenkenberg, J. M. (2009). *The Power of Exports*. Policy Research Working Paper 5081, The World Bank, Washington, D.C.

Elder, J. & Kennedy, P. E. (2001). Testing for Unit Roots: What Should Students Be Taught ? *Journal of Economic Education*, 32, 137–146.

Engle, R. F. & Granger, C. W. J. (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica*, 55, 251–276.

Evenett, S. J. & Venables, A. J. (2002). *Export growth by developing economies: market entry and bilateral trade*. CEPR working paper 2315.

Falvey, R. & Kierzkowski, H. (1987). Product quality, intra-industry trade and (im) perfect competition. In H. Kierzkowski (Ed.), *Protection and Competition in International Trade: Essays in Honor of W. M. Corden* (pp. 143–161). Oxford: Blackwell.

Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The next generation of the Penn World Table. *American Economic Review*, 105(10), 3150–3182.

Feenstra, R. C. & Kee, H. L. (2008). Export variety and country productivity: estimating the monopolistic competition model with endogenous productivity. *Journal of International Economics*, 74, 500–518.

Feenstra, R. C. & Kee, H. L. (2011). *Trade Liberalization and Export Variety : A Comparison of Mexico and China*. Technical report, World Bank, Washington, DC.

Felipe, J., Kumar, U., Abdon, A., & Bacate, M. (2012). Product complexity and economic development. *Structural Change and Economic Dynamics*, 23(1), 36–68.

Felipe, J., Lanzafame, M., & Estrada, G. (2019). Is Indonesia's growth rate balance-of-payments-constrained ? a time-varying estimation approach. *Review of Keynesian Economics*, 7(4), 537–553.

Felipe, J. & McCombie, J. S. L. (2007). Is a theory of total factor productivity really needed ? *Metroeconomica*, 58(1), 195–229.

Felipe, J. & McCombie, J. S. L. (2013). *The aggregate production function and technical change: "not even wrong"*. Cheltenham: Edward Elgar.

Felipe, J., McCombie, J. S. L., & Naqvi, K. (2010). Is Pakistan's Growth Rate Balance of Payments Constrained ? Policies and Implications for Development and Growth. *Oxford Development Studies*, 38(4), 477–496.

Fernandes, A. M. & Isgut, A. E. (2015). Learning-by-exporting effects: are they for real ? *Emerging Markets Finance and Trade*, 51(1), 65–89.

Ferrarini, B. & Scaramozzino, P. (2016). Production complexity, adaptability and economic growth. *Structural Change and Economic Dynamics*, 37, 52–61.

Frenkel, R. & Rapetti, M. (2014). *The real exchange rate as a target of macroeconomic policy*. MPRA Paper 59335, University Library of Munich, Germany.

Garcia-Herrero, A. & Koivu, T. (2008). China's exchange rate policy and asian trade. *International Economics*, 116, 53–98.

Gaulier, G. & Zignago, S. (2010). *BACI: international trade database at the product level. The 1994-2007 Version*. CEPII Working Paper 2010-23.

Gopinath, G., Boz, E., Casas, C., Díez, F. J., Gourinchas, P.-O., & Plagborg-M, M. (2020). Dominant Currency Paradigm. *American Economic Review*, 110(3), 677–719.

Gouvea, R. R. & Lima, G. T. (2010). Structural Change, Balance of Payments Constraint and Economic Growth: Evidence from the Multi-Sectoral Thirlwall's Law. *Journal of Post Keynesian Economics*, 33(1), 169–204.

Gozgor, G. (2017). Does Trade Matter for Carbon Emissions in OECD Countries ? Evidence from a New Trade Openness Measure. *Environment Science and Pollution Research*, 24(36), 27813–27821.

Gozgor, G. & Can, M. (2016). Export product diversification and the environmental Kuznets curve: evidence from Turkey. *Environmental Science and Pollution Research*, 23(21), 21594–21603.

