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THESE

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Titre :

AGGLOMERATION ECONOMIES IN DEVELOPING COUNTRIES.

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A ma famille

L'Université de Paris I n'entend donner aucune approbation ou improbation aux opinions émises dans cette thèse. Ces opinions doivent être considérées comme propre à leur auteur.

Abstract

This thesis studies empirically the agglomeration forces posit in the economic literature. It overcomes several of the methodological limitations of previous empirical works. It privileges applications to developing countries that experienced increased integration to the world economy through trade liberalization or colonization. The empirical applications maintain a close connection with theoretical models, especially those issued from the recent literature known as New Economic Geography.

Chapter 1 investigates the evolution of the world economic geography. A theoretical relationship between the proximity to demand (termed as “market access”) and the level of manufacturing wages is tested. Using trade gravity equations for the period 1980-2003 for 27 industries, measures of market access are built. Results indicate that 16 out of 27 manufacturing industries exhibit this wage response. The fact that panel data econometrics (static and dynamic) is employed reduces considerably the risks of omitted variable bias. The absence of effect of market access can be attributed to the influence of labor relocation, human capital requirements, supplier access, and labor regulations.

Chapter 2 and 3 focus on the impact of a recent trade reform on Brazilian regional labor markets, and take advantage of detailed information on trade at intranational level, as well as microdata on firms and workers. In chapter 2, the same hypothesis postulated in Chapter 1 is tested, but using individual wages and a market access that captures demands from the rest of Brazil and international partners. Results confirm the impact of market access on wages, which is robust to controls for firm productivity, knowledge spillovers, and endowments.

Chapter 3 continues the exploration of Brazil economic geography in a dynamic setting. In a general equilibrium framework, it is expected that wage differentials are arbitrated away through migration. The chapter explores the impact of market access on bilateral migration. Microdata are used to warrant that self-selection is properly taken into account, and to build migration flows breakdown by skill levels and industrial affiliation. Results confirm an important migration response to the evolution of market access, although migration costs and selection bias limit migration flows.

In Chapter 4, the role of history in agglomeration processes is studied by following the evolution of cities founded in the American continent over the more than 3 centuries of Spanish rule. Major events affecting these cities (natural disasters, wars, etc) are employed to assess the role of the shocks on city relocation. The identification is made by looking at determinants of the duration of a city in a particular site and the effect of past outcomes (hysteresis) is measured by using the age of a city. Results indicate a great urban instability in the earlier periods of the Conquest, where political disorders together with an orientation to extractive activities seem to explain a high instability. In later periods, when the empire stabilizes politically, there are important changes towards strong urban stability. All these results suggest strong non-linearities and path-dependency in the agglomeration process.

Keywords : Economic Geography, Market Access, Latin America, Trade
JEL : F12, F16, F54, J31, N96, O18, R10, R12, R23

“no atribuyas a tus merecimientos la merced recibida...”

Don Quijote (Miguel de Cervantes)

A thesis is a journey into the unknown.

My advisor, Prof. Thierry Mayer provided a wonderful guidance and constant support. I would like to express my deep and sincere gratitude to him.

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Living abroad is also a journey into the unknown.

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Resumé en Français

“La tendance vers la spécialisation associée aux différences dans les dotations factorielles est renforcée par les avantages de production à grande échelle. La localisation d’une industrie dans une région à la place d’une autre peut être due tout simplement au hasard”

Ohlin (1933), cité par Krugman (1999)

Les dernières décennies ont vu apparaître un intérêt croissant pour le rapport entre espace et performance économique. Les apports théoriques provenant de l’économie et la géographie ont commencé par explorer premièrement la géographie physique comme explication pour la tendance à l’agglomérations spatiale de l’activité économique. Certain écoles ont aussi considéré des autres déterminants comme les coûts de transport et les externalités technologiques. Les économistes du développement comme W. Arthur Lewis, François Perroux, Gunnar Myrdal, John Harris et Michael Todaro ont aussi conçu l’industrialisation dans les milieux urbaine (et donc l’agglomération) comme un passage obligé pour le développement économique, ainsi que la migration urbaine rural comme le mécanisme permettant un tel industrialisation. L’intérêt est aussi témoigné aujourd’hui par la thématique choisi pour le dernière Rapport pour le Développement Mondiale de la Banque Mondiale (2009), qui s’intéresse à l’ “aménagement de l’économie géographique”, cet à dire, à la façon comment les pays, provinces et villes peuvent profiter de la tendance de l’activité économique à se concentrer dans l’espace.

Cette thèse analyse les implications empiriques des économies d'agglomération. De nombreuses limitations présentes dans les études existantes sont surmontées. Des applications vers des pays en développement sont privilégiés, en particuliers ceux qui ont expérimenté une plus forte intégration croissante à l'économie mondiale à cause de l'ouverture commerciale ou à cause des colonisations. Cette thèse est basée sur l'intuition que l'avantage comparatif coexiste avec les économies d'agglomération, comme suggéré par l'affirmation de Bertol Ohlin dans l'épigraphe. En fin, les applications s'intéressent plus particulièrement aux mécanismes proposés par la Nouvelle Économie Géographique (NEG).

Cette nouvelle courant de pensée est né officiellement en 1991, suite à l'apparition de l'article de Paul Krugman intitulé "Increasing Returns and Economic Geography (Rendements croissants et Economie Géographique)". Krugman développe un modèle à deux régions symétriques que divergent dans son niveau de concentration industrielle comme résultat d'une combinaison ingénieuse de rendements croissants, coût au commerce, différenciation horizontale et mobilité de facteurs. L'étude montre que, sous certaines conditions, un choc peut entraîner une migration qui se auto renforce. Comme le processus n'est pas défait une fois le choc enlevé, le modèle est considéré comme un cas de équilibre multiple et hystérèse. Au delà de cette propriété intéressant, la contribution majeur de ce modèle est de nous fournir une explication pour les inégalités spatiale qui presente une base microéconomique.

Au present, de multiple variantes du modèle de base ont été développé, avec des implications pour les politiques publiques, l'intégration commerciale, la croissance économique,

etc. La popularité de l'approche est évident, pas seulement à cause du Rapport de la Banque Mondiale mentionné, mais aussi pour le Prix Nobel octroyé à Paul Krugman en 2008 pour "son analyse de la structure du commerce et la localisation de l'activité économique". En fait, malgré sa courte trajectoire, cette ligne de pensée a pris un rôle majeur dans les débats sur le développement. La raison d'un tel essor pourrait venir du fait de sa capacité de traiter des sujets liés au progrès économique et les défis de la mondialisation. Quelques exemples concrets:

- Elle fournit des explications pour les processus d'industrialisation et désindustrialisation dans un contexte d'intégration dans la mondialisation des échanges et de l'investissement direct étranger.
- Elle génère des prédictions sur l'évolution des disparités régionales (au niveau de salaires ou emploi) au niveau intra national.
- Elle renseigne sur le potentiel et limites de la migration comme mécanisme d'ajustement des inégalités spatiales.
- Elle ajoute des nouveaux éléments au débat sur le rôle de l'intervention publique dans la génération des clusters d'activité économique et la maîtrise des coûts de congestion.

Les applications empiriques de la NEG ont été rares encore au début des années 2000, quand Peter Neary (2001) a rédigé la première révision de la littérature. Dans les années suivantes, des développements empiriques ont permis l'apparition des révisions centrées

exclusivement sur des applications et tests des modèles (Head et Mayer, 2004b; Redding, 2009). Cependant, il faut noter que la plus part des études concerne les pays développés.

Cette thèse concerne les applications des modèles de la Nouvelle Economie Géographique. Elle cherche à incorporer des nouvelles méthodes, explorer des nouveaux tests, et étendre les applications vers les pays en développement. La suite de cette exposition est organisée dans quatre parties. La première développe les objectifs et structure de la thèse, en cherchant à justifier les sujets de recherche, les méthodes et les résultats principaux. La deuxième partie se concentre sur les contributions générales, que traversent tous le chapitres. La troisième partie décrit les résultats généraux de l'ensemble de la thèse, et la quatrième énonce quelques propositions de recherche future.

Objectifs et structure de la thèse

Les ingrédients essentiels d'un modèle de la NEG sont (Head et Mayer 2004):

- Un cadre de concurrence imparfaite (généralement concurrence monopolistique, où les firmes et ménages bénéficient mutuellement d'une localisation centrale en raison du plus grand nombre de variétés)
- L'existence de rendements croissants internes à la firme, qui détermine l'intérêt des entreprises à approvisionner les consommateurs depuis une seule localisation.
- Des coûts au commerce, qui déterminent l'intérêt de la firme à se localiser près d'un grand marché.

- La localisation endogène des firmes, donnée par les conditions précédentes.
- La localisation endogène de la demande, qui détermine une causalité circulaire et l'existence d'équilibres multiples.

Les éléments signalés permettent de distinguer deux types de forces d'agglomération. D'un côté, les grands marchés permettent aux agents économiques d'économiser des coûts de transport, ce qui conduit à un coût de la vie plus faible (Cost of Living effect). D'un autre côté, les entreprises peuvent s'installer dans les grands marchés et exporter vers les petits marchés (Market Access effect). L'accès aux marchés constitue la variable d'intérêt de ce chapitre.

L'agglomération n'est cependant pas absolue en raison de l'existence de coûts de congestion issus d'une concurrence plus forte dans les localisations centrales (Market Crowding effect). Il existerait ainsi une tension entre les forces qui poussent à l'agglomération des activités et celles qui poussent au contraire à leur dispersion. Il est possible aussi que le mécanisme d'ajustement ne soit pas l'agglomération mais plutôt la hausse de prix de facteurs. Dans ce cas, on trouve une relation théorique entre l'accès aux marchés et la rémunération de facteurs.

Les questions de recherche dans cette thèse restent très proches de l'agenda de recherche proposé par Head et Mayer (2004), Neary (2001) et Hanson (2000):

- Identification des mécanismes de la NEG, avec un intérêt particulier pour tester des hypothèses alternatives (Neary, p. 554; Head et Mayer, p. 2663; Hanson, p. 490)

et focalisé sur les différences entre les industries (Neary, p. 557; Head et Mayer, p. 2663).

- Une analyse approfondie des mécanismes d'ajustement (migration, délocalisation des firmes, délocalisation de villes) qui entraînent les agglomération dans un cadre d'équilibre général (Head et Mayer, p. 2631; Hanson, p. 490). Ce type d'analyse est relativement peu examiné en comparaison aux études sur l'impact des économies d'agglomération sur les prix, qui restent en équilibre général.
- Une analyse minutieux du rôle de l'histoire, la possibilité des phénomènes catastrophiques, et des équilibres multiples dans la configuration de l'équilibre de l'économie spatiale, avec un intérêt spéciale pour les expériences naturelles, qui ont l'avantage de permettre un meilleur control des problèmes de simultanéité (Head et Mayer, p. 2662; Neary, p. 556; Hanson 2000, p. 490).

Ces problématiques sont développées dans quatre chapitres.

Chapitre 1: Les changements de l'économie graphique mondiale du secteur manufacturier

Le chapitre 1 étudie l'évolution de l'économie géographique mondiale en testant l'impact de l'accès aux marchés comme variable explicative de la structure spatiale des salaires pour 27 industries pour la période 1980-2003. Pour cela, on utilise la relation positive (en équilibre partiel) de la proximité de la demande (l'accès aux marchés) et les profits. Sous

l'hypothèse de profit nul, cette relation est établie empiriquement entre l'accès aux marchés et les niveaux de salaires.

L'accès aux marchés (aussi appelé potentiel marchand) constitue un indicateur du degré d'"attractivité" du marché. Il est composé de trois éléments:

- La taille du marché, qui correspond au niveau de dépense dans un région/pays dans le bien à rendement croissant.
- L'indice de prix pour le produit manufacturier, qui peut être interprété comme un indicateur inverse du niveau de la concurrence. En effet, plus la région est accessible à de nombreux fournisseurs des autres régions, plus l'indice de prix y est faible. Dans tous les cas, il est important de signaler que le résultat est aussi déterminé par l'élasticité de substitution entre les variétés: Si elle est grande, les coûts au commerce pèsent plus dans la détermination de l'indice de prix. Par conséquent, Redding et Venables (2004) emploient le terme de "Supplier Access" (SA) pour dénommer un indice de prix qui est corrigé par l'impacte de l'élasticité de substitution.
- La ouverture aux commerce, connu sous le nom de "phi-ness of trade" (Baldwin et al. 2003) et qui permet de décrire, sur une échelle de 0 à 1, le degré de friction du commerce, le 0 correspondant à un monde avec coûts de transports prohibitifs. Elle est aussi corrigée par l'élasticité de substitution.

L'accès aux marchés ainsi défini, a l'avantage, par rapport à d'autres indicateurs utilisés dans les études empiriques, de prendre en compte les demandes potentielles, les frictions

au commerce et les effets pro-concurrentiels (les différences provoquées par les variations relatives de l'indice de prix). Cette variable a reçu aussi les dénominations de potentiel marchand, et potentiel marchand réel (parce qu'il considère l'index des prix)

Les changements dans le accès aux marchés entraînent le déploiement des forces d'agglomération, soit par le biais des migrations et délocalisations (version quantité), soit par le biais de la rémunération des facteurs (version prix). Dans ce dernier cas, dans l'hypothèse où les profits sont nuls, on obtient une relation entre le salaire nominal maximal que une firme peut se permettre de payer dans une région et le potentiel marchand réel de ce région. Elle est souvent nommé "équation de salaires de la Nouvelle Economie Géographique".

L'estimation a été appliquée sur un certain nombre des pays (la plupart développés) avec des résultats favorables. Trois critères distinguent ces travaux.

Le premier fait la différence entre les études qui cherchent à estimer les paramètres du modèle en utilisant la variable dans sa version structurelle et les estimations "inspirées" de la NEG (version dite "réduites") qui utilisent des proxies ou une partie seulement des composantes du potentiel marchand. Les premières estimations empiriques ont privilégié naturellement ce dernière méthodes, plus simples à mettre en place. La forme la plus connue est l'utilisation d'un indicateur nommé "Harris Market Potential" (HMP) proposé dans le décennie 1950's. Il prend en compte les demandes des régions pondérées par la distance bilatérale et ne considère pas l'indice de prix. Il est important de noter que même si sa performance empirique est remarquable, il ne permet pas d'obtenir des paramètres structurels. L'absence de l'indice de prix implique aussi qu'il n'y a pas d'indicateur pour

mesurer le *Supply Access* (SA, une autre mesure de proximité économique, cette fois-ci, des fournisseurs). Une solution partielle à ce problème a été proposée par Amiti et Cameron (2004) qui développent une variable de Supplier Access basée sur des données très détaillées relatives aux achats entre firmes appartenant à plusieurs secteurs industriels en Indonésie. Elles proposent également une variable de *Market Access* pour chaque région et secteur industriel, intégrant la demande de biens intermédiaires et la demande finale. L'avantage de cette spécification est la possibilité d'introduire le Market Access et le Supplier Access dans une même estimation sans avoir de problème de multicollinéarité. Les deux variables sont significatives et robustes, avec des élasticités de 9,3% pour le SA et de 14,5% pour le MA. Néanmoins, encore une fois, l'élimination de l'indice de prix détermine que le *Market Access* proposé par les auteurs ne soit pas le même que celui identifié dans les modèles de la NEG.

Le deuxième critère pour analyser les travaux empiriques de l'équation de salaires de la NEG, est la prise en compte du temps pour étudier l'évolution des variables d'intérêt et pour contrôler l'hétérogénéité temporelle. Les premières travaux ont privilégié des analyses en coupe (par exemple, Redding et Venables, 2004). Néanmoins, si on considère que les éléments les plus riches des modèles de la NEG impliquent des ajustements au cours de temps liés à des phénomènes d'équilibres multiples, une étude dynamique est beaucoup plus attractive. Mion et Naticchioni (2005) par exemple, ont fait une telle analyse pour l'Italie pour un long période (1985-1998).

Les travaux ont été également classés selon le niveau de désagrégation des variables

dépendante (le salaire) et indépendante (l'accès aux marchés). La plupart des études ont réalisé des estimations avec les deux variables agrégées au niveau spatial choisi (national ou intra-national). A cet égard, il faut rappeler que la théorie soutient la relation entre salaire et market access pour le secteur caractérisé par des rendements croissant et en concurrence imparfaite. D'un point de vue empirique, certains phénomènes, comme les effets frontières, peuvent varier énormément selon les produits échangés, en raison par exemple de leur "transportabilité" (Head et Mayer, 2002). Finalement, il est nécessaire de prendre en compte le fait que les salaires présentent d'importantes variations induites par les différences de taille des firmes et les niveaux de capital humain demandés. Même si l'on intègre ces variables de contrôle, l'existence de frictions à la mobilité du travail entre les industries peut impliquer l'identification des "industry premiums" (Amiti et Cameron, 2004). Finalement, il est possible d'être plus ambitieux en utilisant, pour tester la relation entre le RMP et le salaire, des données individuelles de salaire, et en y associant les caractéristiques individuelles pertinentes telles que le nombre d'années d'études, l'expérience, etc. Il est intéressant de remarquer à ce titre que des études structurelles avec données individuelles n'ont pas encore été faites (ce qui est justement l'application empirique dans le Chapitre 2 de cette thèse).

L'application du chapitre 1 suit de près la méthode proposée par Redding et Venables (2004). Ils utilisent l'équation de la demande pour dériver une équation de gravité du commerce. L'avantage d'une telle démarche est qu'il permet d'utiliser des effets fixes des importateur et exportateur pour capturer la composante non dyadique de l'accès aux marchés et du SA (et par conséquent, ils incluent l'indice des prix). La composante de *phi-ness of*

trade est modélisée comme fonction de la distance bilatérale et de la contiguïté, de langue commune, de liens coloniaux, etc.

Dans son analyse, Redding et Venables (2004) utilisent des données du commerce international pour 1995 et l'équation de salaire est donc estimée en coupe. L'objectif du chapitre 1 est d'estimer la même régression, mais en panel et pour plusieurs industries. La base de données TradeProd du CEPII (Centre d'études et prospectives internationales) du commerce internationale avec une classification industrielle de 27 secteurs est mise à jour pour permettre une étude avec une série de données d'accès aux marchés qui couvre la période 1980-2003. Cette stratégie permet de mieux contrôler pour l'hétérogénéité des pays (puisque l'estimation est un modèle à effets fixes) et pour l'hétérogénéité des industries (puisque les régressions sont estimés séparément pour chaque industrie). Les résultats suggèrent que les coefficients sont positifs et significatifs pour 16 parmi les 27 secteurs. Les magnitudes des élasticités (économétriquement significatives) se trouvent entre 0.10 et 0.37. Ces coefficients sont beaucoup plus bas que ceux de Redding et Venables (2004) (on rappelle que les estimations de ces auteurs sont pour un échantillon en coupe). D'un autre côté, ils sont très proches des valeurs des études plus récentes, estimés en panel mais qui ne contrôlent pas pour l'hétérogénéité industrielle (Mayer, 2008; Boulhol and de Serres, 2008).

Par conséquent, les niveaux des revenus sembleraient être affectés par la position spatiale de un pays dans ces industries. Le risque de biais due aux variables omises est réduit par l'utilisation d'un modèle à effets fixes. De plus, l'étude du chapitre 1 innove par l'application d'un modèle de panel dynamique (méthode de moments généralisés, GMM).

Finalement, plusieurs variables de contrôle ont été incorporés pour prendre en compte la relocalisation des travailleurs, les niveaux de capital humain, le Supplier Access, et les régulations des marchés du travail. Un résultat intéressant est que les secteurs souvent qualifiés comme de bas technologie, à savoir le textile et habillement, sont moins robuste a ces variables de contrôle. En revanche, les secteurs à haute technologie telle que la fabrication de outils scientifiques et professionnels, se montrent très robustes à tous les tests et contrôles. Cette situation suggère qu'il y a un effets combiné de l'avantage comparative et l'économie géographique, comme a été proposé par Fujita, Krugman et Venables (1999) dans une série de simulations de son modèle théorique.

Etude approfondie de l'économie géographique brésilienne

Les chapitres 2 et 3 se concentrent sur l'impact de l'ouverture commerciale sur les régions brésiennes. Le chapitre 2 confirme l'impact positif de l'accès aux marchés sur les salaires à l'aide des donnés individuels et des entreprises. Comme l'existence des différentiels de salaires devrait entraîner à terme la mobilité des facteurs, le chapitre 3 évalue l'hypothèse d'un effet significatif et positif de l'accès aux marchés sur les flux de migration bilatéraux. L'utilisation des données individuelles permet de construire des mesures de migration au niveau industriel et par niveau de qualification. Les résultats confirment l'impact positif de la variable d'intérêt, mais soulignent aussi l'importance des coûts à la migration et le biais de sélection dans la réduction des flux migratoires.

Le Brésil est caractérisé par la plus grande inégalité individuelle de revenus d'Amérique Latine (Pendant la décennie 1990's, le Gini des revenues est resté proche de 0.60). De

telles inégalités se retrouvent aussi à l'échelle spatiale. Les salaires dans les régions les plus riches sont 7 fois plus élevés que dans les régions plus pauvres. L'état de Sao Paulo dans le Sud-Est concentre plus de 33% du PIB national pendant toute la période 1985-2002. Certains états (Minas Gerais, Espírito Santo, Goiás et Pernambuco) très similaires au début du vingtième siècle ont suivi des parcours très différents en termes de PIB, probablement à cause de leur proximité avec d'autres régions riches ou pauvres.

L'activité économique est aussi très concentrée dans la région sud du pays, même s'il existe des signes montrant que les changements de politiques économiques favorables à la libéralisation pourraient avoir des effets sur la géographie économique du pays. On va survoler succinctement ces changements:

Réformes structurelles. Les efforts commerciaux de libéralisation au Brésil ont commencé autour de 1988. Des barrières non tarifaires ont été substituées par des tarifs, et les tarifs ont été réduits en moyenne de 60% en 1988 à 15% en 1998, et devraient passer sous la barre de 11% dès lors que le tarif externe commun du MERCOSUR entrera en vigueur en 2006. La libéralisation commerciale, ainsi que d'autres réformes structurelles (déréglementation et privatisation des entreprises d'Etat) ont affecté la totalité de l'économie, mais plus particulièrement le secteur manufacturier, plus exposé à la concurrence internationale. Des études récentes ont trouvé une réduction des mark-ups, et une augmentation marquée de l'efficacité de grandes entreprises manufacturières en raison de la libéralisation commerciale. Menezes-Filho and Muendler (2004) trouvent une augmentation remarquable de la productivité dans le secteur de fabrication dû à la concurrence étrangère et à l'augmentation

de la probabilité de sortie des entreprises moins efficaces.

Intégration régionale (Mercosur 1991-1995). Le Mercosur a été créé en 1991 par le Traité d'Asunción et il a comme but final de former un marché commun autour de l'Argentine, du Brésil, du Paraguay et de l'Uruguay. Il comportera la libre circulation de toutes les marchandises, services, travail et capital, l'adoption d'une politique commerciale commune vers les non membres, et la coordination des politiques macro-économiques et sectorielles dans beaucoup de secteurs. L'union douanière a été établie en janvier 1995. Une délocalisation des entreprises vers le sud a été observée pour se rapprocher du marché argentin.

Concurrence fiscale entre les états brésiliens pour attirer des entreprises. Lall et al (2004) explorent l'influence de la structure de taxation de chaque état et "município" sur le coût des entreprises, et ils trouvent un impact assez mitigé. Pourtant, la concurrence entre les états est assez forte. Pendant la décennie des années 1990s, le gouvernement de l'état brésilien Rio Grande do Sul avait fait une offre généreuse des réductions des impôts au constructeur automobile Ford pour attirer sa localisation dans l'état. Quelque temps plus tard, le gouvernement de l'état a essayé de réduire les avantages, et Ford s'a délocalisé vers l'état de Bahia (World Bank, 2009).

Réduction de coût de transport à l'intérieur du Brésil. Entre 1970 et 1995, les investissements publics en infrastructure ont été importants, surtout dans les territoires en retard de développement ou plus isolés. Lall et al. (2004) trouvent que cette composante est significative en termes de réduction de coûts pour les entreprises et qu'elle est plus

signifiante par rapport aux incitations fiscales.

Chapitre 2: Economique géographique et salaires au Brésil

Les résultats du chapitre 1 suggèrent un impact robuste de l'accès aux marchés sur les niveaux des salaires. Néanmoins, cet impact pourrait être dû à des autres explications alternatives, tels que des dotations factorielles ou des autres forces d'agglomération (des externalités de connaissance). La recherche proposée dans le chapitre 2 cherche à isoler ces effets d'une meilleure façon, avec une application aux régions brésiliennes, et à l'aide de micro données pour les salaires. Cette information est issue d'un recensement des firmes provenant du secteur formel. Le Brésil a aussi un grand avantage en qualité des données du commerce international et intranational, qui sont désagrégés par état brésilien et par catégorie des produits.

Cette information permet de calculer l'accès aux marchés pour les 27 états brésiliens. De plus, on peut diviser le potentiel marchand en trois éléments. Un lié à la taille de la demande de la région en question (Local RMP), un autre associé aux accès aux marchés des régions voisines (Régional RMP) et le dernier élément lié aux accès aux marchés internationaux (International RMP).

La disponibilité des microdonnées permet d'approcher l'équation de salaire inspiré dans la spécification de Combes et al (2008). Même si ces auteurs se sont intéressés aux externalités non pécuniaires plutôt qu'aux modèles de la NEG, leur formulation générale met en lumière les différentes explications possibles pouvant faire l'objet d'une application au cas brésilien

ainsi que les limites de cette étude de cas. Les auteurs postulent que le salaire d'une travailleur dans une région et un industrie spécifiques est donné par les qualifications de l'individu, les dotations de la région qui affectent la productivité du travail, et les gains de productivité engendrés par les interactions entre les travailleurs et les firmes au niveau local: interactions favorisant toutes les industries (économies d'urbanisation), ou propre à l'industrie (économies des localisation).

Le modèle dérivé de cette proposition générale, s'il permet d'identifier les déterminants des disparités spatiales de salaires, ne met pas en évidence les mécanismes à l'origine des économies d'agglomération. Par exemple, la densité d'emploi peut avoir des effets positifs (économies d'urbanisation) mais aussi négatives (congestion). Les dotations peuvent être une source de gain à cause de l'abondance de ressources naturelles, et en même temps déterminer un mauvais potentiel marchand si elles se trouvent loin des centres économiques.

Ce type de formulation souligne l'importance d'envisager une désagrégation par secteur industriel de l'accès aux marchés. La rentabilité de l'éducation peut aussi varier selon les secteurs. On peut considérer un modèle avec des biens intermédiaires et postuler l'existence des liens verticaux. Les données individuelles brésiliennes de salaire fournissent les secteurs productifs auxquels appartiennent les travailleurs. Par conséquent, l'indentification de variation spatiale de salaires et poussé au maximum possible permis par la désagrégation industrielle, et considère aussi l'utilisation des effets fixes par industrie pour mieux capturer l'hétérogénéité sectorielle.

L'estimation de l'équation de salaire de la NEG permet non seulement de déterminer

l'importance du potentiel marchand dans la détermination du salaire, mais aussi d'apporter une contribution au débat sur les déterminants des inégalités de salaire au Brésil. Plusieurs études ont déjà estimé l'équation de Mincer pour le Brésil et ont mis en évidence des coefficients liés à l'éducation compris entre 12 et 15%, parfois plus élevés. Quand l'analyse est désagrégée par région, les salaires sont souvent corrigés en utilisant des estimations de l'indice de prix régional pour considérer le salaire réel. Dans certains cas, les disparités spatiales disparaissent, et la conclusion est que le problème central est la concentration de populations peu qualifiées dans certaines régions. L'avantage du caractère structurel de l'équation de salaire de la NEG est de se concentrer sur les salaires nominaux. D'un autre côté, l'introduction de "Supplier Access" dans la régression permet de capturer l'indice de prix.

Les bases de données des flux internationaux ont été fournies par le Secrétariat de Commerce Extérieur (SEDEX) du Brésil et celles des flux nationaux par la Commission de Finance brésilienne (CONFAZ). Ces dernières sont disponibles seulement pour l'année 1999, ce qui impose une analyse de coupe transversale. Les données sur les états brésiliens (latitudes et longitudes, surfaces) sont publiées par l'Institut de Statistique Brésilien (IBGE). Les latitudes et longitudes, contiguïté et langue ont été obtenues à partir de la base de distances de CEPII.

En ce qui concerne les analyses au niveau du commerce, les coefficients obtenus pour la distance, la contiguïté nationale, etc. ont les signes attendus. L'avantage d'utiliser les effets fixes dans ces régressions de commerce bilatéral est que ceux-ci peuvent rendre compte

des caractéristiques particulières à chaque pays et qui influencent les échanges bilatéraux (même si ces caractéristiques sont non observées). Les paramètres obtenus de l'inclusion des effets fixes nous seront indispensables au moment de construire les variables d'accès aux marchés.

Il est intéressant de remarquer que la variable d'accès aux marchés (Total) est toujours positive et statistiquement significative au seuil de 1%. Leurs magnitudes varient entre 0,050 et 0,160, ceci sont de grandeurs que nous trouvons dans la littérature existante. À mode d'exemple; le coefficient 0.14 du accès aux marchés total est similaire au coefficient de Head et Mayer (2006) dans son étude pour les régions européennes. En ce qui concerne aux différentes composantes du RMP (Local, Régional et International), leurs coefficients sont eux aussi toujours du signe attendu et significatif.

Les estimations empiriques de l'équation de salaire de la NEG ont reçu des critiques à cause de la endogénéité potentielle. Il est possible que un choc exogène dans le salaire d'une région entraîne l'augmentation du RMP. Etant donné la magnitude des effets frontières estimés pour le Brésil, une partie très importante du RMP est dépendante de la demande de la même région. Le problème peut être abordé en utilisant la technique de variable instrumentale. Il est nécessaire une variable corrélée avec l'accès aux marchés mais pas corrélée avec le terme d'erreur. Head et Mayer (2005) proposent des variables liées à la géographie physique tel que: la distance vers les centres économiques. Un instrument additionnel, qui correspond à la date de création des municipalités a été ajouté. Tous les instruments passent les tests de validité et les résultats suggèrent des élasticités entre 0.119

et 0.145. En conclusion et en regardant nos régressions basées sur des données individuelles, nos variables du accès aux marchés sont robustes au biais d'endogénéité.

Parmi les résultats additionnels, on remarque les impacts différenciés par niveau de qualification. En effet, certaines variations du modèle canonique de la NEG proposent que les travailleurs qualifiés devraient profiter plus des avantages liés à l'accès aux marchés puisque le secteur manufacturier devrait demander d'avantage des travailleurs qualifiés (Redding et Schott, 2003). D'un autre côté, il est possible que les effets Stolper-Samuelson s'imposent puisque le Brésil étant un pays avec une abondance de main d'œuvre non qualifié (Muriel et Terra, 2009), les salaires refléterait l'avantage comparatif du pays. Il s'agit donc d'une question qui peuvent être tranché seulement au niveau empirique. Les résultats des régressions suggèrent que c'est la dernière théorie qui l'emporte: l'élasticité est plus grande pour les groupes des travailleurs non qualifiés.

Chapitre 3: Migration et accès aux marchés au Brésil

Une des principales critiques de la mondialisation est qu'elle augmenterait les inégalités des revenus. Les deux chapitres précédents ont montré un mécanisme (peu exploré jusqu'à maintenant) qui est l'impact sur les salaires du au changements dans l'attractivité des pays ou régions, mesuré par le potentiel marchand. Néanmoins, ces prédictions sont obtenues en équilibre partiel. En équilibre général, les différentiels des salaires devraient entraîner des flux migratoires pour les compenser. Les travailleurs donc, suivraient les changements des potentiels marchands. Cette prédiction empirique a été rarement testée dans les études empiriques. On poursuit l'étude de cas brésilien, cette fois-ci en regardant toute la période

1993-2003, pour évaluer l'ajustement des régions brésiliennes suite à l'ouverture unilatérale initiée au début des années 1990s, qui a augmenté les écarts de potentiel marchand entre les régions.

Plus précisément, le test évalue l'hypothèse d'un effet significatif et positif du potentiel marchand sur les flux de migration bilatéraux. Nous avons considéré trois raffinements qui améliorent notablement les estimations: (1) introduire des mesures des coûts à la migration; (2) une estimation qui corrige pour le biais de sélection, notamment grâce à l'aide de micro-données et (3) des contrôles pour des variables non observées (par exemple, des aménités).

La base de micro-données utilisée dans l'étude est générée à partir d'une enquête des ménages réalisée par l'institut brésilien de statistique et géographie (IBGE) connue sous le nom de PNAD (Pesquisa Nacional por Amostra de Domicílios). Le niveau très détaillé des domaines enquêtés ainsi que la couverture nationale explique qu'elle soit la source privilégiée pour estimer l'équation de salaire de Mincer au Brésil, ainsi que des études sur la migration. L'échantillon pris dans l'étude suit les recommandations des travaux précédents: Des salariés avec un contrat de travail ("Carteira de trabalho assinada") pour toutes les secteurs (sauf l'agriculture et le secteur public) âgés entre 18 et 65 années. Il est souvent considéré un sous-échantillon caractérisé par des hommes entre 24 et 39 années en argumentant que les dynamiques du marché du travail féminine sont plus complexes et que les réactions des salariés plus âgés aux incitations à la mobilité spatiale et sectorielle sont différentes.

Une deuxième base de micro-données est utilisée pour tester la robustesse, ainsi que

pour explorer des aspects additionnels concernant la spécificité industrielle de la migration. Il s'agit du recensement brésilien pour l'année 2000. Un échantillon avec plus de 20 millions des individus est utilisé pour construire de flux migratoires des travailleurs selon son niveau de qualification, et son affiliation industrielle. Cette démarche permet de tester l'impact spécifique à l'intérieur de chaque industrie de l'accès aux marchés sur la migration de l'industrie correspondant. De plus, la limitation des données du commerce disponible empêche de tester un accès aux marchés avec tous ces composants (international, intranational, domestique) pour la période 1993-2003, mais il est possible de le faire avec le même données de l'année 1999 utilisés pour l'équation de gravité testé dans le chapitre 2.

A l'issue de ces estimations, le bilan concernant l'influence du potentiel marchand est éclaircie. Deux résultats sont particulièrement importants. Premièrement, les régions à haut potentiel attirent d'avantage des migrants, qui ont la tendance à provenir des régions à faible potentiel marchand. Les résultats révèlent un fort biais de sélection dans la migration à l'intérieur du Brésil. Nous avons trouvé aussi que les coûts à la migration restent importants, mais son impact est mitigé quand il s'agit de migration des travailleurs dans la même branche économique.

Le deuxième résultat principal trouvé est la robustesse de l'impact pour la grande majorité des secteurs industriels. A différence de l'équation de salaire, le potentiel marchand (spécifique à chaque industrie) montre un effet sur la migration dans tous les secteurs. Bien entendu, il est loin d'épuiser le différentiel de salaires, phénomène expliqué en grande partie par le biais de sélection et par les coûts à la migration. Mais le fait que la migration

soit présente dans tous les secteurs suggère que elle a le pouvoir de réorganiser de façon significative la géographie économique du Brésil. Un exercice contrefactuel est fait pour explorer cette possibilité. Pour certains secteurs, les effets d'une intégration régionale sont très importants, mais l'impact total sur la immigration au niveau des états brésiliens suggère que les changements sont mitigés. Par conséquent, la possibilité d'une "agglomération catastrophique", souvent proposé dans les modèles de la NEG, est écartée pour le Brésil.

Par conséquent, la principale conclusion de cette étude est que, si l'ajustement de salaires reste prédominant (et donc l'inégalité spatiale), certain secteurs économiques sont en train d'expérimenter des changements dans sa distribution spatiale par la voie de la migration.

Chapitre 4: La stabilité spatiale des villes nomades du Nouveau Monde

*Au debout, Les indiens ont été accablés par la surprise,
 Pour des Dieux ils nous ont pris et obéi,
 Mais après la découverte qu'on été des simples mortels,
 Ses révérences ont devenu hostilité et mépris*

Alonso de Ercilla, 1569.

La Araucana. Poème II, p. 42

Version anglaise dans Crow (1960)

*Aucune nation n'entreprendra la conquête d'un territoire sauvage, Mieux protégé par
 ses misères qu'il ne le pourrait par des armés*

Captain Antonio de Alcedo, 1786.

The Geographical and Historical Dictionary of
 the America and the West Indies. Vol 2, p.217.

Les conclusions du chapitre 3 et un bon nombre des études empiriques (par exemple, Davis et Weinstein, 2002 et 2008; Miguel et Roland, 2005) nous suggèrent que l'agglomération catastrophique et les équilibres multiples, des propriétés très remarquables des modèles de la NEG, ne retrouvent pas sa confirmation dans les études empiriques.

De plus, Krugman lui-même (2009) fait noter que l'impact majeur des forces de la NEG devrait se trouver dans le passé, par exemple avant la Deuxième Guerre Mondiale pour

le cas des Etats-Unis (pour le Brésil, on pourrait spéculer que l'impact est arrivé dans les grands vagues de migration entre 1950s et 1970s).

Il serait donc intéressant d'étudier des événements historiques pour évaluer l'évolution des phénomènes des agglomérations, avec un intérêt particulier pour des test empiriques concernant les propriétés de la NEG les plus controversés: hystérèse, équilibre multiple, et dépendance du sentier. Néanmoins, les défis pour une bonne identification économétrique sont particulièrement sévères.

Un bon nombre d'études ont regardé l'évolution des villes sur le long terme, et ont essayé d'expliquer l'évolution des variables liés aux agglomérations (croissance de la population, densité ou classement dans la hiérarchie des villes) avec des variables telles que dotations de la géographie physique, infrastructure, des niveaux d'éducation de la population, qualité institutionnel, etc. On trouve des exemples pour les Etats-Unis ((Beeson et al., 2001; Simon and Nardinelli, 2002; Kim, 2000; Dobkins and Ioannides, 2001), le Japon et la France (Eaton and Eckstein, 1997), l'Italie (Bosker et al., 2008), la Méditerranée et l'Europe pre-industrielle (Long and Shleifer, 1993; Bosker et al., 2008), la Chine (Anderson and Ge, 2005) et encore un étude de couverture international (Henderson and Wang, 2007). La plus part de ces études trouvent une forte persistance de la structure urbaine, mais ils n'ont pas des chocs exogènes et temporaires pour assurer une identification convaincante. Des autres études ont privilégié des chocs (assumé) exogènes tel que les bombardements pour évaluer la stabilité de la population dans les villes. Comme il serait expliqué plus tard, les villes de l'Amérique Latine permettent de offrir une source alternative de validation empirique.

Une autre raison qui rend intéressant d'étudier les pays de l'Amérique Latine est la tendance à présenter un haut degré de concentration spatiale de leurs activités économiques. Quelles sont les causes profondes de ce phénomène? Les théories des avantages naturels privilégient une vision basée sur les différences écologiques initiales (Diamond, 1997), dotations factorielles ou des institutions (Acemoglu et al, 2002; Ades et Glaeser, 1995). Les théories de la NEG ont mis l'accent sur la possibilité des équilibres multiples, et l'importance de la "dépendance du sentier" des agglomérations spatiales. Il y a très peu d'études empiriques sur ce sujet du à la rareté des expérience dit "naturelles" (Davis et Weinstein, 2002 et 2008). L'Amérique latine constitue un cas très intéressant pour approfondir cette nouvelle ligne de recherche. Le processus de conquête espagnole, nous fournit de très grands chocs (exogènes); il en va de même pour le cas des épidémies et des catastrophes naturelles, avec des variations importantes suivant la localisation des villes. Cette variation a amené les historiens à qualifier les villes espagnoles dans le Nouveau Monde des "villes nomades" (Musset, 2002) et constitue la source clé pour identifier des équilibres multiples.

Une étude de ce genre demande un important travail sur les données sources: recueil des données, développement des bases contenant les localisations, les dates des fondations, les chocs connus au cours de plus de trois cents ans de colonisation espagnole, et les conséquences pour les villes. Ce rassemblement d'informations a été fait pendant un stage de recherche au Séville, à l'Ecole des Etudes Hispano-américaines et l'Archive des Indes, en juillet 2007. La base est constituée de villes fondées sur le continent entre 1492 et 1825, obtenues à partir des plusieurs sources historiques. La base contient également information sur catastrophes naturelles qui ont entraîné le déplacement ou l'abandons des villes, et des

épisodes de déplacements.

Dans la mesure que l'expansion de l'empire était basée sur la fondation vertigineuse des villes pour occuper le territoire avant que les autres concurrents européennes, un bon nombre de choix de localisation aient été faites dans l'urgence, et ils ont été abandonnés ou la ville a été délocalisé. De plus, il y a eu des guerres civiles entre les conquistadors espagnoles pour s'approprier des ressources pendant le premier siècle de conquête, et les attaques de pirates et les révoltes des indiens était fréquent. Les catastrophes naturelles et la crise démographique ont surpris un group des colonisateurs préparés pour faire la guerre, mais par pour la gestion des risques.

L'étude innove sur plusieurs dimensions par rapport à la littérature existante. Premièrement, l'analyse se fait sur un très long période du temps, qui s'étend sur toute la période de domination espagnole sur les continent américain. Information détaillée est collecté pour des régions qui correspondent aujourd'hui à 22 nations, pendant un période de presque 350 ans, ce qui fait de cette étude le plus complète à présent. Deuxièmement, il y a une reformulation du problème de détection de l'équilibre spatial, avec un accent sur un contexte dans lequel les conditions initiales peuvent être mieux contrôlés. Troisièmement, bien que inspiré pour l'idée d'employer des très grand chocs sur le système urbaine (ce qui est la méthode employé jusqu'à maintenant), une innovation importante est fait concernant l'implémentation d'un nouveau test d'hystérèse, ainsi que des nouveaux méthodes économétriques (analyse de durée de vie). En particulier, l'étude identifie les déterminants de la durée d'une ville dans un endroit spécifique. L'effet des événement passés (hystérésis)

est mesuré avec l'âge d'une ville. La justification vient du fait que pendant les premières années de fondation, le risque d'abandon est fort parce que les habitants doivent découvrir les avantages de la localisation (y compris les chocs négatifs comme les tremblements de terre), aussi parce que les colonisateurs n'ont pas encore des liens fortes avec la localisation, et finalement parce les interactions sociales sont encore très faibles. Si la population reste dans la même localisation après un période, la ville s'enclave là-bas parce que les habitantes apprennent à vivre avec les problèmes associé a cette localisation, parce que les coût de relocalisation devient trop grands, et à cause de l'accroissement des avantages (qui se auto - renforcent) provenant des interactions sociales locales.

Les études empiriques jusqu'à maintenant on centré l'analyse sur le croissance des villes pour évaluer la stabilité des systèmes urbaines. Données des populations pour les villes coloniales dans l'Amérique Hispanique sont rare et de douteuse fiabilité, spécialement pour les périodes initiales. D'un autre coté, les registres des dates des fondation, relocalisation, abandon ou refondation permet l'application d'un méthode alternatif qui se base sur l'historique des événements des villes, tout en préservant l'idée initiale, bien que l'unité d'analyse change de villes vers les localisations potentiels. L'interprétation d'un équilibre multiple dans le approche de croissance des villes est que, une fois le choc enlevé, quelques villes auront une croissance plus bas par rapport à son période qui précède au choc. Un cas extrême entraînera l'abandon de la localisation. Trois alternatifs peuvent être associés a l'abandon: (1) Toute le monde est mort après la catastrophe (et la localisation est considéré comme "morte"), (2) les survivants migrent vers des autres villes, ou (3) les habitants reconstruisent la ville dans une localisation. Dans les trois cas, le changement reflète la

fin d'un état, où la localisation était occupée vers un nouvel état, où la localisation est abandonnée. Si on connaît la date de fondation de la ville, la durée de la localisation dans l'état "occupé" peut être utilisé comme variable dépendante pour évaluer les déterminants du risque de changement d'état dans un modèle de survie.

L'effet d'hystérèse est capté par une test emprunté des études de durée du chômage (Frijters et al., 2009). Si les événements passés influencent les opportunités du travail au présent, une durée plus longue du chômage devrait affecter négativement la transition vers l'emploi (justifié, par exemple, pour une obsolescence des qualifications). Le même test est appliqué pour explorer l'hystérèse dans la durée des exportations (Esteve-Pérez et al., 2006). Dans un contexte de colonisation, on s'attend que pendant les premières années de colonisation, le risque d'abandon soient très forte, puisque les habitants doivent d'abord découvrir les avantages de la localisation. D'où la hypothèse de dépendance négative de l'âge de la ville sur la survie de la localisation.

De plus, on attend que le système urbain devienne plus résilient aux chocs. Au fur et à mesure que la colonisation s'approfondisse, le continent est occupé avec des nouvelles villes, et un réseau urbain se développe. Les villes peuvent mieux exploiter les économies d'échelle dans le commerce (exporter vers des autres localisations). Les historiens convergent sur l'idée que le commerce dans l'Amérique Hispanique avait augmenté au cours des siècles (Carmagnani, 2004). Un réseau urbain facilite le soutien des autres villes face à un choc. Par exemple, la très appauvrie province Chilienne se faisait financer son armé pour défendre ses territoires des incursions constantes des indiens. Le transfert, appelé *situado*, était

donné par le riche Vice royaume Péruvien. En fin, les villes sont en concurrence pour les ressources, et dans une période tardive de colonisation, les habitants ont moins de la marge pour se délocaliser, tous simplement parce que il y a déjà des autres villes installées. Les dispositions de la couronne avaient établi que les villes ne pouvaient pas être trop proches entre elles. Par conséquent, une deuxième hypothèse centrale serait que les villes des périodes plus récents devraient avoir moins de possibilités d'être abandonnées.

Les résultats, robuste à plusieurs contrôles et méthodes d'estimation, indiquent une forte stabilité des villes sur longue période. Néanmoins, on trouve aussi une très forte instabilité des villes au début de la conquête, attribués aux désordres politiques. Plus tard, la maturité institutionnelle conduit à une plus forte stabilité urbaine. Par exemple, une variable de proximité vers les centres miniers contribue négativement à la stabilité des villes pendant ce premier période, mais il n'est plus important après. Il y aurait donc, des fortes non-linéarités et dépendance du sentier dans le processus d'agglomération.