Gregory, A. W. & Hansen, B. E. (1996). Residual Based Tests for Cointegration in Models with Regime Shifts. *Journal of Econometrics*, 70, 99–126.

Grether, J.-M. & Mathys, N. A. (2013). The pollution terms of trade and its five components. *Journal of Development Economics*, 100, 19–31.

Grether, J.-M., Mathys, N. A., & de Melo, J. (2009). Scale, technique and composition effects in manufacturing SO2 emissions. *Environmental and Resource Economics*, 43, 257–274.

Grossman, G. M. & Helpman, E. (1989). Product Development and International Trade. *Journal of Political Economy*, 97(6), 1261–1283.

Grossman, G. M. & Krueger, A. B. (1993). Environmental impacts of the North American Free Trade Agreement. In P. Garber (Ed.), *The U.S.-Mexico Free Trade Agreement* (pp. 13–56). Cambridge, MA: Massachusetts Institute of Technology, The MIT Press.

Grossman, G. M. & Krueger, A. B. (1995). Economic growth and the environment. *Quarterly Journal of Economics*, 110(2), 353–377.

Growth Commission (2008). *The Growth Report: Strategies for Sustained Growth and Inclusive Development*. Washington, DC.

Grubel, H. G. & Lloyd, P. J. (1975). *Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products*. London: Macmillan.

Guangyue, X. & Deyong, S. (2011). An empirical study on the environmental Kuznets curve for China's carbon emissions: based on provincial panel data. *Chinese Journal of Population, Resources and Environment*, 9, 66–76.

Guzman, M., Ocampo, J. A., & Stiglitz, J. E. (2018). Real exchange rate policies for economic development. *World Development*, 110, 51–62.

Ha, Y., Chung, K., & Seo, J. (2016). An Analysis of Korea-ASEAN Trade and its Implications for the Shipping Industry in Korea. *Asian Journal of Shipping and Logistics*, 32(3), 63–71.

Habiyaremye, A. (2016). Is Sino-African trade exacerbating resource dependence in Africa ? *Structural Change and Economic Dynamics*, 37, 1–12.

Hausmann, R. & Bailey, K. (2006). *Structural Transformation and Patterns of Comparative Advantage in the Product Space*. CID Working Paper 128.

Hausmann, R. & Hidalgo, C. A. (2010). *Country diversification, product ubiquity, and economic divergence*. CID Working Paper 201.

Hausmann, R., Hidalgo, C. A., Bustos, S., Coscia, M., Chung, S., Jimenez, J., Simoes, A., & Yildirim, M. A. (2014). *The atlas of economic complexity: mapping paths to prosperity*. MIT Press.

Hausmann, R., Hwang, J., & Rodrik, D. (2007). What you export matters. *Economic Growth*, 12(1), 1–25.

Hausmann, R. & Rodrik, D. (2003). Economic development as self-discovery. *Journal of Development Economics*, 72(2), 603–633.

Hettige, H., Mani, M., & Wheeler, D. (2000). Industrial pollution in economic development: Kuznets revisited. *Journal of Development Economics*, 62(2), 445–476.

Hidalgo, C. A. & Hausmann, R. (2009). The building blocks of economic complexity. *Proceedings of the National Academy of Sciences*, 106(26), 10570–10575.

Hidalgo, C. A., Klinger, B., Barabasi, A.-L., & Hausmann, R. (2007). The product space conditions the development of nations. *Science*, 317(5837), 482–487.

Hooy, C.-W., Law, S.-H., & Chan, T.-H. (2015). The impact of the Renminbi real exchange rate on ASEAN disaggregated exports to China. *Economic Modelling*, 47, 253–259.

Hummels, D. & Klenow, P. J. (2005). The Variety and Quality of a Nation's Exports. *American Economic Review*, 95, 704–723.

Humphreys, M., Sachs, J. D., & Stiglitz, J. E., Eds. (2007). *Escaping the resource curse*. Columbia University Press.