Contributions générales de la thèse

Premièrement, l'introduction de deux dimension d'analyse nouvelle dans la littérature empirique de la NEG: l'hétérogénéité individuelle et l'hétérogénéité industrielle. Tous les deux ont éclaircie plusieurs mieux les implications empiriques de la NEG.

Au niveau industriel, on a obtenu information concernant la sensibilité des résultats, souvent disponible seulement pour un agrégé du secteur manufacturier. Plus précisément, on observe comment la mondialisation (réduction des coût au commerce) influence le niveau

d'agglomération comme résultat d'une tension entre l'accès aux marchés et l'avantage de coûts. Quelques industries ont un niveau de différenciation bas, ce qui affaiblit l'impact de la distribution géographique de l'accès à la demande. Les données sectorielles permettent aussi de prendre en compte les niveaux de spécialisation des régions et pays. On pourrait argumenter que la dimension industrielle est prise en compte même dans le cas de l'étude de la colonisation espagnole, puisque la proximité aux centres miniers est incluse dans les régressions.

Au niveau individuel, les études dans cette thèse cherchent à isoler les effets d'agglomération de l'assortissement spatiale de niveau de qualification (spatial sorting of skills) et le biais de sélection dans la migration. Même dans le cas de la durée des villes, l'impact potentiel de l'hétérogénéité individuelle non observé est exploré. Une forme additionnelle de hétérogénéité est la productivité au niveau de la firme, que pourrait aussi être assorti spatialement.

Deuxièmement, la vérification correcte des hypothèses repose sur des techniques économétriques rigoureuses ainsi que sur la disponibilité des bases de données très riches. Les études dans chaque chapitre ont rassemblé des grandes quantités des types de données, de préférence en panel, pour mieux contrôler pour l'hétérogénéité non observé. Dans le premier chapitre, l'information au niveau industriel du commerce, production, salaires et emploi a été matché au niveau ISIC Révision 2 de la classification des Nations Unies. Dans le deuxième et troisième chapitre, des mesures d'accès aux marchés sont construites pour la première fois au niveau intra nationale pour le Brésil. Aussi des données matchées au niveau employeur

- salarié sont utilisés pour mieux contrôler pour les caractéristiques de la firme tels que productivité et innovation. Dans le dernier chapitre, une base de données entièrement nouvelle a été créée, pour documenter l'évolution des villes espagnoles en Amérique Latine, avec une couverture d'une période de plus de 300 années, ainsi que des informations sur les catastrophes, les ports, et les centres miniers.

Troisièmement, l'espace est un terme ambigu. Dans cette thèse, la sensibilité des modèles de la NEG a été explorée à plusieurs niveaux de échelle géographique. Dans le chapitre 1, l'unité d'analyse est le pays. Dans le chapitre 2 et 3 les niveaux d'analyse sont des régions à l'intérieur d'un pays: Les états et municipalités Brésiliens. Dans le chapitre 4, l'unité d'analyse est la ville (ou pour être plus précis, les localisations qu'une ville peut avoir sur un long période de temps). Un résultat important de ces études est que l'unité spatiale n'a pas un effet de premier ordre sur la détection des interactions spatiales qui émerge à travers du commerce.

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Introduction

“The tendency toward specialization because of differences in factor endowments is reinforced by the advantages of large-scale production. The location of an industry in one region and not in another might simply be due to chance.”

Ohlin (1933), cited by Krugman (1999)

Over the last two decades, an increasing interest on the relationship between space and economic performance emerged. Why people and firms prefer to stay proximate? What are the economic and social consequences of agglomerations? How is globalization reshaping the spatial distribution of economic activities?

Classic traditions in economics and geography focused on the intuitive justification of locational fundamentals, and to a lesser extent on transport costs and technological externalities. Depending on the emphasis of these elements, as well as the spatial unit of analysis, researchers diverged to different schools of thought: International economics, regional science and urban economics. Development economics literature also contributed to this debate. Economists like W. Arthur Lewis, François Perroux, Gunnar Myrdal, John Harris and Michael Todaro considered industrialization in cities as the obligated passage for economic development, and the urban-rural migration as a mechanism leading to this process. The growing interest for these questions is acknowledged in the last World Development Report by the World Bank (2009). It is devoted to “Reshaping Economic Geography”, that is, the way countries, provinces and cities can take opportunity of the inclination of the economic activity to be spatially agglomerated. The report begins with

the hopeful thought “Economic growth will be unbalanced, but development still can be inclusive”, and puts forward spatial integration as a key for development.

This thesis studies empirically the agglomeration forces posit in the economic literature. It overcomes several of the methodological limitations of previous empirical works and privileges applications to developing countries, for which there are much less information at present. It is inspired by the intuition that comparative advantages coexists with agglomeration economies, as described in the Ohlin’s statement presented above. Finally, the empirical applications in this thesis maintain a close connection with theoretical models, especially those issued from the recent literature known as New Economic Geography.

This literature was formally born in 1991, when the article “Increasing Returns and Economic Geography” by Paul Krugman was published. It presented a two-region model where agglomeration emerged from initially symmetric regions. It consisted of a fancy combination of ingredients from trade models (increasing returns, trade costs and horizontal differentiation) augmented with factor mobility. Under certain conditions, a shock gathered a self-reinforcing worker migration. As the process was not reversed after the shock was removed, the model exhibited multiple equilibria and hysteresis. In every case, perhaps the main contribution of his work was to offer a micro-founded explanation for the spatial unevenness of economic activity.

Nowadays, an extensive theoretical literature has explored this approach, deriving implications for public policy, trade integration, economic growth, among many others. The popularity of the approach is now visible. In addition to the World Development Report by the World Bank mentioned, Paul Krugman was awarded with the Nobel Prize in Economics in 2008 for “his analysis of trade patterns and location of economic activity”. Actually, despite its relative short history as field in economics, this subject is taking a leading role in development issues. This may come from the fact that New Economic Geography (NEG) models seem particularly well suited to deal with topics that are closely associated to the economic progress and the challenges of globalization. To mention a few:

- It brings explanations for industrialization and deindustrialization processes, especially in the context of increasing world trade integration and Foreign Direct Invest-

ment.

- It derives predictions concerning the evolution of spatial disparities (in wages or employment) inside of countries.
- It assists in the assessments of the potentiality and limits of the internal migration as an adjustment mechanism.
- It adds renovated elements in the debate of the role of public intervention in the generation of clusters of economic activity and the control of congestion costs.

Empirical applications of the NEG models were scarce at the time that Peter Neary (2001) wrote the first extensive literature review (Hanson wrote a shorter one in 2000). Nonetheless, the wave of applied studies was about to come. In the following years, enough empirical work was available to justify new revisions concentrated exclusively on this aspect (Head and Mayer, 2004b; Redding, 2009). It is noted that most of the applications, however, are still related to developed economies.

This thesis concerns the applications of the New Economic Geography models. It pretends to incorporate new methodologies, explore new tests, and extend the applications to developing countries. In the following, I start describing the general objectives, with a brief description of the chapters focused on the justification of the research involved, methods and main results. Then I present some general contributions that cross all chapters.

Objectives and Structure of the Thesis

The research questions in this thesis follow closely the research agenda set by Head and Mayer (2004), Neary (2001) and Hanson (2000), comprising the following subjects:

- Identification of the NEG mechanisms, with special attention on testing against plausible alternatives (Neary, p. 554; Head and Mayer, p. 2663; Hanson 2000, p. 490) and focused on differences across industries (Neary, p. 557; Head and Mayer, p. 2663).

- A deep analysis on the adjustment mechanisms (migration, firm relocation, city relocation) supposedly driving to agglomeration in general equilibrium (Head and Mayer, p. 2631; Hanson 2000, p. 490). This kind of analysis is relatively neglected with respect to the study of the impact of agglomeration forces on prices, which is only partial equilibrium.
- A careful assessment of the role of history, spatial catastrophes, and multiple equilibria in shaping the agglomeration outcomes with special focus on natural experiences that mitigate simultaneity problems (Head and Mayer, p. 2662; Neary p. 556; Hanson 2000, p. 490).

In this thesis, I structure these problems in four chapters.

Chapter 1 investigates the evolution of the world economic geography. It exploits a relationship of partial equilibrium between the proximity to demand (termed as “market access”) and the formation of profits. Under a zero profit condition, a positive relationship between the country market access and wages can be stated. Starting with Redding and Venables (2004), most of the studies up to date explore with success this relationship in cross-sectional data and using aggregated information of the manufacturing sector. In this chapter a more precise cross-country analysis is obtained. Using trade gravity equations for the period 1980-2003 for 27 industries, measures of market access are built. The objective is to establish in which industries the mechanisms of the Economic Geography are at work. Results indicate that 16 out of 27 manufacturing industries exhibit this wage response. Market access elasticities for these 16 sectors range between 10 and 37%. This is much lower than Redding and Venables (2004)’s cross-section estimates, but close to the most recent studies, performed at aggregated level and using panel data (Mayer, 2008; Bouhol and de Serres, 2008).

Hence, income levels seem to be affected by the spatial position of a country in these industries. The fact that panel data econometrics (static and dynamic) is employed reduces considerably the risks of omitted variable bias. Also several variables are included to control for the influence of labor relocation, human capital, supplier access, and labor

regulations. One interesting finding is that low-tech sectors associated to relocations like textile and apparel are less robust to these controls, while high-tech sectors exhibit very robust coefficients indicated a role for the combined effect of comparative advantage and economic geography, as simulations by Fujita, Krugman, and Venables (1999) suggested.

Although the results are robust to a number of controls and econometric techniques, a problem of identification persists. The impact on wages could be observationally equivalent to other potential explanations related to locational fundamentals (physical geography, endowments) or other agglomeration forces (knowledge spillovers). The investigation presented in Chapter 2 deals with these issues, by focusing in a case study on Brazil. It exploits detailed information on trade at intranational level, as well as microdata on firms and workers, to test the same hypothesis postulated in Chapter 1, but using individual wages and a market access that captures demands from the rest of Brazil and international partners. Results confirm an elasticity of around 14%. More importantly, this finding is robust to controls for firm productivity, knowledge spillovers, and endowments, among many others.

Additionally, two aspects of economic geography are explored in detail. The first concerns the role of international trade in the market access impact. Trade liberalization took place in the early 1990s in Brazil, and the impacts of this may have differed across the country precisely due to the differences in international MA among the regions. On this basis, the impact of trade liberalization should be greater in regions with greater international MA. The disaggregation of trade flows permits to isolate local, national and international market and supplier access. International market access turns out to have a greater impact than the other components of market access.

The second aspect considered is a differentiated effect for skilled workers. Redding and Schott (2003) postulate that a good market potential will increase the incentives to invest in education for individuals living in that region. A way to test this impact is to look for higher impacts of market access for skilled workers. The results for the Brazilian case suggest that higher international MA raises the wages of unskilled workers relatively more. Given that our study corresponds to a period of just a few years after a massive trade

liberalization program, this finding could actually be a sign that the Stolper-Samuelson mechanism is at work. This mechanism posits that trade liberalization in Brazil, a country where unskilled labor is relatively abundant, increases relative returns to this factor of production. When viewed through the prism of economic geography, such an impact would not be homogeneous across the country: it would be greater in regions with higher international MA. Hence, the role of comparative advantage interacts with NEG forces.

Chapter 3 continues the exploration of Brazil economic geography in a dynamic setting. In general equilibrium, it is expected that wage differentials are arbitrated away through migration, which in turn changes the economic geography of the country. As already indicated, Brazil implemented an ambitious trade reform during the nineties. Unilateral trade reductions and trade integration with Mercosur affects the market access of Brazilian states, potentially affecting wages and migration. The chapter explores the impact of market access on bilateral migration. Microdata are used to warrant that self-selection is properly taken into account, and to build migration flows breakdown by skill levels and industrial affiliation. Two main results arise: First, an important migration response to the evolution of market access is found, although the role of migration costs and selection bias limits migration flows. Second, market access affects migration in nearly all manufacturing sectors. Consequently, migration can reshape the economic geography of Brazil in the next decades, leading to specialization of some regions. All in all, catastrophic agglomerations as often postulated in some variations of the theoretical models of Economic Geography can be rule out in the Brazilian case: counterfactual exercises suggest that the migration response to market access can have significant impacts on specific bilateral flows; but the overall impact on the number of workers is modest.

A mitigated role of NEG forces to change the agglomeration patterns have also been suggested by the works of Crozet (2004) for Europe, Kim (1997) for the US and Davis and Weinstein (2002, 2008) for Japan. As Krugman suggested in its Nobel Price lecture, published in *American Economic Review* (Krugman, 2009), the peak impact of NEG forces may have found in the past, specifically, before the World War II in the case of the United States (In the case of Brazil, the great rural-urban migration waves occurred some decades

later, but in every case they decline in the 1980s).

Consequently, there is a growing interest in searching for evidence of agglomerations through history, and especially to assess if the other properties of original NEG models - hysteresis, multiple equilibria and path-dependency agglomerations- represent well the way agglomerations arise. However, this poses enormous identification problems.

Many studies have looked at long run evolutions of cities, and attempted to explain urban evolution variables (specifically population growth, density, or rank in the urban hierarchy) with endowments, infrastructure, educational levels, institutional quality, etc. Examples of studies include applications to the United States (Beeson et al., 2001; Simon and Nardinelli, 2002; Kim, 2000; Dobkins and Ioannides, 2001), Japan and France (Eaton and Eckstein, 1997), Italy (Bosker et al., 2008), Mediterranean basin and Europe in pre-industrial times (Long and Shleifer, 1993; Bosker et al., 2008), China (Anderson and Ge, 2005) and a worldwide study (Henderson and Wang, 2007). Most of the studies find strong persistence in the urban structure, but they lack of a specific temporary shock that allows for a convincing identification strategy. Other studies have focused on (supposedly) exogenous shocks like bombing to assess stability of urban population.

In Chapter 4, the role of history in agglomeration processes is studied by exploiting a unique natural experience. I follow the evolution of cities founded in the American continent over the more than 3 centuries of Spanish rule. This experience has the advantage of providing a setting where economic agents create from scratch an economic system in a territory that they enter for the first time. They have to put together resources, cope with uncertainties and obstacles, and transfer and adapt their institutions to survive and prosper. Detailed information on the cities, including foundation, abandon, relocation to other places, etc is collected. In addition, major events affecting these cities (natural disasters, wars, etc) are employed to assess the role of the shocks and the resilience of cities. As the expansion of the empire relied on fast city foundations, hundreds of cities established in a hurry, were abandoned or relocated. Civil wars exploded among conquerors for resources in the first century of the Conquest, and pirate attacks and Indian rebellions were common through all the period. Natural disasters and demographic collapse took by

surprise a group of men prepared for war but not for hazard management.

The study innovates in several ways with respect to existing literature. First, it explores urban evolution in the very long-run, by looking at the Spanish colonial rule in the Americas. Extensive data for 22 present-day countries for a period of almost 350 years is collected, which makes its spatial and temporal coverage much more complete than previous studies. Second, it restates the problem of detecting spatial equilibria by looking for a setting where initial conditions can be better controlled. Third, although inspired by the idea of using big shocks over the urban system to determine the presence of hysteresis, it innovates by looking at a new test of hysteresis and new econometric methods, namely survival analysis. Specifically, I look at determinants of the duration of a city in a particular site. The effect of past outcomes (hysteresis) is measured by using the age of a city. The rationale is that during the first years of foundation, the risk of abandon is high because settlers must discover the advantages of the location (including negative shocks like earthquakes), they are newcomers without strong ties to the location, and the interactions among them are weak. If the population remain in the same location after a given period, the city locks-in there because they learn how to cope with the problems associated to the location, because of the sunk costs associated to relocate the city, and because of the self-reinforcing advantages given by the local interactions.

Like previous studies exploring multiple equilibria in agglomerations, I confirm a great stability in the urban system over the very long-run. However, in opposition to them, I also find evidence of great instability in the earlier periods of the Conquest, where political disorders together with an orientation to extractive activities seem to explain a high urban instability, with proximity to mining contributes notably. In later periods, when the empire stabilizes, demographic decline starts to reverse, and new economic activities appear there are important changes in urban stability: mining proximity is no longer a source of instability, and proximity to great political and economic centers starts to matter. All these results suggest strong non-linearities and path-dependency in the agglomeration process.

Transversal Contributions

Some of the contributions cross all the chapters. I enumerate them briefly.

First, the introduction of two new dimensions in the NEG empirical analyses: industrial level and individual heterogeneity. Incorporating them has proven useful.

Regarding the industrial level, we get information on the sensibility of results at aggregated level (all manufacturing). More specifically, how globalization (reduction in trade costs) is affecting agglomeration outcomes through the tension of market access and cost advantage. Some industries have a lower differentiation level, so the importance of geography of demand is decreasing. Sectoral data also help to take into account the specialisation levels of the regions and countries. The industry dimension is taken into account (indirectly) even in the case of the historical study of Spanish colonization, because mining proximity is included.

Regarding the individual heterogeneity, the studies in this thesis attempt to isolate the effects of agglomeration forces from spatial sorting of skills and selection bias in migration. Even in the case duration of the cities, the impact of potential unobserved heterogeneity is explored. Another way of individual heterogeneity is the firm productivity, which could be potentially sorted spatially.

Secondly, test for the hypothesis required rigorous econometric techniques as well as very rich datasets. Each chapter involved assembling enormous new groups of datasets, preferably developing panels, in order to control for unobservables as better as possible. In the first chapter, information at industrial level on trade, production wages and employment was matched at ISIC Rev 2 level. In the second and third Chapters, measures of market access are calculated for the first time at intranational level for Brazil. Also matched employer-employee data is used in chapter 2 to add controls for firm characteristics like productivity and innovation. The last chapter creates an entirely new dataset on the evolution of the Spaniard cities in Latin America covering a period of more than 300 years, as well as information on disasters, ports and mining spots.

Thirdly, space is an ambiguous term. In this thesis I explore the sensibility of NEG models to several spatial unit levels. In Chapter 1 the unit of analysis is countries. In

chapter 2 and 3 the levels of analysis are at subnational level: Brazilian states and municipalities (counties). In chapter 4 the unit of analysis is the city (or to be more precise, the locations that a city had over a period of time). An important finding of the studies included in this thesis is that the spatial unit of analysis have a secondary effect on the detection of spatial interactions arising through trade.

Chapter 1

The changing world economic geography of manufacturing

1.1 Introduction

Since the eighties, the world economic geography for the manufacturing sector has experienced important changes. While most of the production is still agglomerated close to the greatest demand centers, standardized technologies and reduction in trade costs (i.e. globalization) lead to a more dispersed structure in some industries. The interplay of proximity to demand (often called market potential or market access), input prices and trade costs is central in theories aiming to explain agglomeration processes in manufacturing (for instance, the seminal contribution by Krugman, 1991b). The empirical counterpart has exploited with success the cross-country differences in market potentials to explain income levels (Redding and Venables, 2004) or firm location choices (Head and Mayer, 2004a).

Figure 1.1 provides some illustrations of the varying importance of this production - demand linkage. It shows the change in a rank of the market potential for 4 manufacturing sectors between 1980 and 2003. Darker colored countries correspond to countries experiencing important progress in the market access. Details of the measure are presented in the section 1.4.2. In this part, I just underline the fact that two sectors exhibit important changes in countries' market potential suggesting a redispersion (*Textiles* and *Iron &*

Steel), while two others (*Tobacco*, and *Professional & Scientific Equipment*) seem to show lower evidence of spatial deconcentration, with Developed economies retaining their high ranks in the beginning of the period. Economic geography models predict a relationship between this measure of market potential and wages in the short run. In the long run, firms relocate to places with lower wages, and subsequent industrialization can change the market potential or weaken the demand linkage, leading to dispersion. Moreover, the globalization process should entail a reduction in trade costs, potentially stimulating these relocations. In practice, dispersion can be very slow because of technological differences, country specialization, specific factors of production, labor and fiscal regulations, etc. All these aspects can operate at a very specific industrial level, leading to different market potential evolutions, as suggested by the Figure 1.1.

To identify the impact of the economic geography, researchers exploited the emphasis given by the theory to the impact of demand proximity on profits. As a consequence, the higher wages that firms can afford to pay in a chosen location are positively correlated to market access. The main strategy of identification has relied on cross-country regressions of GDP per capita on aggregated market access. There are two important potential improvements to this approach. First, identification in the time dimension enables to better control for differences in technical efficiency (and other country heterogeneity sources of variation). Second, industry heterogeneity can be considered if the dependent variable is an industry-specific wage instead of GDP per capita. As Figure 1.1 suggests, market access follows different trajectories in different sectors.

In this study, I determine in which sectors, wages are more responsive to market access evolutions. Two version of the market access are considered, as well as an important number of robustness checks are performed, including dynamic panel data regressions. I find evidence of robust coefficients for 16 out of 27 industries. The results also suggest that internal flows have to be included to generate the market access variable, as Mayer (2008) does. Market access elasticities for these 16 sectors range between 10 and 37%. This is much lower than Redding and Venables (2004)'s cross-section estimates, but close to the most recent studies, performed at aggregated level and using panel data (Mayer, 2008;

Boulhol and de Serres, 2008).

I also investigate through simulations how the different modalities of trade integration (incorporation to Regional Trade Agreements (RTA) and to World Trade Organization (WTO), two alternatives to improve market access) influence manufacturing wages. While results aforementioned suggest a robust relationship between economic geography and wage evolutions for the 16 industries, impacts widely vary across countries. An important part of the spatial competitiveness changes slowly, and several peripheral countries will have to wait until new demand centers will arise, as it has been the case for Asia in the last quarter century. Trade integration policies, can have important effects, specially for isolated countries and for nations strategically located close to the richest markets.

The rest of the chapter will proceed as follows: Section 1.2 will present some aspects of the theoretical framework (see Appendix, section 1.6.1 for more details), and summarizes some implications for the empirical part; Section 1.3 will present the estimation strategies and data; Section 1.4 reports findings as well as some simulations to assess the potential impact of trade in market access; and Section 1.5 concludes.

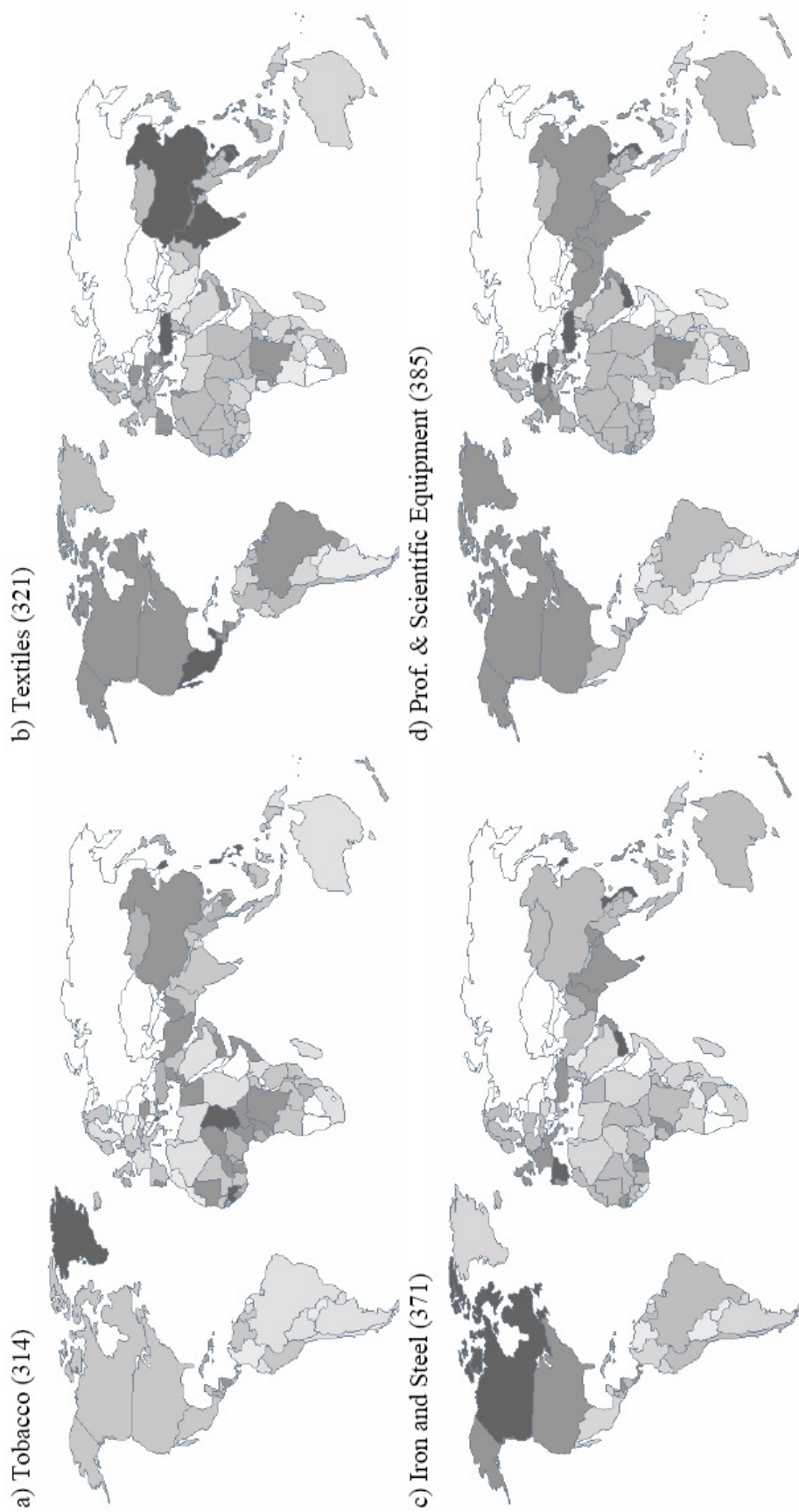


Figure 1.1: Market Access (HM) evolution for selected industries (1980-2003).

1.2 Theoretical background

I consider a monopolistic competition framework with product differentiation, including firm-level increasing returns to scale, symmetric trade costs and homogeneous firms. The theoretical result shows that, under a zero profit condition, a positive relationship between market access and regional wages could be established, called “NEG wage equation”: firms are willing to pay higher wages in regions that are close to large markets, since firms in these regions are able to deliver goods to markets at low transport costs. I follow the standard framework as developed by Fujita et al. (1999). Details of the model are presented in the Appendix. There are two sectors in the economy. The first (A-sector) is characterized by constant returns, perfect competition and no trade costs. This sector offsets all trade imbalances in the other sector, thus permitting spatial specialization. The second sector (M-sector) produces an horizontally differentiated good with trade costs. The production function for this sector includes a fixed cost per plant f_i , and a constant marginal cost m_i . Hence, profits of a firm in the region i are:

$$\pi = p_i q_i - m_i q_i - f_i \quad (1.1)$$

Profit maximization results in a constant mark-up:

$$p_i = \frac{m_i \sigma}{\sigma - 1} \quad (1.2)$$

Using the demand function (See Appendix for details) and the fact that gross profits are given by $\pi_{ij} = p_{ij} q_{ij} / \sigma$, profits earned in each market j are defined as follows:

$$\pi_i = \frac{1}{\sigma} \left[p_i^{1-\sigma} \left(\frac{\mu Y_j}{P_j^{1-\sigma}} \right) \phi_{ij} \right] - f_i \quad (1.3)$$

I adopted the notation of Baldwin et al. (2003) using the term *free-ness* (*phi-ness*) of trade, $\phi_{ij} \equiv \tau_{ij}^{1-\sigma}$, that represents the combined impact of (1) trade costs (τ) and (2) the elasticity of substitution on demand (σ). When these variables are too high, trade becomes prohibitive, and only the local demand is relevant ($\phi_{ij} = 0$). A frictionless world

is represented by a $\phi_{ij} = 1$. μY_j corresponds to the importer expenditure devoted to the M-good. The price index, $P_j^{1-\sigma}$, is defined as the sum over the prices of individual varieties (See Appendix for the derivation) and reflects the potential suppliers of this market, considering trade costs, the elasticity of substitution, and the prices they charge. In this sense, it could be considered as a measure of the market crowding: it is in a well served nation where a high competition is expected, and therefore lower product prices. This term is also mentioned in the literature as a *multilateral resistance term*. Net profit in each potential location i , are the sum of the profits from all locations j using equation (1.3):

$$\Pi_i = \frac{1}{\sigma} \left[\left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma} m_i^{1-\sigma} \underbrace{\sum_j \left(\frac{\mu Y_j}{P_j^{1-\sigma}} \phi_{ij} \right)}_{MA_i} \right] - f_i$$

The term in the sum is called *Market Access* or *Real Market Potential* (Head and Mayer, 2004b), and is usually abbreviated as MA , where MA_i is defined as the sum of the final demand addressed to region i , weighted by the accessibility from i to these markets j (since it considers ϕ_{ij}) and by the market crowding level of every region j (since it considers the price index $P_j^{1-\sigma}$).

The spatial equilibrium can be achieved under the hypothesis that all firms will earn the same profit. An iso-profit equation that normalizes the profit to zero gives us a relationship between costs and MA :

$$m_i^{\sigma-1} f_i = \frac{1}{\sigma} \left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma} MA_i \quad (1.4)$$

1.2.1 The price version: Market access and factor rewards

Tracing a more direct relationship between wages, employment and the MA requires specifying the technology and production factors considered for the M-Sector, as well as assumptions about labor mobility. In this model, labor is the only production factor.¹ The original

¹Redding and Venables (2004) develop a model with labor and vertical linkages in a Cobb-Douglas function. Baldwin et al. (2003) present models with capital and labor. Head and Mayer (2006) introduces

model assumes that the A-sector employs immobile, unskilled workers (denoted with the superscript u) whereas the M-sector employs (perfectly) mobile skilled ones (superscript sk):²

$$C_i = w_i^{sk} l_i^{sk} = w_i^{sk} (a^{sk} q_i + F^{sk}) \quad (1.5)$$

In that case there is a labor need of a^{sk} per production unit and a labor fixed requirement F^{sk} , both common to all regions. The equation (1.4) becomes the “NEG wage equation” postulated by Fujita et al. (1999) that indicates which wages a firm from a given location i can afford to pay:

$$w_i^{sk} = \left[\left(\frac{\left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma}}{\sigma F^{sk} [a^{sk}]^{\sigma-1}} \right) M A_i \right]^{\frac{1}{\sigma}} \quad (1.6)$$

Up to this point, only three of the NEG theory ingredients are considered. Together with the other two –endogenous firm locations and endogenous location of demand– they give the full general equilibrium (extensively presented in Fujita et al. (1999) and Baldwin et al., 2003). These two other key elements of NEG theory represent the *quantity version*, briefly discussed in the next section.

1.2.2 The quantity version: Relocation and the spatial adjustment

In general equilibrium, labor migration (or alternatively, foreign direct investment) can (at least partially) eliminate the effects of market access on wages. Suppose that trade liberalization (a fall in ϕ_{ij}) affects countries unequally. This will generate differences in the market access across locations. Restoring the equilibrium demands a spatial equalization of profits. Head and Mayer (2006) explore this question by using the two extreme cases of no migration at all and completely free migration: in the first case, there is an increase in differences in Human capital across regions. The Redding and Venables’ version is developed in Chapter 2.

²Given the assumptions in relation to the A-sector, there is interregional price equalization for this good, and wage equalization for the unskilled workers as well. This allows to take the A good as numeraire: $p_i^A = w_i^u = 1$.

wages in higher market access regions due to higher product prices. In the other extreme, with factors migrating to high market access regions, factor price equalization holds. As a consequence, the number of firms in the region will increase in response to the decline of trade costs. This agglomeration of firms will rise the price index $P_j^{1-\sigma}$, which in turn will lower the *MA* in that region.

Migration is not the only mechanism to explain a quantity expression of the NEG forces. Fujita et al. (1999) propose alternative mechanisms related to the congestion costs. While a first stage of globalization may trigger agglomeration of industries in a core region, further trade integration will entail a redispersion of industries toward the periphery. The argument is also developed by Puga (1999), by introducing input-output linkages as a component of the production function. As intermediates are also affected by trade costs (actually, they are termed Supplier Access in the NEG literature, mirroring the Market Access), the integration makes possible to import intermediates instead of relying on national input-output linkages, weakening agglomeration forces. At the same time, as the wage gap remains, firms will relocate to low-wage countries, and this should start in industries that are (1) oriented to final demand rather to intermediate goods and (2) labor intensive (Zeng, 2006).

Independent of the mechanism invoked, the quantity version can be assessed by looking the evolution of some outcome of agglomeration. In the model presented in the previous section, as the employment level depends on the number of firms in each region, Head and Mayer (2006) consider the employment level as an indicator of this quantity version, and exploit spatial variations of wages and employment levels to test which version potentially prevails. In the empirical part, the quantity effect will be controlled in a similar way, and robustness checks will be made to explore the role of the input-output linkages.

1.2.3 Identification issues

Despite the appealing explanation for the influence of economic geography on labor outcomes, it would be *naive* to consider that these forces are the only ones capturing the evolution of industries in the recent decades for the whole world. Already in their earlier articles treating this subject, Krugman and Venables (1995) cautioned about alternative

explanations coming from changes in technology of production or in factor endowments. The caution remains valid here. The static panel data estimates control for differences in technological levels, endowments (and any other variable fixed in time, like institutional quality), but discards the evolutions of these variables. Dynamic panel data estimates (GMM) are performed to show that still the effect of market access on wages is present for an important number of industries. Also some time-varying regressors are introduced to increase reliability on the results. Nevertheless, it is a well-known fact that GMM estimations are a delicate exercise, with proper tests to assess their validity still in development.

This identification problem is not exclusive of NEG models. Empirical works in trade literature have searched for long time a definitive test for theories of factor proportions. Researchers are also confronted there to alternative explanations like technological evolution. One of the most recent works (Fitzgerald and Hallak, 2004) succeed in proposing a test –based on Rybczynski equations– robust to technological differentials. Nevertheless, the authors recognize that as long as “factor endowments are correlated with the level of development through the process of accumulation, any model that links specialization to level of development will predict such an empirical relationship” (p. 279).

Another empirical article nicely combines Economic Geography arguments with factor endowment explanations to predict trade patterns (Romalis, 2004). Once again, the author acknowledges that factor accumulation and technological differences are not taken into account in his framework.

Finally, in their assessment of increasing returns in world trade, Antweiler and Trefler (2002) convincingly argues that scale and dynamic international technology differences are almost impossible to distinguish empirically, because technical change is in most of the cases, performed by larger plants. One may conclude that the combination of all these elements into a single empirical analysis (where all variables are potentially endogenous), and disentangle their individual effects is a very elusive task.

In sum, the results provided here should be seen as suggestive of the influence of countries’ economic geography on labor outcomes. They are robust to a number of controls and estimation methods, and its values are plausible when compared to other studies, but

complete identification can not be claimed. More satisfying identification should come from specific settings where control for other alternative explanations can be properly made. A promising avenue are the recent works at intranational levels by Hering and Poncet (2009) and the work performed in Chapter 2 of this thesis.

1.3 Empirical issues and data

1.3.1 Trade, gravity and economic geography variables

The more complicated aspect for its correct estimation is the incorporation of the price index $P_j^{1-\sigma}$. I follow the methodology pioneered by Redding and Venables (2004), capturing the price indexes in a trade gravity equation using country fixed effects. Also the estimation of the ϕ_{ij} should be more precise because it takes into account more variables than just bilateral distance, usually the only proxy used. Moreover, introducing some trade policy variables in trade costs may provide a way to explore some policy simulations. Finally, an estimation based on a gravity regression has the advantage of using information of the economic mechanism that our theoretical model wants to stress, namely, spatial interactions arising from trade.

Denoting T_{ij} the bilateral exports from region i to region j ,³ Equation (1.18) in the Appendix and the iceberg trade costs can be used to show that:

$$T_{ij} = n_i p_{ij} q_{ij} = \underbrace{n_i p_i^{1-\sigma}}_{FX_i} \phi_{ij} \underbrace{\mu Y_j P_j^{\sigma-1}}_{FM_j} \quad (1.7)$$

The region-specific variables can be captured by exporter and importer fixed effects FX_i and FM_j , respectively. The phi-ness of trade ϕ_{ij} is defined by three groups of variables that enhance or deter trade :

1. Variables fixed in time such as bilateral distance⁴ d_{ij} , contiguity C_{ij} , common lan-

³All regressions are at industry level, estimated for each year. Subscripts for industry and time are omitted, except for RTA and WTO variables, that can be time-varying.

⁴Great circle distances are used, which only require latitudes and longitudes. Head and Mayer (2002) argue that using different methods to calculate the bilateral distance can affect the estimation of the other

guage L_{ij} , past colonial ties Col_{ij} .

2. Two (time-varying) trade policy variables with dummies set to one when both partners have signed a Regional Trade Agreement RTA_{ij} or both partners are members of the World Trade Organization WTO_{ij} .
3. A national border effect dummy (B_{ij}) that will be explained in more detail below.

Our trade equation is finally specified as:

$$\ln T_{ij} = FX_i + FM_j + \delta \ln d_{ij} + \lambda_1 C_{ij} + \lambda_2 L_{ij} + \lambda_3 Col_{ij} + \lambda_4 RTA_{ij,t} + \lambda_5 WTO_{ij,t} + \lambda_6 B_{ij} + u_{ij} \quad (1.8)$$

And a ϕ_{ij} measure can be obtained as follows:

$$\hat{\phi}_{ij} = d_{ij}^{\delta} \exp \left(\hat{\lambda}_1 C_{ij} + \hat{\lambda}_2 L_{ij} + \hat{\lambda}_3 Col_{ij} + \hat{\lambda}_4 RTA_{ij,t} + \hat{\lambda}_5 WTO_{ij,t} + \hat{\lambda}_6 B_{ij} \right) \quad (1.9)$$

A country's market potential is composed of two parts reflecting the market access to the national level (domestic market access, DMA), and to the international markets (Foreign market access, FMA):

$$DMA_i = \exp \left(\widehat{FM}_i \right) d_{ii}^{\delta} ; \quad d_{ii} = 2/3 \sqrt{area_i / \pi} \quad (1.10)$$

$$FMA_i = \sum_{j \neq i}^{countries} \exp \left(\widehat{FM}_j \right) \hat{\phi}_{ij} \quad (1.11)$$

coefficients. They propose a measure that refines the great circle formula adding weights. It is referred in the dataset as *distance-weighted (distw)*. This variable uses the distribution of population inside each country. These authors also develop an alternative measure of *distw* that introduces an additional parameter to reflect a sensitivity of trade flows to great circle bilateral distance, which is often -1 in empirical estimations (More details in Head and Mayer, 2002). I also calculated market potential using these measures. I do not report these results here, because they are quite similar to those found for simple great circle distances. I prefer the simplest method because latitudes and longitudes are available for all countries, which is not the case for internal distribution of the population.

I report results for two variations of the market access. The difference arise from the addition of the national border effect (B_{ij}).

The first method follows closely that of Redding and Venables (2004), and considers bilateral components in the trade costs, but no specific border effects (hence, B_{ij} is set to 0 for all observations). The advantage of this method is that only international bilateral trade is needed. Note that, although I am not using internal trade data, it is possible to estimate the national component, because it uses the own country's fixed effect and a measure of internal distance. Nevertheless, the absence of a measure of border effect may bias the coefficients of the ϕ_{ij} component. The market access built by this way will be referred as **RV method**.

The alternative proposed by Head and Mayer (2006) includes a border effect B_{ij} , set to 1 for international trade and 0 for internal trade. These additional observations (with respect to the RV specification) should proxy for trade with itself (T_{ii}). These authors propose an estimation corresponding to production minus total exports. The coefficient is expected negative for this variable, reflecting that additional costs are incurred when a product leaves the origin country. Although it is not always possible to have industrial production to compute T_{ii} , the dataset employed in this study is one of the most complete available (I explain the dataset in the sub-section 1.3.3). The market access built by this way will be referred as **HM method**.

Equation (1.8) is estimated for each year and industry separately, using OLS with importer and exporter fixed effects. Two comments are in order concerning the choice of the estimations. Firstly, some researchers recommend non-linear estimations (e.g. Gamma or Poisson regressions) to deal with some specific problems of trade data. Specifically, OLS has been criticized because (1) the error term u_{ij} is a log-linearized version of the original error term (a problem that may entail a bias in the presence of heteroskedasticity) and (2) is not the ideal method to deal with zero values in trade flows. A definitive method has not emerged in the literature (Silva and Tenreyro, 2006; Martinez-Zarzoso et al., 2007; Martin and Pham, 2008; Helpman et al., 2008; Silva and Tenreyro, 2009), specially when the non-linear estimations (the potential alternatives to OLS) are combined with country

fixed effects in presence of a high proportion of zero values (Buch et al., 2006). I found this problem particularly acute when trade regressions are run at industrial level. The proportion of zeros can easily surpass 80%, and iterative methods for Poisson or Gamma estimations often do not converge. In order to explore the sensibility of results to a non-linear estimation including zeros, I reduced the dimensionality of the zeros, by dropping all countries that trade with less than 20 partners. By doing this, the proportion of zeros in the more extreme cases fall to around 50%, allowing the convergence of 632 out of the potential 648 regressions (27 industries * 24 years). Still, in an important number of the regressions border effects or fixed effects are not identified, reducing dramatically the quality and availability of market potential measures. In any case, regressions on wages using these MA measures confirm most of the results given by the OLS.

Secondly, Baier and Bergstrand (2007) argues that RTAs (and trade policy variables by extension) are endogenous, because of a selection bias. Unfortunately, they also argue that there are no satisfying methods to correct the bias in cross-section, and resort on panel data methods. As I am interested in obtaining year-specific coefficients, I am not able to use these techniques here. All in all, these authors show that cross-section suffers from a downward bias. Consequently, its impact on the market access and the simulations presented in this article can be seen as lower bounds.

While these are very important subjects, interesting extensions for future research, I consider them beyond of the scope of this study. The main focus of this article is to provide several tests of the NEG wage equation, the subject of the next sub-section.

1.3.2 Panel estimation of the NEG wage equation

Log-linearizing equation (1.6) gives us a direct relationship between MA and the regional wage, empirically testable:

$$\ln w_i = \zeta_1 + \hat{\sigma}^{-1} \ln MA_i + \zeta' X_i + \nu_i \quad (1.12)$$

where w_i is the wage in region i . The superscript sk is dropped because only infor-

mation of the manufacturing sector is included in the analysis. The estimated coefficient for the MA correspond to an inverse of the measure of the elasticity of substitution in the underlying model. As many other cross-country variables can be correlated to market access, researchers usually introduce a number of controls (here represented by X_i): Human capital levels, proxies for institutional quality, geographical fundamentals and other NEG variables like Supplier Access, among others. The inclusion of a time dimension is highly desirable for at least three reasons.

First, country heterogeneity is explicitly taken into account, improving the control for alternative hypotheses. Starting from the first empirical work of this literature (Redding and Venables, 2004), the possibility of technology differences across countries affecting the residual in equation (1.12) is acknowledged. If panel data is available, the introduction of country (c_i) and year (D_t) fixed effects helps to mitigate this potential omitted bias, giving the following specification:

$$\ln w_{i,t} = \eta_1 + \hat{\sigma}^{-1} \ln MA_{i,t} + \eta' X_{i,t} + c_i + D_t + \epsilon_{i,t} \quad (1.13)$$

In some specifications, I will also include two time-varying controls, namely human capital levels and supplier access.

Second, the combination of industrial and time data allow for a richer analysis of the demand linkage, with a closer connection with the theory (the price and quantity versions aforementioned). The NEG wage equation is considered as a partial equilibrium. Nevertheless, if a reduction in trade costs is at work, a spatial reallocation should start. It is not possible to determine a priori the expected outcome, because it may depend on the stage of trade integration at the start of the period of analysis, and on industrial specificities like the elasticity of substitution (Head and Mayer, 2004b). Industry-specific estimations partially incorporates these specificities in the analysis. The time dimension can provide suggestive evidence concerning dispersion processes, associated to global integration, or the surge of new consumption centers, like in South-East Asia. As it will be shown in the section 1.4.2, some industries exhibit important spatial changes during the last decades, while other remained relatively unchanged. Moreover, following Head and Mayer (2006), the

spatial evolution of the employment level can be considered to assess a quantity response to market access changes:

$$\ln L_{i,t} = \kappa + \kappa_1 \ln MA_{i,t} + c_i + D_t + \vartheta_{i,t} \quad (1.14)$$

Finally, it is possible to resort on dynamic panel data models to control for potential endogeneity and wage persistence. Indeed, a better focus on the dynamic of change is appealing because of countries' specificities of the labor markets. This problem was not addressed in the NEG wage equation literature, probably because most of the works focus on GDP per capita as dependent variable, and the impact of labor regulations is usually treated in models of inter-sectoral labor adjustment. More details on the GMM estimation are provided in the section 1.4.3.2.1.

1.3.3 Data

This article employs the new release of *TradeProd*, a cross-country dataset developed in CEPII, which integrates information on trade from COMTRADE and industrial production, manufacturing wages and employment levels from UNIDO and OECD-STAN. All these data is matched for 27 manufacturing sectors (ISIC Rev. 2, 3-digit level) and covers the period 1980-2003. A detailed description of the original sources and procedures is available in Mayer et al. (2008) (See also Mayer and Zignago, 2005). Two features of the dataset deserve to be mentioned. First, information on trade is very complete, exploiting information on reports from importers and exporters. On the whole period, information for 222 countries/territories is included. The increase is particularly high for North-South trade (specially from Europe to the Developing world) and for intra-Asian trade (See Table 2 in Mayer et al., 2008 for the number of flows and volumes of trade between continents). A second important feature is that production levels and trade flows have been carefully matched at industrial level, which permits the construction of internal flows, i.e. production minus exports. By this way, an internal border can be estimated. Available Internal flows ranges (for all industries) from 1,145 in 2003 to 2,203 in 1993; and (for all years) from

1,011 (ISIC 372, Non-ferrous metal basic industries) to 2,186 (ISIC 311, Food products).

Dyadic information to estimate the gravity equation is taken from the *CEPII Distances database*. It comprises bilateral distances, dummies for common language and colonial links. Thierry Mayer kindly gave access to his dataset on trade policy variables (dummies on Regional Trade Agreements and WTO ascension), which is an extended version of Baier and Bergstrand (2007).

Manufacturing wages are also taken from *TradeProd*. Availability ranges (for all industries) from 1,144 in 2003 to 2,601 in 1984; and (for all years) from 1,353 (ISIC 372, Non-ferrous metal basic industries) to 2,240 (ISIC 311, Food products). Availability for employment levels is similar.

In the robustness section I employ information on cross-country human capital levels from Barro and Lee (2001). This widely used dataset reports levels of education attainment in periods of 5 years. I follow Hall and Jones (1999) in the allocation of education attainment levels proportions in the population for each country. An alternative dataset by Cohen and Soto (2007) is currently available, but it contains information by periods of 10-years, which entails a dramatic reduction for our sample. Data on labor regulations and legal origins is taken from Botero et al. (2004).

The dataset with countries' market potential is made available in the CEPII website (www.cepii.fr).

1.4 Results

This section groups the results in three categories. First I describe the trade gravity equations and the measures of MA generated. Second, regressions for the impact of economic geography on wages are reported, as well as robustness checks. Finally, I perform some simulations to see the potential impact of trade policy changes on the world economic geography, and spatial inequality on wages.

1.4.1 Impact of gravity equation methodologies in the economic geography variables

I present some summary statistics for the coefficients of the 1,296 (24 years * 27 industries * 2 methods) regressions of this first stage. Figure 1.2 summarizes the distributions of the distance coefficient. Panels (a) and (b) correspond to values from the RV and HM estimation, respectively. Each line corresponds to the distribution of coefficients for a specific year, and years are displayed in sequential order. Despite the strong heterogeneity across sectors, all values are found within the expected range (between -0.67 and -1.73). The impact of the distance is not reducing in time, which is in line with other studies (Mayer, 2008; Disdier and Head, 2008; Anderson and Yotov, 2008; Egger, 2008; Boulhol and de Serres, 2008).⁵

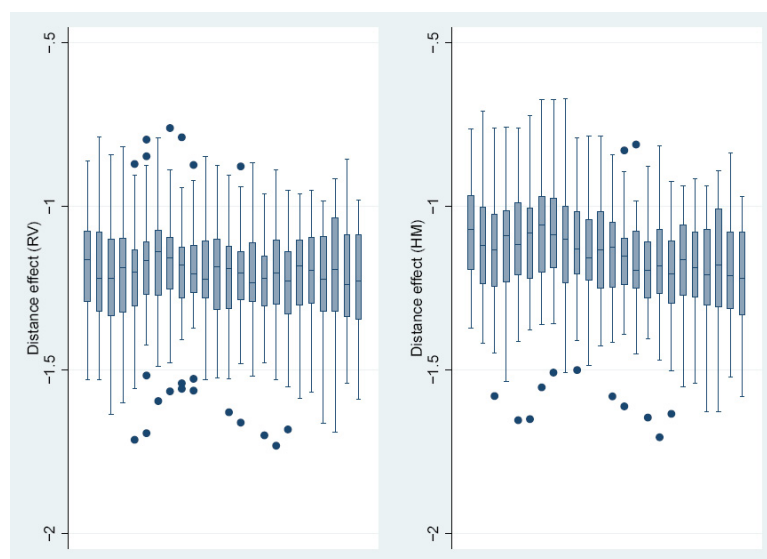


Figure 1.2: Distance effect (1980-2003).

Figure 1.3 offers a closer look at the specific evolution of some industries. The numbers correspond to the industry codes (See Table 1.3 in the Appendix). Points with a number correspond to the maximum and minimum for each year. For example, at the start of

⁵Several explanations have been proposed for this result, among others, the surge of capital/labor ratios (Egger, 2008) and substitutability of goods (Berthelon and Freund, 2008). Siliverstovs and Schumacher (2008) report falls in distance coefficients with industry-specific regressions, only for OECD countries.

the period, the industry with the highest impact was *Other Non-metallic Mineral Products* (369), and that with a lower impact was *Pottery* (361). At the end of the period, maximum was for *Paper Products* (341) and minimum was for *Professional & Scientific Equipment* (385). During the period, the industry *Petroleum Refineries* (353) exhibits the highest values for most of the years. Two industries are usually found among the less affected by distance: *Pottery* (361) and *Tobacco* (314). Lines connect coefficients for some industries, and they suggest that the impact of the distance across industries follows a rather stable pattern, with some of them experiencing a rather slight increase (e.g., Industry 361, *Pottery*).

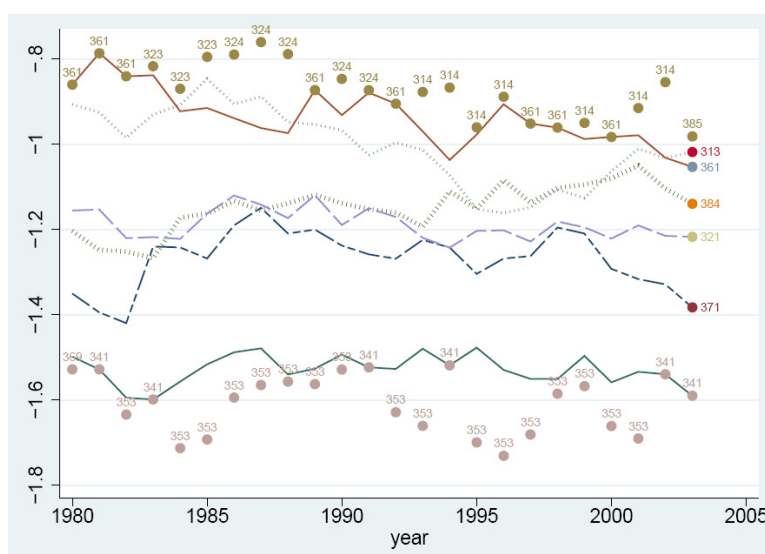


Figure 1.3: Distance effect for selected industries (RV estimation).

A low variation in the value of the coefficient could be a problem to identify the impact of the trade costs on wages through the market access, if only distance is introduced in the computation of the freeness of trade. Fortunately, other variables show more variation in time and across industries. Figure 1.4 replicates the same type of evolutions for the coefficients of the Regional Trade Agreements (RTA). This time no specific industries are predominant in the lowest or highest bounds (although *Iron and Steel* (371) appears in several years as the most impacted industry), and coefficients tend to become less dissimilar over time. In the lower bound, some coefficients are below zero for some industries, but at

the end of the period all coefficients are positive. Looking at specific trends, much more variation is present for each industry. These results correspond to the RV method (Results for the HM method show also important variation across industries and time).

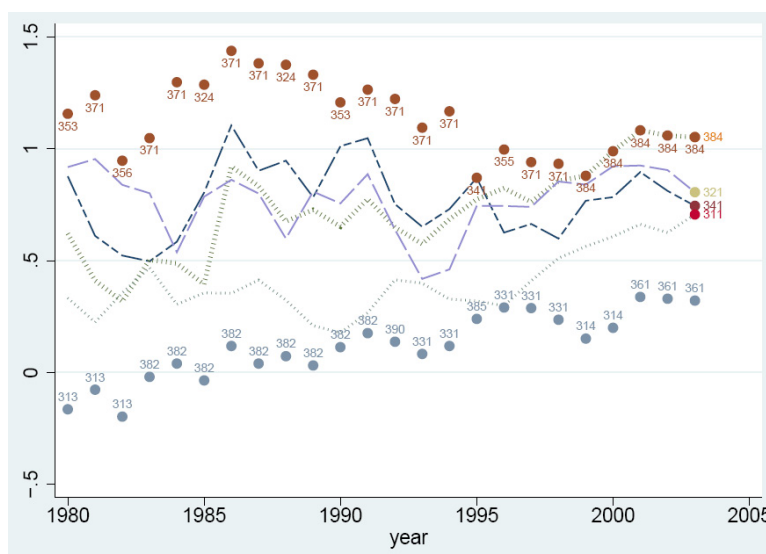


Figure 1.4: RTA effect for selected industries (RV estimation).

The combination of the variables used as proxies for trade costs provides estimations of freeness of trade specific to each pair of countries. A summarized measure of this impact is obtained by summing across importers. This is equivalent to a measure of market access, but discarding the demand and price index components, that could be more endogenous to wages (That is, $\sum_j \phi_{ij}$ instead of $\sum_j \frac{\mu Y_j}{P_j^{1-\sigma}} \phi_{ij}$). This variable will be used as instrument for market potential in section 1.4.3.2.1. Figure 1.5 summarizes the variation in time of each distribution of the (sum of) freeness of trade, as well as a comparison between the RV and HM methods. It is noteworthy that the distribution is highly skewed, suggesting a low level of integration across countries in relation to the maximum level. Also graphs do not exhibit an increasing trend over time, as once would expect due to trade globalization.

However, the graph should not be interpreted as freeness having a low variation in time and industries. When looking at specific industries (not shown here) important variations in the distributions can be found. Note also that extreme values are excluded in the graph to ease readability. A comparison between freeness for the RV and HM method shows

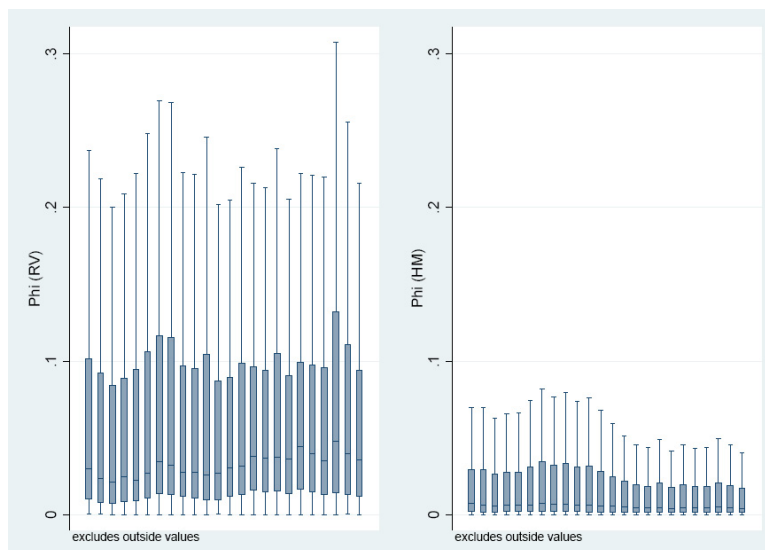


Figure 1.5: (Sum of) Phiness of trade (1980-2003).

important differences (associated to the border effect, not measured in the RV method) and differences in the value of coefficients estimated.

1.4.2 Changes in world economic geography

Non-decreasing distance coefficients suggest that, despite the ongoing process of globalization, distance remains an important obstacle to trade. However, this is an average effect, and each country can display positive or negative evolution during the last decades, not only due to its own trade openness, but also due to the evolution of its main partners. Our variable of interest, the market potential, combines the freeness of trade with the market size from destination countries. It provides a way to compare each country's progress toward a more integrated world economic geography.

Figure 1.1, presented in the introduction, illustrates the rank evolution⁶ of four specific industries. The darker (lighter) the colors, the more positive (negative) is the country's progress. Specifically, countries colored with tattletale gray correspond to those countries

⁶Rank evolution is the change in gained or lost places in the market access hierarchy, relative to the United States. Values are normalized as deviations from the mean across countries, and they are grouped in 5 classes. The middle group is comprised between the mean ± 0.5 standard deviation, and the next groups are delimited by 1 standard deviation. Blanks correspond to countries with no data.

that experienced important backward movements in the ranking. Light gray (ash gray) is employed to highlight countries with slight deteriorations or no variation in the ranking. Dark gray indicates moderate positive changes and Black represent important progress in the ranking. Countries in white are missing values for the change in the ranking.

Panel (a) reveals that the ranking in the Tobacco industry has barely changed. This low dynamism can reflect a highly regulated sector (e.g. special taxes, restriction to advertising), and should hinder our identification strategy, based on the time dimension. Panel (b) corresponds to the ranking changes for the textile industry, usually seen as a low-tech industry. We distinguish advances for China, Vietnam, Mexico, India and Turkey, and strong downfalls for Argentina, Iran, and Angola, among others. Note also that a moderate progress is observed in the case of some peripheral European countries (Spain, Portugal, Poland, Romania, etc), reflecting the proximity advantage, rather than only low-wage competitiveness. Other countries escape to decline by virtue of their internal demand, like Brazil or USA. The fact that the main reason to relocate in this industry are the low-wage advantages and standardized technologies (Lu, 2007), can also reduce the power of the market access to explain wage evolutions. Although trade frictions are also influencing this outcome in this case (some reduction in tariffs and transport costs is necessary, in order to allow a separation of production and consumption locations), it is possible that spatial relocations are not correlated with wage evolutions. Panel (c) depicts the evolution for the Iron/Steel industry, considered for some studies as a Low to Medium-tech sector (Lall, 2000; Zhu, 2005). Notable advances can be traced for Canada, Spain, Vietnam, followed closely by India, USA, Turkey, among others. The figure suggests a spatial pattern of demand. Finally, in panel (d) the economic geography for the manufacturing of professional & scientific equipment is displayed. It is considered as a high-tech sector (Lall, 2000) and exhibiting a low product-cycle trade as measured by Zhu (2005). The figure suggests a concentrated spatial pattern, with developed countries retaining their high ranks from the beginning of the period. However, an important number of Asian nations exhibit sizable progress.

Similar graphs can be generated using the RV method. In fact, correlation among

both measures of market access is high (0.74) for the whole sample. Among sectors, the lowest correlations are for *Footwear* (0.53), *Beverages* (0.55) and *Printing and Publishing* (0.55), while the highest are for *Professional & Science Equipments* (0.80) and *Non-ferrous Products* (0.83).

1.4.3 NEG Wage Equation at industrial level

1.4.3.1 Baseline regressions

Table 1.1 reports unconditional elasticities for total and foreign market access. Threshold of significance is set at the 10% confidence level. Before entering in more detailed comments, some general aspects may be highlighted. First, only two coefficients have a significant negative sign (*Machines* and *Machinery Electric*, both in column (4)). Second, two industries do not exhibit significant coefficient across almost all specifications: *Tobacco* and *Petroleum Refineries*. Considering only significant and positive elasticities, values range between 0.48 (*Leather products*, Market Access from RV method, column (1)) and 0.05 (*Transport* and *Tobacco*, Market Access from HM method, column (4)). Third, comparing columns (1), (2), (5) and (6), HM method seems to result in more precise estimates than RV method. Fourth, in the case of RV method, coefficients for Foreign market potential (column (5)) are often lower than those for total market access, suggesting that internal demands are playing an important role for the estimated elasticities. Moreover, coefficients for Foreign Market Access and total Market Access are more similar in the case of HM method. In the following, I discuss results in more detail.

Table 1.1: NEG Wage equations: Baseline regressions

INDUSTRY	Name	Market Access			Foreign MA		Influence on wages	R^2		N
		(1)	(2)	(3)	(4)	(5)		(6)	max	
311	Food	0.39 ^a	0.30 ^a	0.23 ^a	0.01	0.31 ^a	0.31 ^a	25	18	1982
313	Beverages	0.33 ^a	0.18 ^a	0.10 ^a	0.14 ^a	0.21 ^b	0.26 ^b	44	23	1911
314	Tobacco	-0.04	0.04	0.10	0.05 ^b	-0.05	-0.01	47	31	1663
321	Textiles	0.15 ^b	0.16 ^a	0.09 ^c	-0.01	0.13 ^c	0.17 ^b	19	17	1949
322	Apparel	0.19 ^a	0.22 ^a	-0.03	0.03	0.12 ^b	0.15 ^b	24	16	1831
323	Leather	0.48 ^a	0.20 ^a	0.18 ^a	0.18 ^a	0.42 ^a	0.38 ^a	33	16	1819
324	Footwear	0.32 ^a	0.22 ^a	0.11 ^b	0.18 ^a	0.24 ^b	0.27 ^a	37	10	1708
331	Wood	0.40 ^a	0.26 ^a	0.11 ^b	0.09 ^a	0.32 ^a	0.35 ^a	24	17	1939
332	Furniture	0.32 ^a	0.25 ^a	0.32	0.15 ^a	0.33 ^a	0.39 ^a	36	19	1691
341	Paper	0.17 ^b	0.24 ^a	0.18 ^c	0.01	0.21 ^a	0.27 ^a	25	21	1974
342	Printing	0.46 ^a	0.30 ^a	0.12	0.14 ^a	0.40 ^a	0.44 ^a	26	22	1854
351	Ind. Chem.	0.18	0.28 ^a	-0.08	0.09 ^b	0.16	0.16	28	25	1787
352	Oth Chem.	0.22 ^a	0.31 ^a	0.02	-0.02	0.21 ^b	0.29 ^a	29	24	1813
353	Petr. Ref.	0.09	0.05	0.13 ^b	0.08 ^a	0.07	0.05	24	15	1312
355	Rubber	0.11	0.28 ^a	0.26 ^b	0.18 ^a	0.22 ^a	0.28 ^a	25	17	1813
356	Plastic	0.31 ^a	0.28 ^a	0.12 ^b	0.13 ^a	0.25 ^a	0.28 ^a	32	21	1762
361	Pottery	0.45 ^a	0.29 ^a	0.22 ^b	0.17 ^a	0.34 ^a	0.31 ^a	32	22	1495
362	Glass	0.35 ^a	0.36 ^a	0.15	0.13 ^a	0.36 ^a	0.35 ^a	28	22	1706
369	Non-metal	0.11	0.23 ^a	-0.11	0.12 ^a	0.13 ^c	0.17 ^b	24	17	1793
371	Iron/steel	0.23 ^a	0.23 ^a	0.01	0.16 ^a	0.12 ^b	0.13 ^b	31	23	1592
372	Nf metals	0.39 ^a	0.34 ^a	0.38 ^a	0.16 ^a	0.28 ^b	0.26 ^b	42	31	1241
381	Metal prod	0.27 ^a	0.28 ^a	0.21 ^b	0.04	0.33 ^a	0.37 ^a	25	18	1894
382	Machines	0.14	0.19 ^a	0.17 ^b	-0.09 ^a	0.30 ^a	0.34 ^a	21	19	1734
383	Mach elec	0.19 ^b	0.22 ^a	0.18 ^b	-0.05 ^c	0.28 ^a	0.32 ^a	25	22	1759
384	Transport	0.12 ^c	0.19 ^a	0.23 ^a	0.05 ^b	0.17 ^a	0.20 ^a	33	29	1749
385	Prof/Sci	0.26 ^a	0.37 ^a	0.33 ^a	0.17 ^a	0.26 ^a	0.28 ^a	33	29	1454
390	Misc	0.18 ^c	0.25 ^a	0.21 ^b	0.12 ^a	0.16 ^b	0.19 ^b	26	18	1798
Significant Elasticities										
Using internal flows		RV	HM	HM	HM	RV	HM	Gravity Equation and MA construction		
Econometric method 1st stage		OLS	OLS	OLS	Gamma	OLS	OLS	Gravity Equation		
Econometric method 2nd stage		FE	FE	GMM	FE	FE	FE	Wage Equation		

Columns (1) to (4) present coefficients for market access, columns (5) and (6) present coefficients for Foreign Market Access. All regressions in Col. (1), (2), (4) and (5) are Panel Fixed Effects (FE). Column (3) corresponds to two-step panel GMM (Arellano & Bond). GMM regressions are detailed in the Tables 1.5 and 1.6 in the Appendix. a , b and c represent respectively statistical significance at the 1%, 5% and 10% levels. Inference based on Robust Standard Errors, clustered by country (not reported in this table). For GMM estimator, standard errors were estimated by using the correction proposed by Windmeijer (2005). To ease reading and summary results, the column *Influence on wages* proposes a judgement concerning the evidence of the regressions. The next two columns present respectively, the maximum and minimum (across all regressions, except GMM regressions) of within R squared. The last column shows the number of observations for the panel FE regressions (except column (4)). All estimations include time Fixed Effects and a constant (not reported).

Although all industries exhibit some evidence of wage response to market access, these supporting results are variable among sectors. In 9 cases, almost all coefficients provide evidence in favor of the NEG wage equation (qualified as *strong* in the column titled *Influence on wages*). As an example, an increase of 10% of market access for *Manufacturing of Machinery Electric* (383) entails an increase in wages of 2-3%. 11 sectors display moderate evidence (termed as *Good* or *Good/Weak*). For example, coefficients for Beverages are always significant, but measures of market potential that discard internal demand are of lower magnitude or less precisely estimated. Finally, evidence seems rather unfavorable for 7 industries because several of the coefficients are not significant. In industries from the Chemical sector (ISIC 35), the impact of market access appears low or nonexistent. Finally, in the 5th column I present estimations from panel-dynamic GMM regressions. In 9 cases, regressions fail to find an effect of market access (More on GMM regressions in the next Sub-section).

Regarding methodologies, three aspects deserve special attention. First, for many industries, using the market access built with the RV method results in higher elasticities than using the HM method. Second, foreign and total market access can make important differences in several industries (Textiles, Apparel, Leather, Paper, Printing, Iron/Steel, Machinery, products derived from Petroleum, Transport Equipment and Miscellaneous). Finally, elasticities resulting from a market access incorporating zero trade values (column 4) tend to give similar results than the FE benchmark (column 2), and the GMM regressions (column 3).

1.4.3.2 Robustness Checks

In these subsections I employ only the market access built using the HM method⁷, unless otherwise indicated.

1.4.3.2.1 Endogeneity issues and industrial labor adjustment. Previous studies on market access mention the potential of endogeneity. The main criticism is the possibility of reverse causality: a shock in wages can have an impact on the market access. This concern is more acute when an aggregated MA is employed, which is the level of analysis for most of these works. By using an industrial-specific MA, exogenous impacts in wages in a specific industry should have only minor implications on the market access for the same industry. Also the risk of omitted variable bias should be reduced by the panel FE estimation presented in the previous part. All this being said, it remains the possibility of time-varying unobservables correlated with the error term. Consequently, instrumentation is advisable. Exogenous instruments for the MA are scarce, even more when searching for instruments offering not only a country variation, but also variation by industry and time. A possible candidate is the sum of ϕ_{ij} across importers. That is, to compute a market potential that considers all trade costs measured in gravity equations, but discards the importer fixed effects, and hence, the income component. Also recall that ϕ_{ij} could be interpreted as an index of integration between both countries. Summing across destinations j , generates a proxy of the remoteness of a country i from the rest of the world. This measure has been used by Mayer (2008) to instrument market access in a panel of countries at aggregated

⁷In all regressions presented in this study, I eliminate extreme observations below (above) the 1st (99th) percentile of the wage distribution. Results are robust to this change. They are also robust to: (1) consider only countries with more than 10 observations in a specific industry, (2) discard the high values of market potentials of Hong Kong, Macao and Singapore and (3) discard countries that entered in the dataset later in the period (e.g., former communist countries). Finally, I checked the stationarity for the series of wages and market potential by using the Fisher-type test for panel data developed by Maddala and Wu (1999). This is a non-parametric test where p-values from individual unit root tests are combined in a single statistic. I consider models with a simple random walk (without drift) and with a random walk around a stochastic trend. In the case of market potential, only for one industry (341), the null hypothesis can not be rejected in one variation of the test (the other strongly rejecting nonstationarity). For wages, there are four industries where both tests suggest nonstationarity (352, 353, 361, 372). Consequently, caution is needed in the interpretation of results for these four cases. Results from a variation of GMM (System GMM) suggest that market access is not significant for the first three of them. Industry 372 did not passed the tests required to obtain consistent estimation using System GMM.

level.

Endogeneity can also be associated to other aspects of the labor market, often neglected in the NEG literature, in particular the labor market adjustment and the long term response to market access. Workers should react to wage differentials across sectors inside of a country (job mobility), or across countries for the same industry (international migration), potentially dampening the total impact of the market access on wages. The second case is treated in the next section, and here I explore intranational job reallocation. I take advantage of the panel data dimension to explore the dynamic adjustments between wages and labor, and a two-step difference GMM estimator is chosen. It is important to mention that most empirical works on sectoral labor adjustment find a relatively sluggish employment response to wage evolutions (e.g., Artuc et al., 2007), or to trade liberalization (e.g., Wacziarg and Wallack, 2004). Several explanations have been proposed in the literature, often related to labor market conditions (e.g. search frictions or legal regulations like in Davidson et al., 1999 or Hasan et al., 2007), sectoral specificities (factor-specificity as in Kambourov, 2009) or individual idiosyncrasy (Artuc et al., 2007). Finally, studies may fail to find employment adjustment because they usually do not have data on movements outside the industrial sector, specially toward the service sector (Hoekman et al., 2005) or simply because the adjustment happens within an industry, across firm differing in productivity (Bernard et al., 2003). This study will not escape to these caveats and alternative explanations. All this being said, this sectoral low response is consistent with industrial wages exhibiting some persistence. On the empirical side, researchers have treated this by introducing several lags of both variables to better capture this process, and implement GMM dynamic panel techniques. In particular, I follow studies in labor adjustment like Arellano and Bond (1991) (and more specifically to the case of trade liberalization impact, like Milner and Wright (1998) and Greenaway et al. (1999)), by introducing as regressors one and two lags⁸ of wage and employment, and I implement a two-step GMM estimator applied to first-differenced data. I also treat the market access variable as predetermined

⁸In one case (industry 332), the full specification of employment and wage lags results in rejection by the mentioned tests, but a version with only the lagged term for wages ($\ln w_{i,t-1}$) and the contemporaneous term for employment levels ($\ln L_{i,t}$) passes the tests.

(i.e., it is introduced lagged of one year). Hence the variables considered are:

$$\ln w_{i,t} = \psi_1 + \psi_2 \ln MA_{i,t-1} + \psi' \ln w_{i,t-\Theta} + \psi' \ln L_{i,t-\ell} + c_i + \mu_{i,t} \quad (1.15)$$

with $\ell = \{0, 1, 2\}$ and $\Theta = \{1, 2\}$.

GMM implies first-differencing equation (1.15) to eliminate the country fixed effects c_i . This introduces correlation between the transformed error term $(\mu_{i,t} - \mu_{i,t-1})$ and the lagged, differenced dependent variable $(\ln w_{i,t-1} - \ln w_{i,t-2})$. Lagged values (starting from the second-lag) can be used as instrument, provided that the residual $\mu_{i,t}$ is not serially correlated.⁹

Tables 1.5 and 1.6 in the Appendix detail the results. In all regressions, the transformed error term exhibits first-order correlations, and no second-order correlations, as required for the validity of the instruments. Hansen and Sargan tests never reject the validity of instruments. In all cases but one (industry 341), instruments considered are at least third lags of the variables. As the panel has a rather long time dimension (in comparison to most of the panels using GMM), I follow recent literature on GMM (Calderon et al., 2002; Roodman, 2006; Beck and Levine, 2004) in collapsing the instruments to reduce the dimensionality and hence avoid over-fitting problems.¹⁰

As expected, the first lag for wages is always highly significant, confirming the persistence. Employment levels (lagged or contemporaneous terms) are significant in 13 industries only. As expected in an adjustment process, the first lags for employment are almost always of negative sign. Coefficients for market access are in general supportive of the

⁹Additionally, the assumption of weak exogeneity must be valid, i.e., current explanatory variables may be affected by past and current realizations of the dependent variable, but not by its future innovations.

¹⁰Collapsed instruments refers to apply each moment condition to all available periods, instead of applying them to a particular time period, as usual. In the latter case, the number of moment conditions increases more than proportionally with the number of time periods. Also with the objective of reducing instruments, I report in Tables 1.5 and 1.6 the regression for each industry, that uses the lowest number of instruments, provided that the estimation pass the Sargan, Hansen and autocorrelation tests. Similar results (including tests for validity of instruments) are obtained when the entire number of possible lags is used and instruments are collapsed. Finally, similar coefficients are obtained in unreported regressions where instruments are not collapsed, but Sargan tests often rejected them, as expected in presence of “too many instruments”.

results found in panel FE, although more imprecisely estimated and often of lower magnitudes. Among different significant coefficients, elasticities range between 9%-38% (*Textiles* and *Non-ferrous Metals*, respectively). They are more in line of results found by Head and Mayer (2006) and Boulhol and de Serres (2008) at international level, and by me and coauthors (Chapter 2 of this thesis) and Hering and Poncet (2009) at intranational level.

As already stated, persistence in wages can be associated to imperfections in the labor market, an issue that is barely treated in NEG models. Although a full treatment of this issue is beyond the scope of this study (and constrained by data limitations), some exploratory regressions can be presented to illustrate its potential importance for further research. Cross-sectional data on labor regulations is available for 85 countries from Botero et al. (2004). One of the indicators proposed in their article, capturing differentials in Social Security laws (like unemployment and health benefits), performs rather well to explain wages. Unfortunately, this indicator is not time-varying. I force the variable to have a time variation by interacting them with GDP per capita, because these researchers also established that the relation of the index is more robust for developed countries, suggesting that law enforcement is important for the identification of the impact of this variable. Obviously, it is not possible to disentangle what comes from labor regulation and what from the GDP per capita. Moreover, both are endogenous. I follow the authors in instrumenting this raw measure by legal origins. Tables 1.7 and 1.8 reports the results. All regression use the lagged specification of equation 1.15. Only coefficients for market potential and the labor regulation index are presented. Panel (A) displays regressions where the market potential is lagged of one period, while panel (B) exhibit coefficients with the contemporaneous market potential. The reader will notice that some of the regressions are not passing the tests or are at the borderline for rejection. I present them for completeness and to illustrate how problematic can be the generation of valid GMM regressions with this limited sample and the inclusion of another endogenous variable. Several industries are no longer exhibiting a significant coefficient for market potential in at least one of the specifications (Beverages, Footwear, Printing, Rubber, Plastic, Metal products and Miscellaneous). The variable of Social Security index interacted with GDP per capita is significant in most of

the regressions. I will not elaborate more on these results because the regressions seem very noisy. The point here is that exploring the interaction between labor regulations and Economic Geography can be a worthwhile avenue for future research, which will demand a development of new indicators of labor regulation with a time varying dimension, or the research of specific case studies.

1.4.3.2.2 Spatial adjustment. The performance of the wage equation gives some support to the idea that the international spatial adjustment is expressed in a price version. This makes sense under the plausible hypothesis of factor immobility. Nonetheless, it is also possible that agglomeration economies affect the industry concentration (through adjustment channels like migration and firm relocation). A way to explore this issue is considering if the market potential could explain also the employment distribution for the manufacturing industries (also in Panel FE method). For the sake of brevity, I will not show regressions here (they are available on request). Only in six sectors a significant coefficient is found. Interestingly, three of them are among industries that are often associated to relocations in the recent decades: Apparel (322), Leather (323) and Footwear (324). The rest are Beverages (313), Plastic (356) and Non-metal (369) products. Their coefficients are, respectively, 0.27, 0.25, 0.16, 0.06, 0.12, 0.06. In sum, evidence in favor of a quantity response is not found by using labor as indicator.

1.4.3.2.3 Wage equation with human capital controls. I perform the same baseline regressions, adding a control for human capital levels. The number of observations falls, ranging between 202 to 355 since data on education levels are only available over a 5-year period and for a restricted number of countries. To save space, only the coefficients of interest are discussed here. In the Appendix (See Table 1.4) I report detailed coefficients, significance levels and within R-squared for each regression, for HM and RV methods and distinguishing between total market access and the “Foreign” versions. The focus here will be only on regressions using the total market access, which are summarized for both the RV and HM method in the Figures 1.6 and 1.7. There, coefficients are plotted for each industrial regression. Each point indicates the magnitude of the coefficient for MA (Horizontal

axis) and for human capital (vertical axis). Hollowed circles correspond to MA coefficients that are not significant at least at a 5% confidence level.

In the case of RV method (Figure 1.6) controlling for skill sorting has important consequences for the market access. In 7 sectors the elasticities for market access become non-significant at conventional levels (Tobacco, Furniture, Paper, Other Chemicals, Petroleum Refineries, Rubber and Transport Equipment). Moreover, it seems that substitutability among both variables is present: wages in industries like manufacturing of Professional & Scientific products are strongly affected by the education level. By contrast, wages in sectors like Pottery, exhibit a very high sensibility to Market Access, and no significant influence from schooling. Despite the interesting variations of returns to schooling (and their plausible magnitudes in most of the cases), coefficients are very imprecisely estimated (as it is often the case in growth regressions). I attribute this in great part to the reduced number of observations, and maybe also to potential measurement error and missing cross-country differences in educational quality, the usual criticism for this variable. Finally, it is also possible that the impact of the schooling level may be specially captured in industry growth rather than wage differentials, as the study by Ciccone and Papaioannou (2008) suggests.

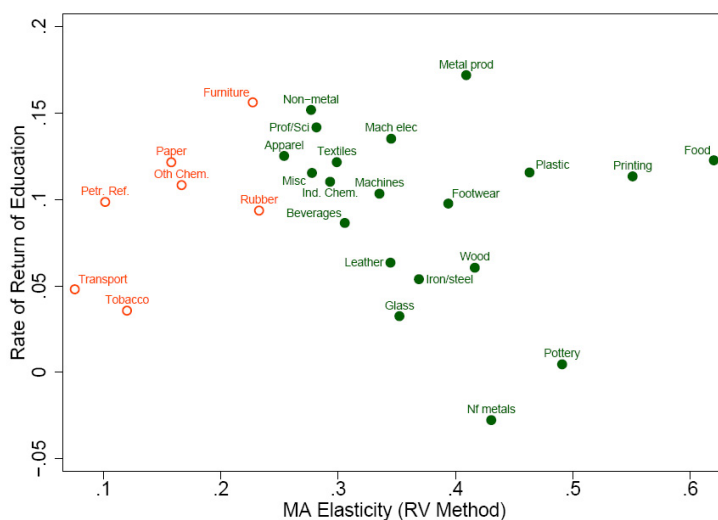


Figure 1.6: Market access (RV) impact and skill sorting

Figure 1.7 suggests that HM method is much less affected by the skill sorting, and again the same 25 out of 27 industries identified in the baseline regressions exhibit a significant coefficient for the market access.

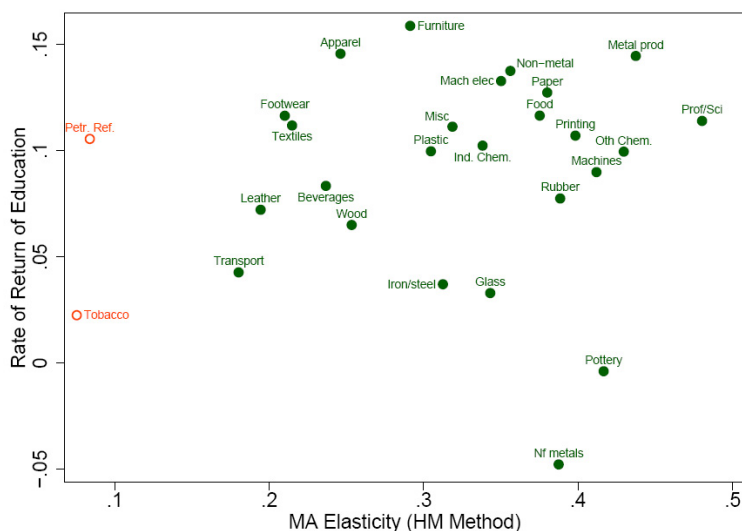


Figure 1.7: Market access (HM) impact and skill sorting

1.4.3.2.4 Controlling for the geography of production costs: Supplier Access.

The impact of trade on wages through NEG mechanism can also be linked to the so-called Supplier Access (SA).¹¹ This reflects the locational advantage for a firm when many producers are proximate which could be reflected in lower costs. In partial equilibrium, the theory predicts that both variables should play a role in the formation of profits. Nevertheless, over time, one can distinguish two stages of geographic concentration associated to globalization. In a first part, a reduction in trade costs entails a concentration close to demand centers. The coordinated concentration of industries in the core following market access will determine that suppliers will also be located there. Nevertheless, deepening the globalization process lead to a redispersion: at some point the reduction in trade costs renders profitable to relocate in the periphery to take advantage of lower labor costs. In

¹¹I will only comment main results. All regressions are available on request. I will not comment regressions on Tobacco or Petroleum Refineries because they gave similar results to all other previous results, that is, no wage response at all to the NEG variables.

this second stage, the geography of low costs will prevail over that of demand, gathering a dispersion process for some industries. Based on simulations, Fujita et al. (1999) and Zeng (2006) find that the first relocating industries should be those that are more oriented to final demand, with poorer input-output linkages, and labor intensive (e.g. those of clothing sector). Once they have migrated, other industries that uses them as inputs may also relocate. Under the same hypotheses of zero profits and no international migration, the impact of Supplier Access should be found in wages. Hence, I will try to identify which industries are exhibiting wage responses to several supplier access measures, and if this effect is behind the price impact of market access.

As expected, at national level, Supplier and Market Access should be highly correlated, making difficult to disentangle their effects. Industry level data could mitigate this problem. It is possible to build a measure of Supplier Access following a similar method employed for the market access, using the exporter fixed effect from aggregated gravity regressions (FX_i) or from industry-specific gravity regressions (FX_{ik}). Using an industry-specific supplier access is less appealing, because it is expected that other industries influence the cost function. Actually, regressions using this version of Supplier Access are never significant in panel FE (even if market access is not included as regressor). Consequently, I built a second version of the supplier access that takes into account all manufacturing industries, that is generated by an aggregated gravity regression like in Redding and Venables (2004).¹² These aggregated Supplier Access performs better, specially when a RV version is employed. Specifically, SA is significant in the case of 14 industries, when it is introduced as unique regressor (in Panel FE) to explain industrial-specific wages. The industries are: Textiles, Apparel, Leather, Wood products and Furniture, Paper, Printing, Other Chemicals, Plastic, Glass, Iron/Steel, Metal products, Machinery and Machinery Electric. Finally, when industry-specific market access is included in the regressions together with the Supplier Access, we get interesting results. Supplier Access is still significant in 8 industries. In two cases, only proximity to suppliers is significant, which is consistent with the argument that geography of demand is no longer important in these sectors. These sectors are Textiles and

¹²In this case, trade regressions using all manufacturing are performed, and the exporter fixed effects recovered are country-specific, but not industry-specific.

Paper products, both industries often considered as low differentiated. A second group of regressions had both coefficients significant. Among these industries, it worth to note that we found the rest of industries linked to clothing (Apparel, Leather and Footwear), as well as industries of Furniture, Plastic, and Metal products. Finally there are two industries (Transport and Prof/Sci Equipments) for which the evidence is mixed: When RV measures for SA and MA are introduced, I do not found any significant coefficient, but when HM measure are used instead, market access is the only significant.

In sum, the evidence is suggestive of more influence of Supplier Access in some industries. All in all, caution is needed because results are highly dependent on the specification of trade costs. In the case of HM measures most of the coefficients are no longer significant, and when only Foreign SA is considered, coefficients are seldom significant, even when market access is not introduced in the regressions. More investigation is needed to develop more precise measures of this variable.¹³

1.4.3.2.5 Summary on robustness checks. Based on the evidence provided in the previous sections, two results can be established. First, although both measures of Market Access are highly correlated, HM method seems more robust. Second, focused in the HM estimations, 16 industries exhibit very robust results concerning the market access impact on wages. They are: Food (311), Beverages (313), Leather (323), Footwear (324), Wood (331), Printing (342), Rubber (355), Plastic (356), Pottery (361), Non-Ferrous metal products (372), all industries of manufacture of fabricated metal products, machinery and Equipment (38), and Miscellaneous (390). Figure 1.8 displays coefficients obtained by the GMM and panel method (respectively, columns (2) and (3) in the Table 1.1). Those in the right side correspond to coefficients significant using both econometric methods. In the next section, simulations for some of the industries are presented.

¹³I also explored a weighted Supplier Access (See Chapter 2 for the methodology, in the context of a cross-regional study) where all industry-specific exporter fixed effect FX_{ik} are considered in a composite indicator. Weights are the share of expense devoted to inputs, taken from an input-output table. I employed the USA matrix. Results did not improve (no more than 8 industries exhibited some significant impact of SA), possibly because the USA matrix is not correctly representing technological levels for all countries.

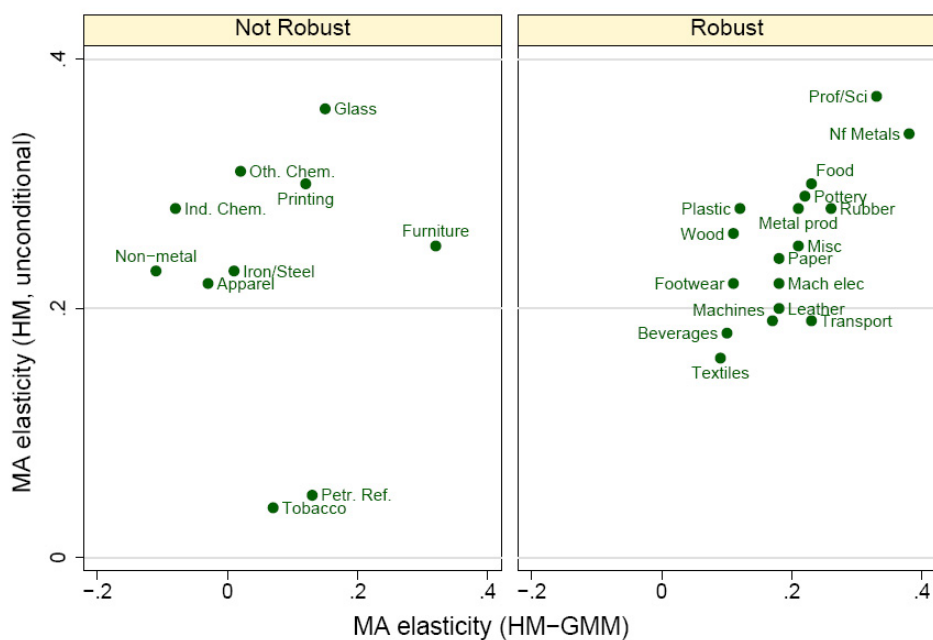


Figure 1.8: Market access (HM) elasticities

1.4.4 How policy changes could affect the economic geography and wages

In this section I explore the potential impacts of some of the market access components on national wages.¹⁴ I employ the same policy variables proposed by Mayer (2008), what allows for a comparison of country level impacts versus country-industry-specific impacts. The first variable is Regional Trade Agreements (RTA) status (a dummy set to 1 when partners have signed a RTA). RTA coefficient experienced an increasing evolution in time as figure 1.4 shows. The second variable is World Trade Organization (WTO) affiliation (a dummy set to 1 if both partners are members). Both characteristics affect the trade cost component of market access, reshaping the world economic geography, and hence the

¹⁴Simulations in New Economic Geography models have followed two paths. A group of studies are interested in the long-term consequences of reduction in trade costs on agglomeration patterns. These works emphasize migration or FDI as adjustment channels. Some examples are Forslid et al. (2002), Crozet (2004) and the Chapter 3 of this thesis. The second line of research (followed here) is interested on the spatial transmission of the shocks in the market access (or its components). These simulations focus on wages (or GDP per capita) at intranational (e.g. Hanson, 2005, and Mion, 2004) or international level (e.g. Mayer, 2008).

maximum wages that can be afforded to pay in each location. Like Mayer, impacts are evaluated for the year 2003 and using the MA built with the HM method.

One alternative is to calibrate the model, choosing plausible values for labor share in production β and for the elasticity of substitution among varieties σ . Mayer (2008) proposes $\beta = 0.2$ and $\sigma = 5$. Results for these simulations are available in columns 3, 4, 7 and 8 of Table 1.2. The columns 3 and 7 correspond to effects averaged over all concerned countries, and columns 6 and 8 report the maximum lost for each industry. A simple comparison confirms some of the Mayer's results: Figures are sizable, and losing benefits of WTO membership are more important in terms of wages than losing benefits of RTAs signed. Industrial data permit to evaluate which sectors appears more sensible. Average loses are the highest for the industries of manufacture of fabricated metal products, machinery & equipment (38) for both RTA and WTO status.

Table 1.2: Impact of policy changes on wages (HM estimations)

INDUSTRY		No RTA				No WTO			
		$\beta = .2; \sigma = 5$		HM		$\beta = .2; \sigma = 5$		HM	
Code	Name	Average	Max	Average	Max	Average	Max	Average	Max
311	Food	8.6	25.1	2.7	8.3	17.8	30.2	5.8	10.2
313	Beverages	5	34.1	1	7.2	27	60.7	6.2	15.3
323	Leather	9.1	27.5	1.9	6.2	46.3	54	11.7	14.3
324	Footwear	5	18.8	1.1	4.5	42.3	61.1	11.9	19
331	Wood	7.3	34.4	2	10.4	22.6	33.1	6.5	9.9
342	Printing	4.9	20.3	1.5	6.6	24.3	56.5	8.6	22.1
355	Rubber	9.4	24	2.7	7.3	43.3	61.7	14.8	23.3
356	Plastic	9.5	37.1	2.8	12	39.9	65.7	13.9	25.6
361	Pottery	3.4	11.3	1	3.4	39.4	65.2	13.9	26.3
372	Nf metals	9.9	22.7	3.5	8.3	31.4	38.5	11.9	15
381	Metal prod	9	28.6	2.7	9.1	30.8	48.3	10.1	17
382	Machines	15.1	39	3.2	9.1	43	51.3	10.4	13
383	Mach elec	14.7	38.3	3.5	10.2	56.7	66.3	17.2	21.5
384	Transport	16.9	52.7	3.6	13.4	38.7	52	9.1	13.1
385	Prof/Sci	11.3	26.3	4.3	10.6	50.3	60.2	22.8	28.8
390	Misc	9.7	22.4	2.6	6.3	48.2	58.2	15.5	19.9

Columns 3 and 4 present estimations of quantitative losses (in terms of wages) for all RTAs abandoned employing some parameters, while column 5 and 6 report estimations using the coefficients. Columns 7 and 8 present wage losses for all WTO membership abandoned employing some parameters, while column 9 and 10 report estimations using the coefficients.

One problem with this calibration approach is that parameters chosen suggest an elasticity of market access of 1, unrealistic given the results of this study. I propose to take directly the coefficient from the Panel estimations from column 4 in table 1.1. The results are displayed in Table 1.2, in columns 5 and 6 for RTAs, and 9 and 10 for WTO membership. This time coefficients are much lower but still important for several industries. Among industries, and taking average values, losses can vary between 1% and 4.3% for RTAs, and between 5.8% and 22.8% for WTO affiliation.