Hussain, M. N. (1999). The Balance of Payments Constraint and Growth Rate Differences Among African and East Asian Countries. *African Development Review*, 11(1), 103–137.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogenous panels. *Journal of Econometrics*, 115(1), 53–74.

Imbs, J. & Wacziarg, R. (2003). Stages of diversification. *American Economic Review*, 93(1), 63–86.

IMF (2014a). *Sustaining Long-run Growth and Macroeconomic Stability in Low-Income Countries – The Role of Structural Transformation and Diversification. Background Notes*. IMF Policy Paper.

IMF (2014b). *Sustaining Long-run Growth and Macroeconomic Stability in Low-Income Countries-The Role of Structural Transformation and Diversification.* IMF Policy Paper.

IMF (2015). *Regional economic outlook: Sub-Saharan Africa, Dealing with the Gathering Clouds.* Washington, D.C: International Monetary Fund.

IMF (2016). *Economic diversification in oil-exporting Arab countries.* IMF Policy Paper, International Monetary Fund, USA.

IMF (2017a). *Cluster Report - Trade Integration In Latin America And The Caribbean.* IMF Country Report 17/6, International Monetary Fund, Washington, D.C.

IMF (2017b). *A Rebalancing Act for China and Africa: The Effects of China's Rebalancing on Sub-Saharan Africa's Trade and Growth.* Departmental Papers / Policy Papers, International Monetary Fund/African Dept., USA.

IMF (2019). *World Economic Outlook Database.* Washington, DC: October.

IMF (2020). *A crisis like no other, an uncertain recovery.* World economic outlook update, Washington, DC: June.

Jefferson, G. H. (1988). The aggregate production function and productivity growth: Verdoorn's Law revisited. *Oxford Economic Papers*, 40(4), 671–691.

Jeon, Y. (2009). Balance of Payments Constrained Growth: the Case of China 1979-2002. *International Review of Applied Economics*, 23(2), 135–146.

Kaldor, N. (1957). A model of economic growth. *Economic Journal*, 67, 591–624.

Kaldor, N. (1966). *Causes of the slow rate of economic growth of the United Kingdom. An inaugural lecture.* Cambridge: Cambridge University Press.

Kaldor, N. (1967). *Strategic Factors in Economic Development.* New York State School of Industrial and Labor Relations, Cornell University, Ithaca, NY.

Kaldor, N. (1968). Productivity and growth in manufacturing industry: a reply. *Economica*, 35(140), 385–391.

Kaldor, N. (1970). The case for regional policies. *Scottish Journal of Political Economy*, 17, 337–348.

Kaldor, N. (1975). What is wrong with economic theory. *The Quarterly Journal of Economics*, 89(3), 347–357.

Kaldor, N., Lutz, F. A., & Hague, D. (1961). Capital Accumulation and Economic Growth. In *The Theory of Capital*. London: Macmillan.

Kim, D.-H., Suen, Y.-B., & Lin, S.-C. (2019). Carbon dioxide emissions and trade: Evidence from disaggregate trade data. *Energy Economics*, 78, 13–28.

Kleemann, L. & Abdulai, A. (2013). The impact of trade and economic growth on the environment: revisiting the cross-country evidence. *Journal of International Development*, 25, 180–205.

Klinger, B. & Lederman, D. (2004). *Discovery and development: an empirical exploration of "new" products*. World Bank Policy Research Working Paper 3450, World Bank, Washington, D.C.

Klinger, B. & Lederman, D. (2006). *Diversification, innovation, and imitation inside the global technological frontier*. World Bank Policy Research Working Paper 3872, World Bank, Washington, D.C.

Knell, M. (2004). Structure change and the Kaldor-Verdoorn law in the 1990s. *Revue d'économie industrielle*, 105, 71–83.

Koopman, R., Wang, Z., & Wei, S.-J. (2014). Tracing Value-Added and Double Counting in Gross Exports. *American Economic Review*, 104(2), 459–494.

Koren, M. & Tenreyro, S. (2007). Volatility and Development. *The Quarterly Journal of Economics*, 122(1), 243–287.

Kowalski, P., Lopez Gonzalez, J., Ugarte, C., & Ragoussis, A. (2015). *Participation of developing countries in global value chains: implications for trade and trade-related policies*. OECD Trade Policy Papers 179, OECD Publishing, Paris.

Kraemer, K. L., Linden, G., & Dedrick, J. (2011). *Capturing Value in Global Networks: Apple's iPad and iPhone*. Technical report, Unpublished work. University of California, Irvine, University of California, Berkeley, and Syracuse University.

Krugman, P. (1979). Increasing Returns, Monopolistic competition and International trade. *Journal of International Economics*, 9, 469–479.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *American Economic Review*, 70(5), 950–959.

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, 45(1), 1–28.

Lall, S., Weiss, J., & Zhang, J. (2006). The "sophistication" of exports: a new trade measure. *World Development*, 34, 222–237.

Le, T.-H., Chang, Y., & Park, D. (2016). Trade openness and environmental quality: international evidence. *Energy Policy*, 92, 45–55.

Lederman, D. & Maloney, W. F. (2003). *Trade structure and growth*. Policy Research working paper 3025, World Bank Group, Washington, D.C.

Lederman, D. & Maloney, W. F. (2006). *Natural Resources: neither curse nor destiny*. Latin American development forum. Washington, D.C.: The World Bank.

Lederman, D. & Maloney, W. F. (2012). *Does what you export matter ? in search of empirical guidance for industrial policies*. Latin America Development Forum, World Bank, Washington, DC.

Lederman, D., Olarreaga, M., & Perry, G. E. (2009). Latin America's Response to China and India: Overview of Research Findings and Policy Implications. In D. Lederman, M. Olarreaga, & G. E. Perry (Eds.), *China's and India's Challenge to Latin America Opportunity or Threat* (pp. 3–35). Washington, D.C: The World Bank.

Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, 108, 1–24.

Levinson, A. & Taylor, M. S. (2008). Unmasking the pollution haven effect. *International Economic Review*, 49(1), 223–254.

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *Manchester school*, 22, 139–191.

Lin, J. Y. (2010). *New Structural Economics: A Framework for Rethinking Development*. Policy Research Working Papers 5197, World Bank, Washington D.C.

Lin, J. Y. & Chang, H.-J. (2009). Should Industrial Policy in Developing Countries Conform to Comparative Advantage or Defy it ? A Debate Between Justin Lin and Ha-Joon Chang. *Development Policy Review*, 27(5), 483–502.

Lin, J. Y. & Monga, C. (2010). *The Growth Report and New Structural Economics*. World Bank Policy Research Working Paper 5336.

Lin, J. Y. & Monga, C. (2014). The Evolving Paradigms of Structural Change. In B. Currie-Adler, R. Kanbur, R. Medhora, & D. Malone (Eds.), *International Development: Ideas, Experience, and Prospects* (pp. 277–94.). New York: Oxford University Press.

Linder, S. B. (1961). *An essay on trade and transformation*. New York: John Wiley.

Liobikiene, G. & Butkus, M. (2019). Scale, composition, and technique effects through which the economic growth, foreign direct investment, urbanization, and trade affect greenhouse gas emissions. *Renewable Energy*, 132, 1310–1322.

Lopez-Calix, J. R. (2019). *Leveraging export diversification in fragile countries: the emerging value chains of Mali, Chad, Niger, and Guinea*. Washington, D.C.: World Bank Group.

Lorenz, M. O. (1905). Methods of Measuring the Concentration of Wealth. *Publications of the American Statistical Association*, 9(70), 209–219.

Low, P. & Yeats, A. (1992). Do dirty industries migrate ? In P. Low (Ed.), *International Trade and the Environment*, World Bank Discussion Papers (pp. 89–103).

Maddala, G. & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61(Special Issue), 631–652.

Mani, M. & David, W. (1998). In search of pollution havens ? Dirty industry migration in the world economy, 1960-1995. *Journal of Environment and Development*, 7(3), 215–247.