The comparison of average and maximum values suggest that the distributions can be dominated for some specific countries suffering big losses. In particular, the list is dominated by (1) smaller countries in terms of surface (Andorra) or GDP (Several African countries, Burma, Bhutan) and (2) geographically isolated nations like Caribbean and Pacific islands and landlocked countries (Bolivia, Paraguay, Central African Republic, Niger, Mongolia, Kyrgyzstan). Also, some Emerging/Developed countries like Canada, Ireland, Austria, Finland, Belgium, Tunisia, Algeria, Morocco and Taiwan, seem highly affected by RTA and WTO withdrawals. A common feature among them is the strategic location, close to great demand centers (USA, Japan, European Union). Third, RTAs effect is sizable specially for (peripheral) European countries, and often for more sophisticated products (Professional & Scientific Equipment, Transport Equipment, Machines). Finally, WTO is more associated to Emerging/Developing economies, specially African ones. For WTO results, there is no clear evidence of industrial specificities. This differentiated effect was already found by Mayer (2008) at aggregated level.

1.5 Concluding Remarks

This study explored the impact of market access on the outcomes of New Economic Geography models. In particular, I assess the results of regressions where factor rewards (proxied by manufacturing wages) and quantity effects (proxied by manufacturing employment) are explained by the Market Access (MA). This variable is tested in two stages. First, MA estimations are built using a gravity equation of trade flows. 1,296 regressions were per-

formed considering 27 industries, 24 years and 2 methods. The second step is a panel linear regression where MA is used as explanatory variable for wages and employment.

Results suggest a robust relationship for the wage equation for 16 out of 27 industries. The alternative of an adjustment of the market access by employment is explored, confirming that a good performance of the price effect (wage equation) is accompanied by a bad performance of a quantity effect (employment), reflecting that migration plays a limited role in equalizing factor rewards. Also weak results were found regarding the impact of Supplier Access (a measure of proximity to intermediate inputs), probably due to limitations to generate a good proxy for this variable at industrial level, constituting an interesting avenue for future research. A similar argument can be elaborated with respect to labor regulations and its potential influence on market access effects.

Although several robust coefficients were found, the impact of market access can strongly vary across countries. An important part of the locational competitiveness changes very slow, and several peripheral countries will have to wait until new demand centers will arise, as it has been the case for Asia in the last quarter century. Other components, like the trade integration policies, can have important effects as it is shown in section 1.4.4. Regional Trade Agreements seem to influence manufacturing wages in (peripheral) European countries, and more often for more sophisticated products (Professional & Scientific Equipment, Transport Equipment, Machines). The impact of membership of World Trade Organization is more associated to developing economies, specially African ones, and there is no clear evidence of industrial specificities.

1.6 Appendix.

1.6.1 Theoretical model

As in the standard version of the Dixit-Stiglitz-Krugman model of trade, I assume preferences to have constant elasticity of substitution across product varieties. Each variety is produced by a single firm under monopolistic competition. Producers and consumers are spread over different countries, and I assume *ad valorem* trade costs, τ_{ijs} , between any two countries i and j specific for each manufacturing industry s . In the following, the industry subscript is dropped reflecting that there are no linkages among industries of any kind. In Chapter 2 the model is extended to include industry linkages in the cost function (Supplier Access) but demand linkages remain independent (the market access of an industry has no effect on the market access of another industry). Like Zeng (2006), I assume that some human capital specificity (or alternatively, labor regulations like firing costs) reduces labor mobility across sectors.

Consider J countries and a two-sector economy. The first (A-sector) is characterized by constant returns, perfect competition and no trade costs. This sector offsets all trade imbalances in the other sector, thus permitting spatial specialization. The agglomeration forces take place in the second sector, usually termed M-sector. This sector produces differentiated goods, experiencing trade costs and increasing returns. Preferences are described by a Cobb-Douglas function with a Dixit-Stiglitz sub-utility for the M-good. A proportion μ of the regional income is devoted to consumption of the M-goods.

$$U_i = M_i^\mu A_i^{1-\mu} ; \quad 0 < \mu < 1 \quad (1.16)$$

M_i is a consumption index of the varieties of the M-sector for region i . The varieties are defined as a *continuum* of N goods, where $q_{ji}(v)$ corresponds to the demand of region i for the v th variety coming from region j . As shown by Baldwin et al. (2003), there is one firm per variety, so it is possible to refer indifferently to a variety or a firm, the total number of symmetric firms from a region being n_j . The parameter σ represents the constant elasticity of substitution (CES) between any two varieties.

$$M_i = \left[\sum_j^J \left(\int_0^{n_j} q_{ji}(v)^{\frac{\sigma-1}{\sigma}} dv \right) \right]^{\frac{\sigma}{\sigma-1}} = \left[\sum_j^J \left(n_j q_{ji}^{\frac{\sigma-1}{\sigma}} \right) \right]^{\frac{\sigma}{\sigma-1}} ; \quad \sigma > 1 \quad (1.17)$$

As I am interested in the market access, MA , of region i , I maximize the profit of each firm to obtain the demand of region j for a variety coming from region i . This demand $q_{ij}(v)$ is determined by the regional income Y_j , the CIF price p_{ij} and a price index P_j . Trade costs between two regions i and j take the form of iceberg costs. With the FOB price (or mill price) being p_i , products from i are sold in region j for the price $p_{ij} = p_i \tau_{ij}$:

$$q_{ij} = \mu Y_j p_{ij}^{-\sigma} P_j^{\sigma-1} \quad (1.18)$$

$$P_j = \left[\sum_i^J n_i (p_i \tau_{ij})^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \quad (1.19)$$

The price index, $P_j^{1-\sigma}$, is defined as the sum over the prices of individual varieties and reflects the potential suppliers of this market, considering trade costs, the elasticity of substitution, and the prices they charge. In this sense, it could be considered as a measure of the market crowding: a well served region is a region where I expect a high competition and therefore lower product prices.

Turning to the supply side of the model, only labor demand is considered (See Chapter 2 for inclusion of intermediate goods). Increasing returns in the M-sector are usually modeled by a fixed cost per plant f_i , and a constant marginal cost m_i . Hence, profits of a firm are:

$$\pi = p_i q_i - m_i q_i - f_i \quad (1.20)$$

Profit maximization results in a constant mark-up:

$$p_i = \frac{m_i \sigma}{\sigma - 1} \quad (1.21)$$

Using the demand function in equation 1.18 and the fact that gross profits are given by

$\pi_{ij} = p_{ij}q_{ij}/\sigma$, profits earned in each market j can be defined as:

$$\pi_i = \frac{1}{\sigma} \left[p_i^{1-\sigma} \left(\frac{\mu Y_j}{P_j^{1-\sigma}} \right) \phi_{ij} \right] - f_i \quad (1.22)$$

I adopted the notation of Baldwin et al. (2003) using the term *freeness* (a.k.a. *phiness*) of trade, $\phi_{ij} \equiv \tau_{ij}^{1-\sigma}$, that represents the combined impact of (1) trade costs and (2) the elasticity of substitution on demand. When these variables are too high, trade becomes prohibitive, and only the local demand is relevant ($\phi_{ij} = 0$). A frictionless world is represented by a $\phi_{ij} = 1$. To obtain the net profit in each potential location i , the sum of the profits from all locations j using equation 1.22 is made:

$$\Pi_i = \frac{1}{\sigma} \left[\left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma} m_i^{1-\sigma} \underbrace{\sum_j \left(\frac{\mu Y_j}{P_j^{1-\sigma}} \phi_{ij} \right)}_{MA_i} \right] - f_i \quad (1.23)$$

The term in the sum is called *Market Access* or *Real Market Potential*, and is usually abbreviated as *MA*, where MA_i is defined as the sum of the final demand addressed to region i , weighted by the accessibility from i to these markets j (since it considers ϕ_{ij}) and by the market crowding level of every region j (since it considers the price index $P_j^{1-\sigma}$).

The spatial equilibrium can be achieved under the hypothesis that all firms will earn the same profit. An iso-profit equation that normalizes the profit to zero gives us a relationship between costs and *MA*:

$$m_i^{\sigma-1} f_i = \frac{1}{\sigma} \left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma} MA_i \quad (1.24)$$

1.6.2 Additional tables

Table 1.3: Names of industries

ISIC Code	Abbreviation	Industry description
311	Food	Food products
313	Beverages	Beverages
314	Tobacco	Tobacco
321	Textiles	Wearing apparel except footwear
322	Apparel	Wearing apparel
323	Leather	Leather products
324	Footwear	Footwear
331	Wood	Wood products except furniture
332	Furniture	Furniture except metal
341	Paper	Paper and products
342	Printing	Printing and publishing
351	Ind. Chem.	Industrial chemicals
352	Oth Chem.	Other chemicals
353	Petr. Ref.	Petroleum refineries
355	Rubber	Rubber products
356	Plastic	Plastic products
361	Pottery	Pottery, china and earthenware
362	Glass	Glass and products
369	Non-metal	Other non-metallic mineral products
371	Iron/steel	Iron and steel basic industries
372	Nf metals	Non-ferrous metal basic industries
381	Metal prod	Fabricated metal products
382	Machines	Machinery except electrical
383	Mach elec	Electrical machinery apparatus, appliances and supplies
384	Transport	Transport equipment
385	Prof/Sci	Professional and scientific, and measuring and controlling equipment, and photographic and optical goods
390	Misc	Other manufactured products

Industry 354 (Manufacture of miscellaneous products of petroleum and coal) is not included in the analysis.

Table 1.4: NEG Wage equations: Conditional estimations

INDUSTRY		Coeffs. for		Coeffs. for		Coeffs. for		R ²		N	
Code	Name	MA-RV	ρ	MA-HM	ρ	FMA-RV	ρ	FMA-HM	ρ	max	min
311	Food	0.62 ^a	0.12	0.38 ^a	0.12 ^c	0.56 ^a	0.12	0.56 ^a	0.12	36	30
313	Beverages	0.31 ^b	0.09	0.24 ^a	0.08	0.18	0.10	0.21	0.10	40	36
314	Tobacco	0.12	0.04	0.08	0.02	0.00	0.04	0.12	0.04	36	35
321	Textiles	0.30 ^b	0.12	0.21 ^a	0.11	0.31 ^b	0.12	0.34 ^a	0.12	30	28
322	Apparel	0.25 ^a	0.13	0.25 ^a	0.15 ^b	0.15 ^c	0.13	0.18 ^b	0.14	26	21
323	Leather	0.34 ^a	0.06	0.19 ^a	0.07	0.37 ^b	0.08	0.37 ^a	0.08	27	26
324	Footwear	0.39 ^a	0.10	0.21 ^a	0.12	0.30 ^b	0.11	0.30 ^b	0.11	27	23
331	Wood	0.42 ^a	0.06	0.25 ^a	0.07	0.39 ^a	0.05	0.44 ^a	0.05	29	25
332	Furniture	0.23	0.16 ^c	0.29 ^a	0.16 ^b	0.31 ^b	0.15 ^c	0.44 ^a	0.16 ^c	32	23
341	Paper	0.16	0.12	0.38 ^a	0.13	0.16 ^c	0.11	0.21 ^b	0.10	33	26
342	Printing	0.55 ^a	0.11	0.40 ^a	0.11	0.49 ^a	0.10	0.51 ^a	0.10	39	34
351	Ind. Chem.	0.29 ^b	0.11	0.34 ^a	0.10	0.38 ^b	0.09	0.36 ^b	0.10	41	37
352	Oth Chem.	0.17	0.11	0.43 ^a	0.10	0.20	0.10	0.25	0.10	39	32
353	Petr. Ref.	0.10	0.10	0.08	0.11	0.04	0.10	0.01	0.10	25	24
355	Rubber	0.23	0.09	0.39 ^a	0.08	0.33 ^b	0.09	0.38 ^a	0.08	26	20
356	Plastic	0.46 ^a	0.12 ^c	0.30 ^a	0.10	0.42 ^a	0.12	0.46 ^a	0.12 ^c	35	32
361	Pottery	0.49 ^a	0.00	0.42 ^a	-0.00	0.38 ^a	0.01	0.32 ^a	0.02	37	29
362	Glass	0.35 ^a	0.03	0.34 ^a	0.03	0.44 ^a	0.04	0.42 ^a	0.04	35	32
369	Non-metal	0.28 ^a	0.15 ^b	0.36 ^a	0.14 ^b	0.24 ^a	0.14 ^c	0.26 ^a	0.14 ^c	39	28
371	Iron/steel	0.37 ^a	0.05	0.31 ^a	0.04	0.26 ^b	0.06	0.27 ^b	0.06	36	29
372	Nf metals	0.43 ^a	-0.03	0.39 ^a	-0.05	0.34 ^a	0.01	0.32 ^b	0.02	47	40
381	Metal prod	0.41 ^a	0.17 ^b	0.44 ^a	0.14 ^b	0.43 ^a	0.15 ^b	0.47 ^a	0.15 ^b	38	29
382	Machines	0.34 ^b	0.10	0.41 ^a	0.09	0.54 ^a	0.08	0.55 ^a	0.08	29	23
383	Mach elec	0.35 ^a	0.14 ^c	0.35 ^a	0.13 ^b	0.36 ^a	0.12 ^c	0.38 ^a	0.12 ^c	37	32
384	Transport	0.08	0.05	0.18 ^a	0.04	0.16 ^b	0.05	0.18 ^b	0.05	38	34
385	Prof/Sci	0.28 ^c	0.14 ^c	0.48 ^a	0.11 ^c	0.29 ^c	0.14 ^c	0.31 ^b	0.14 ^c	43	37
390	Misc	0.28 ^b	0.12	0.32 ^a	0.11	0.24 ^c	0.11	0.28 ^b	0.11	31	26

Columns 3 and 5 present coefficients for market access, columns 7 to 9 present coefficients for Foreign Market Access. Columns 4, 6, 8 and 10 report coefficients for the human capital. ^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. Inference based on Robust Standard Errors, clustered by country (not reported in this table). Columns 11 and 12 present respectively, the maximum and minimum (across all regressions) of within R squared. The last column shows the number of observations. All estimations include time and country Fixed Effects, and a constant (not reported).

Table 1.5: NEG Wage Equation (GMM). Ind 311-353

	(311)	(313)	(314)	(321)	(322)	(323)	(324)	(331)	(332)	(341)	(342)	(351)	(352)	(353)
$Ln(w_{t-1})$	0.73 ^a (0.15)	0.66 ^a (0.13)	0.96 ^a (0.20)	0.73 ^a (0.14)	1.14 ^a (0.24)	0.42 ^a (0.14)	0.55 ^a (0.17)	0.52 ^a (0.16)	0.72 ^a (0.25)	1.12 ^a (0.16)	1.13 ^a (0.25)	0.70 ^a (0.13)	0.85 ^a (0.25)	0.67 ^a (0.12)
$Ln(w_{t-2})$	-0.12 (0.12)	-0.04 (0.10)	0.07 (0.28)	-0.04 (0.13)	-0.19 (0.30)	0.15 (0.11)	0.05 (0.15)	-0.00 (0.12)	-0.24 (0.15)	-0.24 (0.15)	-0.30 ^c (0.18)	0.07 (0.11)	-0.02 (0.19)	-0.11 (0.12)
$Ln(L)$	-0.35 ^b (0.17)	-0.28 ^c (0.14)	-0.44 (0.56)	-0.18 (0.16)	0.10 (0.28)	-0.22 ^b (0.09)	-0.16 (0.20)	-0.34 ^a (0.10)	0.19 ^b (0.09)	-0.17 (0.11)	-0.06 (0.36)	-0.19 (0.13)	-0.84 (0.55)	-0.50 ^c (0.26)
$Ln(L_{t-1})$	0.25 (0.19)	0.36 ^b (0.18)	0.50 (0.52)	0.23 (0.14)	-0.09 (0.23)	0.06 (0.06)	0.16 (0.19)	0.16 (0.10)	0.21 ^b (0.10)	0.21 ^b (0.10)	0.34 (0.43)	0.14 (0.15)	0.74 (0.50)	0.34 (0.23)
$Ln(MA_{t-1})$	0.23 ^a (0.06)	0.10 ^a (0.04)	0.10 (0.17)	0.09 ^c (0.05)	-0.03 (0.19)	0.18 ^a (0.07)	0.11 ^b (0.05)	0.11 ^b (0.05)	0.32 (0.25)	0.18 ^c (0.09)	0.12 (0.11)	-0.08 (0.11)	0.02 (0.09)	0.13 ^b (0.05)
No. of obs	1475	1423	1208	1460	1370	1358	1269	1453	1379	1478	1363	1307	1259	908
No. of groups	121	115	108	118	112	112	106	119	111	118	114	115	91	89
Hansen(p)	0.60	0.31	0.54	0.57	0.73	0.46	0.49	0.76	0.24	0.96	0.50	0.36	0.64	0.97
Sargan(p)	0.65	0.13	0.49	0.71	0.91	0.12	0.32	0.96	0.22	0.98	0.67	0.27	0.47	0.49
AR(1)p	0.00	0.00	0.07	0.01	0.00	0.03	0.02	0.01	0.00	0.00	0.01	0.02	0.04	0.00
AR(2)p	0.24	0.59	0.35	0.30	0.96	0.30	0.54	0.89	0.31	0.15	0.44	0.17	0.46	0.83
No. instr.	61	86	32	81	36	106	66	76	26	49	42	77	47	116
Lags instr.	3-10	3-15	7-8	3-14	3-5	3-19	3-11	3-13	10	2-7	5-8	4-14	11-15	3-22

Robust Standard Errors in parentheses. ^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All regressions include time dummies. AR(1) and AR(2) are tests for Autocorrelation for the first and second lags. Hansen and Sargan tests (p-values) are test for the validity of instruments. For more details, see the text.

Table 1.6: NEG Wage Equation (GMM). Ind 355-390

	(355)	(356)	(361)	(362)	(369)	(371)	(372)	(381)	(382)	(383)	(384)	(385)	(390)
$Ln(w_{t-1})$	0.66 ^a (0.13)	0.59 ^a (0.15)	0.59 ^a (0.15)	0.50 ^a (0.17)	1.40 ^a (0.25)	0.71 ^a (0.16)	0.50 ^a (0.12)	0.56 ^a (0.14)	0.70 ^a (0.16)	0.98 ^a (0.15)	0.65 ^a (0.16)	0.58 ^a (0.20)	0.47 ^a (0.12)
$Ln(w_{t-2})$	0.16 (0.13)	0.04 (0.13)	-0.23 ^c (0.12)	0.06 (0.07)	-0.62 ^c (0.33)	0.07 (0.13)	-0.25 ^b (0.11)	-0.07 (0.13)	0.10 (0.17)	-0.29 ^c (0.15)	0.05 (0.16)	0.03 (0.15)	0.06 (0.09)
$Ln(L)$	-0.06 (0.14)	0.02 (0.14)	0.19 ^c (0.11)	-0.14 (0.14)	-0.07 (0.53)	0.32 (0.22)	-0.16 ^c (0.08)	-0.28 (0.17)	-0.12 (0.20)	-0.19 (0.14)	-0.45 ^c (0.24)	0.18 ^c (0.11)	-0.31 ^a (0.11)
$Ln(L_{t-1})$	-0.00 (0.11)	-0.01 (0.15)	-0.13 (0.12)	-0.14 (0.12)	0.13 (0.28)	-0.15 (0.18)	0.26 ^b (0.12)	0.37 ^b (0.16)	0.20 (0.19)	0.17 (0.12)	0.42 ^c (0.25)	-0.18 ^c (0.11)	0.18 ^c (0.09)
$Ln(MA_{t-1})$	0.26 ^b (0.13)	0.12 ^b (0.05)	0.22 ^b (0.10)	0.15 (0.14)	-0.11 (0.29)	0.01 (0.10)	0.38 ^a (0.11)	0.21 ^b (0.10)	0.17 ^b (0.08)	0.18 ^b (0.08)	0.23 ^a (0.06)	0.33 ^a (0.13)	0.21 ^b (0.10)
No. of obs	1361	1326	1077	1281	1325	1174	909	1405	1318	1315	1314	1103	1336
No. of groups	106	105	100	105	111	101	76	116	106	109	105	87	113
Hansen(p)	0.68	0.24	0.82	0.57	0.75	0.63	0.74	0.23	0.29	0.25	0.58	0.61	0.30
Sargan(p)	0.73	0.18	0.94	0.15	0.54	0.99	0.18	0.20	0.51	0.63	0.35	0.76	0.20
AR(1)p	0.01	0.03	0.00	0.01	0.00	0.01	0.01	0.00	0.03	0.00	0.01	0.04	0.01
AR(2)p	0.22	0.12	0.17	0.25	0.40	0.36	0.26	0.41	0.31	0.86	0.21	0.57	0.19
No. instr.	102	99	46	102	31	67	83	71	77	71	57	70	92
Lags instr.	4-19	3-18	3-7	5-20	3-4	6-14	7-19	3-12	4-14	3-12	4-10	7-16	5-18

Robust Standard Errors in parentheses. ^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All regressions include time dummies. AR(1) and AR(2) are tests for Autocorrelation for the first and second lags. Hansen and Sargan tests (p-values) are test for the validity of instruments. For more details, see the text.

Table 1.7: NEG Wage Equation (GMM) and labor regulation. Ind 311-321

	(311)	(313)	(314)	(321)	(322)	(323)	(324)	(331)	(332)	(341)	(342)	(351)	(352)	(353)
<i>Panel(A)</i>														
<i>GDPpc * SocSec</i>	0.62 ^a (0.20)	0.38 ^a (0.13)	0.56 ^a (0.17)	0.68 ^a (0.18)	0.53 ^a (0.12)	0.79 ^a (0.21)	0.85 ^a (0.22)	0.56 ^a (0.15)	0.79 ^b (0.34)	0.17 (0.21)	0.27 ^c (0.15)	0.49 ^a (0.12)	0.92 ^a (0.20)	0.74 ^a (0.17)
<i>Ln(MA_{t-1})</i>	0.17 ^b (0.08)	-0.16 (0.15)	0.05 (0.06)	0.13 ^c (0.07)	0.13 ^c (0.08)	0.19 ^b (0.09)	-0.01 (0.07)	0.18 ^a (0.05)	0.20 ^a (0.08)	0.19 (0.15)	0.06 (0.08)	-0.00 (0.12)	0.21 ^c (0.11)	-0.01 (0.04)
No. of obs	1058	1029	911	1073	1032	1016	980	1063	998	1083	1009	963	981	711
No. of groups	76	75	71	77	75	77	71	75	71	78	73	75	73	68
Hansen(p)	0.45	0.87	0.39	0.24	0.46	0.95	0.36	0.79	0.20	0.84	0.52	0.90	0.39	0.98
Sargan(p)	0.20	0.93	0.10	0.33	0.70	0.73	0.24	0.99	0.64	0.92	0.15	0.94	0.86	0.98
AR(1)p	0.01	0.01	0.03	0.04	0.00	0.03	0.02	0.01	0.02	0.04	0.00	0.01	0.00	0.01
AR(2)p	0.54	0.40	0.28	0.16	0.83	0.77	0.76	0.65	0.86	0.76	0.16	0.56	0.68	0.83
No. inst.	62	32	77	63	62	98	73	62	72	32	57	67	62	86
<i>Panel(B)</i>														
<i>GDPpc * SocSec</i>	0.67 ^a (0.22)	0.45 ^a (0.14)	0.64 ^a (0.18)	0.53 ^a (0.15)	0.50 ^a (0.12)	0.65 ^a (0.24)	0.80 ^a (0.19)	0.59 ^a (0.19)	0.67 ^b (0.27)	0.22 (0.18)	0.38 ^a (0.13)	0.48 ^a (0.15)	0.72 ^a (0.22)	0.75 ^a (0.17)
<i>Ln(MA_t)</i>	0.23 ^a (0.07)	-0.10 (0.12)	-0.08 (0.05)	0.18 ^b (0.09)	0.07 (0.06)	0.27 ^b (0.13)	0.08 (0.11)	0.15 ^a (0.05)	0.16 ^b (0.07)	0.39 ^a (0.12)	0.22 ^a (0.08)	0.09 (0.10)	0.28 ^b (0.11)	0.03 (0.05)
No. of obs	1058	1029	910	1073	1032	1016	980	1063	998	1083	1009	963	981	711
No. of groups	76	75	71	77	75	77	71	75	71	78	73	75	73	68
Hansen(p)	0.29	0.82	0.33	0.72	0.37	0.94	0.56	0.50	0.27	0.67	0.59	0.93	0.34	0.98
Sargan(p)	0.54	0.81	0.11	0.14	0.56	0.86	0.46	0.99	0.25	0.88	0.17	0.86	0.68	0.98
AR(1)p	0.03	0.01	0.03	0.01	0.00	0.03	0.03	0.01	0.01	0.00	0.02	0.02	0.01	0.01
AR(2)p	0.58	0.36	0.40	0.10	0.85	0.79	0.75	0.55	0.86	0.62	0.28	0.57	0.81	0.71
No. inst.	62	32	62	85	62	98	73	62	72	62	62	67	62	86

Robust Standard Errors in parentheses. ^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All regressions include time dummies and lags for wages and employment levels as explained in the text. Besides internal instruments, the following external instruments are used: (1) sum of ϕ_{ij} across importers; (2) Dummies for Legal Origins as coded by Botero et al. (2004). AR(1) and AR(2) are tests for Autocorrelation for the first and second lags. Hansen and Sargan tests (p-values) are test for the validity of instruments. For more details, see the text.

Table 1.8: NEG Wage Equation (GMM) and labor regulation. Ind 355-390

	(355)	(356)	(361)	(362)	(369)	(371)	(372)	(381)	(382)	(383)	(384)	(385)	(390)
<i>Panel(A)</i>													
<i>GDPpc * SocSec</i>	0.53 ^a (0.18)	0.80 ^a (0.17)	0.74 ^a (0.17)	0.71 ^a (0.19)	0.72 ^b (0.32)	0.56 ^a (0.14)	1.20 ^a (0.19)	0.45 ^a (0.15)	0.54 ^a (0.13)	0.68 ^a (0.11)	0.44 ^a (0.15)	0.62 ^a (0.11)	0.48 ^b (0.21)
<i>Ln(MA_{t-1})</i>	0.08 (0.09)	0.10 (0.06)	0.22 ^b (0.09)	0.08 (0.12)	-0.06 (0.07)	0.09 ^c (0.05)	0.14 (0.13)	0.07 (0.07)	0.23 ^a (0.08)	0.21 ^a (0.05)	0.17 ^b (0.09)	0.28 ^a (0.10)	0.02 (0.13)
No. of obs	1065	1114	844	983	1002	917	782	1019	1031	1016	997	930	990
No. of groups	77	74	70	73	74	69	61	74	73	74	72	69	75
Hansen(p)	0.55	0.64	0.19	0.93	0.64	0.96	0.75	0.33	0.14	0.79	0.23	0.86	0.37
Sargan(p)	0.10	0.18	0.18	0.40	0.90	0.16	0.39	0.56	0.11	0.34	0.02	0.21	0.24
AR(1)p	0.01	0.00	0.00	0.01	0.01	0.01	0.03	0.00	0.02	0.01	0.04	0.01	0.02
AR(2)p	0.73	0.19	0.38	0.81	0.76	0.98	0.12	0.79	0.97	0.62	0.39	0.22	0.35
No. inst.	70	78	67	102	43	89	60	57	57	87	67	82	32
<i>Panel(B)</i>													
<i>GDPpc*SocSec</i>	0.38 ^b (0.19)	0.72 ^a (0.15)	0.53 ^a (0.19)	0.61 ^a (0.20)	0.89 ^b (0.37)	0.63 ^a (0.15)	1.03 ^a (0.22)	0.29 (0.18)	0.47 ^a (0.12)	0.70 ^a (0.14)	0.39 ^b (0.20)	0.54 ^a (0.16)	0.48 ^b (0.19)
<i>Ln (MA2)</i>	0.28 ^b (0.12)	0.11 ^a (0.04)	0.35 ^a (0.11)	0.12 (0.14)	-0.11 (0.09)	0.00 (0.07)	0.38 ^b (0.16)	0.20 ^b (0.09)	0.32 ^a (0.11)	0.21 ^a (0.07)	0.26 ^b (0.12)	0.43 ^a (0.13)	0.00 (0.12)
No. of obs	1065	1114	844	983	1002	917	782	1019	1031	1016	997	930	990
No. of groups	77	74	70	73	74	69	61	74	73	74	72	69	75
Hansen(p)	0.76	0.65	0.28	0.97	0.75	0.82	0.82	0.58	1.00	0.73	0.12	0.74	0.38
Sargan(p)	0.13	0.11	0.54	0.34	0.93	0.13	0.65	0.81	0.36	0.27	0.10	0.66	0.24
AR(1)p	0.04	0.00	0.00	0.01	0.01	0.01	0.03	0.04	0.00	0.01	0.04	0.01	0.01
AR(2)p	0.64	0.21	0.06	0.70	0.62	0.93	0.22	0.34	0.45	0.74	0.28	0.21	0.35
No. inst.	55	78	62	102	43	89	60	57	97	92	62	72	32

Robust Standard Errors in parentheses. ^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All regressions include time dummies and lags for wages and employment levels as explained in the text. Besides internal instruments, the following external instruments are used: (1) sum of ϕ_{ij} across importers; (2) Dummies for Legal Origins as coded by Botero et al. (2004). AR(1) and AR(2) are tests for Autocorrelation for the first and second lags. Hansen and Sargan tests (p-values) are test for the validity of instruments. For more details, see the text.

Chapter 2

Economic geography and wages in Brazil

2.1 Introduction

Brazil,¹ the fifth largest country² in the world in surface area, is also among the most unequal ones. Its inequality is reflected not only at the individual level, but also in its geographic distribution. Lall et al. (2004) report that per capita income in São Paulo, the wealthiest Brazilian state, is 7.2 times that in Piauí, the poorest northeastern state. In addition, population density and market size vary substantially across regions. Most of the population lives in the coastal areas of the Northeast and the Southeast. While the average density in the Southeast is over 150 inhabitants per square-kilometer, this number drops below 4 for the states in the North.

New Economic Geography (NEG) models, by emphasizing the impact of proximity to markets on economic outcomes, provide an interesting framework to study regional wage inequalities in Brazil. As shown in the previous chapter, an important relationship put forward by NEG models is the impact of trade costs on firm profits. Trade costs are captured by two structural terms referred to in the literature as “market access” and “supplier access”. The first measures access to potential consumers, while the latter refers to the access to intermediate inputs. Since market and supplier access have a positive

¹This chapter is based on an article co-authored with Thibault Fally and Cristina Terra, accepted in the *Journal of Development Economics*.

²See section 2.7.4 for an overview and a political map of Brazil.

impact on profits, maximal wages that firms can afford to pay are positively related to these variables.

In this chapter, estimates of market and supplier access are used to explain regional wages, as in Redding and Venables (2004) and Head and Mayer (2006). We draw on industry-level trade data across states and control for individuals' characteristics in our estimations. Thereby, we are able to isolate the impact of location on wage inequality from other sources of wage inequality such as differences in the composition of the labor force or the local diversity of industries.

In two seminal works mentioned in the previous chapter, Hanson (2005) and Redding and Venables (2004) test structural models of the New Economic Geography. The first is applied to US counties and the second to a sampling of countries. Both find a significant impact of trade costs on wages. Inspired by this approach, intra-national studies have been applied to European NUTS regions (Head and Mayer, 2006), US states (Knaap, 2006) and Chinese provinces (Hering and Poncet, 2009).³

Our empirical framework brings two noteworthy methodological contributions. First, we control for individual characteristics. The spatial distribution of individuals could be such that their characteristics would be correlated with structural NEG variables, thus leading to spurious results in the estimation of the NEG wage equation.⁴ Such control is particularly important in the case of Brazil, since individual diversity is vast and it is an important determinant of the wage inequalities in the country. For instance, Barros et al. (2000) show that the distribution of education and its return account for about half of the wage inequality from observed sources in Brazil. Additionally, we observe large differences in human capital distribution across regions: workers from Southern regions are on average more educated than those from Northern regions. Duarte et al. (2006) show that over 55% of the difference in the return to labor between the Northeast and the Southeast regions are

³All these articles follow the methodology proposed by Redding and Venables (2004), performing a structural estimation of NEG models. There are also empirical studies using alternative frameworks, such as Mion and Naticchioni (2005) for Italy, Combes et al. (2008) for France, and Lederman et al. (2004) and Da-Mata et al. (2007) for Brazil.

⁴To our knowledge, only Hering and Poncet (2009) control for worker characteristics in a NEG framework, and no other study have introduced firm productivity. Mion and Naticchioni (2005) also control for individual characteristics, but in a different framework.

due to differences in education attainment. This substantial difference in the educational level of the work force across regions may be explained by sorting (Combes et al., 2008) or endogenous differences in returns to schooling (Redding and Schott, 2003). In any case, controlling for education allows for the correction for bias induced by the differences in work force composition across regions.

The second methodological contribution is an estimation of market and supplier access using trade flows at the industry level, while other studies use aggregate trade flows (or just compute market access, like Head and Mayer, 2006). This procedure alleviates the collinearity problem found in the literature when attempts are made to estimate these two variables simultaneously. While it is true that demand and supply should be naturally correlated at the aggregate level, since workers are also consumers, it is less likely to be true at industry level. A region may be specialized in a particular industry production, while using inputs from all industries in general.⁵ Hence, by adopting this procedure we are better equipped to disentangle the effects of market and supplier access. As a matter of fact, in the case of Brazil, the distribution of economic activity across regions varies largely across industries. Chemicals, for example, are mainly produced in Bahia, whereas transportation industries are mostly located in São Paulo.

With data on intra- and international trade flows disaggregated at the industry level we are also able to isolate local, national and international market and supplier access. Consequently, we are able to establish which kinds of trade (intra- or international) have the greatest impact on wages through a NEG mechanism.

Our empirical strategy implements a three-step procedure. Firstly, wages are regressed on worker characteristics, controlling for state-industry fixed effects. Secondly, following the NEG literature, we estimate gravity equations in order to calculate market and supplier access for each industry in each state. We compute access to international, national and local markets separately, and measure market and supplier access for each state and industry pair. Finally, market and supplier access derived in the second step are used as

⁵As explained in the previous chapter, similar methods were applied to the panel of countries, but results were less compelling, probably because differences in technologies determines different input-output matrices.

explanatory variables for the wage disparities captured by the state-industry fixed effects in the first step.

We find a positive and significant effect of market and supplier access on state-industry wage disparities, with the impact of market access being stronger than the one of supplier access. International market access turns out to have greater impact than national or local market access. The positive impact of market access on wage disparities is robust after controlling for several variables, such as firm productivity, taxes, regulation, endowments, and after using instrumental variables. The results are also unchanged in regressions at the municipality level where we are able to further control for local amenities and endowments.

The chapter is organized as follows. Section 2 describes the methodology, with a very brief summary of the theoretical background and a description of the empirical strategy pursued. The data is described in section 3, while section 4 and 5 discuss the results. Section 5 concludes.

2.2 Methodology

2.2.1 Theoretical framework

The main aspects of the model were presented in the previous chapter (See section 1.2 and 1.6.1). The innovation here is the inclusion of intermediate inputs and the Supplier Access. We start by presenting again the Price Index for region j , this time with a subscript s to reflect the industry:

$$P_{js} \equiv \left[\sum_r n_{is} (p_{is} \tau_{ijs})^{1-\sigma} \right]^{1/1-\sigma}. \quad (2.1)$$

As for production costs, we assume that firms use labor and intermediate goods as inputs, and incur a fixed cost. More precisely, in industry s , intermediate inputs consist in a composite of goods from all industries where ϖ_{rs} is the share of expense devoted to inputs from industry r , and, for each industry s , $\sum_r \varpi_{rs} = 1$. The total price index of

intermediate inputs is equal to $\prod_r P_{ir}^{\varpi_{rs}}$.⁶ “Supplier access” of a firm in region i and sector s , SA_{is} , is defined as the price index of intermediate inputs, raised to the power $1 - \sigma$, as in:

$$SA \equiv \prod_r (P_{ir}^{1-\sigma})^{\varpi_{rs}}. \quad (2.2)$$

It is worth noting that in this chapter we adopt a more precise definition of supplier access than the one provided in the NEG literature, by computing supplier access separately for each industry, and taking into account the inter-industry linkages. This procedure helps to disentangle supplier from market access.

Given the definition of supplier access, total costs of a firm in region i and industry s may be represented by $SA^{\alpha/(1-\sigma)} w_{is}^\beta (f_s + \sum_j x_{ijs})$, where α and β are parameters, f_s indicates the fixed cost in industry s , and w_{is} is wage in region i and industry s .⁷ Supplier access is a measure of the firm’s access to intermediate inputs, and it is negatively related to trade costs. The larger the supplier access, the smaller the cost of intermediate inputs.

In maximizing profits, prices are set as a constant mark-up over marginal cost. Profits, then, can be shown to be given by:

$$\Pi_{is} = \frac{1}{\sigma} \left(SA_{is}^{\alpha/(1-\sigma)} w_{is}^\beta \right)^{1-\sigma} MA_{is} - f_s SA_{is}^{\alpha/(1-\sigma)} w_{is}^\beta, \quad (2.3)$$

where MA_{is} is the “market access”, or “real market potential”:

$$MA_{is} \equiv \sum_j \left(\frac{\tau_{ijs}^{1-\sigma} E_{js}}{P_{js}^{1-\sigma}} \right) \quad (2.4)$$

Market access will be larger when trade costs are smaller and real expenditure of the importing region is larger. The larger the market access, the larger the potential demand for the region’s products in industry s .

We are able to relate regional wages to market and supplier access (hereafter, MA and

⁶This specification of the price index of intermediate inputs may be derived from a Cobb-Douglas production function, using input from all other industries.

⁷We assume that labor migration across regions is not sufficiently high to arbitrage away all regional wage disparities. The topic of Chapter 3 is the impact of market access on migration in Brazil.

SA, respectively). With free entry, profits must be zero in equilibrium. Given the profit function in equation (2.3), this equilibrium condition yields:

$$w_{is} = \left(\frac{MA_{is}}{\sigma f_s} \right)^{\frac{1}{\beta\sigma}} SA_{is}^{\frac{\alpha}{\beta(\sigma-1)}} \quad (2.5)$$

Hence, wages are higher in regions with higher MA, that is, with low trade costs to importing regions with high spending. Also, wages are higher in regions with higher SA, that is, where inputs can be bought at low prices due to low transport costs to suppliers.

2.2.2 Empirical strategy

Our empirical implementation of the theoretical framework described above involves a three step strategy in a cross section analysis for 1999.⁸ Firstly, wages are regressed on worker characteristics, including state-industry fixed effects. The wage premium captured by these fixed effects is the variable to be explained by market and supplier access. Secondly, in keeping with the new economic geography literature, we estimate gravity equations in order to calculate market and supplier access for each state and industry pair. Finally, market and supplier access derived in the second step are used as explanatory variables for wage disparities captured by state-industry fixed effects from the first step.⁹ We explain each step in turn.

First step

While the theoretical framework described in the previous subsections treats labor as a homogeneous factor of production, we know that it is not the case. There is an extensive literature explaining wage differences across individuals through their characteristics, such as educational attainment, experience in years, gender, marital status, among many other variables. For Brazil, in particular, the seminal work by Langoni (1973) presents evidence of the importance of worker heterogeneity in income inequality. If patterns of diversity

⁸We limit our analysis to 1999 due to the lack of intra national trade data for other periods in Brazil, as explained in section 2.3.

⁹We thank an anonymous referee for suggesting an empirical procedure where fixed effects from the wage equation are regressed on market and supplier access.

among individuals in the labor force were similar across regions, we could still explain average regional wages by regional market and supplier access differences, as proposed in equation (2.5). Previous empirical work, however, has identified substantial differences in the composition of the labor force across Brazilian regions, especially with respect to educational attainment (see Duarte et al., 2006). Thus, our results would be biased if we did not to control for individual characteristics and sorting across regions and sectors. The first step of our empirical study consists in estimating the following equation:

$$\log w_{k,is} = \lambda_1 age_{k,is} + \lambda_2 age_{k,is}^2 + \sum_{m=1}^9 \mu_m ed_{k,is}^m + \omega_{is} + \xi_{k,is}, \quad (2.6)$$

where $w_{k,ri}$ is the wage of a male¹⁰ worker k working in industry s , of region i , $age_{k,is}$ is the worker's age, $ed_{k,is}^m$ is a dummy variable for each of the 9 educational levels (see Appendix), and ω_{is} are dummy variables for each state-industry pair.¹¹

State-industry fixed effects capture wage disparities that are not explained by worker characteristics, and that is the variable that will be used to be explained through state-industry market and supplier access.

Second step

The second step consists in estimating MA and SA in the same way as in the Chapter 1 (See Section 1.3.1 for details). Total sales are used to derive a gravity equation as follows:

$$\log T_{ijs} = FX_{is} + \sum_g \delta_{gs} TC_{g,ij} + FM_{js} + \varepsilon_{ijs}, \quad (2.7)$$

where T_{ijs} stands for exports from region i to region j in industry s , FX_{is} and FM_{is} are respectively exporting and importing region fixed effects, and ε_{ijs} is an error term. A region may be defined as either a Brazilian state or one of the 210 countries in our dataset. Trade costs will be captured by a set of variables, $TC_{g,ij}$, such as the distance between the

¹⁰In keeping with most of the labor literature, we focus on male workers between the ages of 25 and 65, because the wage dynamics and labor supply of the female work force are often affected by non-economic factors, such as fertility decisions.

¹¹In section 2.5.4, on robustness checks, this equation will be estimated adding in productivity as explanatory variable. In that case, the regression will incorporate the firm dimension.

regions (in log), whether they share borders, a language, or whether they have a colonial link.¹²

In order to render our results comparable to those in the literature, we have also estimated equation (2.7) for aggregate trade flows, instead of disaggregating by industry. In this way we can compute MA and SA measures comparable to the ones in Redding and Venables (2004), Knaap (2006), Head and Mayer (2006) and Hering and Poncet (2009).

We would like to note that an estimation based on gravity regressions has the advantage of using information related to the economic mechanism that our theoretical model intends to stress, namely, spatial interactions arising from trade. We would thus be less prone to capture other effects of proximity, such as technological or urban externalities. Nevertheless, we will perform several robustness checks to investigate a potential correlation between the trade channel and other covariates and competing explanations.

Despite their empirical success in explaining trade flows, gravity equations have an important caveat: they treat the size of regions as exogenous (Knaap, 2006). We acknowledge this limitation in explaining the long-term evolution of a country's economic geography, and we see our work as an effort to uncover the impact of market access on wages, taking the spatial distribution of economic activity as given.

From equation (2.4), the estimated coefficients in equation (2.7) can be used to compute market access as in:

$$\hat{M}A_{is} \equiv \sum_j \left[(\exp FM_{js}) \prod_g (\exp TC_{g,ijs})^{\delta_{gs}} \right]. \quad (2.8)$$

We have, then, a market access measure for each industry separately, in each Brazilian state.

As for the SA, defined in equation (2.2), its estimated value is computed in a similar fashion, but using the coefficient from the exporting region dummy variables. To account

¹²It is possible to choose a number of alternative sets of variables, but changing specifications of the gravity equation yields little change in results of the final-step. Similar results are obtained for example, whether we introduce a dummy for pairs of countries that belong to Mercosur, whether we introduce distances by road (for intra-national trade only) instead of physical distance, or whether we estimate differentiated distance coefficients for intra versus international trade. Finally, in Paillacar (2006) I show that Gamma PML yields similar results to OLS in a similar specification.

for vertical linkages across industries, we use coefficients from the input-output matrix, $\hat{\omega}_{rs}$, to weigh the impact of each industry in supply access. We, then, compute:

$$\hat{S}A_{is} \equiv \prod_r \left\{ \sum_j \left[(\exp FX_{ir}) \prod_g (\exp TC_{g,ijr})^{\delta_{gr}} \right] \right\}^{\hat{\omega}_{rs}} \quad (2.9)$$

which yields a SA measure for each industry in each Brazilian state.

This study is the first to weigh industry supplier access through an input-output matrix in the structural approach proposed by Redding and Venables (2004). Amiti and Cameron (2007) also take into account industry vertical linkages in a study for Indonesia, but with a somewhat different empirical strategy. In their computation of SA, they use the shares of GDP by industry for each Indonesian district instead of exporter fixed effects derived from gravity equations.

Third step

Lastly, the MA and SA estimated in the second step are used to explain wage differences across states and industries. The equation for wages (2.5) can be written as:

$$\log w_{is} = -\frac{1}{\beta\sigma} \log(\sigma f_s) + \frac{1}{\beta\sigma} \log MA_{is} + \frac{\alpha}{\beta(\sigma - 1)} \log SA_{is}. \quad (2.10)$$

As previously discussed in the beginning of this section, differences in human capital allocation across regions may distort the impact of market and supplier access on regional wages, and previous empirical studies suggest this to be a relevant issue for Brazil. Therefore, instead of adopting wages as a dependent variable, we use the state-industry fixed effects estimated in equation (2.6). They stand for the wage differentials across states and industries that are not explained by age and education, thus controlled for composition of labor force with respect to these variables. We estimate the equation as follows:

$$\hat{\omega}_{is} = \theta_0 + \theta_1 \log \hat{M}A_{is} + \theta_2 \log \hat{S}A_{is} + \theta_3 D_s + \zeta_{is} \quad (2.11)$$

where D_s represents industry dummies, $\hat{\omega}_{is}$ are the state-industry fixed effects estimated

in the wage regression (2.6), and ζ_{is} is an error term.¹³

Two issues arise from the use of estimated values for the variables in the NEG wage equation. Firstly, regarding the use of estimated wage premia, the error term ζ_{is} in the NEG equation will contain part of the variance of the error term from the wage premium estimation (equation (2.6)), which can generate heteroscedasticity. This has led some researchers to use weighted least squares (WLS), using as weights the inverse of the standard error of the wage premium estimates from the first stage (see, for example, Pavcnik et al., 2004). Nevertheless, Monte Carlo experiments by Lewis and Linzer (2005) suggest that WLS can only surpass White standard error estimates in efficiency when a very high proportion (80% or more) of the residual in the final regression results from errors in the dependent variable estimation. Moreover, they found that WLS can actually produce biased standard error estimates if the contribution of the error term in the first stage is low. In our case, we have a very high number of individual observations, yielding very precise estimations of the wage premium. Consequently, we chose to report regressions with robust standard errors.