Mathai, K., Gottlieb, G., Hong, G. H., Jung, S. E., Schmittmann, J., & Yu, J. (2016). *China's Changing Trade and Implications for the CLMV Economies*. Technical report, The Asia and Pacific Department, International Monetary Fund, Washington, D.C.

Mayer, T., Melitz, M. J., & Ottaviano, G. I. (2014). Market size, competition and the product mix of exporters. *American Economic Review*, 104(2), 495–536.

McCombie, J. S. L. (1982). Economic growth, Kaldor's Laws and the Static-Dynamic Verdoorn Law Paradox. *Applied Economics*, 14(3), 279–294.

McCombie, J. S. L., Pugno, M., & Soro, B. (2002). Introduction. In J. S. L. McCombie, M. Pugno, & B. Soro (Eds.), *Productivity Growth and Economic Performance: Essays on Verdoorn's Law* (pp. 1–27). London: Palgrave Macmillan.

McCombie, J. S. L. & Spreafico, M. R. M. (2016). Kaldor's "technical progress function" and Verdoorn's law revisited. *Cambridge Journal of Economics*, 40(4), 1117–1136.

McCombie, J. S. L. & Tharnpanich, N. (2013). Balance of payments constrained growth, structural change and the thai economy. *Journal of Post Keynesian Economics*, 35(4), 569–595.

McMillan, M. S. & Rodrik, D. (2011). *Globalization, Structural Change and Productivity Growth*. National Bureau of Economic Research Working Papers 17143.

McMillan, M. S., Rodrik, D., & Verduzco-Gallo, I. (2014). Globalization, Structural Change, and Productivity Growth, with an Update on Africa. *World Development*, 63, 11–32.

Meier, G. M. & Seers, D. (1984). *Pioneers in development*, volume 9948. Oxford University Press.

Melitz, M. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71, 1695–1725.

Michl, T. R. (1985). International comparisons of productivity growth: Verdoorn's Law revisited. *Journal of Post Keynesian Economics*, 7, 474–492.

Millemaci, E. & Ofria, F. (2012). *Kaldor-Verdoorn's Law and increasing returns to scale: a comparison across developed countries*. FEEM Working Paper 92.2012.

Mohapatra, S., Adamowicz, W., & Boxall, P. (2016). Dynamic technique and scale effects of economic growth on the environment. *Energy Economics*, 57, 256–264.

Mosley, P. (2018). Why has export diversification been so hard to achieve in Africa ? *The World Economy*, 41, 1025–1044.

Muhammad, B. (2019). Energy consumption, CO2 emissions and economic growth in developed, emerging and Middle East and North Africa countries. *Energy*, 179, 232–245.

Naudé, W. & Rossouw, R. (2011). Export Diversification and Economic Performance: Evidence from Brazil, China, India and South Africa. *Economic Change and Restructuring*, 44, 99–134.

Nell, K. (2003). A Generalised Version of the Balance of Payments Growth Model: An Application to Neighbouring Regions. *International Review of Applied Economics*, 17(3), 249–267.

Nicita, A. & Rollo, V. (2015). Market access conditions and Sub-Saharan Africa's exports diversification. *World Development*, 68, 254–263.

OECD/WTO (2019). *Aid for Trade at a Glance 2019 : Economic Diversification and Empowerment*. Paris, oecd edition.

Olofin, S. & Babatunde, M. A. (2009). Estimating price and income elasticities of Sub-Saharan African exports. *African Journal of Economic Policy*, 16(2), 1–37.

Panayotou, T. (1993). *Empirical tests and policy analysis of environmental degradation at different stages of economic development*. ILO Working Papers 992927783402676, International Labour Organization.

Papageorgiou, C. & Spatafora, N. (2012). *Economic Diversification in LICs: Stylized facts and macroeconomic implications*. IMF Staff Discussion Note 2012/13, International Monetary Fund.