Secondly, the use of MA and SA estimates from trade equations as independent variables implies that trade equation residuals also affect ζ_{is} . As Head and Mayer (2006) point out, this invalidates standard errors, but it has no impact on the estimated coefficient. In this case, several researchers (Redding and Venables, 2004; Hering and Poncet, 2009) have implemented bootstrap to obtain unbiased confidence intervals in order to make inferences. We, therefore, have also computed bootstrapped standard errors.

Furthermore, there are additional potential problems with the estimation of equation (2.11) related to the simultaneous impact of other variables on both wage differentials and MA, or the possibility of endogeneity of MA. We discuss and deal with these issues in section 2.5, where we perform several robustness checks.

¹³Combes et al. (2008) employ similar methodology, but they estimate location and industry fixed effects separately, due to computational problems and insufficient data (they have 341 locations and 99 industries, see p. 727, Footnote 7). Our aggregation level, with 27 Brazilian States and 22 industries, precludes such problems. The only exception being in section 2.5.5, where we adopt municipalities and not states as regional units. For 3439 municipalities (instead of 27 Brazilian States), we only consider the spatial dimension.

2.3 Data

In this study we use three sets of data: on individual characteristics, trade flows and country characteristics. We perform a cross sectional analysis for 1999, since intra-national trade data by industry for Brazil is only available for that year (Vasconcelos and Oliveira, 2006).

Individual characteristics are drawn from the RAIS database (*Relação Anual das Informações Sociais* issued by the Brazilian Labor Ministry) that covers all workers in the formal sector.¹⁴ We focus on the manufacturing sector for compatibility with the trade data. When more than one job is recorded for the same individual, we select the highest paying one.¹⁵ The database provides several individual characteristics (wages, educational level, age, gender, etc.), as well as worker and firm identification numbers which allows us to match the RAIS database with the manufacturing survey.

The manufacturing survey, PIA (*Pesquisa Industrial Anual* from IBGE, *Instituto Brasileiro de Geografia e Estatística*), includes all firms with thirty employees or more from 1996 to 2003, covering the majority of the workforce in the manufacturing sector. This dataset provides a large range of variables on production, which includes sales, labor, materials, energy and investments, which allows for measuring productivity (see Appendix). We complete the PIA with IBRE-FGV (*Instituto Brasileiro de Economia - Fundação Getulio Vargas*) balance sheet data from 1995, from which we draw initial fixed capital, and with patent data from INPI (*Instituto Nacional da Propriedade Industrial*). All datasets can be matched thanks to firm identification numbers.¹⁶

In order to estimate the gravity equation we need three sets of trade data: (1) trade data among Brazilian states, which is drawn from Vasconcelos and Oliveira (2006) who processed value-added tax information provided by the National Council of Financial Policy (CON-

¹⁴Because of the very large number of observations, we ran our regressions on random samples of 500,000 or 800,000 employees (out of 2,786,852 employees in the full sample). Changing the size of the sample does not affect our coefficients nor does it particularly affect the estimation of state-industry fixed effects. Table 2.10 in the Appendix provides summary statistics of individual characteristics.

¹⁵For example, a worker may change occupation or place of work over time, or may even hold two recorded jobs at the same time. To assess the robustness of our results, we alternatively chose the average wage, the total wage, in December or over the year, and the choice did not affect the results.

¹⁶Note that firm-level data is employed exclusively to compute the productivity measure used in one of the robustness checks in section 2.5.4. Otherwise, we use worker- industry-level data.

FAZ, *Conselho Nacional de Política Fazendária*) from the Ministry of Finance (*Ministerio da Fazenda*); (2) trade data between Brazilian states and foreign countries, from *Secretaria de Comércio Exterior* (SECEX), Ministry of Trade;¹⁷ and (3) among foreign economies, from BACI: *Base pour l'Analyse du Commerce International*, CEPII. Moreover, using total sales by region and industry from the PIA database allows us to compute internal flows within state by subtracting intra and international exports. These sets of data provide a complete and consistent picture of all trade flows, defined at the 2 digit ISIC Revision 3 level (which corresponds to the Brazilian CNAE 2 digit industry classification).

We complete the trade and individual information with additional data on geography, infrastructure and regulations. Distances, colonial links, languages, coordinates, GDP, areas and demographic densities are provided by CEPII (*Centre d'Etudes Prospectives et d'Informations Internationales*) and IBGE. The distance between states is measured in geodesic distance between their respective capitals (computed in km using the coordinates).

We construct a dummy for international border that equals zero if both the origin and the destination of the trade are within the same country, and it equals 1 otherwise. Analogously, the dummy for internal border equals zero if the trade is within one Brazilian state, and it equals 1 otherwise. In addition, we construct a dummy for international contiguity that equals 1 if the dummy for international border equals 1 and if both countries (or the country and the Brazilian state) share a border. Analogously, the dummy for internal contiguity equals 1 when both Brazilian states share a border. The dummy for language equals one if the trade is between two different countries (that is, the international border dummy equals 1) and they share the same language (more precisely, if the official language is the same or if the same language is used by at least 20% of the population). Lastly, the colonial link dummy equals 1 if the trade is between two different countries and one of them has been colonized by the other in the past.

The Census 2000 (IBGE) provides us data on migration rates per municipality. The input-output matrix is constructed by OECD and IBGE, across ISIC Rev3 2-digit industries. The cost of starting a business has been measured by the World Bank for 13 Brazilian

¹⁷International trade data by Brazilian state is available since 1992. In Chapter 2, this information is used to build a panel of market access

states (Doing Business database). An index of tax pressure across Brazilian states is constructed using the PIA data. The data on harvested agricultural area in 1996 is from the Agricultural Census. The *Anuário Mineral Brasileiro* 1999 (table 8 page 51) was our source for regional shares of mineral production. Municipality data on natural endowments is from Timmins (2006).

2.4 Results

We organize the results in five subsections. We start, in subsection 2.4.1, by presenting the results of the first and second steps of our empirical procedure, that is, the estimation of the state-industry wage differentials and of the market and supplier access through gravity equations. Subsection 2.4.2 presents the results of the regressions of MA and wage differentials, while 2.4.3 incorporates SA to the analysis.

2.4.1 Preliminary regressions

First step: wage premium

The first step of the empirical procedure consists of estimating wage differentials across states and industries that are not driven by individual characteristics. We regress wages on education attainment, experience, and on state-industry fixed effects, as described in equation (2.6). We use individual data for male workers between the ages of 25 and 65. This group of workers was chosen to render the sample more homogeneous, thus eliminating possible effects from differences in variables such as early school dropouts and female participation. We measured education by dummy variables for nine levels of education (as described in the Appendix). Age and age squared are used as proxies for experience. Table 2.1 presents the results.

We should note that the R-squared (adjusted or not) is very high. If worker characteristics are excluded, state-industry dummies explain 83.1% of wage variance (not shown in the table). However, if state-industry dummies are excluded, still 34.1% of the variance is

explained by worker characteristics, suggesting that the explaining power of state-industry dummies is partly due to differences in labor force composition.

Table 2.1: Wages and individual characteristics

Dependent variable:	Wages
	(1)
Age	0.072 ^a (0.001)
Age squared / 100	-0.072 ^a (0.001)
Education (level 5 = 0):	
level 1	-0.365 ^a (0.005)
level 2	-0.239 ^a (0.003)
level 3	-0.149 ^a (0.002)
level 4	-0.075 ^a (0.002)
level 6	0.156 ^a (0.003)
level 7	0.419 ^a (0.002)
level 8	0.852 ^a (0.004)
level 9	1.240 ^a (0.003)
State x Industry FE	yes
R-squared	0.880
Observations	798494

Notes: OLS regressions with robust standard errors.
^a represents statistical significance at the 1% level.

Second step: market and supplier access

In order to compute estimated values of market and supplier access, we start by estimating the gravity equation (2.7), where bilateral trade flows are explained by exporter and importer fixed effects, and a set of variables capturing trade costs. We define each

Brazilian state as a region, and follow two procedures. In the first one, we take coefficients to be the same for all industries, in keeping with the literature, and use them to compute aggregate measures of MA and SA. In the second procedure a regression is run separately for each industry, estimating, thus, different coefficients for each of them. We are thereby able to compute market and supplier access measures for each state-industry pair.

The first column of Table 2.2 presents regression coefficients using aggregate trade flows, with the corresponding standard errors in the second column. The next three columns of the table shows some summary statistics for the 22 regressions by industry: average values of the estimated coefficient across industries (third column), average values of the standard errors of each regression in parentheses beneath each coefficient (fourth column), and the standard deviation of the 22 coefficients in square brackets (fifth column). Standard deviations of the coefficients are generally larger than average standard errors which indicate notable differences in transport costs coefficients across industries.

With estimated coefficients from equation (2.7) (presented in Table 2.2), we used equation (2.8) and (2.9) to compute estimated values for MA and SA, respectively, for each state-industry pair. Note that, when calculating MA, we sum over all states and countries with which a particular state trades. It is then possible to construct a market access measure from a subgroup of trade partners, and that is exactly what we do to investigate the varying impact of local, national and international market access.

Before proceeding to the estimation of the NEG wage equation, it is worth visualizing the relation between wages and MA estimated in steps 1 and 2. In Figure 2.1, four maps of Brazil show the spatial distribution of wages and MA. Values are normalized as deviations from the mean across regions, and they are grouped in five classes. The middle group falls between the mean ± 0.5 standard deviations, and the subsequent groups are delimited by 1 standard deviation.

Panel (a) presents regional wages *after controlling for individual characteristics*. It is clear that, even after skill sorting is taken into account, there are still substantial spatial differentials in wages across states, São Paulo being the region that offers the highest wages, followed by nearby states (Rio de Janeiro, Paraná, Minas Gerais, among others).

Table 2.2: Gravity equations

Dependent variable:	Aggregated trade flows		Trade flows by industry		
	Coefficient	Standard error	Average of coefficients	Average of std. errors	Std. deviation of coefficients
Physical distance	-1.448 ^a	(0.018)	-1.359	(0.031)	[0.180]
International border	-4.326 ^a	(0.116)	-4.534	(0.563)	[0.983]
International contiguity	1.001 ^a	(0.095)	0.785	(0.249)	[0.184]
Internal border	-2.594 ^a	(0.386)	-3.212	(0.224)	[0.968]
Internal contiguity	0.128	(0.225)	0.205	(0.118)	[0.469]
Language	0.839 ^a	(0.043)	0.604	(0.071)	[0.263]
Colonial link	0.832 ^a	(0.100)	0.903	(0.115)	[0.140]
Exporter FE	yes		yes		
Importer FE	yes		yes		
Industries			22 regressions		
R-squared	0.982				
Observations	25315		total: 246833		

Notes: OLS regressions with robust standard errors. Dependent variable: trade flows (aggregated or by industry). ^a represents statistical significance at the 1% level.

Interestingly, the State of Amazonas, a landlocked region in the more sparsely populated north, also shows high wages. We expect these differentials to reflect exogenous regional characteristics, such as amenities and the availability of natural resources, as well as spatial externalities, such as knowledge spillovers and market access, among others.

Panel (b) displays the total MA across regions. If we look at Figure 2.1, we are given the impression that MA and regional wages are indeed related. São Paulo is the state with largest MA (followed by Rio de Janeiro), which is compatible with the fact that wages are the highest in that state. For Amazonas, though, its MA is not differentiated from that of the rest of the North region. A more precise understanding of the factors at work is obtained by decomposing MA into its national and international scopes.

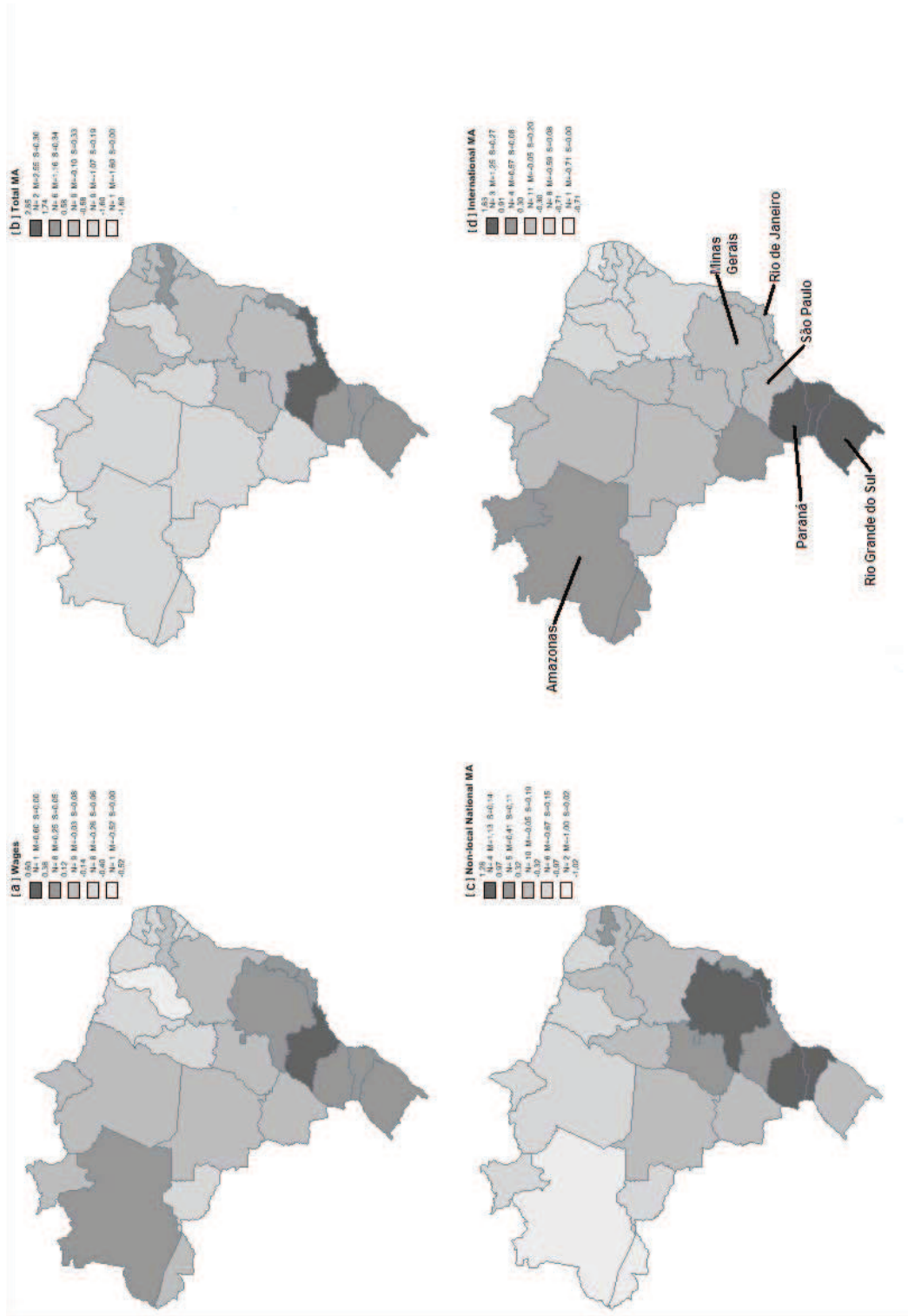


Figure 2.1: Market access and wages across Brazilian states

In Panel (c) we highlight the role of inter-regional trade, by excluding international and local (i.e., own state) MA. As expected, the states neighboring São Paulo exhibit highest non-local national MA, while the value for São Paulo itself is smaller. More interestingly, this exercise shows that Amazonas and Rio Grande do Sul (the southern region closest to Argentina) are remote from the main sources of demand within the country.

Panel (d) completes the picture by considering only international MA. We see that in these two regions the international component of market access seems to explain their high wages. Rio Grande do Sul is close to Buenos Aires, the other important economic center of MERCOSUR (besides São Paulo). Similarly, the state of Amazonas is close to medially developed countries in South America (Colombia and Venezuela), and NAFTA members.¹⁸

2.4.2 Wages and market access

The empirical strategy we propose for the estimation of the impact of MA on wage differentials departs from Redding and Venables (2004) in basically two aspects: we control for individual characteristics and we use industry-level data. We introduce each of them in turn.

Firstly, using aggregate data, we control for individual characteristics. In the first step of the empirical procedure we use individual characteristics and state fixed effects to explain individual wages, in the aggregate version of equation (2.6). These fixed effects are used as dependent variables in the estimation of equation (2.11), where the aggregate MA is obtained from the use of aggregate trade flows in the gravity equation (2.7). As shown in the results presented in the first column of Table 2.3, wage differentials are positively and significantly correlated with MA. The coefficient for MA is approximately 0.08, which is lower than the coefficients found by Redding and Venables (2004). Since they do not control wages for individual variables as we do, their larger estimated coefficient may be capturing different composition patterns of the labor force across countries. Our coefficient

¹⁸One may wonder whether this high market access for Amazonas is just an artifact of the data, since Brazilian trade with Colombia and Venezuela is not very high. Actually, exports to Colombia and Venezuela represent 20% of total exports from Amazonas, while this ratio is only 2.4% for Brazil as a whole. Moreover, Amazonas exports a higher proportion of its production compared to the rest of Brazil.

is closer to the one found by Hering and Poncet (2009), who also control for individual characteristics in a study of Chinese regions.

Secondly, in the results presented in the second column of the table we use industry-level data, but we do not control for individual characteristics. Instead of running the first step of the empirical procedure, we simply use average state-industry wages as dependent variable in the estimation of equation (2.11). The coefficient for MA is estimated with higher precision, probably due to the use of more disaggregate data. Its estimated value, 0.17, is significantly larger than the one in the previous regression, where we control for individual characteristics. This higher coefficient may be capturing part of the impact of spatial sorting of human capital.

Finally, column 3 presents our baseline regression, where we simultaneously control for workers characteristics and use industry-level data. Wage differentials captured by state-industry fixed effects in the first step of our empirical procedure are regressed on MA, as calculated in the second step.¹⁹ The estimated coefficient for MA in this regression is 0.14, which is smaller than the one from the previous regression, without controlling for individual attributes. This difference may be explained by the impact of spatial sorting of human capital.

Despite being larger than the one estimated in column (1), the MA coefficient in our baseline regression is still smaller than the one estimated in Redding and Venables (2004). It is closer to the MA coefficient found for European regions in Head and Mayer (2006), who also control for education.

In this baseline regression, 35% of wage disparities across regions and industries is explained by MA and industry dummies. If we employ industry dummies exclusively, instead of MA, only 17.5% of wages differentials are explained (regression not reported): The explanatory power of the regression increases substantially with the inclusion of MA.

We use separate measures of MA to analyze the different impacts of local, national

¹⁹Since the predicted values for market access and wage premiums are generated from prior regressions, we checked our results for sensibility to bootstrap techniques. Results remained unchanged and bootstrapped standard errors were slightly lower than robust standard errors reported in the tables. Redding and Venables (2004), De Sousa and Poncet (2007) and Hering and Poncet (2009) also found bootstrapped standard errors that were close to the non-bootstrapped estimation.

Table 2.3: Response of wage premium to market access

Dependent var:	Wage premium					
	(1)	(2)	(3)	(4)	(5)	(6)
Measure of MA:	Total MA (aggregate)	Total MA	Total MA (baseline)	Components of MA:		
				Non-local	National	International
Market Access	0.079 ^a (0.02)	0.168 ^a (0.013)	0.140 ^a (0.012)	0.185 ^a (0.022)	0.162 ^a (0.021)	0.228 ^a (0.018)
Controlling for skills in 1st step	yes	no	yes	yes	yes	yes
By industry	no	yes	yes	yes	yes	yes
Industry FE	no	yes	yes	yes	yes	yes
R-squared	0.275	0.432	0.350	0.255	0.248	0.294
Observations	27	540	540	540	540	540

Notes: OLS regressions with standard errors robust to heteroscedasticity and industry fixed effects (except column 1). Dependent variable: wage premium (see section 2.2.2, fixed effects from the regression of individual wages on individual characteristics) Regressor: market access (see section 2.2.2, calculated from a gravity equation on intranational and international trade flows); “non local”: excluding own state; “national”: excluding foreign and local markets; “international”: foreign countries with a common frontier with Brazil. ^a represents statistical significance at the 1% level.

and international MA. When we drop local market access and consider access to other Brazilian states and other countries exclusively (results in column 4), we still find a large and significant coefficient. In fact, the coefficient is even larger than the one in the third column, which also includes local market access, but the difference is not statistically significant.

Columns 5 and 6 present the results when considering only national market access (excluding local) and when considering only international market access, respectively. It is worth noting that the international market access alone yields the highest impact on wages and its coefficient is estimated with the highest precision when compared to the other sub groupings of market access. The R-square of the regression with international market access is also higher when compared to the other sub groupings, although it is still smaller than total market access (column 3).

This interesting result may be explained by the trade liberalization that took place in the early 1990’s. Trade barriers were lowered during the first half of that decade, and

it may have had differential impacts over the country precisely due to the differences in international MA across the regions. The impact of trade liberalization would be larger in regions with larger international MA. It is possible that in the late 1990's, our period of study, labor mobility across regions had not yet been sufficient to arbitrage the differential impact on wages of the opening to trade. In a study of the Mexican trade liberalization, Chiquiar (2008) shows that after the second stage of trade liberalization, "regions with a larger exposure to international markets exhibited a relative increase in wage level". We may be capturing a similar pattern for Brazil.

2.4.3 Market access and supplier access

So far we have studied the impact of MA on wages. As discussed in section 2.2.1, MA captures how close a firm in a given region is to consumers, whereas SA establishes the proximity to suppliers of intermediate goods. While MA has a positive impact on wages due to the effect of demand, SA's impact on wages is associated to lower costs and higher productivity.

A common problem with MA and SA measures is that they tend to be strongly correlated. To address this issue, Redding and Venables (2004) incorporate additional assumptions on the link between MA and SA. In our procedure however, this problem is mitigated, without having to resort to supplementary restrictions. By calculating MA and SA for each industry as we do, market and supplier access are less likely to be correlated. Take for instance, a hypothetical industry N, whose output is consumed by all consumers or by all industries in general, while its inputs come from one particular industry Y. In this case there would be high supply access associated to regions with high production in industry Y, while its MA level would be independent of the production composition of the importing region. In practice, we found a high partial correlation between MA and SA (0.76), although lower than the correlation reported by Redding and Venables (0.88). Still, the correlation is apparently sufficiently low so as to allow for the inclusion of both variables in a single regression, without experiencing multicollinearity problems.

We apply the same three-step procedure adopted for the MA regressions. In the first step

we regress wages on individual characteristics and on state-industry dummies. Secondly, we compute the SA measure following equation (2.9), as described in section 2.2.2. Lastly, we use SA as an explanatory variable of the state-industry wage disparities estimated in the first step. The results are presented in Table 2.4.²⁰

Table 2.4: Market access and supplier access

Dependent variable:	Wage premium				
	(1)	(2)	(3)	(4)	(5)
Supplier Access	0.140 ^a (0.010)		0.066 ^a (0.017)		
Non local SA		0.193 ^a (0.023)		-0.019 (0.078)	
SA (excl. own ind)					0.040 ^b (0.017)
Market Access			0.108 ^a (0.021)		0.135 ^a (0.019)
Non local MA				0.238 ^a (0.079)	
Industry FE	yes	yes	yes	yes	yes
controlling for skills	yes	yes	yes	yes	yes
R-squared	0.347	0.222	0.384	0.241	0.382
Observations	441	441	441	441	441

Notes: OLS regressions with robust standard errors and industry fixed effects. Regressors: supplier and market access (see section 2.2.2, calculated from a gravity equation on intranational and international trade flows); “non local”: excluding own state; “excl. own ind”: supplier access excluding own industry in the input-output matrix. ^a and ^b represent respectively statistical significance at the 1% and 5% levels.

The first column of Table 2.4 is equivalent to the baseline regression for MA in the third column of Table 2.3, but using SA instead of MA as explanatory variable. It is interesting to note that the estimated coefficient for SA has the same value as the one found for MA. We obtain a similar coefficient using only non-local SA, as shown in the second column. This could be a sign that our MA and SA measures are actually correlated, so that both variables are capturing the same effect.

²⁰Since we need exporter fixed effects for industry inputs, we cannot compute SA for industries using non-industrial inputs. Therefore, regressions in Table 2.4 exclude Food and Beverages, Tobacco, Wood and Fuel Refinement.

In order to investigate whether these two measures impact regional wages independently, we include both simultaneously as explanatory variables of wage differentials. The results presented in the third column show that both variables have a positive and significant impact on wages, with a larger coefficient for MA. Furthermore, beta estimates of 0.242 for SA and of 0.467 for MA indicate that MA is more important than SA in explaining wage differentials across states and industries in Brazil. In the regression presented in the fourth column we use non-local MA and SA, and in this case only MA has a positive and significant coefficient. Note the high standard deviations, indicating that co-linearity problems may be more important for the non-local market and supplier access than for local ones.

One concern with the SA measure is that it may be correlated to its own industry characteristics, such as productivity. To account for this possibility, we compute a SA measure that excludes its own industry, that is, we set to zero the input-output matrix coefficient for own industry and normalize the other coefficients so as to obtain a sum equal to one. When this proxy is used in the place of SA (results in the fifth column), we still find positive and significant coefficients for SA and MA. Moreover, the difference between them is larger compared to the results from the third column, using the original SA measure.²¹

2.5 Robustness checks

2.5.1 Instruments for market access

There may be some concern about the endogeneity of market access. Wages might positively affect individual demand for goods, thus increasing the index of market access. Similarly, a productivity shock in a region would affect both wages and the market access index if productivity also impacts the demand for goods. If we consider “non local” market access constructed through excluding the demand from its own market, as we have already done

²¹We also employed this measure as instrument for the SA, finding similar results. Coefficients for MA and SA are respectively, 0.124 and 0.049. MA is significant at 1%, while SA is significant at 5%.

in column (4) of Table 2.3, such biases are mitigated. In this section, we instrument the MA index by geographical and demographic variables that should impact market access but not directly affect the wage differentials across regions.

We propose two alternative instruments.²² Firstly, we consider a ‘‘Harris Market Potential’’ (HMP, sum of other regions’ GDP divided by the distance) constructed using GDP by states in 1939:

$$HMP_i = \sum_j GDP_j / Dist_{ij} \quad (2.12)$$

This variable was first used in NEG empirical studies of the new economic geography literature by Hanson (2005), in his working paper version of 1998. Using HMP in 1939 as an instrument relies on the assumption that wages in 1939 are only indirectly related to current wages (which is a reasonable assumption given technological innovation). As shown in the first row of Table 2.5,²³ this instrument yields a significant and strong coefficient for MA, which is nevertheless smaller than in the baseline OLS specification. We also consider a second instrument, which employs population size (in 1940) instead of GDP in equation (2.12). It provides similar results to the HMP (result not reported here).

We also instrument market access by average registration dates of municipalities in the region²⁴ (second row of Table 2.5), and we still obtain a similar coefficient for MA. If we use both HMP and the average registration date as instruments, to test for over-identification, the Hansen J-test may not be rejected (as the P-value equals 0.229) and the coefficient remains unchanged.

²²We also tried the distance to the main economic centers as instruments, as proposed by Redding and Venables (2004). In particular, we estimated regressions using the distance to São Paulo and the distance to Buenos Aires as instruments of national and international MA, respectively. Although the coefficients for MA in the wage equations support our results (0.20 for national MA, 0.32 for international MA, both highly significant), we share the concerns raised by Head and Mayer (2006): Economic centers may be themselves endogenous. More specifically, the distance to São Paulo may capture effects that are not related to MA, such as the proximity to firm headquarters, and therefore managerial power, which may have a positive impact on wages. Regressions are available on request and in a previous working paper (Fally et al., 2008).

²³First stage regressions corresponding to Table 2.5 are reported in the Appendix.

²⁴We thank an anonymous referee for suggesting this instrument.

Table 2.5: Response of wage premium to market access, instrumented

Market access variable	Instrument	Estimated coefficient	Robust std. error	Hansen J-test	Number of obs.
MA	HMP in 1939	0.145 ^a	(0.015)		540
MA	av. date of registration	0.119 ^a	(0.024)		540
MA	HMP and date of registration	0.144 ^a	(0.014)	0.229	540

Notes: 2SLS regressions with standard errors robust to heteroscedasticity and industry fixed effects. Wage premium regressed on Market Access. Instruments: HMP: Harris Market Potential = $\sum(\text{GDP}/\text{distance})$ in 1939; average date of registration of municipalities within the state. ^a represents statistical significance at the 1% level.

2.5.2 Differences across skills

One of the underlying assumptions of our methodology is that returns to education are constant across states, that is, they are independent of MA. This assumption allows us to control for education in the first step independently of the final step regression. Theoretical articles have shown however, that MA may affect the skill premium and returns to education (see for example Redding and Schott, 2003): On the one hand, skilled workers are more mobile; on the other hand, the concentration of activity may particularly increase the productivity of skilled workers through either increasing returns to scale or pervasive input-output linkages in skill-intensive sectors. The results in the first two columns of Table 2.6, however, indicate that this link is not relevant in the Brazilian case: the observed correlation between wages and MA does not seem to vary significantly across educational levels.

In column (1), where the wage premium is constructed only from data on skilled workers (workers who completed high school or higher), the coefficient for MA is higher but not statistically different from the coefficient of the third column in Table 2.3 (same specification for all workers). In column (2), the wage premium is constructed using data on unskilled workers only (workers who have not completed high school), and the coefficient obtained for MA is close to the baseline regression in Table 2.3. Hence, the impact of market access on wages seems stronger on skilled workers, but the difference is not significant.²⁵ In other

²⁵Alternatively, we have also directly regressed the skill premium on MA (results not reported). The coefficient has the expected sign but it is not significant.

words, returns to education are not strongly correlated with market access, which validates our methodology in the first step.

When we consider only international MA, we obtain different and very interesting results. The coefficient for international MA on wage differences across state-industry is significantly larger among unskilled than skilled workers (results in columns 3 and 4 of Table 2.6). This result means that higher international MA increases relatively more the wages of unskilled workers. Given that our study corresponds to a period of just a few years after a massive trade liberalization program, this result could actually be a sign that the Stolper-Samuelson mechanism is at work. According to this mechanism, trade liberalization in Brazil, a country where unskilled labor is relatively abundant,²⁶ should increase relative returns to that factor of production. When viewed through the perspective of economic geography, such an impact would not be homogeneous across the country: it would be larger in regions with higher international MA. This interpretation is in line with the findings of Gonzaga et al. (2006) that present evidence for Brazil of relative wage changes compatible with Stolper-Samuelson predictions.

Table 2.6: Wage premium to market access - skilled versus unskilled workers

Dependent variable:	Wage premium			
	(1) Skilled	(2) Unskilled	(3) Skilled	(4) Unskilled
Market Access	0.160 ^a (0.014)	0.134 ^a (0.011)		
International MA			0.196 ^a (0.023)	0.229 ^a (0.017)
Industry FE	yes	yes	yes	yes
R-squared	0,373	0,387	0,278	0,344
Observations	504	532	504	532

Notes: OLS regressions with standard errors robust to heteroscedasticity and industry fixed effects. Skilled workers: educational level above high school. ^a represents statistical significance at the 1% level.

²⁶Muriel and Terra (2009) present evidence that Brazil is relatively abundant in unskilled labor.

2.5.3 Controlling for additional covariates across states

Endowments are unequally distributed across Brazilian states and play an important role in explaining wage differentials. In addition, endowments may be correlated with market access, thus biasing our coefficient. Notice that in section 2.4.3, the correlation between wages and MA was not affected when we restricted our analysis to sectors that do not depend on natural resources (see footnote 20). We now perform another robustness check in which we directly control for endowments. In Table 2.7, column (1), we control for minerals, harvested land area, access to the sea and dummies for macro regions.²⁷ As expected, wages are positively correlated to the presence of natural resources: the coefficient for harvested land is positive and significant; minerals (share of total national extraction) have a positive and significant coefficient; access to sea (minus landlocked) has a positive albeit not strongly significant effect on wages. Among macro-region dummy variables, only the Northeast is significant at the 1% level: its value is -0.22 (with an estimated standard error of 0.06). This may be partially explained by its harsh climate (e.g. frequent droughts). In spite of the inclusion of these controls, the coefficient for MA remains large and significant.²⁸

Brazilian states also exhibit sensible differences in tax rates. Successive governments have adopted fiscal incentives to promote industrial development in lagging regions, with various degrees of effectiveness. If tax rates are positively or negatively correlated with market access, omitting this control might bias our results. We should also note that Manaus, the capital of the state of Amazonas, is a Free Trade Zone. Thus, we check the sensibility of our results to the inclusion of a dummy for the state of Amazonas. Finally, as both the market access and the wage premium are the largest for São Paulo, a reasonable concern is whether wages are high in São Paulo for reasons unrelated to MA. As a robustness check, we estimate the response of wages to MA including a dummy for São Paulo to isolate potential measurement errors or an outlier effect. In column (2) of Table 2.7, we regress the wage premium on market access, tax rates estimated at the firm-level data (sum of taxes

²⁷The Brazilian states are regrouped in five macro-regions based on geographical characteristics. They are: North, Northeast, Southeast, South and Center-West. Our category of reference is the Southeast.

²⁸As climate and land seem to have the strongest impact among the different types of endowments, we performed further robustness checks using more detailed data. This analysis is discussed in section 2.5.5 as these variables are available by municipality.

paid by each firm divided by total sales), and dummies for Amazonas and São Paulo. We obtain significant coefficients for all controls, and the coefficient for market access is not affected.²⁹

Table 2.7: Additional controls

Dependent variable:	Wage premium	
	(1)	(2)
Market Access	0.116 ^a (0.016)	0.138 ^a (0.013)
Harvested land	0.027 ^b (0.011)	
Minerals	0.028 ^b (0.012)	
Landlocked	-0.039 (0.055)	
Taxes		-0.234 ^a (0.038)
Dummy Amazonas		0.446 ^a (0.048)
Dummy São Paulo		0.219 ^a (0.043)
Industry FE	yes	yes
Macro-region FE	yes	no
controlling for skills	yes	yes
R-squared	0.875	0.432
Observations	540	540

Notes: OLS regressions with robust standard errors and industry fixed effects. Controls: minerals: regional share of mineral production (source: *Anuario Mineral Brasileiro* 1999); harvested land area in 1999 (source: Agricultural Census); taxes: average tax/sales ratio of industrial firms in the state. ^a and ^b represent respectively statistical significance at the 1% and 5% levels.

²⁹The coefficient for MA remained unchanged in similar robustness checks for international MA. In Fally et al. (2008) we also control for the cost of starting a business in 13 states, using data from the World Bank (Doing Business in Brazil).

2.5.4 Controlling for productivity and technology

Recent models on international trade and the selection of firms show that access to foreign markets may have a positive impact on average firm productivity, which in turn has a positive impact on wages (Melitz, 2003, and Melitz and Ottaviano, 2008). Baldwin and Okubo (2006) describe in a model how MA may impact productivity across regions. It is, thus, possible that the impact of MA on wage differentials is due to its impact on productivity, rather than through the NEG labor demand channel.

Hence, in the same way we have controlled for the individual characteristics of laborers, we can also control for productivity when estimating wage differentials in the first step. Our dataset allows for this control since we are able to match the data on workers with data on firms with more than 30 employees. In particular, these firm-level data provide information on labor, wages, investment, capital, materials and energy.³⁰ We measure total factor productivity using a cost share approach (see Foster et al., 2008, and Syverson, 2004, for similar measures of productivity using US data). Details are provided in the Appendix. In short, productivity is measured by the logarithm of total sales at the firm level, minus the log of labor, capital, energy and materials with respective coefficients given by the share of each input in total costs. In addition to its simplicity, this methodology is very robust to measurement errors and misspecifications compared to alternative methods (Biesebroeck, 2007). Moreover, using alternative measures of productivity yields similar results (see the Appendix).

A major concern is that productivity is measured using revenues and expenses in inputs (except for labor), since we do not have data on quantities and prices. Our productivity measure may be capturing mark-ups, which vary endogenously across regions depending on market access and competition. Thus, we use data on patents in order to control for technology in a way that is not affected by price levels. The data made available by INPI (*Instituto Nacional da Propriedade Industrial*) list all patents recorded in the 1990's. Our first variable is a dummy for innovative firms, which equals one when there is at least one

³⁰Productivity is measured at the firm-level. We suppose that productivity is related to firm characteristics which should be similar across establishments within the same business unit.

patent recorded for a given firm. The second variable is the count of patents, in log.³¹

Table 2.8 presents the results of the impact of MA on state-industry wage differentials, controlling for productivity and patents. The first column of Table 2.8 is the equivalent to the baseline regression in the third column of Table 2.3, but using a version of the wage regression in the first step (equation (2.6)) that also controls for firm productivity. The wage premium corrected for productivity is still highly correlated with MA, though the coefficient is slightly smaller: 0.11 instead of 0.14. The same comparison is true for the regression comprising only national and only international MA (in columns 2 and 3, respectively): When we control for productivity in the first step, the MA coefficient becomes smaller in the third step. Additionally, the R-square of the regressions controlling for firm productivity is larger than in the regressions without such control.

Note that, in the first step, we find a positive and significant elasticity of wages to productivity, close to 0.3, as shown in the second part of Table 2.8. Alternatively to controlling for productivity in the first step, we can control for it directly in the third step, taking industrial and regional averages. The estimated effect of MA remains similar (results not reported).

The first-stage regression in the fourth column of Table 2.8 shows that wages are strongly correlated with both variables on patents. Since the use of patents (access to technology) may also be correlated with market access, controlling for patents affects the coefficient for market access. The impact, however, is small: the coefficient of MA in the regression of the fourth column of Table 2.8 is not very different from that of the third column of Table 2.3. We find the same result if we use aggregate data on patents across states and industry.

2.5.5 Per municipality: Local amenities and spillovers

The results found so far are consistent with the NEG explanation for regional wage disparities. However, it is possible that other explanations are in line with these results as well. More specifically, our MA measure could be also capturing short-distance interactions as

³¹The number of patents is discounted at a 15% yearly rate, but results are not sensible to moderate changes in the discount rate. This variable is normalized to zero for non-innovative firms.

Table 2.8: Controlling for productivity and technology

Dependent variable:	Wage premium			
	(1)	(2)	(3)	(4)
Market Access	0.112 ^a (0.011)			0.126 ^a (0.010)
National, Non local MA		0.134 ^a (0.018)		
International MA			0.201 ^a (0.017)	
R-squared	0.403	0.328	0.388	0.343
Observations	466	466	466	534
<i>First step regression:</i>				
Firm productivity	⏟			
		0.297 ^a (0.002)		
Innovative firm				0.259 ^a (0.002)
Patent stock				0.044 ^a (0.001)
Controlling for skills		yes		yes
Region x industry FE		yes		yes
R-squared in first step		0.899		0.886
Observations in first step		499144		499878

Notes: OLS regressions with robust standard errors and industry fixed effects. See data appendix for the measure of productivity. ^a represents statistical significance at the 1% level.

modeled by the urban economics literature. If that is the case, the relation between wages and MA found in this study would actually reflect explanations for wage disparities from urban economics, rather than the explanations proposed by NEG. Additionally, natural endowments and local attractiveness could just as well play a role in explaining wage premiums across regions, and we should check if our results still hold after controlling for these features.

Our dataset on the individual workers allows us to refine our analysis at the municipal level, which is the finest administrative unit in Brazil (the municipality refers to the location of the firm). This refinement allows us to control for additional variables related to these alternative explanations.

Firstly, we estimate wage premiums across municipalities by running a first-step regression of wages on individual characteristics (education and age for males between 25 and 65 years of age). The corrected wage premium is obtained by taking the mean of the residual for each municipality.³²

In order to estimate MA per municipality, we would need to regress gravity equations of the trade flows between them, as specified in equation (2.7). Since we do not have such trade information, we use aggregate trade flows across states to estimate the importer fixed effects per state, and the coefficients for distance, language, colonial link, border effects (internal and international) and international contiguity.³³ Our estimation of trade costs involves the coefficients estimated in the gravity equation as well as the physical distance between municipalities. If we further assume that price levels are relatively similar within states, we can construct pseudo-importer fixed effects per municipality, by multiplying state importer fixed effects by the industrial GDP share of the municipality in the state. Formally, market access per municipality is computed as follows:³⁴

$$\hat{M}A_i \equiv \sum_j \left[\left(\frac{GDP_j}{GDP_{J(j)}} \right) (\exp FM_{J(j)}) \prod_g (\exp TC_{g,ij})^{\delta_g} \right] \quad (2.13)$$

where j refers to municipality or foreign country and $J(j)$ stands for the state to which municipality j belongs in the first case or the foreign country itself in the latter.

Besides MA, other factors are likely to influence wages and their spatial correlation across municipalities, such as, in particular, the interactions between municipalities and spillovers. In order to correct for spatial autocorrelation, which induces underestimated standard errors via OLS, we employ the GMM methodology reported by Conley (1999). We specify a cutoff point for spatial interactions at 1.5 degree in latitude or longitude,

³²This simplified method permits to avoid the estimation of thousands of fixed effects by municipalities, if we had rigorously followed the same methodology we used across states. This may lead to an underestimation of the correlation between wages and MA since we overestimate the effects of age and education. Nevertheless, the estimated coefficients for age and education are very close to the results obtained previously in Table 2.1.

³³The estimated gravity equation is similar to the specification of column (1) in Table 2.2 but excluding the “internal” contiguity variable which is insignificant and has no meaning at the municipality level.

³⁴We exclude the internal demand from the municipality in the calculation of MA. Excluding large cities from the regression does not affect the results.

that is, 100 miles. It means that we neglect interactions between cities at a distance greater than 100 miles. Specifying other cut-off points does not increase the standard error. This approach is robust to misspecification of the degree of spatial correlation among geographical units and allows us to obtain robust standard errors for coefficients estimated through OLS.

Our results are reported in Table 2.9, where average wages by municipality are regressed on MA and controls. The correlation between wages and MA still holds for this finer spatial scale. The first column shows the results when wages are not controlled for skills in the first step, while in the second column the dependent variable is the wage premium corrected by worker skills. This last result is very close to the corresponding one in regressions by state, presented in the first column of Table 2.3 (using aggregate MA). It should also be noted that the standard error corrected for spatial autocorrelation is three times higher than the one estimated using traditional OLS across municipalities, which confirms that OLS standard errors are underestimated. The corrected standard error is closer to the one estimated in the regressions across states.

In the results presented in the third column, wages are regressed on MA plus state fixed effects in order to capture variations within-state. The estimated coefficient is similar to the one obtained from the corresponding regression at the state level (Table 2.3, column 3), which is consistent with MA having similar impact on wages at different geographical scales.

In order to investigate whether short-distance interactions are driving our results, that is, in an attempt to disentangle the urban economics and the NEG explanations for the regional wage premium, we control for some of the variables used in that literature (Rosenthal and Strange, 2004). Specifically, we use demographic density, the average age of workers and the proportion of workers at each level of educational attainment (our reference is level 5: Complete primary education) as our controls (see Acemoglu, 1996; Combes et al., 2008).

It is interesting to note that the coefficients for the highest levels of education in the final step are positive (not shown), even after controlling for this variable in the first step. This result suggests an additional impact of education on average wages, besides the one

arising from its spatial composition of the labor force. A possible explanation could be the existence of positive externalities for workers with tertiary education. The resulting coefficient for MA in column (4) is slightly lower than in the first specification in column (1), but it remains significant. This result suggests that, while it is true that local interactions play a role in explaining local wages, the NEG approach has also an important part in it.

We control for the attractiveness of each municipality in column (5). A variety of regional amenities may influence the decisions of individuals to establish their location, and, ultimately, may be reflected in compensating wage differentials. Since the role of amenities is not easy to assess and constitutes a research topic in itself, we do not pretend to fully investigate it. In this article we simply use recent migration as a (raw) indicator of revealed attractiveness in the wage regression. In our regression we include the proportion of new residents in the municipality,³⁵ and the coefficient of market access remains unchanged. We are aware that recent migration may also capture decisions to change residence driven by differences in market access themselves that induce wage premium across regions. Nevertheless, it is not easy to disentangle these two effects. The relation of market access differentials and migration flows is explored in detail in the next chapter.

Finally, we add a number of controls for local amenities and endowments (altitude, temperatures, rainfalls, soil quality, land by type of agriculture), and the coefficient for MA is still large and significant, as shown in column (6).

2.6 Concluding remarks

Migration within a country could offset in great part regional advantages derived from market and supplier access, and, in that case, wage disparities would be the result of diversity in individual, industry and firm characteristics. Our results, however, indicate that labor mobility did not arbitrage away all cross-regional wages differences in Brazil. We find that market and supplier access have a positive and significant impact on wages, and even stronger than has been found for the European regions. Nevertheless, there are no

³⁵The proportion of new residents refers to the proportion of males between 25 and 65 years old who have moved from another municipality within the past five years.

Table 2.9: By municipalities

Dependent variable:	Wage premium by municipality					
	(1)	(2)	(3)	(4)	(5)	(6)
Market Access	0.162 ^a (0.016)	0.086 ^a (0.013)	0.091 ^a (0.012)	0.107 ^a (0.012)	0.091 ^a (0.010)	0.095 ^a (0.011)
Controls in final step			State fixed effects	Density Av. age Av. age ² Education (% workers by level)	New residents (%)	Erosion type Soil type Temperatures Precipitations Land by type of agriculture
controlling for indiv. skills (1st step)	no	yes	yes	yes	yes	yes
R-squared	0.242	0.109	0.301	0.151	0.170	0.255
Observations	3439	3439	3439	3439	3439	3439

Notes: OLS regressions with standard errors corrected for spatial dependence (Conley, 1999). The proportion of new residents is from the Census 2000; endowments are from Timmins (2006). ^a represents statistical significance at the 1% level.

restrictions to internal migration in Brazil, as opposed to, for instance, the case of China. In fact, migration levels in the country are even higher than in Europe. Menezes-Filho and Muendler (2007) do find evidence of large labor displacements out of import competing industries due to the Brazilian trade liberalization in the 1990's. Nevertheless, this does not mean that labor reallocation took place in the expected direction.³⁶

While it is possible to propose NEG models with migration and spatial wage inequality (see Hanson, 2005), it seems that a more complex phenomenon is happening, one that requires us to take into account labor market frictions, migration dynamics (in particular preferences and spatial variation of skill rewards) and the match between worker heterogeneity and firm heterogeneity. A step in that direction has been carried out in the next chapter.

³⁶The detailed study on labor adjustment by Menezes-Filho and Muendler (2007) is particularly striking: "Brazil's trade liberalization triggers worker displacements particularly from protected industries, as trade theory predicts and welcomes. But neither comparative-advantage industries nor exporters absorb trade-displaced workers for years" (p. 2).

2.7 Appendix

2.7.1 Data

Education: Educational variables are 9 dummies, one for each schooling level:

- Level 1 : Illiterate
- Level 2 : Primary School (incomplete)
- Level 3 : Primary School (complete)
- Level 4 : Middle School (incomplete)
- Level 5 : Middle School (complete)
- Level 6 : High School (incomplete)
- Level 7 : High School (complete)
- Level 8 : College (incomplete)
- Level 9 : College (complete)

Table 2.10: Summary statistics of individual characteristics

Variable:	Mean	Std. dev.
Log wage	1.508	0.852
Age	36.38	8.639
Age squared / 100	13.98	6.927
Educ. level 1	0.026	0.161
Educ. level 2	0.098	0.297
Educ. level 3	0.168	0.374
Educ. level 4	0.203	0.402
Educ. level 5	0.193	0.394
Educ. level 6	0.076	0.264
Educ. level 7	0.151	0.358
Educ. level 8	0.027	0.162
Educ. level 9	0.059	0.235
N obs	798494	

Notes: Summary statistics for the random sample; statistics for the full sample do not differ by more than 0.001.

2.7.2 First step regressions for the instrumental variable approach

Table 2.11 provide the first step estimations of the 2SLS regressions of Table 2.5. The P-value for the test of excluded instruments is lower than 0.01 for all regressions.

Table 2.11: First stage regressions corresponding to IV estimations

Instruments for Market Access:	Coefficient	Std. error	Observations
HMP in 1939	1.707 ^a	(0.056)	540
Av. date of registration	-0.027 ^a	(0.002)	540
{ HMP in 1939 { Av. date of registration	{ 1.616 ^a { -0.005 ^a	{ (0.064) { (0.001)	540

Notes: First-stage regressions for table 2.5, with industry fixed effects. Market Access instrumented by: HMP: Harris Market Potential = sum(GDP/distance) in 1939; average date of registration of municipalities within the state. ^a represents statistical significance at the 1% level.

2.7.3 Measurement of productivity

Data. Data by workers and firms are matched thanks to the firm identification number (CNPJ). Labor corresponds to the yearly average number of workers in the firm. Capital stock is estimated using the perpetual inventory method with a discount rate of 15% (results are not sensible to changes in discount rate between 5% or 25%).

The manufacturing survey (PIA after 1996) does not have information on capital stock, but we could impute the initial capital stock in 1995 from IBRE data (*Fundação Getulio Vargas*) for a large subset of firms. For the other firms we estimate the initial capital stock using capital stock data by industry obtained from the old PIA (corrected by the sampling rate in terms of labor) and other firm characteristics from the new PIA database, including investments and the depreciation of the capital stock.

Index of productivity. We use a cost share approach to measure productivity (see Foster et al., 2008, and Syverson, 2004, for similar measures of productivity using US data).

Our index of productivity θ_{sh} for the firm h , in industry s , is defined by:³⁷

$$\log \theta_{sh} \equiv \log Y_{sh} - sh_{Ls} \log L_{sh} - sh_{Ks} \log K_{sh} - sh_{Es} \log E_{sh} - sh_{Ms} \log M_{sh} \quad (2.14)$$

where Y refers to revenues, L , K , E and M refer to labor, capital, energy and materials, respectively, and sh_{Zs} denotes the share of input Z in annual costs for firms in industry s , taken as the average of the period between 1996 and 2003 across all firms in the industry, for $Z = L, K, E, M$. Total costs equal the cost of labor (wages), capital (investments), energy (electricity, fuel and gas expenses) and materials (material expenses). This methodology is relatively simple to implement and very robust to measurement errors and misspecifications compared to alternative methods (Biesebroeck, 2007).

Alternative measures. We constructed alternative measures of productivity using either the residual of OLS regressions or the Levinsohn and Petrin (2003) methodology. Table 2.12 show how the main results are affected by the choice of the productivity measure. OLS regressions yield very similar results in the intermediary and final step regressions. Levinsohn and Petrin estimations yield lower correlations between productivity and wages but larger correlation between productivity and market access. As a result, the correlation between wages and market access is less affected by controlling for productivity with the OLS and the Levinsohn and Petrin measure.

Correlation between productivity and market access. As an additional result, we explore the relationship between our chosen measure of productivity and MA. According to the results in the first column of the table 2.13, there is no significant correlation between productivity and global MA at 5% (although it is significant at 10% level). When splitting MA between national and international (results in the second column), we find a non-

³⁷This formula can be derived from the optimization of a Cobb-Douglas production function with constant return to scale. Note that our results are not sensible to small changes in return to scale (multiplying the coefficients sh_{Zs} by the same factor, between 0.90 and 1.10). Moreover, we should note that our measure is robust to differences in wages across regions. The share of labor in total cost remains constant across firms in the same industry as long as the coefficient in the Cobb-Douglas production function is constant.

Table 2.12: Main results with alternative measures of productivity

Measure of productivity	Cost share	OLS	LP
Productivity in first step	0.297 ^a (0.002)	0.227 ^a (0.002)	0.045 ^a (0.001)
MA in final step	0.112 ^a (0.011)	0.116 ^a (0.012)	0.120 ^a (0.013)

Notes: The first line corresponds to the coefficient of productivity in the first step of Table 2.8; the second line corresponds to the main coefficient of MA in Table 2.8 (final step). Columns correspond to different measures of productivity. ^a represents statistical significance at the 1% level.

significant coefficient for national MA, while for international MA the coefficient is positive and significant at 1% level.

Table 2.13: Productivity and market access

Dependent variable:	Productivity (1)	Productivity (2)	Productivity dispersion (3)
Market Access	0.022 (0.012)		
National MA		-0.012 (0.019)	0.020 (0.011)
International MA		0.062 ^a (0.020)	-0.021 ^b (0.009)
Industry FE	yes	yes	yes
R-squared	0.079	0.087	0.256
Observations	420	420	242

Notes: OLS regressions with robust standard errors and industry fixed effects. Productivity dispersion is the standard deviation of the log of productivity by region and industry. ^a and ^b represent respectively statistical significance at the 1% and 5% levels.

2.7.4 Map and overview of Brazil

Brazil is a federal country composed of 26 states and the federal district of Brasilia, which is also the capital (We refer in the text to Brasilia as just another state). The Brazilian

states are grouped in five macro-regions (see Figure 2.2). This classification is based on the structural and economic development of the different states, regrouping states with similar characteristics. The North is sparsely populated, poor, and largely inaccessible. The Northeast is the poorest macro-region of Brazil with the lowest life expectancy and wages, little access to mineral deposits or navigable rivers, and the highest proportion of low educated persons. The Center-West combines a diverse set of characteristics, mixing poor rural areas, dense forests, and the federal capital city of Brasilia, where income and education levels are high. The Southeast and the South are the most economically developed regions of Brazil. Education levels, income and life expectancy are all high in these regions, and dense highway networks make it easy to get around. These regions offer high economic opportunities and have a high population density.



Figure 2.2: Map of Brazil

Chapter 3

How does market access shape internal migration?

3.1 Introduction

In¹ economic theory, migration acts as an adjustment mechanism for spatial disequilibria. To understand migration patterns and to design successful regional policies, the identification of the macro-economic determinants of the migrants' location choice is essential. The aim of this chapter is to emphasize the role of trade on migration by studying its impact on internal migration within Brazil. Even though the link between migration and trade has been at the center of many studies, these have mainly focused on the reverse causality, the impact of international migration on shaping international trade.²

Yet, in an open economy trade should effect migration patterns. As for the role of exports, a region which increases its access to foreign markets attracts firms and raises labor demand. This is likely to attract additional workers from less well located regions. The effect of imports is more ambiguous. On the one hand, if imports increase and the newly imported good has been produced locally before, imports may substitute for local

¹This chapter is coauthored with Laura Hering. Part of this work is under revision for a journal. We thank the referees for the excellent comments which helped to improve the study.

²Studies on the impact of immigration on trade are numerous. See for example Gould (1994), Head and Ries (1998), Rauch and Trindade (2002) and Combes et al. (2005).

production. The following decrease in labor demand may lead to the emigration of workers. On the other hand, for a good to be imported, it is likely that it is cheaper to buy than to produce it. Increasing imports then result in lower living costs which in turn attract migrants. A region's access to consumer markets and suppliers can thus shape migration patterns. With ongoing globalization, this effect of trade on migration is likely to become more and more pronounced. It is thus also of political interest to assess its importance.

The two studies treating the impact of international trade on internal migration we are aware of are Aguayo-Tellez et al. (2008) and Kovak (2008). As in this chapter, both studies apply to Brazil. Aguayo-Tellez et al. (2008) analyze one particular aspect of exports by looking at the role of multinational enterprises. They find that migrants are attracted by the growth of employment opportunities in states with high concentration of foreign owned establishments. Kovak (2008) highlights the negative effect of imports on labor demand. He shows that decreases in regional wage levels resulting from tariff cuts will trigger migration between the Brazilian states.

This chapter concentrates on the export channel of trade by using regional differences in access to consumer markets to explain internal migration patterns. Brazil³ is a particular interesting country to study this link, since internal migration in Brazil is exceptionally high: in 1999, 40% of all Brazilians lived in a state different from the state they were born in (Fiess and Verner, 2003).⁴ Further, Menezes-Filho and Muendler (2007) highlight that albeit the geographic mobility is high, inter-sector mobility is low. Spatial adjustment takes thus place mainly within industries. In Chapter 2, it is shown that access to consumer markets varies substantially across the 27 Brazilian states.

A theoretical framework that is well suited to study the relationship between access to markets and migration is the New Economic Geography (NEG) theory. This theory explains the agglomeration of economic activity and how workers will choose their location following changes in trade. It underlines the importance of the region's proximity to consumers, which is modeled by the region's access to markets. Regions closer to big consumer

³See section 2.7.4 for an overview and a political map of Brazil.

⁴ For a comparison: Dahl (2002) finds that in 1999 in the US, a country known for its high labor mobility, only 30% of all male workers no longer live in the state in which they were born.

markets (i.e. with higher “market access”) experience lower transport costs and can sell at lower prices in these markets. Firms located in high market access regions thus face higher demand for their products and a higher labor demand. Another important feature of high market access regions is that they are more likely to pay higher wages because of the low transport costs, resulting in higher income levels. This effect is reinforced since the costs of living in these regions are lower because also imported consumption goods incur lower transport costs (Krugman, 1991b).

The fact that previous work on migration determinants has seldom focused on the trade channel, is partly due to the fact that international trade studies concentrate on labor relocation rather than on migration per se. Using such an approach, researchers explore changes in the employment levels, implicitly assuming that factors are mobile. In the context of NEG models, the effect of market access on employment has been estimated by Hanson (1998) for Mexico and Head and Mayer (2006) for the European Union. The first study looking at the impact of market access on migration in a NEG framework is Crozet (2004). He derives a quasi-structural migration equation from Tabuchi and Thisse (2002) to test how cost advantages due to higher market access shape migration flows within the countries of the European Union. His approach has been adopted by Pons et al. (2007) to explain migration flows within Spain and by Kanacs (2005) for migration flows between the Baltic states.⁵

In our study, we first want to assess empirically whether changes in market access lead indeed to changes in the migration behavior. We therefore test whether regional differences in access to foreign markets have an impact on bilateral migration rates within Brazil. Yearly bilateral migration rates between the Brazilian states are obtained from a micro data set for the period 1993 to 2003. We further check whether this effect is robust to the introduction of various control variables relating to alternative explanations of migration.

Our second objective, is to test whether the main driver of migration patterns is the

⁵ There is also a long tradition of economic models treating the connection between industrialization processes and rural-urban migration in developing countries, backing at least at Lewis (1954) and Harris and Todaro (1970). Our point is that this literature is not addressing the specific features of a trade channel as NEG models do. In addition, these approaches focus on unilateral rural-urban migration and are thus not suited for analysis where we observe migration flows in different directions.

evolution of market access in the particular industry of the migrant. Thanks to the availability of Brazilian trade data at the sectoral level for the year 1999, we can calculate market access for 16 manufacturing industries. This allows us to assess the impact of market access for each sector separately and to test for possible heterogeneity across industries. Menezes-Filho and Muendler (2007) find that the high migration rate in Brazil stands in sharp contrast to the low sector relocation in the country. As a consequence of this low inter-sector mobility, workers are likely to choose their destination depending on the spatial distribution of market access in their industry, letting spatial labor adjustment take place mainly within industries. Bilateral migration rates by sector are obtained from the 2000 population census. As shown in Chapter 1, there is an important level of heterogeneity of the impact of market access on wages and on employment levels across industries. To see whether also migrants vary in their sensitivity to market access according to their industry, we estimate the impact of market access for each sector separately.

In both cases, we investigate whether the sensitivity to market access varies across different types of workers. According to Redding and Schott (2003), under certain conditions, highly skilled workers benefit more from a higher market access. If this model correctly describes the case of Brazil, highly educated migrants should react more strongly to market access.

Thirdly, from simulations with obtained estimation coefficients, we can derive predictions for changes in internal migration flows between the 27 Brazilian states in case of further trade liberalization.

Our study hence contributes to the literature in at least two ways. We are the first to highlight the link between trade and internal migration in an economic geography framework. While Crozet (2004) concentrates on the role of domestic market access, we include also the access to foreign markets and exploit the sectoral composition of market access. Since we are interested in the role of trade, we measure access to markets using revealed trade flows, as do Redding and Venables (2004). The use of bilateral trade data between the Brazilian states and the foreign countries reveals both observed and unobserved trade costs and market characteristics, both for foreign countries and for the Brazilian states.

These allow us to obtain a structural measure of market access. For the Brazilian states this is of a particular importance. If international market access is estimated as a simple function of the country's income weighted by the bilateral distance as often done in the literature, it follows that the Northern regions have a higher market access than the Southern regions. This is because they are closer to the US and the European market. Yet, most of the country's export activity is located in the South. Using trade data thus reflects much better the restricted access to foreign markets of the isolated Northern region than the simple income over distance measure.

The second contribution is that we are the first to draw on individual data to demonstrate the link between economic geography and migration. Using bilateral migration rates that are obtained from micro data has several advantages. First, it allows the disaggregation of migration flows and to compare different types of migrants. Previous studies looking at the impact of economic geography on migration have not done this before. Here, we focus on differences in migration behavior across two educational levels and 16 manufacturing industries. Second, it allows us to take into account the migration literature, which highlights the aspect of a possible self-selection of migrants towards certain destinations. By estimating regional wage levels following Dahl (2002), we control for a possible self-selection bias in this variable. Even though we are looking at bilateral migration rates, thanks to the use of micro data, our empirical strategy is based on the individual migration decision. Our estimated migration equation is derived directly from the utility differential approach that is widely used in the migration literature.

Our results, obtained from panel data regressions and from yearly cross-sections, indicate that people indeed migrate from states with low to states with high market access. In line with the migration literature, which highlights the importance of pecuniary incentives for migration, especially spatial wage differentials (Greenwood 1985, 1985), we add also regional wage levels as migration determinants. Findings of a significant impact of market access are robust to the inclusion of regional wages and a number of other controls. We find that the sensitivity to market access is much lower for higher educated workers. We thus find no evidence for the Redding and Schott (2003) prediction. Further, we find that the

sector-region specific market access plays a much more important role than the state's total market access. The fact that migration patterns are affected by the location's industrial specialization suggests that implications of NEG theory (i.e. regional advantages generated by the region's position in the spatial economy) are better understood in combination with comparative advantage in a context of low sectoral labor reallocation (which in turn can be associated to sector-specific inputs like human capital specificity, or some labor regulations like firing costs).

Altogether, these results suggest that the geography of regional access to international markets can help explain migration patterns within a country.

The rest of the chapter will proceed as follows: Section 3.2 presents the theoretical framework, and summarizes some implications for the empirical part; Section 3.3 outlines the estimation strategy; Section 3.4 indicates the data sources and describes the computation of our market access variables and how we obtain consistent region-specific wage levels; Section 3.5 gives some descriptive statistics and stylized facts on migration and its link to market access in Brazil; Section 3.6 gives the empirical results of the migration equation. Simulations are reported in Section 3.7 and Section 3.8 concludes.

3.2 Theoretical background

We consider the standard New Economic Geography (NEG) model presented in Chapter 1.⁶ We will present only the essential equations here. The wage equation obtained states a relationship between the market access and the the maximum wages a firm from a given location i can afford to pay (cf. eq. 1.6):

$$w_i = \left[\left(\frac{\left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma}}{\sigma F a^{\sigma-1}} \right) MA_i \right]^{\frac{1}{\sigma}} \quad (3.1)$$

where a is the labor need per production unit and F is a labor fixed requirement.⁷

⁶In this version, labor is the only factor of production.

⁷the superscript sk used in the Chapter 1 is dropped, as we are not making any reference to the A-sector

Given the assumptions of the model, the equilibrium output q^* is the same for all firms:

$$q^* = F(\sigma - 1)/a. \quad (3.2)$$

Using q^* and the labor demand function (see section 1.6.1 in Chapter 1) the equilibrium labor input is defined as $l^* = F\sigma$. With L_i the number of workers in the manufacturing sector M (which in turn groups s sub-sectors) in region i , the equilibrium number of manufacturing firms located in i is

$$n_i = L_i/l^* = L_i/F\sigma \quad (3.3)$$

and total output of region i is $n_i q^*$.

From this definition we can see that when a region i increases total output, in the long run, the number of firms and workers in i will have to increase as well. Using this relationship, together with the price index (see section 1.6.1 in Chapter 1), and the fact that the equilibrium output q^* produced by each firm has to be equal to the demand function, the wage equation can be restated in a way to better visualize how market access, wages and the number of workers in a given region are linked.

$$w_i = \left(\frac{\sigma - 1}{\sigma a}\right) \left[\frac{\mu}{q^*} \sum_{j=1}^J \phi_{ij} \left[\sum_{i=1}^J n_i p_{ij}^{1-\sigma}\right]^{\frac{\sigma-1}{1-\sigma}} Y_j\right]^{1/\sigma} = \left(\frac{\sigma - 1}{\sigma a}\right) \left[\frac{\mu}{q^*} \sum_{j=1}^J \phi_{ij} \left[\sum_{i=1}^J \frac{L_i}{l^*} p_{ij}^{1-\sigma}\right]^{\frac{\sigma-1}{1-\sigma}} Y_j\right]^{1/\sigma} \quad (3.4)$$

According to the theory above, Brazilian trade liberalization should result in the creation of new firms and labor reallocation between locations, with workers going to locations that experienced an increase in market access. Given that spatial relocation is very slow, we state that under the period of our study (1992 to 2003), Brazil is still in the phase of adjustment to the lower trade costs.

workers, that are assumed unskilled and unable to get a job in the M-sector or migrate. Also we want to avoid confusion with the skill levels inside of the M-sector that we consider in the empirical part of this chapter.

As can be seen from eq. (3.4), either wages in region i or the number of firms and workers in region i will have to adjust, for location i to come back to an equilibrium situation.

The adjustment by wages occurs when the production of goods do not increase albeit lower transport costs. Lower transport costs lead to lower consumer prices which in turn results in an increased demand. But since the additional demand cannot be satisfied, prices will raise. Firms transfer this gain to workers by paying higher wages. If the total production of region i stays constant, the increase in the region's market access, will result in a proportional increase in the wage level. An increase in the demand, which is not accompanied by an increase in the production will thus lead to spatial price (wage) disparities. This is what Head and Mayer (2006) call the *price version* of the adjustment to a change in market access.

In the case of the quantity adjustment, the total output of the region increases, resulting in a higher labor demand L_i . New workers are attracted to region i . These newly arriving workers exert a downward pressure on wages, which (at least partially) offsets the upward pressure coming from the higher market access (as described above in the *price version*). This quantity adjustment via an increase in n_i and L_i is reflected in a decrease of the price index of region i .⁸ The decrease in trade costs is thus compensated by an increase in L .

Of course, both adjustment mechanisms can also occur simultaneously. When labor is not perfectly elastic, some locations with a higher demand for their manufactured goods may pay a higher nominal wage even if the number of firms increases. Fujita, Krugman, and Venables (1999) highlight that locations with a higher demand for manufactures tend, other things being equal, to offer a higher real wage to manufacturing workers.⁹ This effect creates a strong agglomeration force, resulting in the concentration of economic activity in certain regions.

In this study, we are interested in the market access indicator of state i , MA_i , and the market access indicator of state i in sector s , MA_{is} . Does an increases in the state's market access increases the number of open positions (either because firms grow or because new

⁸ If wages stay constant, the decrease in the price index will have to compensate all of the original increase to come back to equilibrium.

⁹ If expenditure for manufacturing good is high, real wages might be high both because the nominal wage is high and because the price index is low.

firms open) attracts new workers and contribute to an increase in L_i and L_{is} ?

3.3 Methodology

The central objective of this study is to empirically relate bilateral migration rates between Brazilian state to regional differences in market access. The derivation of the empirical specification of our migration equation used for this purpose is presented in this section and follows Grogger and Hanson (2008) and Sorensen et al. (2007).

We consider a log utility model as in Grogger and Hanson (2008). Every individual k coming from location i maximizes his indirect utility V_{kij} across all possible destinations j . The individual location choice M_{kij} in a general utility differential approach can then be written as:

$$\begin{aligned} M_{kij} &= 1 \quad \text{if and only if } V_{kij} = \max(V_{ki1}, \dots, V_{kiJ}), \\ &= 0 \quad \text{otherwise.} \end{aligned}$$

The indirect utility V_{kij} can be decomposed as follows.

$$V_{kij} = X_{ij}\beta + \xi_{ij} + e_{kij} \tag{3.5}$$

The utility of migrating to region j for an individual k from origin i is determined by X_{ij} , the characteristics of the location j . The product $X_{ij}\beta$ represents the utility the individual receives from these characteristics, where β is a vector of marginal utilities. The subscript i is included because some characteristics of location j can vary across original locations, as for example bilateral distance.

The error term ξ_{ij} represents unobserved location characteristics. $X_{ij}\beta$ and ξ_{ij} assign the same utility level to all individuals coming from i and going to j . In order to still allow individuals from the same region to choose different locations, we include an idiosyncratic error term that varies across both individuals and locations, e_{kij} . We assume that this error term follows an i.i.d. extreme value distribution.

Given that individuals choose the location that maximizes their utility, equation (3.5) leads to:

$$Pr(V_{kij} > V_{kim}) \forall j \neq m$$

$$Pr(e_{kij} - e_{kim} > X_{im}\beta - X_{ij}\beta + \xi_{im} - \xi_{ij}) \quad \forall j \neq m \quad (3.6)$$

McFadden (1974) shows that thanks to the i.i.d. extreme value distribution of the individual error term, integrating out over the distribution of the logistic distribution yields the following migration probabilities:

$$Pr(M_{kij} = 1) = \frac{\exp(X_{ij}\beta + \xi_{ij})}{\sum_{j=1}^J \exp(X_{ij}\beta + \xi_{ij})} \quad (3.7)$$

Using the methodology proposed by Berry (1994), this probability of migration from i to j can be interpreted as the share of individuals from i migrating to j . As in Sorensen et al. (2007), we then write the share of migrants from i to j , s_{ij} , as

$$s_{ij} = Pr(M_{kij} = 1) = \frac{\exp(X_{ij}\beta + \xi_{ij})}{\sum_{j=1}^J \exp(X_{ij}\beta + \xi_{ij})} \quad (3.8)$$

and the share of stayers of region i , s_{ii} , as

$$s_{ii} = Pr(M_{kii} = 1) = \frac{\exp(X_{ii}\beta + \xi_{ii})}{\sum_{j=1}^J \exp(X_{ij}\beta + \xi_{ij})} \quad (3.9)$$

Dividing equation (3.8) by equation (3.9) and taking the log yields:

$$\ln\left(\frac{s_{ij}}{s_{ii}}\right) = \ln\left(\frac{\exp(X_{ij}\beta + \xi_{ij})}{\exp(X_{ii}\beta + \xi_{ii})}\right) = X_{ij}\beta - X_{ii}\beta + \xi_{ij} - \xi_{ii} \quad (3.10)$$

In section 3.6.1, we estimate this migration equation adding a time dimension t and replacing the vector X by our location variables of interest (expressed in logarithms). This yields:

$$\ln m_{ijt} = \ln \frac{s_{ijt}}{s_{iit}} = \beta_1 + \beta_2 MA_{jt} - \beta_3 MA_{it} + \beta_4 \widehat{w}_{jt} - \beta_5 \widehat{w}_{it} + \varphi_{ij} + \eta_t + v_{ijt} \quad (3.11)$$

where the dependent variable m_{ijt} is defined as the ratio of the number of migrants in year t going from i to j over the number of stayers. MA and \widehat{w} correspond to the state's international market access to the state's wage level. The construction of these two variables is described in Section 3.4. η represents yearly fixed effects and v_{ijt} is a i.i.d. bilateral error term. With the bilateral fixed effects φ_{ij} , we attempt to capture time invariant unobserved location characteristics of the destination and the fact that they might vary depending on the state of origin. Due to data limitations, we cannot add variables on the states' amenities even though we suspect them to play a significant role in shaping migration patterns within Brazil. However, if they are constant over time, they are captured by the bilateral fixed effects. The same applies to information on unemployment rates.

As a consequence of controlling for bilateral and time fixed effects, we exploit the panel dimension of our data. The coefficients of market access indicate how a change in the origin's or destination's market access affects the evolution of migration between a given pair of states.

In Section 3.6.3, we are interested in the sectoral dimension of market access and migration flows. Introducing the sectoral dimension s , but restricting the analysis to a single year due to data availability for the year 2000 only, we obtain:

$$\ln m_{ijs} = \ln \frac{S_{ijs}}{S_{iis}} = \beta_1 + \beta_2 MA_{js} - \beta_3 MA_{is} + \beta_4 \widehat{w}_{js} - \beta_5 \widehat{w}_{is} + \varphi_{ij} + \theta_s + v_{ij} \quad (3.12)$$

where θ represents sector fixed effects.

A last important feature of our model is the independence of irrelevant alternatives (IIA). This implies that the probability of choosing one state relative to the probability of choosing another is independent of the characteristics of a third state. IIA arises from the assumption that the error terms are i.i.d. across alternative destinations. IIA may be violated if two or more destinations are perceived as close substitutes by potential migrants. Hausman and McFadden (1984) note that if IIA is satisfied, then the estimated regression coefficients should be stable across all 27 destination sets. To test whether IIA is violated in our sample, we follow Grogger and Hanson (2008) by re-estimating our model 27 times,

each time dropping one of the destinations.¹⁰ Coefficients of our market access and wage variables stay similar across samples, suggesting that the IIA property is not violated here.

3.4 Data

In this section we will first present the data sources and how we calculate our variables for migration rates, market access and region-specific wages.

3.4.1 Individual data

In this study, we use individual data for the years 1992 to 2003 (with data missing for 1994) collected and published by the Brazilian Institute of Geography and statistics (IBGE). Data the years 1992-1999 and 2001 - 2003 comes from the yearly household survey *Pesquisa Nacional por Amostra de Domicilios* (PNAD), which covers between 310.000 and 390.000 individuals each year.¹¹ In 1994 the PNAD was not conducted because of a strike. 2000 was the year of the population census which is conducted every ten years. We have access to a random sample covering over 20 million individuals which represents nearly 12% of the total Brazilian population. Migration rates and regional wages are obtained from these data sets.

We will use the PNAD data set to assess the importance of international market access for bilateral migration flows. Panel regressions in the first empirical section are based on this data set. The second empirical section concentrates on the sectoral composition of migration flows and the link to sectoral market access. For this, we use the Census data for 2000, given its much higher coverage that allows a disaggregation of migration flows at the sectoral level.

¹⁰ We undertake this procedure once for the panel data set from Section 3.6.1 and once for the cross-section in Section 3.6.3, where we look at the sectoral composition of migration flows and market access.

¹¹ The PNAD does not follow individuals, but interviews a different random sample of residents each year.

3.4.1.1 Migration rates

We define an individual as a migrant, when the answer given to the question “In which Brazilian state did you live five years ago?” differs from the actual state of residence.

Given our interest in bilateral migration within Brazil, individuals having lived abroad in that period are excluded from our analysis. We further limit our sample to individuals who declare to have a job with a positive wage and who are at least 20 years old at the time of the interview, but not older than 65. In line with migration literature, we restrict our sample for the calculation of migration rates to information of household heads only. This leaves us with 69,000 (1993) to 93,000 (2003) individuals for each round of the PNAD and nearly 4.6 million individuals in the census year 2000.

Bilateral migration rates are defined as the number of migrants from state i to j over the number of workers that stayed in state i . Whereas for 2000, thanks to the access to the census data sample, we observe positive migration flows for 697 out of 702 state combinations, we have only on average 435 flows in each year of the PNAD. For the panel regression analysis we exclude migration rates involving the state Tocantins, leaving us with on average 406 out of 650 migration flows.¹²

Despite this relatively high number of zero-flows, the PNAD is considered as being representative of real migration rates and thus adequate for studying migration patterns within Brazil (Fiess and Verner, 2002). We will nevertheless address the problem of unobserved flows by various robustness checks. In Section 3.6.5, we will run Poisson-Maximum-Likelihood estimations including the zero-flows. Also when comparing regressions on the aggregated level for 2000 which contains migration rates for all possible flows, and yearly regressions of the PNAD, we find that coefficients do not vary substantially, indicating that a bias resulting from the omission of zero-flows might be small.¹³

To take into account heterogeneity of the impact of market access across different types of individuals, we calculate migration rates also at more disaggregated levels.

¹² Tocantins has officially separated from Goiás in 1988. Trade data for this state is not available for all years of the PNAD and for the first half of the 1990s statistical information on this state is not yet reliable.

¹³ Yearly regressions on the PNAD and aggregated migration flows for the 2000 census are not reported but are available at request.

On the one hand, we distinguish between qualified and unqualified individuals, where a person is defined as qualified when she has more than eight or nine years of schooling.¹⁴ On the other hand, we are interested in bilateral migration rates at the sectoral level. These rates are obtained from the census data for the year 2000. Given that we don't have information about the individual's work in 1995, we make the assumption that individuals already worked in the same sector as they did in 2000. Sectoral market access is computable only for manufacturing goods and agriculture, we hence limit our analysis to individuals who declare working in these industries. This reduces our sample to nearly 465,000 individuals for 2000.

3.4.1.2 Regional wages

Our migration equation will also contain state-specific wage variables. Regional wage differentials are considered as one of the key determinants of migration patterns. Also it is important to take into account this variable since, as described in Section 3.2, market access can simultaneously impact wages and migration. The simplest way to include a wage variable in our specification would be to take the average wage of each region. There are two reasons, not to do so. First, given that an individual's wage depend crucially on his educational attainment, it would be better to allow the wage variable to vary across the educational levels. Second, as highlighted in the literature, individuals currently living in state j are not a random sample of the population, because similar individuals tend to move to the same locations. This is reflected by the fact that immigrants in a specific region often share common characteristics like gender, ethnic group or educational level. Since these variables are also the main wage determinants, the wage level in a region will correspond to the average characteristics of the people living there. As a consequence, the average wage level is subject to a potential selection bias.

This problem is particularly important in the case of estimating migration as a function of wages. The individual's location choice is not a function of the average wage level in each region, but depends on the wage she will gain in each region. Her personal wage

¹⁴ We use the information on school years and on the highest degree the individual has obtained or is enrolled in to identify the educational level of each individual.

expectations are likely to differ substantially from the mean depending on her personal characteristics. To circumvent this problem, Falaris (1987) proposes to use predicted wages that have been estimated by a Mincerian wage equation using an additional correction term, that accounts for self-selected migration.

We follow closely De Vreyer et al. (2009) in obtaining predicted wages of each individual corrected for self-selection. These authors generalize the approach of self-selection correction developed by Dahl (2002). Dahl (2002) includes the individual's migration probabilities into the state-specific wage equation. In a first step, we thus need to determine migration probabilities of all individuals in our data set. For this, we estimate a multinomial logit model based on the individual's location choice.¹⁵

This allows us to obtain the probabilities of an individual to migrate to each of the Brazilian states as a function of his personal characteristics. A polynomial of these migration probabilities are then added as additional regressors in the wage equations to get consistent estimates of the coefficients.¹⁶

The obtained estimates are then used to predict wages for each individual in each of the 27 states.

We are interested in comparing the wage an individual gains in her actual state of residence with the wage she could gain in any other of the 27 Brazilian states. But since we aggregate migrants for the estimation of bilateral migration rates, we will use also an aggregated wage variable.

The aggregation of individual wages to regional average wages is done in the following way: The wage variable for the state of origin i , w_i , will be the average of all workers who actually lived in i five years ago (more precisely, the mean of the predicted wages). In

¹⁵ For the sake of brevity, regression results used for the construction of the wage variable are not reported but are available on request. Traditional selection bias corrections (like the conditional logit model) are not very well suited to cases where individual migration decisions imply numerous potential destinations. We thus run a multinomial logit separately for each year, predicting individual migration probabilities for each state based on the individual's educational level, age group, family status, state of origin and a dummy for migrants.

¹⁶ The wage equation includes the individual's education, gender, age, ethnic group and its location (rural vs urban). As correction terms we include the individual's probability of living in the state of destination. We try different specifications of the wage equation including more migration probabilities and different number of polynomials, but find only small differences in predicted wages. Wage equations are run separately for each year.

contrast, the wage variable for a given destination j , w_j , varies according to the state of origin of the migrants. For each destination j , we compute the wage variable w_j according to the origin of the residents. The wage variable of São Paulo thus differs between individuals coming from Amazonas and those coming from Acre. For the former we take the mean of the predicted wages for São Paulo of all the workers declaring Amazonas as the origin, and for the later we take the mean of the predicted wages for São Paulo for the individuals having lived in Acre. This method allows us to use the mean of predicted wages of the same individuals for the wages at the origin and at the destination, which reduces again any selection bias.

We compute the wage variable once using the predicted wages corrected by self-selection bias and once using predicted wages that do not take into account the additional correction term. Both variables are highly correlated and in the empirical analysis, results obtained with the corrected and with the uncorrected wages are mostly the same, so in the interest of space, we will mainly report and discuss results with corrected wages.

In section 3.6.2, we distinguish migration rates and wages according to the educational level of migrants. The wage variables are obtained in the same way as on the aggregated bilateral level, but take different values for skilled and unskilled workers. In section 3.6.3, we look at migration flows by industry. In these regressions, regional wages are industry-specific.¹⁷

By introducing the state's wage level in our migration equation, we also control for an impact of market access on wages. The market access impact we observe in our regression is the effect on migration beyond the effect on wages.

3.4.2 Trade data and market access calculation

Our main variable of interest is the state's market access, which is estimated as in the previous chapters, following the methodology by Redding and Venables (2004). Detailed

¹⁷ Note that we are using nominal wages here, which are deflated for all years using the Brazilian consumer price index. The pertinent variables for migration should be real wages that are deflated by region-specific price indices. Unfortunately, information on state-specific price indices covers only main Brazilian cities in a limited number of states. By including dyadic fixed effects in our final regression, we can control at least for time invariant differences in price indices between two states.

derivation of the trade gravity equation and the market access construction can be found in the chapters 1 and 2. We compute two measures of market access. One is disaggregated at sectoral level for one year (1999), and the other is an aggregated measure for the period 1992-2002.

3.4.2.1 Sectoral market access

For the calculation of a sector-region specific market access variable, we estimate trade equations for the year 1999 separately for each of the 20 manufacturing sectors into which we can classify the Brazilian and international trade flows.¹⁸ Details on the datasets used, the estimations, and its performance with respect to the wage equation are in chapter 2 (Average values of the estimated coefficient across industries are displayed in Table 2.2, second column).

3.4.2.2 Market access for panel regressions

Our migration panel data set covers the years 1993 to 2003. We thus calculate market access the years 1992 to 2002, so that we use a lagged market access variable. In order to allow coefficients and fixed effects to vary across years, we run trade regressions separately for each year. Since intranational trade flows are available only for 1999, the market access variable used in the panel data regressions will be computed only with international trade flows in order to be consistent over years (the data source for international is SECEX, as explained in Chapter 2, section 2.3). Even though it would be preferable to use total market access, Head and Mayer (2004b) highlight that employing only the international part of market access has the important advantage of reducing endogeneity. Endogeneity between market access and migration can result from the fact that high migration inflows increase local demand for goods and thus local market access. By focusing on the international component of market access, we mitigate the endogeneity concern that has often been addressed to studies using market access including domestic demand. In the regression

¹⁸ Data is available at ISIC Rev 3 at 2-digits. The classification used in the official statistics is the Brazilian nomenclature CNAE 3.1 which is fully equivalent to ISIC Rev 3 at the level of aggregation that we are considering (See Table 3.15 in the Appendix for the full list).

analysis, we will however also proxy domestic demand by the state's income per capita and population to control for a possible positive correlation between international and local market access.

Summary statistics of this market access indicator are reported in Table 3.1. We see that international market access varies a lot between states. In 1992, the lowest market access (belonging to Roraima in the North) is only 10% of São Paulo's, where market access is the highest throughout the sample period. Because of trade data unavailability for Tocantins, we cannot compute the indicator for all years for this state and exclude it from the panel regressions.

3.5 Pattern of migration flows

In this section, we present some stylized facts and summary statistics about the migration patterns observed in our data and the relation between migration and the state's access to markets. This section is based on the final data sample we identified in Section 3.4.1.1. For a detailed description of internal migration in Brazil see Fiess and Verner (2003).

3.5.1 Descriptive statistics on migration

Column 1 in Table 3.2 reports the total number of migrants observed for each year. We see that on average 3.31 % of all individuals in our final data set have moved within the last five year to another state, but migration has declined over the sample period. Columns 2 and 3 report the numbers and percentages for qualified and unqualified workers. Qualified individuals are throughout all years more mobile than less qualified workers.¹⁹

When comparing mobility between sectors, we see that it varies substantially across sectors. Whereas in the Leather, bags and footwear industry only 2.8% of workers have moved to another state, this percentage is up to 5% in coke, nuclear and petroleum and nearly 4% in Food, beverages and Tobacco.

¹⁹ Tables and figures in this section would be very similar also if we wouldn't limit our analysis to household heads only or use a finer classification for education.

Table 3.1: International market access by state (1993).

	Code	State	International market access	Rank
North	11	Rondônia	89,36	21
	12	Acre	33,83	25
	13	Amazonas	131,99	12
	14	Roraima	16,45	26
	15	Pará	147,14	7
	16	Amapá	81,71	22
	17	Tocantins		
Northeast	21	Maranhao	110,59	17
	22	Piauí	108,67	19
	23	Ceará	140,06	9
	24	Rio Grande do Norte	110,49	18
	25	Paraíba	112,11	16
	26	Pernambuco	138,49	11
	27	Alagoas	119,01	15
	28	Sergipe	67,12	24
	29	Bahia	144,77	8
Southeast	31	Minas Gerais	153,22	2
	32	Espírito Santo	139,10	10
	33	Rio de Janeiro	150,03	5
	35	São Paulo	156,30	1
South	41	Paraná	149,98	6
	42	Santa Catarina	150,39	4
	43	Rio Grande do Sul	151,17	3
Center-West	50	Mato Grosso do Sul	106,55	20
	51	Mato Grosso	121,12	14
	52	Goiás	124,84	13
	53	Distrito Federal	68,75	23

Source: own calculations.

To see whether migrants with different educational levels have different location preferences, Figure 3.1 displays differences in migrant shares between the two educational groups for each state for the years 1993 and 2003. In 1993 migrants with higher education are dominant in at least one state in every Brazilian macro region.²⁰ Whereas the capital

²⁰ The Brazilian states are grouped in five macro-regions (see Table 3.1). This classification is based

Table 3.2: Yearly migration rates

Year	(1)		(2)		(3)	
	All		High educated		Low educated	
	Nb	%	Nb	%	Nb	%
1992	2,635	3.81	782	4.89	1,853	3.49
1993	2,503	3.54	782	4.59	1,721	3.20
1995	2,409	3.22	789	4.31	1,620	2.87
1996	2,278	3.07	776	4.06	1,502	2.73
1997	1,859	3.31	702	4.46	1,157	2.87
1998	2,543	3.21	949	4.31	1,594	2.79
1999	2,685	3.30	1,034	4.48	1,651	2.83
2000*	155,544	3.39	49,704	4.27	105,840	3.09
2001	2,955	3.28	1,180	4.25	1,775	2.85
2002	3,037	3.31	1,264	4.21	1,773	2.87
2003	2,916	3.13	1,239	3.94	1,677	2.72
Mean		3.31		4.31		2.91

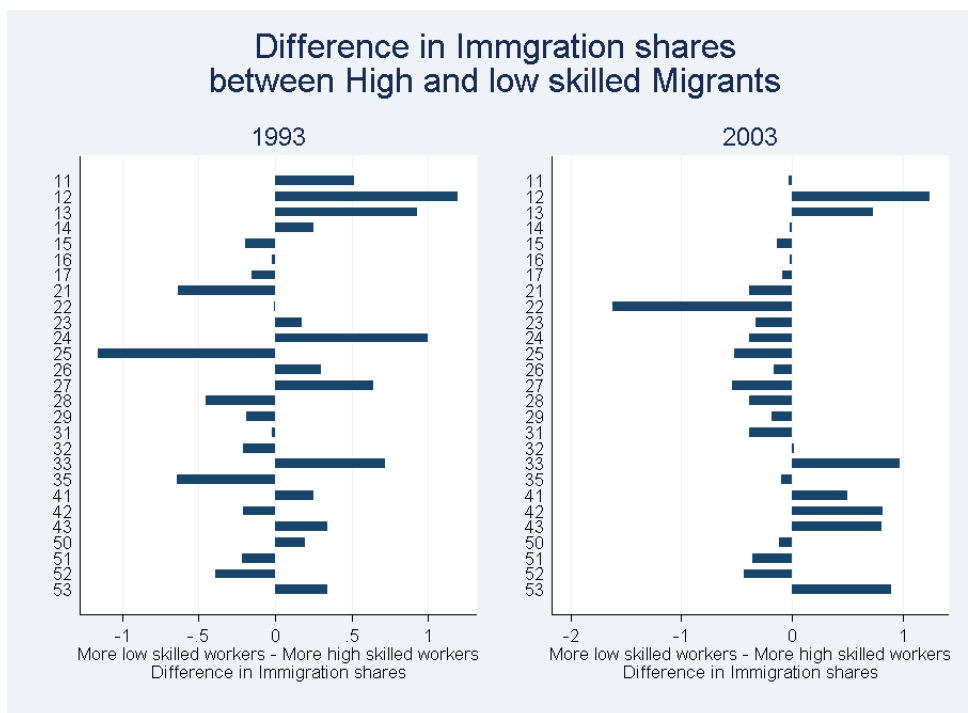
Source: Own calculations. * Data are from the PNAD (1992 - 2003) and the 2000 Population Census (2000). Means are calculated excluding 2000.

Brasilia, Rio de Janeiro and the three states in the South, which are known for their good climate and recent economic development, have stayed the preferred destinations of high skilled workers, the North East and Center region (except Brasilia), have become the main immigration regions for low educated migrants.

These differences in the location choice suggest that the utility of migrating to a specific state might vary across educational levels. They are also an indicator for self-selection or for differences in location choice determinants across different types of migrants.

on the structural and economic development of the different states, regrouping states with similar characteristics. The North is sparsely populated, poor, and largely inaccessible. The Northeast is the poorest macro-region of Brazil with the lowest life expectancy and wages, little access to mineral deposits or navigable rivers, and the highest proportion of low educated persons. The Center-West combines a diverse set of characteristics, mixing poor rural areas, dense forests, and the federal capital city of Brasilia, where income and education levels are high. The Southeast and the South are the most economically developed regions of Brazil. Education levels, income and life expectancy are all high in these regions, and dense highway networks make it easy to get around. These regions offer high economic opportunities and have a high population density.

Figure 3.1: Differences in migrant shares between high and low skilled workers



3.5.2 Correlation between migration and market access

Before we come to the regression analysis, we report some simple statistics and figures to show the link between migration and market access.

Figure 3.2 plots the share of workers out of all migrants a state attracts against its level of market access. We can see a positive correlation between the two variables, indicating that the higher the state's international market access, the higher the share of migrants.²¹

Figure 3.3 displays the link between bilateral migration and regional differences in market access. In this figure, we use the rank of market access for each region, displayed in Table 3.1. São Paulo ranks first. The smallest market access, rank number 26, is found in Roraima at the border to Venezuela. We see when the rank at the state of origin is lower than the rank of the destination, migration is high. Whereas, when the destination has a

²¹ Graphs and correlations are very similar throughout all years in our sample, we thus report only 1993 here.