Papageorgiou, C., Spatafora, N., & Wang, K. (2015). *Diversification, Growth, and Volatility in Asia*. Policy Reasearch Working Paper 7380, The World Bank, Washington, D.C.

Parteka, A. (2007). *Employment and export specialization patterns versus GDP per capita performance: unifying approach*. Working paper 302, Universita Politecnica delle Marche.

Parteka, A. & Tamberi, M. (2011). *Export diversification and development - empirical assessment*. Quaderni di Ricerca 359, Universita Politecnica delle Marche.

Parteka, A. & Tamberi, M. (2012). Relative Product Diversification in the Course of Economic Development: Import-Export Analysis. volume c017_056 of *DEGIT Conference Papers*.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, 61, 653–70.

Perraton, J. (2003). Balance of Payments Constrained Growth and Developing Countries: An Examination of Thirlwall's Hypothesis. *International Review of Applied Economics*, 17(1), 1–22.

Pesaran, M. H. (2004). *General diagnostic tests for cross section dependence in panels*. Cambridge Working Papers in Economics 0435, Faculty of Economics, University of Cambridge.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265–312.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94, 621–634.

Pesaran, M. H., Shin, Y., & Smith, R. P. (2001). Bound testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16, 289–326.

Phi, M. H. & Tran, T. (2020). Should I stay or should I go ? the role of the renminbi in trade partnerships in the Asia-Pacific region. *Post-Communist Economies*.

Porcile, G. & Yajima, G. T. (2019). New Structuralism and the balance-of-payments constraint. *Review of Keynesian Economics*, 7(4), 517–536.

Prebisch, R. (1950). The economic development of Latin America and its principal problems. *Economic Bulletin for Latin America*, 7(1), 1–22.

Prebisch, R. (1959). Commercial Policy in the Underdeveloped Countries. *American Economic Review*, 49(2), 251–273.

Rahul, G., Quayyum, S. N., & Yin, R. J. (2019). *Understanding Export Diversification: Key Drivers and Policy Implications*. IMF Working Paper 19/105.

Rath, B. N. & Akram, V. (2017). Export diversification and total factor productivity growth in case of South Asian region. *Journal of Social and Economic Development*, 19, 196–210.

Razmi, A. (2005). Balance of Payments Constrained Growth Model : the Case of India. *Journal of Post Keynesian Economics*, 27(4), 655–687.

Regolo, J. (2013). Export diversification: How much does the choice of the trading partner matter ? *Journal of International Economics*, 91(2), 329–342.

Regolo, J. (2017). Export diversification and regionalization of trade: Which destinations for newly exported goods ? *International Economics*, 151, 26–47.

Ricardo, D. (1817). *On the Principles of Political Economy and Taxation*. London John Murray.

Rieber, A. & Tran, T. A.-D. (2009). The effects of unilateral environmental regulations in a world with capital mobility and trading costs. *Asia-Pacific Journal of Accounting & Economics*, 16, 317–338.

Rodrik, D. (2011a). Comments on "New Structural Economics" by Justin Yifu Lin. *World Bank Research Observer*, 26(2), 227–229.

Rodrik, D. (2011b). *The Future of Economic Convergence*. NBER Working Paper 17400.

Rodrik, D. (2016). Premature deindustrialization. *Journal of Economic Growth*, 21, 1–33.

Rodrik, D. (2018). An African Growth Miracle ? *Journal of African Economies*, 27(1), 10–27.

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *The Journal of Political Economy*, 94(5), 1002–1037.

Romero, J. P. & Britto, G. (2017). Increasing returns to scale, technological catch-up and research intensity: endogenising the Verdoorn coefficient. *Cambridge Journal of Economics*, 41, 391–412.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal*, 9(1), 86–136.

Sachs, J. D. & Warner, A. M. (1997). Sources of Slow Growth in African Economies. *Journal of African Economies*, 6(3), 335–376.

Sachs, J. D. & Warner, A. M. (2001). Natural Resources and Economic Development: The curse of natural resources. *European Economic Review*, 45, 827–838.

Salim, R., Yao, Y., & Chen, G. S. (2017). Does human capital matter for energy consumption in China ? *Energy Economics*, 67, 49–59.

Santos-Paulino, A. & Thirlwall, A. P. (2004). The Impact of Trade Liberalisation on Exports, Imports and the Balance of Payments of Developing Countries. *The Economic Journal*, 114(493), F50–F72.

Schmalensee, R., Stoker, T. M., & Judson, R. A. (1995). *World Energy Consumption and Carbon Dioxide Emissions: 1950-2050*. Joint Program Report Series Report 5.

Selden, T. M. & Song, D. (1994). Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution ? *Journal of Environmental Economics and Management*, 27, 147–162.

Setterfield, M. (2011). The remarkable durability of Thirlwall's Law. *PSL Quarterly Review*, 64(259), 393–427.

Shafaeddin, S. M. (2005). *Trade liberalization and economic reform in developing countries: structural change or de-industrialization ?* UNCTAD Discussion paper 179, UN, Geneva.

Shafik, N. & Bandyopadhyay, S. (1992). *Economic growth and environmental quality: time series and cross-country evidence*. Policy Research Working Paper WPS904, The World Bank, Washington, DC.

Shahbaz, M., Gozgor, G., & Hammoudeh, S. (2019). Human Capital and Export Diversification as New Determinants of Energy Demand in the United States. *Energy Economics*, 78, 335–349.

Singer, H. W. (1950). The distribution of gains between investing and borrowing countries. *American Economic Review*, 40(2), 473–485.

Stanley, D. L. & Bunnag, S. (1986). A New Look at the Benefits of Diversification: Lessons from Central America. *Applied Economics*, 33(11), 199–219.

Stern, D. I. & Common, M. S. (2001). Is There an Environmental Kuznets Curve for Sulfur ? *Journal of Environmental Economics and Management*, 41, 162–178.

Tang, T. C. (2003). Japanese aggregate import demand function: Reassessment from 'bound' testing approach. *Japan and the World Economy*, 15(4), 419–436.

Taylor, L. (1991). *Income Distribution, Inflation, and Growth. Lectures on Structuralist Macroeconomic Theory*. Cambridge, MA: The MIT Press.

Taylor, L. (1996). Sustainable Development: An Introduction. *World Development*, 24(2), 215–225.

The Growth Lab at Harvard University (2019). Growth projections and complexity rankings/Harvard Dataverse, V2.

Theil, H. (1972). *Statistical Decomposition Analysis*. North Holland.

Thirlwall, A. P. (1979). The Balance of Payments Constraint as an Explanation of International Growth Rate Differences. *Banca Nazionale di Lavoro*, 128, 45–53.

Thirlwall, A. P. (1983). Foreign trade elasticities in centre-periphery models of growth and development. *Banca Nationale del Lavoro Quarterly Review*, 146, 249–261.

Thirlwall, A. P. (1986). A General Model of Growth and Development on Kaldorian Lines. *Oxford Economic Papers*, 38(2), 199–219.

Thirlwall, A. P. (2002a). Front Matter. In *The Nature of Economic Growth: An Alternative Framework for Understanding the Performance of Nations*. Cheltenham, UK: Edward Elgar Publishing.

Thirlwall, A. P. (2002b). *The Nature of Economic Growth: An Alternative Framework for Understanding the Performance of Nations*. Cheltenham, UK: Edward Elgar Publishing.

Thirlwall, A. P. (2011). Balance of Payments Constrained Growth Models: History and Overview. *PSL Quarterly Review*, 64(259), 307–351.

Thirlwall, A. P. (2017). *Nicholas Kaldor's Insights into the Applied Economics of Growth (or Why I Became a Kaldorian)*. a/ Working Papers Series 1701, Italian Association for the Study of Economic Asymmetries, Rome (Italy).

Thirlwall, A. P. (2019). Thoughts on balance-of-payments constrained growth after 40 years. *Review of Keynesian Economics*, 7(4), 554–567.