Figure 3.2: Market access and migrant shares

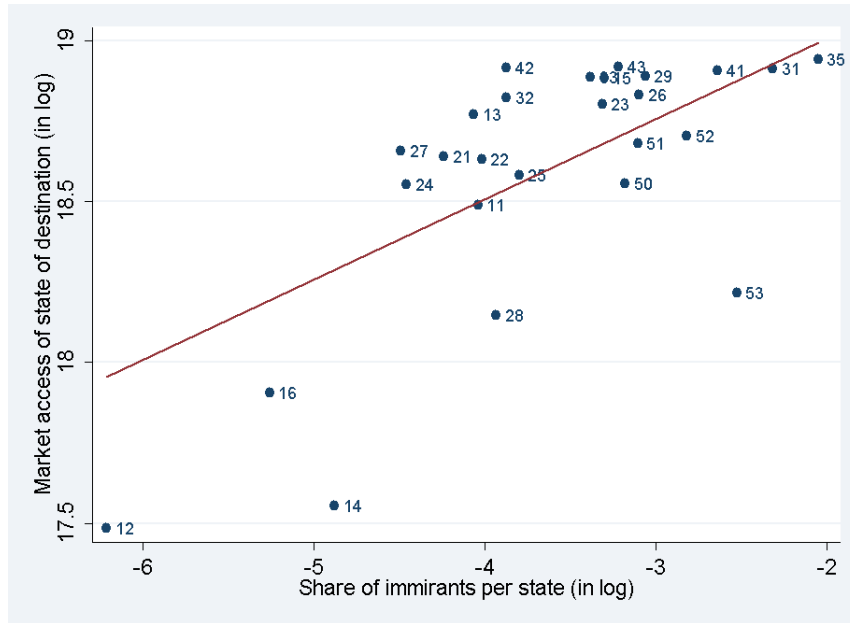
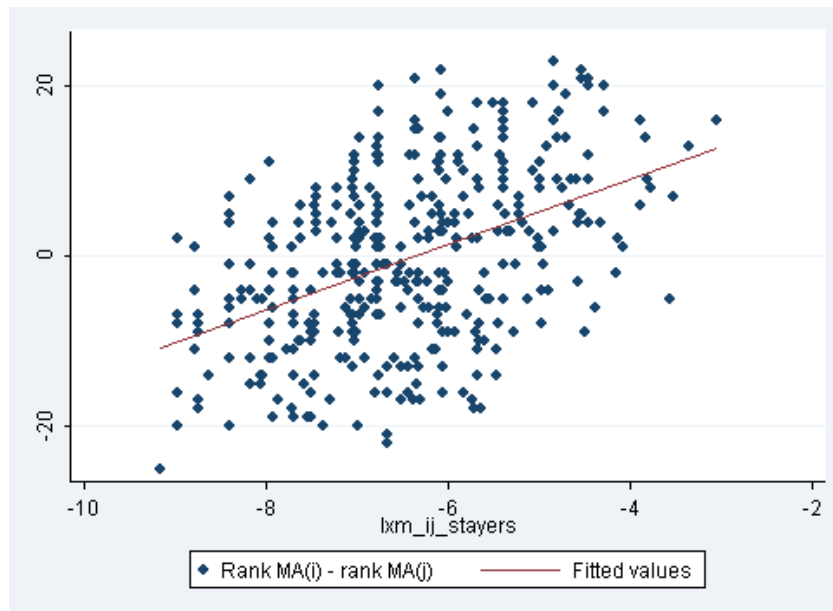


Figure 3.3: Market access and bilateral migration rates



Migration rates are defined as m_{ijs} , the probability of worker in sector s living in i to migrate to state j

higher rank of market access, workers are less likely to go to these states. The bigger the differences the higher the migration rate.

3.6 Results - Market access and migration response

In this section, we estimate the migration equation, equation 3.11 derived in section 3.3, using first panel data estimation techniques. We then look at differences in sectoral market access to evaluate the role of sector-specific market access and heterogeneity in the reaction to market access across manufacturing sectors. At last, we will show several robustness test on our market access indicator.

3.6.1 Panel regressions - Aggregated migration rates

In this section, we test empirically whether an increase in a region's market access results in higher immigration and lower emigration rates. Further, we are interested in the role of regional differences in wages, which are considered as important determinants in the migration decision.

We use a panel including seven years between 1993 and 2003. Our panel variable is defined as the origin-destination state couple. Accordingly, we include dummy variables for each combination of origin and destination state. The dummy for the couple ij (São Paulo - Amazonas) differs from the dummy for the couple ji (Amazonas - São Paulo). These bilateral fixed effects take into account time-invariant specificities concerning migration between two particular states. They typically capture differences in climate, price indices or institutions (those which are stable over our sample period).

Since we are looking at bilateral migration, we include each independent variable once for the state of origin and once for the state of destination. Our main interest lies in the state's access to international markets, MA . We expect market access of the origin, MA_i , to have a negative impact on migration: the higher MA_i , the higher the demand for work. Thus, the individual can attain already a high utility in his home region and is not necessarily motivated to look for a job in another state. For the destination's market

access (MA_j) we expect a positive coefficient: the higher this indicator, the more the region attracts people in search for a job in export-oriented industries.

A gravity model of migration, as we use, should also include a proxy for moving costs between two states (Greenwood, 1997). Moving costs are expected to have a negative impact on the number of migrants and are increasing in distance since the farther away is the destination, the more expensive is the journey and the less familiar is the new environment (climate, institutions, cultural specificities). Given that distance is constant over time, we will not be able to use this proxy when introducing dyadic fixed effects. A component reducing migration costs is the stock of immigrants in a given region. A region with higher number of immigrants with the same origin disposes of a better social network and thus offers better integration of an arriving migrant (Card, 2001). We will thus also include the number of persons who have been born in i but lived already in j at time $t - 5$, when we explain migration in time t between i and j .

Market access and wage variables are all lagged one year in order to reduce endogeneity. Market access is computable only from 1991 on and regional wages from 1992 on. Using a higher number of lags will thus reduce significantly our number of observations. However, we run also regressions with lags of two and three years, which confirm main results. To take into account that market access and regional wages are estimated in a prior regression, displayed standard errors, which are clustered at the origin-destination-couple-level are bootstrapped.

Before reporting results with dyadic fixed effects, we run regressions with regional fixed effects, where we define one dummy variable for each of the five macro-regions. This allows us to include distance and the stock of migrants in our regression.

Table 3.3: Bilateral migration

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
MA_j	0.279 ^a	0.040	0.323 ^a	0.306 ^a	0.327 ^a	0.322 ^a	0.321 ^a	0.312 ^a	
	(0.107)	(0.091)	(0.087)	(0.093)	(0.089)	(0.089)	(0.089)	(0.091)	
MA_i	-0.904 ^a	-1.338 ^a	-0.360 ^b	-0.354 ^b	-0.379 ^b	-0.360 ^b	-0.357 ^b	-0.313 ^c	
	(0.125)	(0.126)	(0.162)	(0.169)	(0.167)	(0.164)	(0.169)	(0.163)	
$dist_{ij}$	-0.703 ^a	-0.316 ^a							
	(0.060)	(0.062)							
$stock_{ij}$		0.332 ^a		0.050					
		(0.028)		(0.040)					
$unemp_j$					0.213				
					(0.226)				
$unemp_i$					-0.313				
					(0.262)				
w_j (unc)						-0.022			
						(0.174)			
w_i (unc)						-0.009			
						(0.197)			
w_j (cor)							-0.015	-0.015	
							(0.062)	(0.064)	
w_i (cor)							0.038	0.044	
							(0.069)	(0.066)	
pop_j								0.958 ^c	
								(0.513)	
pop_i								-2.895 ^a	
								(0.580)	
$gdp\ cap_j$								0.384 ^c	
								(0.210)	
$gdp\ cap_i$								-0.280	
								(0.244)	
MA_j/MA_i									0.307 ^a
									(0.091)
w_j/w_i (cor)									-0.031
									(0.053)
pop_j/pop_i									1.791 ^a
									(0.466)
gdp_j/gdp_i									0.334 ^b
Observations	2473	2473	2473	2473	2473	2473	2473	2473	2473
R^2	0.372	0.495	0.865	0.865	0.865	0.865	0.865	0.868	0.867

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All regressions include time fixed effects. Columns 1 and 2 contain region fixed effects. Column 3 to 9 contain dyadic fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

In the first column of Table 3.3, we regress bilateral migration rates only over market access, bilateral distance and year fixed effects and regional dummies to control for time invariant specificities of each region.

The positive impact of MA_j confirms our expectations on the role of market access in migration. States that experience an increase in this variable attract workers. The negative coefficient of MA_i shows that outflows are lower with increasing market access. The negative and significant parameter of the distance is in line with the literature and shows that migrants tend to stay close to their home. In the second column we add the proxy for the stock of migrants. As expected, this variable has a positive impact on migration rates. Market access of the destination turns not significant.

From Column 3 on, we finally define our panel variable and introduce dyadic fixed effects.

We obtain again significant results for both market access variables, suggesting that this indicator plays indeed a role in the migration choice. From the test on the comparison of the magnitudes of both market access coefficients we can conclude that absolute magnitudes are not statistically different. When adding for the stock of migrants once controlling for dyadic fixed effects, there is not sufficient variation in the time of the migrant stock in order to be still significant and market access of the destination and the origin stay both significant (Column 4).

We consider here that the primary channel by which high market access attracts migrants are the good employment opportunities, including not only the type of job but also the high number of available jobs. This last component is typically also reflected by the local unemployment rate, which is often considered in the estimation of gravity migration. Whereas our market access indicator should be a determinant of contracted as well as speculative migration, the unemployment rate is mostly important for the speculative type of migration. As data do not provide us with this distinction explicitly, we try to capture this effect through the unemployment rate.

In Column 5 we thus include a local unemployment rate that we compute from the

survey data, since official unemployment data at the state level is not available.²² None of the two unemployment variables is significant and no changes in our market access indicator can be observed. We do not conclude that unemployment is not a key parameter for migration, but rather prefer the explanation given by Greenwood (1997). He argues that using local unemployment rates in migration equations has many limitations. For instance, a measure of labor turnover could be more appropriate because migrants “are more concerned by rates at which hiring for new jobs is taking place”.

In the next two columns, we introduce two different wage variables. In column 6 we use the wage variables which are obtained without taking into account a possible selection bias. Wages in column 7 are corrected for a potential selection bias. The introduction of the mean of the predicted wages does not alter the coefficients or significance of the market access indicator, since neither for the uncorrected nor the corrected wages we observe a significant impact.²³ In his survey, Greenwood (1997) underlines that empirical evidence has often failed to confirm the importance of wage differentials on migration. According to this author, the non-significant effect of wages could result from the omission of time variant amenities. While our fixed effects control for location-specific features that are constant over time, it is possible that some amenities evolve in the opposed direction of nominal wages.

A further explanation for the non significant effect of wage differentials is that they are reflecting spot wage differentials. But migrants might value other job characteristics like stability or career opportunities more than the actual wage. Aguayo-Tellez et al. (2008) have shown at the individual level that the impact of spot wage differentials on the location decision of Brazilian migrants is not robust.

Another explanation could stem simply from the fact that the regional average of the predicted wages is still too general and neglects a strong heterogeneity between educational or levels. In the next subsection, where we distinguish between different educational levels of workers, we will thus use state-education specific average wages.

²² Regional unemployment rates are only available for some of the big cities on the coast.

²³ We re-estimated Columns 6 to 9 with different specifications of the wage variable, using different correction terms, different aggregation criteria and just observed wages, but none had a significant sign.

In the last two columns, we introduce two additional controls, population and GDP per capita.²⁴ Both variables can be seen as a proxy for local economic activity and are strongly correlated with our market access variable (see Table 3.12). It is thus possible, that the significant coefficient of our variable of interest captures, at least partially, the impact of the evolution of population or of the per capita income. Indeed, when adding the log of the state's population, the coefficient of market access of the state of origin decreases slightly but stays significant at the 10% level.

The negative sign of the coefficient for population at the state of origin, can also be explained by the fact that a higher population is normally associated with a bigger surface and/or a greater number of cities. It is thus more likely that an individual can find a (better) job within the same state and is less likely to be urged to search for a job farer away (keeping in mind that distance has a strong negative impact on the location choice of migrants).

An increase in GDP per capita has a less important impact than an increase in population and does not alter much the magnitude of market access. Also here, coefficients are according to our expectations. Richer regions are much less likely to send migrants.

In the last column, we replace the origin and destination variables by their respective ratios in order to test directly the importance of the differences in these variables between two different states. The regional differences in market access, population and GDP per capita are positive and significant, whereas the ratio of wages is non significant, confirming previous results.

A preliminary conclusion on this first section thus suggests that international market access can be considered as a good indicator for export-oriented economic opportunities and as a determinant of bilateral migration rates.

²⁴ Data on population and GDP for the Brazilian states are from the IPEA (*Instituto de Pesquisa Econômica Aplicada*).

3.6.2 Panel regression - High versus low educated migrants

In this section, we split our sample according to the two levels of education to see whether qualified or unqualified migrants are more sensitive to changes in market access.

In Chapter 2, it is shown that for Brazil the impact of international market access varies between workers with high and low education. It is therefore likely that the impact of market access on migration varies also across educational levels.

According to Redding and Schott (2003), who predict a higher wage premium of market access for skilled workers, we could expect that highly educated workers have a stronger incentive to go to regions with good access to foreign markets. In this case, the coefficient of market access of the destination should be higher for highly educated individuals.

But the opposite effect is also possible: highly educated people might react less to differences in market access because, thanks to their skills, they are more likely to find a job in the region they like most. Highly educated individuals are known to be very sensitive to non-pecuniary location characteristics like pollution, crime rate, schools, parks etc. For example, Levy and Wadycki (1974) have shown for Venezuelan data that educated individuals tend to value amenities much more than low qualified individuals and Schwartz (1973) argues that the negative impact of distance on migration flows diminishes with educational attainment.

We first look at unqualified workers with no more than 9 years of schooling. Results are reported in Table 3.4.

The coefficients for the destination's market access is higher than those found at the aggregated level, but the origin's market access is significant only at the 10% level. The wage variable used in this subsection is the mean of the predicted wages for each state by level of education. It varies between unqualified and qualified workers and corresponds therefore much better to the expectations for each individual. Nevertheless, wages are not significant for low qualified workers. In the last column, we display again the ratio between the origin and the destination variables.

When looking at the estimates for qualified workers, presented in Table 3.5, we see that market access of the origin has similar coefficients and significance as seen for unqualified

Table 3.4: Low skilled migrants

	(1)	(2)	(3)	(4)	(5)
	Migrants over stayers - Low skilled only				
MA_j	0.281 ^b (0.143)	0.409 ^a (0.134)	0.402 ^a (0.123)	0.406 ^a (0.128)	
MA_i	-1.170 ^a (0.150)	-0.413 ^c (0.218)	-0.414 ^c (0.227)	-0.363 ^c (0.214)	
$dist_{ij}$	-0.557 ^a (0.068)				
w_j			-0.103 (0.065)	-0.098 (0.068)	
w_i			0.013 (0.070)	0.026 (0.070)	
pop_j				0.153 (0.664)	
pop_i				-1.664 ^b (0.770)	
$gdp\ cap_j$				0.488 ^c (0.250)	
$gdp\ cap_i$				-0.269 (0.290)	
MA_j/MA_i					0.380 ^a (0.116)
w_j/w_i					-0.063 (0.048)
pop_j/pop_i					0.756 (0.551)
$gdp\ pc_j/gdp\ pc_i$					0.390 ^b (0.175)
Observations	1841	1841	1841	1841	1841
R^2	0.339	0.877	0.877	0.879	0.878

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All regressions include time fixed effects. Column 1 contains region fixed effects. Column 2 to 5 contain dyadic fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

migrants. In none of the columns, market access of the destination turns out significant. Even in the last column, the ratio of market access of the destination and the origin is non significant.

Results at the aggregated level thus seem to be mainly driven by the sensitivity to mar-

Table 3.5: High skilled migrants

	(1)	(2)	(3)	(4)	(5)
Migrants over stayers - High skilled only					
MA_j	0.062 (0.103)	0.074 (0.107)	0.083 (0.109)	0.082 (0.107)	
MA_i	-0.969 ^a (0.134)	-0.351 ^c (0.180)	-0.358 ^b (0.177)	-0.320 ^c (0.177)	
$dist_{ij}$	-0.482 ^a (0.053)				
w_j			0.163 ^b (0.083)	0.166 ^b (0.081)	
w_i			-0.052 (0.073)	-0.004 (0.075)	
pop_j				1.026 ^c (0.573)	
pop_i				-3.746 ^a (0.643)	
$gdp\ cap_j$				0.058 (0.225)	
$gdp\ cap_i$				-0.424 ^c (0.246)	
MA_j/MA_i					0.154 (0.095)
w_j/w_i					0.083 (0.053)
pop_j/pop_i					2.171 ^a (0.437)
$gdp\ pc_j/gdp\ pc_i$					0.232 (0.166)
Observations	1884	1884	1884	1884	1884
R^2	0.373	0.838	0.839	0.844	0.842

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All regressions include time fixed effects. Column 1 contains region fixed effects. Column 2 to 5 contain dyadic fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

ket access of less educated workers.²⁵ Economic opportunities associated to international trade are most important for the location choice of low educated individuals. The most important variable here is the population size, indicating that high educated people search

²⁵ Note that the numbers of observations are much lower here. Coefficients are therefore likely to be of expected signs but estimated imprecisely. This can lead to non significant parameters.

the big agglomerations. But we also observe a positive impact of the destination's wage level. For all educational groups, population size is a significant determinant of bilateral migration rates.

The differences in migration patterns between educational levels can thus be explained in part by their different sensitivity to market access and wages. The findings of no impact of changes in market access is in line with the migration literature cited above, highlighting that with a higher educational achievement non-pecuniary benefits are crucial for the location choice. Unfortunately, we do not have data on amenities so that we cannot directly control for their effects. Of course, it is also possible that international market access and amenities evolve simultaneously and into the same direction. In this case, we risk to overestimate the effect of market access. But given that market access is not significant for individuals with high education, who are known to react the most sensitively with respect to amenities, the coefficients on market access are unlikely to be biased by omitted amenities.

3.6.3 Sector-specific market access - Pooled regressions

In this section, we will use the 2000 Census data set, restricting our attention to workers in one of the sixteen manufacturing industries in our sample. The migration rates used here are defined as m_{ijs} , the probability of worker in sector s living in i to migrate to state j .

The specification of migration rates at the sectoral level enables us to include market access at the sectoral level as regressor in the migration equation. Since we can calculate sector-specific market access only for a single year, results reported in this section are based on a cross-section for 2000. Magnitudes of estimates based on the census data can thus not be compared directly with the estimates on the PNAD panel data set. Estimates in this section refer to differences in levels and not as in the previous sections to growth rates.

As before, we first report in Column 1 and 2 of Table 3.6 regressions including only market access, macro-region fixed effects and the distance parameter.

Coefficients of market access for destination and origin in Column 1 have the expected sign and are highly significant. The introduction of the stock of migrants is again highly

Table 3.6: Sectoral market access

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Migrants over stayers							
MA_{js}	0.139 ^a (0.054)	0.106 ^b (0.050)	0.173 ^a (0.042)			0.166 ^a (0.042)	0.166 ^a (0.040)	
MA_{is}	-0.144 ^a (0.055)	-0.135 ^b (0.052)	-0.245 ^a (0.043)			-0.242 ^a (0.045)	-0.241 ^a (0.042)	
<i>Inter. MA_{js}</i>				0.489 ^b (0.215)				
<i>Inter. MA_{is}</i>				-1.054 ^a (0.266)				
<i>Local MA_{js}</i>					0.145 ^a (0.035)			
<i>Local MA_{is}</i>					-0.226 ^a (0.039)			
$dist_{ij}$	-0.499 ^a (0.076)	-0.336 ^a (0.087)						
$Stock_{ij}$		0.144 ^a (0.034)						
w_j (unc)						0.641 ^a (0.171)		
w_i (unc)						-0.357 ^b (0.149)		
w_j (cor)							0.639 ^a (0.184)	
w_i (cor)							-0.382 ^b (0.153)	
MA_j/MA_j								0.204 ^a (0.033)
w_j/w_j (cor)								0.493 ^a (0.132)
Observations	3201	3201	3201	3201	3201	3201	3201	3201
R^2	0.518	0.531	0.802	0.799	0.802	0.803	0.803	0.803

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. Columns 1 and 2 contain industry and region fixed effects. Column 3 to 8 contain industry and dyadic fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

significant and decreases the parameters of market access but both MA indicators stay significant.

From Column 3 on, in addition to the industry dummies, we use dyadic fixed effects as in the previous section. Note that this doesn't allow us to introduce any other bilateral,

state or industry-specific variables. Both market access variables stay highly significant and with the expected signs. Testing for the equality of the magnitude of the two MA coefficients indicates however, that the origin's market access has a stronger impact than the destination's market access.

Since we have a sectoral market access including the local, national and international component, we can test for the relative importance of each of the components. Column 4 looks at the impact of international market access only. The market access variable used in Column 5 is limited to the access to the own Brazilian state. These two regressions show that it is not only the local or the international dimension that drives the impact of market access, but that all of its components play a significant role in the migration decision. The importance of the international and national component confirm that including only GDP per capita or other pure local characteristics that represent only the local economic activity can not capture migrants that come to a state because of its relative location in the country or in the world economy.

In the previous section, we also looked at the international market access, but at the aggregated level. Unluckily, we cannot compare directly the coefficients on the international part of the sector-specific market access here (Column 5) with the parameters of the international market access used in the panel regressions. Since we are however interested in knowing which one of the two is more important in the migration choice, we re-estimate the impact of the sector-specific international market access as in Column 5 but using regional fixed effects plus the bilateral distance instead of dyadic fixed effects. We then re-estimate the same equation but replacing the market access variable with the one employed in the previous section (Section 3.6.1), the aggregated international market access for all sectors. Comparing the beta coefficients of these two regressions (displayed in the Table 3.13 in the Appendix), we find that beta coefficients of the sector-specific international market access have bigger magnitudes than the aggregated international market access.

These findings, together with the always highly significant impact of MA_{is} and MA_{js} , suggests that even if a region might have a high aggregated market access, this is not necessarily a sufficient argument for a worker to move to that region. The specific sectoral

conditions seem to play a stronger role in sending and attracting migrants.

The next two columns in Table 3.6, we control for wages (uncorrected and corrected for self-selection). As before, differences between the corrected and uncorrected wages are negligible, and magnitudes of the *MA* parameters are not affected. In contrast to the previous section, sector-specific average wages enter the migration equation significantly for the origin and the destination, supporting the explanation that aggregated wages were not accounting for strong regional wage heterogeneity within and across sectors. Estimates in Column 7 represent our benchmark regression, which will be used in Section 3.7 for the prediction of sector-specific bilateral migration rates and the simulation of the impact on migration following changes in the market access variable.

Also in the last column, when using market access and wage ratios between the two states, wages keep their significant impact.

3.6.4 Sector-specific market access - The heterogeneous impact across sectors

NEG theory predicts that the location choice of a firm depends stronger on market access when transport costs are high and increasing returns to scale are important. Industries that have higher transport costs and a high degree of increasing returns to scale should thus be more sensitive to market access. Chapter 1 shows in a cross-country study that out of 27 manufacturing sectors, only 16 sectors exhibit a robust impact of market access on the wage level in the respective industry. We could thus also expect heterogeneity in the sensitivity of migration rates to market access.

To see whether there are differences in the reaction to market access across sectors, we allow the impact of market access to vary across industries. Having sectoral data only for the year 2000, we cannot run regressions separately by sector while controlling simultaneously for dyadic (or even state) fixed effects. In order to keep these controls, we run one regression including all sectors but interact the market access variable with the respective industry dummy. Coefficients of market access reported in Table 3.7 are thus sector specific. All but four out of the 16 sectors show a positive and significant sign for

Table 3.7: Sectoral market access - by sector

Sector	(1)	(2)
	Migrants over Stayers	
	MA_{js}	MA_{is}
Food and beverages & Tobacco products	0.171 ^a (0.060)	0.055 (0.069)
Textiles	0.156 ^a (0.055)	-0.317 ^a (0.068)
Wearing Apparel	0.153 ^a (0.058)	-0.187 ^a (0.071)
Leather, bags and footwear	0.109 (0.104)	-0.464 ^a (0.101)
Wood	-0.075 (0.064)	0.228 ^a (0.067)
Paper and paper products, publishing and printing	0.184 ^a (0.046)	-0.301 ^a (0.052)
Coke, petroleum and nuclear fuel	-0.042 (0.102)	-0.133 (0.092)
Chemicals	0.216 ^a (0.057)	-0.295 ^a (0.055)
Rubber and plastic products	0.273 ^a (0.059)	-0.544 ^a (0.055)
Other non-metallic mineral products	0.118 ^b (0.053)	-0.016 (0.060)
Basic metals	0.028 (0.126)	-0.675 ^a (0.111)
Fabricated metal products	0.224 ^a (0.052)	-0.332 ^a (0.055)
Machinery and equipment	0.206 ^a (0.064)	-0.339 ^a (0.059)
Electrical machinery	0.119 ^c (0.073)	-0.419 ^a (0.066)
Motor vehicles, transport equipment	0.311 ^a (0.067)	-0.416 ^a (0.061)
Furniture	0.193 ^a (0.052)	-0.102 ^b (0.052)
Observations		3201
R^2		0.837

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. The regression contains industry and dyadic fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

the destination's market access and only for Wood the sign is negative. The sectors Food, beverages and tobacco and other non-metallic mineral products are the only ones with a non significant impact for the origin. Again, for wood manufacturing this coefficient is against expectations, being positive and significant.

This detailed regression shows us that previous results are not driven by some particular sectors. We see however that there are differences across sectors, in particular in the magnitudes of the parameters of the origin's market access. Nevertheless, market access seems to play an important role in the migration choice for nearly all manufacturing workers.

These findings are contribute to a better understanding of the NEG forces at work in the real economy. Whereas NEG theory knows only one manufacturing sector that produces one differentiated good with labor completely mobile between the different varieties, we know that in Brazil workers do not move freely between industries. Though we observe the agglomeration effect described in NEG (higher demand attracts new workers and leads to bigger agglomerations), this mechanism is not affecting all individuals in the same way, but depends on the sectoral composition of market access. This will not necessarily attract all workers to the biggest agglomeration but is more likely to lead to different agglomerations, each one more specialized in different industries. Once a region has acquired an advantage in a certain industry (due to comparative advantages or other) and its market access increases for this industry, specialization will be facilitated, because the high sectoral market access will attract corresponding workers. We thus observe an adjustment by the quantity mechanism also at the sectoral level.

3.6.4.1 Market access and migration: impact of education and sectors

In Section 3.6.2 we stated differences in the sensitivity to international market access between high and low qualified workers. To see whether these two groups also differ in their reaction to sector-specific market access, we again split our sample between high and low educated workers. Results are reported in Table 3.8. The wage variable is defined as the mean of the predicted wages (corrected for self-selection) for the individuals from i with education e and working in sector s .

We find that market access has a significant impact both for high and low skilled workers. A difference in the sensitivity to market access can not be clearly seen in these estimations. Results might be driven by restricting the sample only at workers in manufacturing sectors or that we cannot control for growth rates. The state's access to markets in the sector

Table 3.8: Sectoral market access - High versus low skilled

	(1)	(2)	(3)	(4)	(5)	(6)
	Migrants over stayers					
	Low skilled			High skilled		
MA_j	0.198 ^a (0.052)	0.174 ^a (0.054)		0.167 ^a (0.049)	0.151 ^a (0.049)	
MA_i	-0.151 ^a (0.052)	-0.254 ^a (0.057)		-0.324 ^a (0.054)	-0.311 ^a (0.055)	
w_j (cor)		0.540 ^a (0.204)			0.909 ^a (0.210)	
w_i (cor)		-0.246 (0.223)			-0.705 ^a (0.205)	
MA_j/MA_i			0.215 ^a (0.042)			0.235 ^a (0.038)
w_j/w_i			0.394 ^b (0.169)			0.799 ^a (0.147)
Observations	2447	2447	2447	1923	1923	1923
R^2	0.716	0.807	0.807	0.832	0.836	0.835

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All columns contain industry and dyadic fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

the individual is working seems to be important for all individuals. However, we confirm results on wages from Section 3.6.2: high educated workers value differences in wages more than less educated migrants.

3.6.5 Robustness checks - GMM and ML estimations

In the previous sections, we have seen that the market access variables were robust to the inclusion of additional controls and in the case of sector-specific migration and market access, also to the splitting of the sample between different educational groups. Market access could thus be considered as a good indicator for trade-oriented economic opportunities that attracts migrants. There are however still some concerns about the robustness of our results linked to possible omitted variables and the high number of missing trade flows that could affect our results.

First, there is a concern of reverse causality. A region's market access is likely to increase when new migrants come to the region. Regressing only international market

access on internal migration reduces this causality concern. There is however still a risk of some time-varying unobservables like changes in amenities that could be correlated with the error term. To tackle these issues of endogeneity, we perform a two-step GMM estimator applied to first differenced data for the regression reported in Column 3 of Table 3.3. The endogeneity problem is of course much bigger for the sector-specific market access since we include also the local component, but having data for only one year, we cannot perform similar GMM estimations on this data set. In section 3.6.3 we have however presented regressions including only international or local market access to show that results are not driven only by the local component which is the likely to be the most endogenous one.

GMM results are presented in Table 3.9. Conditions for the validity of GMM are met: the transformed error terms exhibit first-order correlations, and the test rejects second-order correlations. Instruments are not rejected by the Hansen and Sargan tests. In the interest of space, we report only the coefficients for the lagged dependent variable and market access. The three regressions presented are identical except for the number of lags chosen for the instruments. Following the recent literature (Roodman, 2009) we minimize the use of instruments to avoid over-fitting. For instance, the first column shows the regression resulting from using only the third and fourth lags as instruments. Standard errors were estimated by using the correction proposed by Windmeijer (2005).

The first lag for our migration variable is never significant, suggesting the absence of persistence in bilateral migration flows after having controlled for origin-destination-pair fixed effects. Whilst more imprecisely estimated, coefficients for destination market access of the GMM estimations are supportive of the results found in our panel regressions above. Regarding origin market access, we fail to find significant coefficients in the GMM regressions.

As a last test for the robustness of our market access indicator, we address the concern of zero-value flows.

Both the survey data from which we obtain migration rates and the trade data we use to compute our market access variable are characterized by a high number of zero-value migration flows. In this context, OLS regressions on our gravity equations can be criticized

Table 3.9: Non linear estimations - GMM

	(1)	(2)	(3)
	Migrants over stayers		
	lags 3-4	lags 3-5	lags 3-6
$mig_{ij,t-1}$	0.21 (0.28)	0.02 (0.21)	0.13 (0.15)
MA_j	0.88 ^b (0.45)	0.78 ^c (0.44)	0.61 ^c (0.33)
MA_i	1.09 (0.74)	0.92 (0.65)	0.77 (0.56)
No. of obs	1514	1514	1514
No. of groups	352	352	352
Hansen(p)	0.31	0.70	0.68
Sargan(p)	0.21	0.52	0.56
AR(1)p	0.02	0.02	0.00
AR(2)p	0.59	0.85	0.59
No. inst.	27	37	45

Standard errors in parentheses, with ^a, ^b and ^c denoting significance at the 1, 5 and 10% levels respectively. Standard errors were estimated using the correction proposed by Windmeijer (2005). All regressions include time dummies and dyadic fixed effects. All explanatory variables are lagged one year. AR(1) and AR(2) are tests for Autocorrelation for the first and second lags. Hansen and Sargan tests indicate the validity of instruments.

because they lead to biased estimates in the presence of many zero value flows. A high number of zero value trade flows is likely to result in biased estimates of the parameters used to compute market access. To treat zero value flows in a gravity equation researchers often recur to non-linear estimations (e.g. Gamma or Poisson regressions) that allow to deal with some specific problems of trade data.

As explained in Chapter 1, a definitive method on how the problem of zero flows should be treated has however not yet emerged (Silva and Tenreyro (2006); Martinez-Zarzoso et al. (2007); Martin and Pham (2008); Helpman et al. (2008); Silva and Tenreyro (2009)). The question is even more difficult to answer when non-linear estimations are combined with location fixed effects (Buch et al., 2006). When the proportion of zeros becomes too important, iterative methods for Poisson or Gamma estimations often do not converge. This problem appears to be particularly acute, when we run trade regressions at the sectoral

Table 3.10: Non-linear estimations - Aggregated Panel data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Migrants over stayers (aggregated flows) with Zeros							
	Poisson		Gamma		Poisson		Gamma	
MA_j	0.889 ^a (0.249)	0.340 ^b (0.149)	0.762 ^a (0.158)	0.175 (0.191)				
MA_i	0.056 (0.107)	-0.164 (0.198)	-0.008 (0.144)	-0.181 (0.386)				
MA_j (zero)					0.823 ^a (0.267)	0.092 (0.152)	0.863 ^a (0.192)	0.114 (0.218)
MA_i (zero)					0.083 (0.136)	-0.173 (0.152)	0.074 (0.164)	-0.159 (0.292)
$dist_{ij}$	-1.136 ^a (0.073)	-1.213 ^a (0.070)	-1.126 ^a (0.070)	-1.345 ^a (0.064)	-1.143 ^a (0.077)	-1.213 ^a (0.070)	-1.136 ^a (0.071)	-1.345 ^a (0.064)
Fixed effects	region	state	region	state	region	state	region	state
Observations	4550	4550	4550	4550	4550	4550	4550	4550

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All columns include time fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

level. The proportion of zeros is even higher than in the case of the cross-country sectoral data in Chapter 1. Here the proportion can easily surpass 80% for several sectors, and iterative methods for Poisson or Gamma estimations do not converge. In order to explore the sensibility of results to a nonlinear estimation including zeros, we reduce the dimensionality of the zeros, by dropping all countries that trade with less than 20 partners. The proportion of zeros in the more extreme cases then falls to maximal 50%, allowing the convergence of all but one sector. Still, in an important number of the regressions border effects or fixed effects are not identified, reducing dramatically the quality and availability of market access measures. We thus keep as our main variable market access obtained by OLS estimations.

In Table 3.10, we report Poisson and Gamma regressions on all possible bilateral migration flows, including migration rates that take the value zero in our data set. Two kinds of location fixed effects were considered: macro region fixed effects and origin and destination state fixed effects. Regressions with origin-destination-pair fixed effects as used before do

Table 3.11: Non linear estimations - Sectoral MA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Migrants over stayers (sector specific) with Zeros							
	Poisson		Gamma		Poisson		Gamma	
MA_{js}	0.427 ^a (0.115)	0.308 ^a (0.092)	0.371 ^a (0.070)	0.205 ^a (0.074)				
MA_{is}	-0.066 (0.123)	-0.118 (0.097)	0.034 (0.069)	-0.067 (0.084)				
MA_{js} (zero)					0.069 (0.050)	-0.018 (0.037)	0.076 ^b (0.035)	0.084 ^b (0.034)
MA_{is} (zero)					-0.049 (0.058)	-0.030 (0.032)	-0.027 (0.034)	-0.070 ^b (0.031)
$dist_{ij}$	-0.992 ^a (0.169)	-1.167 ^a (0.105)	-1.125 ^a (0.098)	-1.395 ^a (0.084)	-1.004 ^a (0.169)	-1.156 ^a (0.107)	-1.083 ^a (0.098)	-1.378 ^a (0.085)
Fixed effects	region	state	region	state	region	state	region	state
Observations	11232	11232	11232	11232	10530	10530	10530	10530

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All columns contain industry fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

not converge and are thus not displayed here. The absence of dyadic fixed effects allows the inclusion of the distance coefficient.

In the first four columns, we use the same market access variable as in Table 3.3, but the migration equation is estimated using Poisson or Gamma methods including all zero value migration flows. The count data methods confirm a positive impact of the destination's market access. However, including the zeros leads to a non significant impact of the origin's market access.

In the second half of the table (columns 5 to 8), we repeat the same regressions, but use a market access variable that is computed including zero trade flows. Hence, estimations in both stages are made using count data methods.

Table 3.11 shows the corresponding estimations for the sector-specific migration rates and sectoral market access. Market access of the destination is mostly significant and in the last column, also the origin's market access enters significantly the migration equation.²⁶

²⁶ We have fewer observations when we use market access which has been calculated using zeros because in this case, trade equations for two sectors do not converge. They are thus excluded from the regression.

The non-linear estimations, as well as the use of *MA* measures including zero trade flows confirm main results from the OLS regressions in the previous sections. Results here are also in line with those found in the GMM regressions, which suggest that the destination's market access is robust across specifications.

3.7 The impact of national and international integration: Simulations

In this final section, we simulate a reduction of impediments to trade in order to better understand the impact of market access and its evolution on the migration pattern within Brazil. The classical question asked in NEG models is the following: How will a reduction in trade costs influence the number of migrants and their destination choices? To approach this question, two issues must be operationalized. First, what kind of aggregation level should be used (regional, sectoral, both)? Second, what kind of trade cost changes should be simulated?

Regarding the first issue, we prefer an approach that takes into account the sectoral as well as the regional dimension, we thus look at bilateral migration rates that are sector-specific as in Section 3.6.3.

Migration is interpreted as an adjustment mechanism for spatial disequilibria. As long as trade affects wages, trade will affect migration. Nevertheless, the source of regional differentials in trade performances can result in different consequences on the migration patterns. In traditional trade models, workers relocate between sectors. However, empirical evidence for Brazil points out that sector relocation is weak (Menezes-Filho and Muendler, 2007). Hence, spatial differences related to specialization should be reflected in wage differentials favouring regions specialized in sectors in which Brazil holds a comparative advantage. Under these conditions, migrants are likely to go to regions having a comparative advantage in the sector they are specialised in. When in addition increasing returns come into play, migration rates will also reflect advantages linked to the relative location of the regions (irrespective of comparative advantage). Since most manufacturing

industries are likely to exhibit some increasing returns to scale, increasing returns could thus affect comparative advantages.²⁷

In the case of trade liberalization we thus expect that regions that have a traditional comparative advantage in one of Brazilian's main exporting industries, will exhibit more intense net immigration and that the net inflows are higher the more important the industry's returns to scale. Estimating potential changes in migration rates at the sectoral level appears thus to be the appropriate aggregation level.

Regarding the choice of trade cost reduction, we have to consider the Brazilian context. In the recent past, Brazil undertook much effort to equilibrate national and federal demands of competitiveness trying to improve internal and international integration. Recent policies aiming at interlinking and developing Brazilian regions are the investment in highways, tax exemptions intended to raise competitiveness for some lagged regions, and, of course, the famous relocation of the capital to the interior of the country in an entirely new city (Brasilia). In parallel, there have been trade liberalization policies aiming at integrating Brazil into the world economy. These reforms took the form of unilateral reduction of tariffs and the creation of a common market within the Mercosur. All these efforts led to higher trade flows and are reflected in an increase of Brazil's market access in a whole. Some states like Amazonas, São Paulo and Santa Catarina, saw their market access increase in particular because of their location close to the new national and international markets.

In this following section, we investigate the possible consequences of a further reduction in internal and external trade barriers on the internal migration pattern. Which type of liberalization, the international or the intranational one, changes more the spatial distribution of the work force in Brazil? Which sectors appear more concerned?

To answer these questions, we perform a simulation exercise of migration flows similar

²⁷In theory, increasing returns may reverse comparative advantage. Referring to the potentially opposite effect of increasing returns with respect to traditional theory models, Krugman (1999) states: "[...] Factor mobility will tend to increase differences among regions rather than reducing them, and instead of substituting for regional specialization will promote it". Nevertheless, these considerations applies better when the analysis starts from symmetric regions (in terms of endowments). In practice, Brazilian regions are today too different in terms of human and physical capital, so we expect a moderate effect of increasing returns rather than a reversal. See Chapter 4, for a study in a setting where breaking of the symmetry is more pertinent.

to Hunt and Mueller (2004), who study intra- and international migration between Canada and the US, focussing on returns to skill and on the international border effect as main migration determinants. These authors predict migration rates based on their migration equation. In order to evaluate the consequences of a decrease in the international border effect, they reduce gradually the value of the coefficient of the border effect obtained in the estimation of their original migration equation. The impact of the different magnitudes in the international border effect is then measured in terms of changes in the migration rates in comparison to the benchmark (with the observed border effect).

Instead of just mechanically reducing the whole component of trade costs, we prefer to study the impact of the specific variable that could be eventually modified by policy makers by tariff reductions, the decline of paper work or others: the average border effect.

We distinguish between two border effects. The international border for trade between Brazil and another country, and the intranational border effect for trade between two Brazilian states. For international (intranational) trade liberalization we reduce the value of the estimated coefficient of the international (intranational) border, which are obtained separately for each sector from the gravity equation, by first 50% and then 100%. When reducing the national border effect, the coefficient of the international border effect is not changed and vice versa. It is important to note that the applied reduction is on the “average” border effect of each sector. But since border effects vary across sectors, a 50% reduction can represent a much larger reduction for one sector than for another. Because of regional specialization, the impact of this reduction is thus not balanced among Brazilian states.

Computing market access with the reduced border effects shows that the overall increase in market access when reducing the international border effect is sizeable, but not as big as when reducing the national border effect. We limit our analysis on the results obtained when reducing the border effect to 50% and 0%, given that the effects are linear. Results do not change qualitatively between different levels of border effect reduction, but only in magnitude. Figures reported concentrate on the 50% reduction, which is already a very strong decrease - a complete annulation of any border effect being even less realistic.

The counterfactual sector-specific bilateral migration rates are obtained using the new values of sectoral market access in the specification from Column 7 of Table 3.6. In order to be able to make predictions in absolute numbers, we will employ as our dependent variable migrants over the whole population instead of migrants over stayers.²⁸ As shown in Table 3.14 in Appendix A, coefficients do not change significantly.

Note that our simulations capture only the direct effect of a reduction in the border effect on the migration rates. Since we cannot predict neither the indirect effect of market access on migration via its impact on wages nor do we control for physical endowment and comparative advantages of industries, we cannot draw conclusions on the final impact of trade liberalization on regional specialization or on the spatial distribution of the work force. Our simulations mainly highlight that a reduction in trade costs can have an economically significant impact on migration rates and that effects are likely to vary substantially across states and sectors.

3.7.1 Changes in sector-specific migration rates

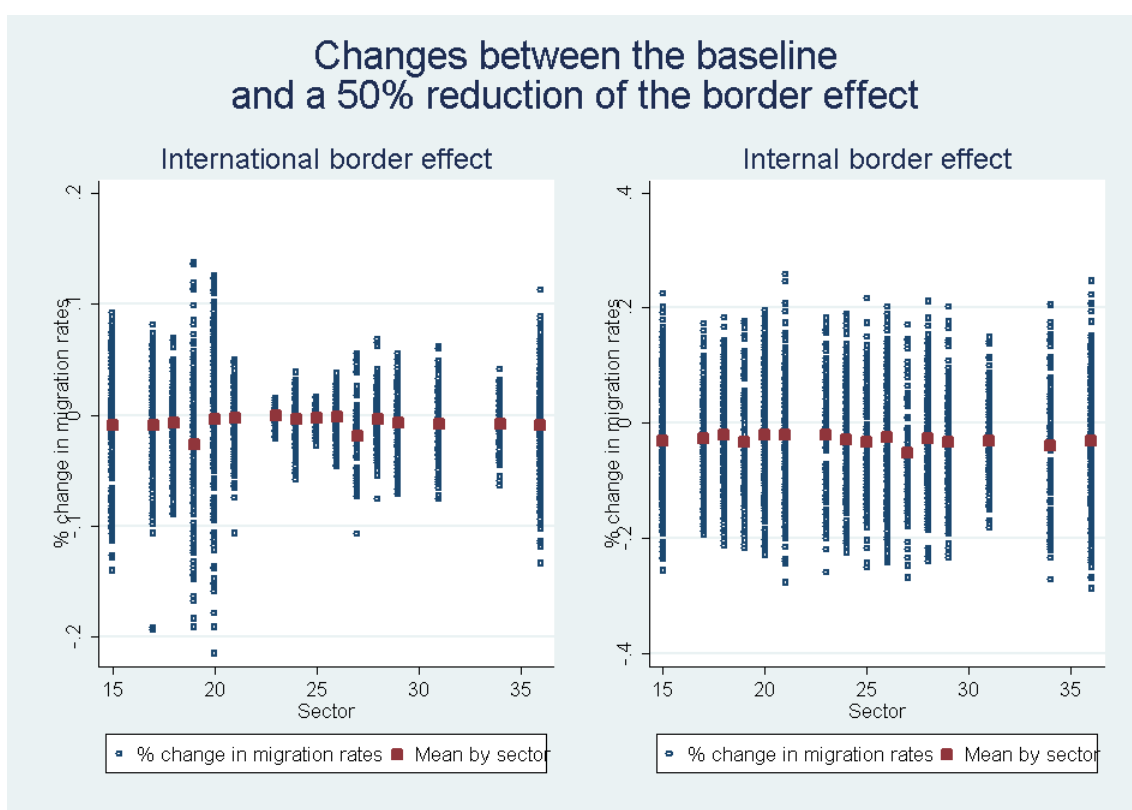
Figures and tables in this and the following section concentrate on the computation of migration rates obtained with a reduction of 50% of the original border effect (either of the international or the intranational border). Figure 3.4 plots the change in percentages in each sector-specific bilateral migration rates once for international and and once for intranational trade liberalization. On the x-axis, we report the sector of origin of the migrants.

For both types of liberalization each sector will experience an increase in some migration rates and a decrease in others. Changes are more important for a decrease in the intranational border effect, but are still very low on average. The averages below zero indicate that we will see a decrease in the total number of migrants. Most importantly, the graphics reveal important variations of the impact of a decrease in the border effect across sectors mainly in the case of international trade liberalization. Sectors like coke and

²⁸ When obtaining an increase of i.e. 5% of the migration rates when using migrants over stayers, this results could be due to an increase in migrants or a decrease in stayers. Using total population which stays constant is alleviating this problem.

petroleum (23) show only little reaction to a decrease in the border effect. In Table 3.7, we couldn't find any significant impact of market access in this sector. Variations are more stronger for Fabricated metal products (28) and Machinery and equipment (29), where we also observed an important impact of market access. Variations for Leather, and especially Wood production, should be interpreted more cautiously since the destination's market access has not been found significant.

Figure 3.4: Simulation: Changes in migration rates by sector



Source: Own calculations. Codes for sectors s are reported on the x-axis (see Table 3.15 for the corresponding names of each sector). Migration rates are defined as m_{ijs} , the probability of worker in sector s living in i to migrate to state j .