Thirlwall, A. P. & Dixon, R. (1975). A Model of Regional Growth-Rate Differences on Kaldorian Lines. *Oxford Economic Papers*, 27(2), 201–214.

Thirlwall, A. P. & Hussain, M. N. (1982). The balance-of-payments constraint, capital flows and growth rate differences between developing countries. *Oxford Economic Papers*, 34(3), 498–510.

Tran, T. A.-D., Phi, M. H., & Diaw, D. (2017). Export diversification and real exchange rate in emerging Latin America and Asia: A South-North vs. South-South decomposition. *The Journal of International Trade & Economic Development*, 26(6), 649–676.

UN (2011). *Towards Human Resilience: Sustaining MDG Progress in an Age of Economic Uncertainty*. United Nations Development Program.

UNCTAD (2013). *Global Value Chains and Development: Investment and Value-Added Trade in the Global Economy*. United Nations publication DAE/2013/1.

UNCTAD (2015). *Global Value Chains and South-South Trade- Economic Cooperation and Integration among Developing Countries*. Technical Report UNCTAD/GDS/ECIDC/2015/1, UNCTAD.

UNCTAD (2017). *Services and Structural Transformation for Development*. UNCTAD UNCTAD/DITC/TNCD/2017/2, UNCTAD.

UNCTAD (2018). *Export Diversification and Employment*. UNCTAD ALDC/2018/3.

Vera, L. A. (2006). The Balance-of-Payments Constrained Growth Model: A North-South Approach. *Journal of Post-Keynesian Economics*, 29(1), 67–92.

Verdoorn, P. J. (2002). Fattori che regolano lo sviluppo della produttivita‘ del lavoro’, L’Industria, 1:3 10. English translation by A. P. Thirlwall. In J. S. L. McCombie, M. Pugno, & B. Soro (Eds.), *Productivity Growth and Economic Performance: Essays in Verdoorn’s Law*. New York: Palgrave Macmillan.

Wade, R. (1990). *Governing the market*. Princeton and Oxford: Princeton University Press.

Wagner, G. (2010). Energy content of world trade. *Energy Policy*, 38, 7710–7721.

Wang, Y., Zhang, X., Kubota, J., Zhu, X., & Lu, G. (2015). A Semi-Parametric Panel Data Analysis on the Urbanization-Carbon Emissions Nexus for OECD Countries. *Renewable and Sustainable Energy Reviews*, 48, 704–709.

Wells, H. & Thirlwall, A. P. (2003). Testing Kaldor’s growth laws across the countries of Africa. *African Development Review*, 15(2-3), 89–105.

Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics*, 69, 709–748.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, 126, 25–51.

Wolfe, J. N. (1968). Productivity and growth in manufacturing industry: some reflections on professor Kaldor’s inaugural lecture. *Economica*, 35, 117–126.

Wood, A. & Mayer, J. (2001). Africa’s export structure in a comparative perspective. *Cambridge Journal of Economics*, 25(3), 369–94.

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Cambridge, MA: MIT Press.

World Bank (1993). *The East Asian Miracle: Economic Growth and Public Policy*. New York, N.Y: Oxford University Press.

World Bank (2020a). *Vibrant Vietnam. Forging the Foundation of a High-Income Economy*. Washington, DC: World Bank.

World Bank (2020b). *World Development Report 2020 : Trading for Development in the Age of Global Value Chains*. Washington, DC: World Bank.

World Bank & Ministry of Planning and Investment of Vietnam (2016). *Vietnam 2035: Toward Prosperity, Creativity, Equity, and Democracy*. Washington, DC.

WTO (2010). *World trade report 2010: Trade in natural resources*. Geneva: WTO.

WTO (2014). *World Trade Report 2014: Trade and development: recent trends and the role of the WTO*. Geneva: WTO.

WTO & IDE-JETRO (2011). *Trade patterns and global value chains in East Asia: from trade in goods to trade in tasks*. Geneva: WTO.