These findings highlight the fact that NEG implications for wage inequality are highly sector-specific: we can expect that wage differentials in certain industries remain higher, because migrants are limited in their spatial movements. In other sectors, a human capital specificity allows workers to reap important gains, which provides enough incentives to

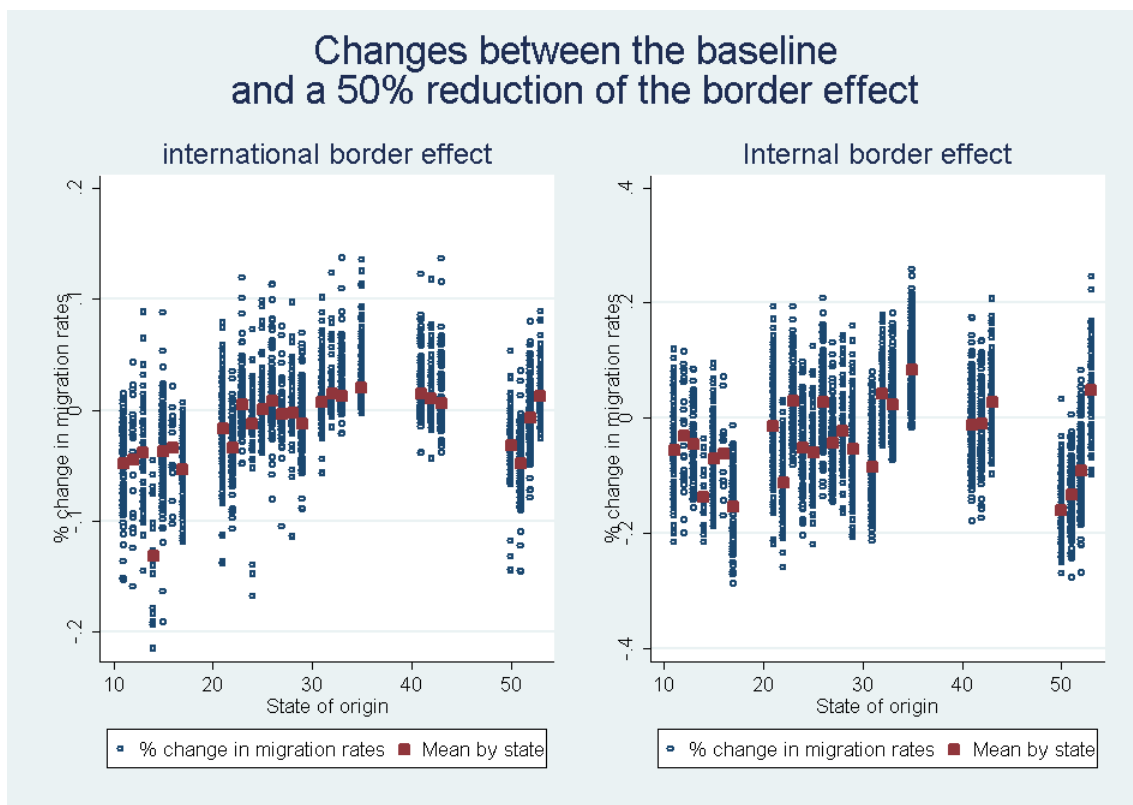
migrate even to places far away. If trade liberalization in Brazil is changing market access, the benefits are likely to be captured mainly by these manufacturing workers.

Since the location choice depends strongly on the sector in which the individual is working, spatial wage inequality can persist since regions specialize in different industries and workers are not sufficiently mobile between these industries to induce a factor price equalization.

3.7.1.1 Changes in state-specific migration rates

Having uncovered the differences across industries, we want to see how the spatial migration pattern changes. Are certain industries agglomerating in certain states and are there regions that will see an increase or a decrease in net immigration? Figure 3.5 plots again the change in percentages for each type of trade liberalization for each sector-specific bilateral migration rate. Here, we report on the x-axis the state of origin i of the migrant working in sector s . That means, a negative change corresponds to the result that less people working in a specific sector s are leaving i to go to j . We find that each state sees certain migration rates decrease and others increase, but the average is for some positive and for some negative.

Figure 3.5: Simulation: Changes in migration rates by state of origin

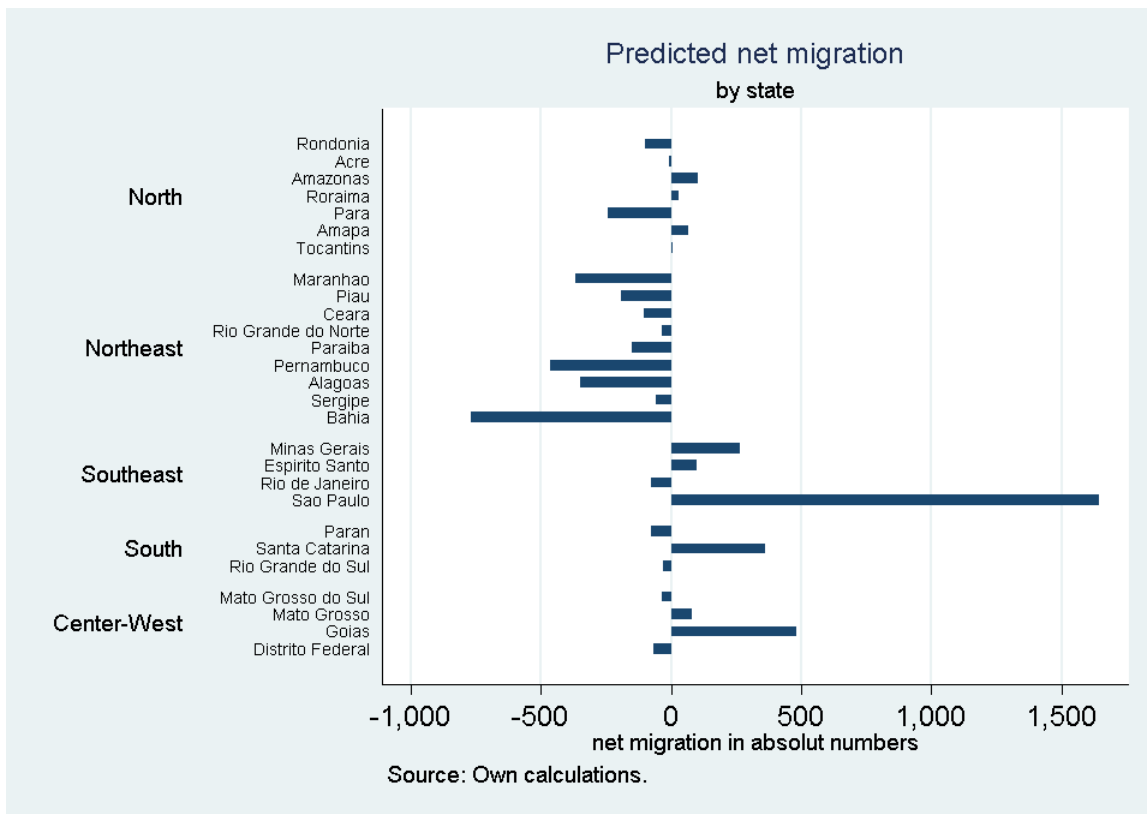


Source: Own calculations. Codes for states of origin i are reported on the x-axis (see Table 3.1 for the corresponding names of each state). Predicted migration rates are defined as the probability of worker in sector s living in i to migrate to state j .

In São Paulo (35) and the other states of the South East (30 - 34) international trade liberalization leads to an increase of most of the migration rates, meaning that they see more people leave these states than before. On the contrary, emigration of the Northern states (11 - 17) is less pronounced than before. Many of the predicted emigration rates from this region are much lower after a reduction in the international border effect. Hence, following an international trade liberalization, the North becomes relatively more and the South East relatively less attractive for workers. A similar pattern is observed as a consequence of intranational liberalization.

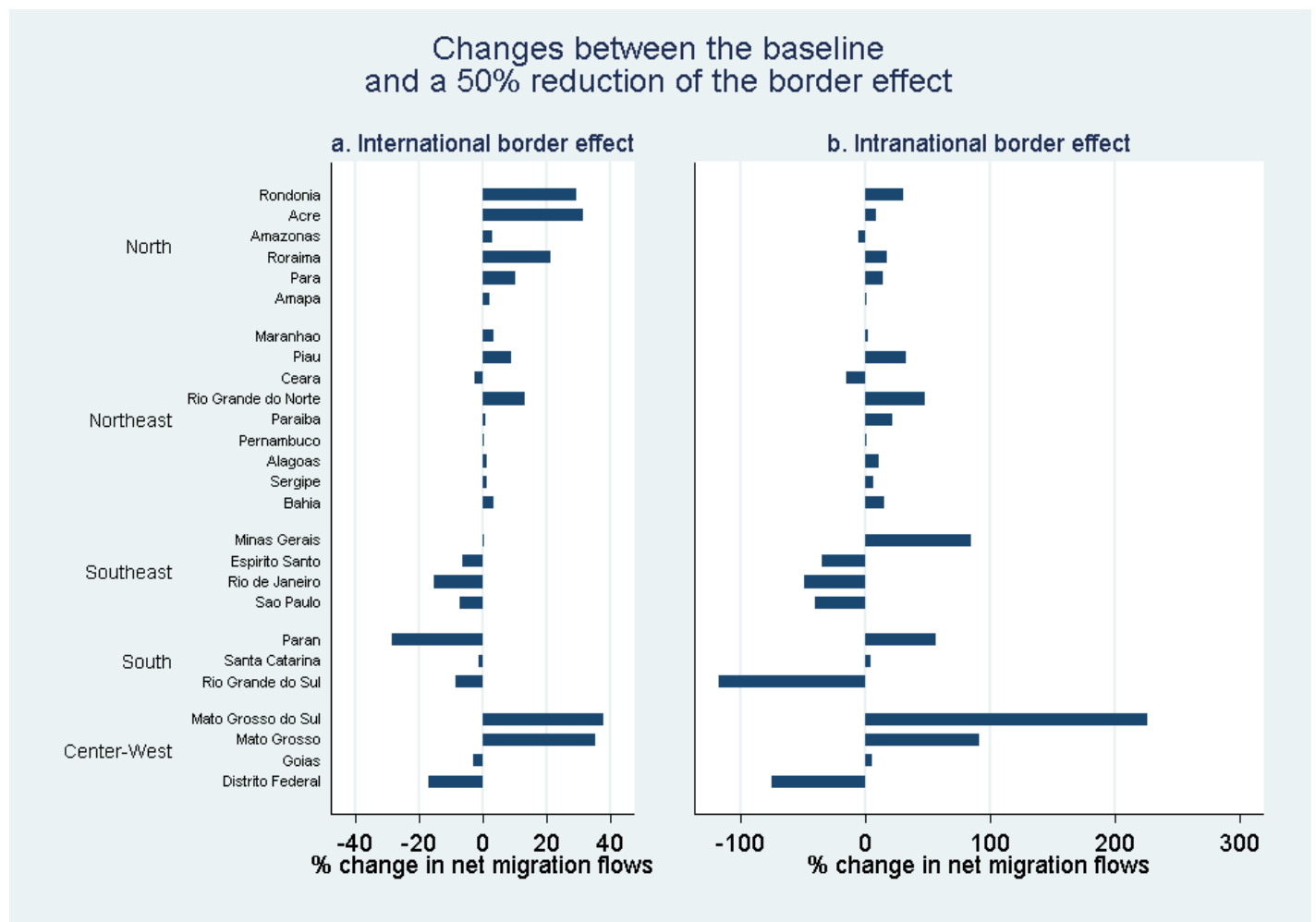
We then calculate the absolute number of migrants and find that overall migration has decreased after trade liberalization. In our data set we observe 16,298 migrating manufac-

Figure 3.6: Predicted migration rates



Source: Own calculations. Net migration rates are calculated using sector-specific bilateral migration rates predicted based on estimates of Table 3.14, Column 2.

Figure 3.7: Simulation of changes in migration rates



Source: Own calculations.

turing workers in 2000 (household heads only). Our benchmark regression from Column 7 in Table 3.6 underestimates slightly the total number of migrants, predicting only 14,301 migrants.²⁹ Reducing the international border effect by half will result in a prediction of only 14,158 migrants and no border effect at all in 13,651 migrants. Nevertheless, there are several states that will receive more migrants than before. In order to see which states will benefit in terms of additional migrants from the decrease in the border effect, we calculate net migration rates before (obtained from the benchmark regression) and after its reduction.

Figure 3.6 shows the resulting net migration for each state calculated with predicted sector-specific bilateral migration rates from our benchmark regression. As can be seen, São Paulo (Southeast), Santa Catarina (South) and Goiás (Center-West) exhibit a positive net migration, while the North and Northeast (with the important exception of Amazonas) tend to exhibit negative net migration. The dramatic emigration from the poorest regions in the Northeast is a very well known fact of Brazilian migration (Fiess and Verner, 2003). This picture is simply the actual pattern of migration in Brazil.

The impact of our exercise on net migration flows for each state can be seen in Figure 3.7. The percentage changes for each flow after a hypothetical reduction in the international border effect are reported in Panel (a). The simulations predict important movements towards two states of the Center-west, Mato Grosso do Sul (50) and Mato Grosso (51), the neighboring Northern state Rondonia (11) and Acre (12). We confirm the decrease in net immigration to the states of the South-East that we have stated already in Figure 5. Hence, trade liberalization favours the “penetration to the interior” of Brazilian territory, the intended strategy of the country since its Independence.

Patterns are very similar in the case of intranational migration (3.7, panel (b)), but magnitudes are stronger, exceeding changes of 100 % for several states. In particular, Mato Grosso (50) and Mato Grosso do Sul (51) in the Center-west and the neighboring state Minas Gerais (31) see their net inflows increase substantially. States of Brasilia and Rio Grande do Sul (43), experience the most important losses. Interestingly, for Southern state

²⁹ Absolute numbers are obtained using Column 2 or Table 3.14.

Parana (41), we observe a sizeable reversal of the net migration flow between intranational and international trade liberalization. This suggests that this small state could benefit from its central position within Brazil, next to São Paulo and its equidistant proximity to the two rich Southern states and to the emerging Center-West. In the case of a better integration of the Brazilian states, its location close to the economic centers of Brazil becomes even more advantageous.

Also the state of Amazonas exhibit opposite outcomes in net migration after the simulation of international versus internal trade liberalization, also if to a much lesser extend than Paraná. This can be explained by the fact that, on the one hand, Amazonas holds an Export Processing Zone which allows preferential access to foreign countries. Also Amazonas is engaged in a very active trade with the neighbouring countries Columbia and Venezuela, as explained in Chapter 2. In the Chapter, it is also indicated that its relatively high access to foreign markets stands in opposition to a very weak national market access. Under the international border effect reduction, Amazonas' neighbours in the North (Rondônia, Acre, Roraima) also benefit. After the reduction of the intranational border effect, Amazonas exhibit a negative net migration, and also the net gains of its neighbors are slightly lower.

3.8 Conclusion

This study analyzes the impact of trade on internal migration decisions in a New Economic Geography framework by looking at the relationship between market access and bilateral migration rates. We regroup migrants into 16 sectors and two educational levels and show how migration patterns and reaction to changes in market access vary across different types of workers.

We see that access to markets plays an important role in the migration decision beyond the effect that market access has on wages which are themselves important determinants of migration flows. States with low market access push residents to migrate to states with higher market access, where higher labor demand offers more jobs and higher wages. Low educated workers seem to be more sensible to changes in market access than highly educated workers.

For manufacturing workers, we see that sector-state specific market access plays a more important role in their migration decision than the state's total market access and that sector-specific market access is significant for all high and low educated migrants. Market access is significant for nearly all manufacturing sectors. Our robustness checks, including GMM and count data methods confirm a positive and significant impact of the destination's market access on bilateral migration rates.

The fact that migration patterns are apparently also driven by industrial specialization suggests that implications of NEG theory (i.e. regional advantages generated by the region's position in the spatial economy) are better understood in combination with comparative advantage in a context of low sectoral labor reallocation.

The coefficients obtained in this exercise for market access and the other migration determinants have been used in simulations for gaining some insight on possible consequences of a international or intranational trade liberalization on migration patterns within Brazil. We find that a deepening of the integration process within Brazil leads to a slight decrease in the absolute number of migrants and has a very heterogeneous impact across sectors and across states. Changes in trade pattern are thus likely to have a significant impact on the redirection of migration flows.

3.9 Appendix

3.9.1 Additional tables

Table 3.12: Correlation table

	m_{ij}/s_i	MA_j	MA_i	w_j (cor)	w_i (cor)	pop_j	pop_i	$gdp\ pc_j$	$gdp\ pc_i$
$m_{ij}/stayers_i$	1.0000								
MA_j	0.0885	1.0000							
MA_i	-0.3167	-0.0266	1.0000						
w_j (cor)	0.0119	-0.1604	-0.0184	1.0000					
w_i (cor)	-0.1423	-0.0060	-0.0370	0.4666	1.0000				
pop_j	0.1993	0.7499	-0.0532	-0.0147	0.0059	1.0000			
pop_i	-0.4046	-0.0204	0.7224	0.0765	0.1478	-0.0518	1.0000		
$gdp\ pc_j$	0.1837	0.0198	-0.0301	0.5499	0.0995	0.2682	-0.0207	1.0000	
$gdp\ pc_i$	-0.1856	-0.0157	0.0487	0.4622	0.7940	0.0209	0.2901	0.2106	1.0000

All variables are in logs. Dependent variables MA_j to $gdp\ pc_i$ are lagged one year.

Table 3.13: Aggregated versus sectoral market access

	(1) OLS	(2) beta	(3) OLS	(4) beta
<i>Inter</i> MA_{js}	0.495 ^a (0.172)	0.310 ^a		
<i>Inter</i> MA_{is}	-0.726 ^a (0.179)	-0.453 ^a		
<i>Inter</i> MA_j (agg)			0.491 ^a (0.059)	0.116 ^a
<i>Inter</i> MA_i (agg)			-1.257 ^a (0.062)	-0.279 ^a
<i>dist</i> _{ij}	-0.500 ^a (0.030)	-0.217 ^a	-0.485 ^a (0.028)	-0.210 ^a
Observations	3201	3201	3201	3201
R^2	0.510	0.510	0.576	0.576

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. All columns contain industry fixed effects. Standard errors in parentheses, clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

Table 3.14: Coefficients for simulation

	(1)	(2)
	$m_{ij}^s/stayers_i$	m_{ij}^s/pop_i
MA_j	0.166 ^a (0.042)	0.165 ^a (0.040)
MA_i	-0.242 ^a (0.045)	-0.232 ^a (0.042)
w_j	0.639 ^a (0.171)	0.654 ^a (0.172)
w_i	-0.357 ^a (0.149)	-0.305 ^b (0.132)
Observations	3201	3201
R^2	0.803	0.0805

^a, ^b and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. Both columns contain industry fixed effects. Bootstrapped standard errors in parentheses (1000 replications), clustered at the origin-destination level. Explanatory variables are in logs and lagged one year.

Table 3.15: Manufacturing industries

Industry code	Industry
15	Food and beverages & Tobacco products
17	Textiles
18	Wearing Apparel
19	Leather, bags and footwear
20	Wood
21	Paper and paper products, publishing and printing
23	Coke, petroleum and nuclear fuel
24	Chemicals
25	Rubber and plastic products
26	Other non-metallic mineral products
27	Basic metals
28	Fabricated metal products
29	Manuf. Machinery and equipment
31	Manuf. Electrical machinery
34	Motor vehicles, trailers & other transport equipment
36	Furniture

Chapter 4

Footloose cities in *Terra Incognita*: Stability of Spanish city distribution in the New World

*The Indians first, by novelty dismayed,
as Gods revered us, and as Gods obeyed;
But when they found we were of woman born,
Their homage turned to enmity and scorn*

Alonso de Ercilla, 1569.

La Araucana. Poem II, p. 42
English version In: Crow (1960)

*No nation would undertake the conquest of an uncultivated country, which is
defended by its miseries better than could be done by arms.*

Captain Antonio de Alcedo, 1786.

The Geographical and Historical Dictionary of
the America and the West Indies. Vol 2, p.217.

4.1 Introduction

Economic development seems to be closely linked to urbanization levels, as stated by classic development economists. Some of them emphasize rural-urban migration as a precondition to industrialization (Lewis, 1954; Harris and Todaro, 1970), while others focus on agglomeration economies that foster the development of cities or industries (Marshall, 1920; Christaller, 1933). Recent theoretical and empirical works introduce new factors like institutional quality (Acemoglu et al., 2005), trade (Fujita et al., 1999) and physical geography (and its consequences like disease environment) (Gallup et al., 1998; Voigtlander and Voth, 2009) as key determinants for urbanization, and hence, for economic development. By construction, all these ingredients interact and reinforce themselves, making identification of their respective contribution an elusive task. One way to deal with this problem is to look for natural experiences where exogenous discrete changes hit an economy. For instance, Acemoglu et al. (2005) look at the differentiated access to Atlantic trade in the Discovery Age to explain subsequent divergences in urbanization among European countries. The same authors show that the impact of colonization experiences in current development levels is significant (Acemoglu et al., 2002).

Therefore, studying colonization experiences permits to control of initial conditions and to follow an agglomeration process step by step. Imagine economic agents that create from scratch an economic system in a territory that they enter for the first time. They have to put together resources, cope with uncertainties and obstacles, and transfer and adapt their institutions to survive and prosper. Let the system evolve for 300 years. What do you get? Between 1492 and 1810, such an experience took place in the Americas. After the Encounter in La Hispaniola by Columbus, the Spanish crown developed a complex system of incentives and administration to spread a population of colonizers in a surface around 40 times bigger than the Iberian Peninsula. The coverage was impressive: with the foundation of Santiago (Chile) in 1541, all present-day countries with Spanish influence in the Americas were officially colonized. However, this frenetic colonization came at a price. Hundreds of cities were established in a hurry, and were abandoned or relocated. Civil wars exploded among conquerors for resources in the first century of the Conquest, and pirate

attacks and Indian rebellions were common through all the period. Natural disasters and demographic collapse took by surprise a group of men prepared for war but not for hazard management. The citations in the beginning of the introduction stem from two soldiers around the beginning and the end of the Spanish rule in the Americas. The first is referring to the fierce resistance by the Mapuche Indians in the South of Chile, while the second is the explanation given by a captain to justify the scarce progress of Spanish colonization in Guayana. They recall us that the promise of fast and easy prosperity of the New World contrasts with an image of instability and permanent internal and external threats.

In this study I follow the evolution of cities founded by Spaniards in America to assess the success of its colonization effort in terms of urbanization stability. I focus on the organization of the spatial economy, because it is a central pillar of the surge of a civilization in general (Bairoch, 1988), and in particular for Latin America, because the Colonization process is linked to its urban development (Sanz, 2004). I treat two questions.

1. Is the urban system stable over time? Specifically, Were the location chosen by the first Conquerors successful? Testing persistence is often an elusive task due to the impossibility of properly control for initial conditions. In this study I follow the history of each city from its birth, along its multiple settlements and eventually its abandon. I also introduce several controls for initial conditions previous to the arrival of Spaniards. The test for persistence is based on the impact of huge, exogenous shocks on cities. Like previous studies, I confirm a great stability in the urban system over the very long-run, but in opposition to them, I also find evidence of great instability in specific (and relatively long) periods in the early periods. This is possible to detect because I do not take locations as fixed, as other studies did. In this study, identification of persistence comes from events of total abandon of locations following strong, exogenous shocks, like natural disasters. I found that the number of disasters is positively associated to the abandon of a location. Moreover, the relationship is non-linear: some cities like Mexico City received a high number of huge disasters, but they were never abandoned. This evidence suggests the presence of a hysteresis in the success of locations. Big temporary changes can change the final settlement of a city, but the cities surviving after a certain period, become highly resilient to big shocks.

2. What determines persistence or change in the urban system? Some theories stress the primacy of first nature geography (e.g. natural harbors, rivers, mines and other endowments) for the development of an economy, suggesting a deterministic path and a single equilibrium. By contrast, other traditions focus on human-made locational advantages arising from institutions or agglomeration economies (second nature geography). In the latter case, path dependency and multiple equilibria may be present. I rely on duration models to explore the relative importance of several location characteristics: the progressive development of the urban system, the proximity to mining resources, the status of port, the remoteness from political and economic centers, among others. Results suggest that all these variables (except ports) are playing a role. The different stages of political and economic development affect the urban stability. In the earlier periods of the Conquest, political disorders together with an orientation to extractive activities seem to explain a high urban instability, with proximity to mining contributes notably. In later periods, when the empire stabilizes, demographic decline starts to reverse, and new economic activities appears there are important changes in urban stability: mining proximity is no longer a source of instability, and proximity to great political and economic centers starts to matter.

Studies on urban stability and growth are diverse in their methodologies (I revise them in detail in section 4.3.1). Some analyses resort to case studies (Krugman, 1991a; Glaeser, 2005a,b; Campante and Glaeser, 2009). Cities are followed over long periods of time, showing the role of first and second nature. For example, New York had the best geographical conditions to become the main port of the United States. Nonetheless, this advantage interacted with historical events and the city reinvented its economic structure and capabilities several times. Although very informative on the microeconomic mechanisms behind urban evolution, these works are limited in providing with a general answer beyond the specific cases they develop. Other researchers prefer to econometrically assess the impact of endowments, infrastructure, education, etc on urban outcomes like population growth or density. As expected, their regressions are plagued of endogeneity problems. The most interesting avenue of research exploits exogenous temporary shocks and looks for the response of city growth (Davis and Weinstein, 2002; Bosker et al., 2007; Redding et al., 2007).

Overall, these studies found mixed results, and we note that most of them have been made for either Germany or Japan, because such particular experiences are rare (both countries suffered from intensive bombing during the World War II).

This study innovates in three aspects. First, it explores urban evolution in the very long-run, by looking at the Spanish colonial rule in the Americas. Extensive data for 22 present-day countries for a period of almost 350 years is collected, which makes its spatial and temporal coverage much more complete than previous studies. Second, it restates the problem of detecting spatial equilibria by looking for a setting where initial conditions can be better controlled. Third, although inspired by the idea of using big shocks over the urban system to determine the presence of hysteresis, it innovates by looking at a new test of hysteresis and new econometric methods.

In addition, studying the economic history of the New World is interesting by itself. There is little (but growing) cliometric research on long-run evolution of Latin American countries (see, for example, Williamson, 2009; Garcia-Jimeno and Robinson, 2009; Bruhn and Gallego, 2008; Dell, 2009) or colonization in general (Huillery, 2009, Nunn, 2008, Acemoglu et al., 2002). This work pretends to bring new kinds of information to this literature. To my knowledge, all datasets presented here are completely new and can help to shed light to several aspects of the colonization period.

The rest of the chapter will proceed as follows. In Section 2 I revise the main antecedents of the Spanish colonization in the Americas. Section 3 is devoted to the identification strategy, estimation issues, and how the data was collected. Section 4 presents the results of the study. The last section summarizes and concludes.

4.2 Spanish colonization as a natural experience

I revise the historical and institutional context of the Spanish rule in The Americas, with a focus on economic consequences. The exposition is selective, looking for elements that show the pertinence of this natural experience to empirically assess urban stability. Table 4.5 in the Appendix gives a chronology of the main events of the Spanish rule in the Americas.

4.2.1 Initial condition: Pre-Columbian spatial economies

At the onset of Spanish arrival, several levels of complexity in state formation coexisted in the Americas (See the Figure 4.1 taken from Benson et al., 2005). In Mesoamerica (Center of Mexico), the Aztec empire had initiated a consolidation of their frontiers through warfare, established a tax system (mainly tributes in-kind), built roads and fostered trade. Other minor cultures were also present in the region, in particular the Tarascan empire in the West (Williams, 2005), and several city-states in the East, like the Tlaxcala kingdom, as well as some city-states covering the ancient Maya Civilization (South of Mexico, Guatemala) which declined several centuries before (Gill et al., 2007; Diamond, 2005). Anthropological evidence collected by Steckel (2004) points to a high variation in health status, with the population often suffering from pathological lesions and poor nutrition. Also warfare and human sacrifices were pervasive in the region.

In South America, the Inca empire represented the most complex structure in the continent, covering extensive regions of Peru, Chile, Argentina, Ecuador and Colombia. An extensive network of bureaucrats was in charge of collecting taxes. In opposition to the more market-oriented system developed in Mesoamerica, the Inca empire could be seen as a State-planned economy, where taxes were payed often in terms of hours of works (a system called *mita*) destined to the execution of public works like irrigation systems (Stanish, 1997; Smith, 2004). The state developed an extensive network of storehouses, supposedly to smooth consumption on the population (while keeping a strong political control), which bring some authors to use the term *Pax Incaica* to refer to the Inca domination (Kuznar, 1996; Cartwright, 1963). Finally, the state's ideology was actively present through political measures like marriages between local chiefs and the Inca elite, forced resettlement of large populations across the empire, long-distance transport of rocks from the core to the peripheral regions to build monuments (Ogburn, 2004; Salomon, 1978), among others.

Trade was intense inside of the advanced Pre-Columbian civilizations, with a developed level of connectivity. The most impressive case is the Inca Road which covered 25,000 kms (Storey and Widmer, 2006), from Quito in Ecuador to Santiago in Chile. The routes were so good that Spaniards continued to use many of them. But also the Aztec empire



Figure 4.1: Pre-Columbian civilizations in the Americas.

developed an advanced system of roads that connected the cities, but it was abandoned by Spaniards, who developed a new one. In the case of Mayans, anthropologists assure that there were also routes (called *Sacbeob*, white roads) (Shaw, 2001), but there is almost no vestiges of them, probably due to the decline of the Mayan civilization. The ignorance of the wheel and the unavailability of draft animals in Mesoamerica determined a traffic based on human carriers, that acted as relays of porters (Storey and Widmer, 2006). A second alternative was water transport, especially through canoes. Tenochtitlan, the Aztec capital settled in a lake, benefited from this way of communication, combining a strategic defensive position with a good availability of traded products. In the Andes the existence of llamas favored the utilization of caravans. Water transport was also employed there.

Another important aspect in life of Amerindians was the permanent presence of natural hazards. A zone of intense movement and collision of crustal plates called *Ring of Fire* crosses all the Pacific coast of the Americas and determines a high frequency of earthquakes and volcanic eruptions (Chester et al., 2001). Anthropologists have documented the impact of these phenomena on the evolution of civilizations, mainly due to loss of hospitable and fertile lands (for a general analysis see Cashman and Giordano, 2008, for the specific case of Ecuador, see Hall and Mothes, 2008). Populations were also affected by severe weather instability (e.g. droughts and floods provoked by the cyclical air oscillation termed El Niño, for details see Lerner-Lam, 2007). The implication of natural hazards for the Spanish urban development will be discussed in more detail below.

A final aspect to consider is the rather low level of exposition to epidemic diseases in the New World. Diamond (1997) attributes this to the low availability of animal species suitable for domestication in the continent (supposedly a way of transmission). As a consequence, in the 100 years following the Encounter, Indian population fell dramatically. Although estimations strongly varies, recent studies tend to converge to a pre-contact population of 50 millions in 1492. There is much less consensus on the reduction that followed, going from around one-tenth to one half of their pre-contact size (Lovell, 1992; Livi Bacci, 2005). Divergences could come in great part from new ethnic groups resulting from the process of mixing between Spaniards and Indians (*mestizaje*) and from the introduction of slaves

coming from Africa. The Spanish policy of regrouping natives in Indian Villages or missions may have accelerated the contagion. In every case, the dramatic reduction in population often resulted in the abandon of new settlements founded by Spaniards. These cases should be distinguished from the abandons caused by exogenous shocks like natural disasters.

These elements carry one important implication for this study. Some empirical evidence suggests that early starts can have important consequences on present-day economic success (Chanda and Putterman, 2007; Diamond, 1997). Other works have found a reversal of fortune (Acemoglu et al., 2002), that is, more advanced regions before colonization are less developed today. In every case, in order to identify the impact of an exogenous shock on city location, it is imperative to control for initial conditions, especially for the pre-existence of advanced civilizations.

4.2.2 The making of a decentralized Empire

4.2.2.1 Bargained Absolutism and territory occupation through city settlements

The Spanish empire has been often considered as centralized and interventionist, in opposition to the British empire, supposedly highly decentralized (see for example, North, 1990, p. 102-103). However, the evidence supports an organizational model based on a decentralized structure for most of the period (specifically, the Habsburg dynasty, which lasts until 1714). A detailed study of fiscal allocations by Irigoin and Grafe (2006) reveals that in peninsular Spanish as well as in the colonies there were a strong level of autonomy, and Madrid did not extract revenues, but instead they were re-distributed through (sometimes *ad-hoc*) flexible arrangements. This is easily understood by looking at the history of this nation, where territories remained independent and well represented (through city councils called *juntas* and *cabildos*). This also determined that Spaniards attributed central place to their regional and city affiliation (Musset, 2002, pag. 29). On the other hand, this emphasis on the urban dimension was useful to give to the empire a focal point in each region from which the trinity of the empire governed: the King (through its bureaucracy),

the Church and the Town. Thus, the city is considered a political entity (Musset, 2002, pag. 26). In addition, the overlapping of several structures determined a certain ambiguity in the decision making, allowing the king to remain as the arbiter of last resort.¹

In the Americas, several facts support this argument. Firstly, while the initial agreements dating from 1492 indicated that new possessions constituted personal belongings of the King, subsequent laws (1519) finally established that territories were considered as part of the empire, and the Council of the Indies received wide powers to decide on the administration of these regions, as it was the historic tradition in Spain since at least the Twelfth Century (North, 1981, p.150-152; Carmagnani, 2004, p.36). Secondly, authority was always applied cautiously, which is mentioned by historians as a the reason why no serious challenges to Spanish rule raised from within the empire during 300 years.² Thirdly, it is well documented that the crown was indebted with some of their subjects in the Americas with respect to the budget for defense. In practice, Spanish army was rather a local militia administrated in the colonies. As the wealthy landlords in the Americas were the most interested in protecting the region from foreign rivals, it is not a surprise that they lend huge amounts of resources to the monarchy, *conditioned to be spent locally* (Serrano, 2004, p. 89; Irigoien and Grafe, 2006, p. 17).³ Finally, the end of the empire itself illustrates the

¹It is not the intention here to argue that Spanish and British institutions are equivalent. Researchers tend to converge in stating that the bargaining mechanisms in the British case were much more clear (North, 1990, p. 116; Irigoien and Grafe, 2006, p. 14). Douglas North is more assertive by considering the British institutions embodied with more efficient check and balances and a better identified structure of property rights. Acemoglu et al. (2005) restate the argument, by reducing the emphasis of the absolutist power of the King on its subjects, to focus on the relative higher freedom to establish monopolies and impose taxes in the Spanish crown with respect to the Tudor and Stuart monarchies in Britain (footnote 29 in Acemoglu et al. (2005)). Also a number of accepted practices like selling public posts reveals important weaknesses in the institutional functioning of Hispanic America. To what extent this finally affected Latin American countries is an unsettled debate (for a discussion, see Edwards, 2009; Bates et al., 2007). As a last antecedent, I mention that, according to González de Lara et al. (2008), noble titles were also sold by the British crown.

²I provide two examples of this. In the very beginning of the conquest there were conflicts between conquistadors, and some of them defied king's authority (for example, by executing administrative representatives). In response, the crown did not sent armies to the continent. On the contrary, other representatives were discretely sent to convince other conquerors already deployed in the Americas to reestablish the royal authority (Manueco Baranda, 2006, p. 137; Childs Kohn, 2007, p. 611). The second illustrative example concerns the application of taxes. Over the Eighteen Century, new taxes were imposed to the Indians, and several revolts exploded. Once again, the combination of targeted repression with the reduction or elimination of the taxes reveals the bargained nature of the Spanish rule (Burg, 2003).

³Two precisions must be established here. First, these distributive policies should not hide the extractive nature of the trade with the colonies: During the first century of the colonization, enormous amounts of

particular role of the king as arbiter. When Napoleon imprisoned the king, total power came back to the town councils (*juntas*), that spontaneously appeared for the first time in the Americas. As Irigoien and Grafe (2006) argues, “had the king been killed, the problem would have probably been simpler: ‘another king’ would have been necessary. With the king alive, the matter was who else could play his part in the constitutional arrangement that had organised state and empire for more than 300 years” (p. 35) (See also Bates et al., 2007).

This decentralization in the empire has important consequences for the evolution of the urban system and how cities reacted to negative shocks. The crown needed to occupy and exploit these territories as fast as possible, because the other European nations were obviously interested. The settlement policy evolved quickly to a system relying on private enterprises, which was already applied with success in the conquest of the Iberian peninsula against the Moors. The crown signed a written contract (*Capitulación*⁴) over a more or less defined territory with an individual who had the permission and obligation of establish formal settlements, subdue rebel Indians, and warrant the sovereignty of the crown. The colonizer received in exchange, a group of rewards (*mercedes*) mainly of two kinds: entitlements and resource allocations. Entitlements consisted in hereditary nobiliary titles (including a reduction of some taxes for a fixed period⁵) and non-hereditary rights of gov-

silver and gold were extracted from the Americas and used by the Habsburg monarchs to finance the expansion of the empire in Europe through warfare. Due to an overestimation of the potential of mining production in the Americas, the crown was obligated to demand contributions to the peninsular bourgeoisie. This determined that the royal authority became also indebted with them, and gave in exchange nobility titles that allowed hereditary tax exemptions. The consequences for the long-term economic development of Spain were catastrophic: in such a rent-seeking environment most of the tax burden fell on the commoners, and all incentives were against an industrialisation process (for more details and figures on revenues and obligations, see Drelichman (2005)). Second, the change of dynasty to Bourbon increased centralization and central planning, which is observed in the tax reforms (that were strongly resisted as mentioned in the previous footnote) and the establishment of an official Spanish army with a clearer budget allocation (Sanz, 2004). More on this in the next subsection.

⁴The first attempt of Spanish colonization followed the Portuguese *factoría* scheme applied in Africa, where only exploitation of resources is concerned, without any kind of commitment to city foundations. This lasted just a couple of decades, in part due to the catastrophic economic results and in part due to the almost total extinction of Indians in the Caribbean islands, after the outbreak of sickness and the abuses committed by the Spaniards. The contract signed between Columbus and the Catholic monarchs was of this kind, although its official name was *Capitulaciones de Santa Fe*.

⁵The Instructions for Settlements enacted in 1559 established formally that new settlements were exempted of taxes for a 10 year period. Nevertheless, the famous 20% tax levied on the mining of precious metals (*Quinto Real*) was established very early (1504) to warrant a big source of income for the monarchy.

ernment over the region. Allocations of resources concerned mainly mines, land and Indian workforce through a kind of serfdom scheme (*encomiendas*) (Musset, 2002, p. 29).⁶ The conquistador had to finance at their own expenses all the expedition, the settlement of the city and the maintenance of the sovereignty. As already explained there were no formal Spanish army during almost the entire Colonization period.⁷ Also in case of any catastrophic event, the population was not helped in an effective way or just not helped at all (Petit-Breuilh, 2004; Musset, 2002).⁸ In every case, the foundation of cities was explosive, and a century after the Encounter, almost all major cities were established, as figure 4.2 shows. A second minor period of foundations can also be observed in the Eighteen Century, which is associated to the Bourbon reforms that will be explained later (details on the source for foundation dates (Romero, 1989) are discussed in section 4.3.3).

The *Capitulaciones* introduced an ambiguity on the geographic limits conceded, as well as the uncertainty on the quality of the resources available. During the first century, several groups of “gangs” of Conquistadors were deployed across the continent and the scrimmages among them abounded, creating quasi-civil wars (Carmagnani, 2004). An important number of settlements were destroyed by the Spaniards themselves due to these internal conflicts. Several decades later, as the royal bureaucracy established in the region, the Spanish justice became more and more strict with these gangs. Also the Church (that settled missions and Indian villages as fast as Conquistadors founded cities and looked for mines) reported to the

⁶More precisely, territory occupation was made in two steps. In a first stage of exploration, a leader of an expedition received the permission to explore a region and create some liaison with the native population through trade (*rescates*). In a second stage, the crown signed the *Capitulacion*. In practice, the individual was often the same. In some particular cases, the system was not respected. The famous conquistador of Mexico, Hernán Cortés, had only permission for exploration, but he decided to found the city of Veracruz. He was judged (among other things) for doing this, but was finally acquitted, probably because of the spectacular success of its expedition.

⁷Strategic settlements like ports or cities in the frontier were protected (in great part) by the crown through a garrison system (Serrano, 2004, p. 33, p. 104). For example, in the case of Nuevo Santander (North of Mexico) the monarchy collaborated with 55% of all colonization costs, in addition to the 10 year tax-exemption incentives (Vasquez-Gomez, 1987, p. 121). In every case, garrisons were systematically underfinanced and exhibited enormous rates of desertion (Serrano, 2004, p. 90-95).

⁸The case of Quito (Ecuador) cited by Petit-Breuilh (2004) is illustrative of this. This city was quite affected by a volcanic eruption in 1660 and an earthquake in 1662. Local authorities wrote repeatedly to the king to ask for financial help to rebuild the city. Only 4 years later, a letter was sent to local authorities to recommend an increase in the preys and avoid public sins to maintain the divine sympathy (p. 223). In sum, once a city founded, the abandon was almost prohibited, with no excuses.

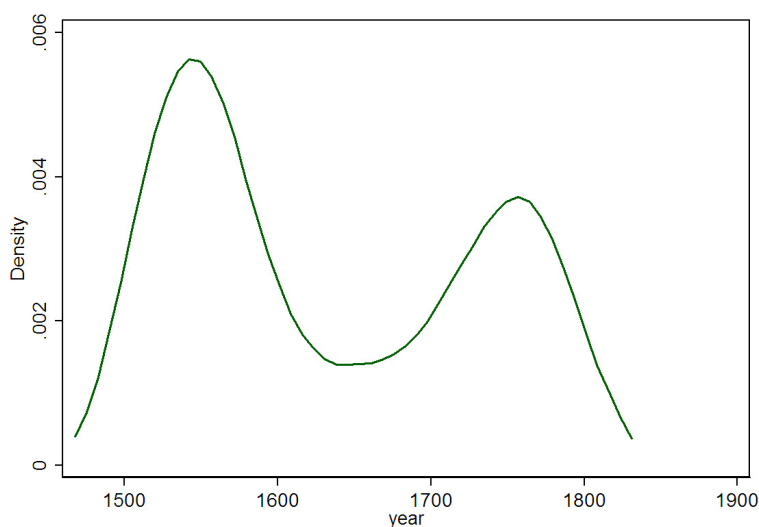


Figure 4.2: Spanish foundations in the Americas

king any anomalies detected, creating an effective peer evaluation system (Vasquez-Gomez, 1987, p 110-111). Actually, the promise of easy gains and freedom from the royal control is far from reality. Manueco Baranda (2006) studied the biographies of 250 conquistadors and found that half of them were either killed (by the natives, conquerors from other bands, or executed by the crown), died in shipwrecks or due to diseases. Among the remaining, most died in poverty or imprisoned. The next generation of rulers in the Americas were royal bureaucrats and merchants.⁹

4.2.2.2 Bourbon reforms and the transition of the extractive economies

Since the start of the colonization, Hispanic America was a source of precious metals for Europe (monopolized by Spain). According to Fisher (1997), at the start of the period (1505-1650), the colonies imported basic commodities needed for subsistence of colonizers (oil, flour, wine), as well as tools, weapons, animals, seeds, building materials. One consequence of Indian depopulation was that the diversification of production in the colonies

⁹Of course, it is possible that the descendants of this generation of conquerors became merchants also, integrating the elite of the New World. The point here is that only a few of this first generation remained rulers of the regions they subdued. Also the new generation was seldom chosen as governors (although they could aspire to other intermediate posts). The crown preferred peninsular representatives as governors, which developed a professional career through several posts across the colonies.

was delayed. Even for a low labor-intensive activity like mining, Spaniards had to develop coercive methods of work like the *mita* system for mining (Dell, 2009) due to labor scarcity. Plantation production (sugar, cacao and cotton) was developed with slaves brought from Africa (Engerman and Sokoloff, 2002; Bruhn and Gallego, 2008). All activities were dominated by the Spaniards, with the exception of Indian production of high-valued agricultural products used as colorants in the South of Mexico and Guatemala (Carmagnani, 2004, p. 53). Another consequence of the demographic crises was the rapid expansion of extensive cattle production, which allowed a certain development of leather products for export.

The arrival of the Bourbon dynasty in the eighteenth century gathers a series of reforms implemented in Spain and its provinces, including the military structures, taxation system, trade policies and new city foundations. For a number of researchers (North, 1990, Irigoin and Grafe, 2006, Serrano, 2004; See Sanz, 2004 for a opposite view) the first two reforms were not plenty implemented because of corruption and resistance in the colonies. By contrast, in the case of trade policy there were important consequences, at least for the Spanish Americas. Notwithstanding the imposed monopoly, contraband trade was pervasive, notably in less controlled ports like Buenos Aires (Ramos, 1980). The 250-years monopoly was phased out, allowing almost all colonies to export directly to most of the Spanish ports (but not to other European ports). The increase in trade is important, although estimations varies widely between authors: between 1782 and 1796, Fisher (1997) calculate a 403% increase (p. 144), while Garcia-Baquero (2003b) proposes 84% (p. 213), both estimating in current values. Figures are presented just for illustrative purposes, because we know that a proper assessment of a trade policy reform requires an appropriate counterfactual (the second half of that century was characterized by a high economic growth). Moreover, figures are expressed in nominal terms.¹⁰

Ramos (1980) reports that the number of ports incorporated to this free trade regime

¹⁰Also note that the change is evaluated starting in 1782, while the reforms were implemented between 1765 and 1778. On the other hand, one may consider that the period 1779-78 is not an appropriate baseline because of the Anglo-Spanish war. The analysis finished in 1796 because in 1797, the British blockade of the main Spanish port, Cádiz, had disastrous consequences for Spain, that some historians like Fisher see as the first event in the process of empire disintegration (Fisher, 1997, p. 202-3). The same author documents a dramatic reduction in trade between Spain and the former American colonies for the 1797-1820 period (Fisher, 1993).

doubled between 1700 and 1765 (more ports were included in subsequent reforms). This reduction on trade costs could have important consequences on the port-cities competitiveness, and by this mechanism, increase the resilience to external shocks. Acemoglu et al. (2005) have documented the differential impact in urbanization rates experienced by cities in Europe that had privileged access to New World trade.¹¹ As I also expect an impact for Spanish American cities, in the empirical part I consider two proxies for this. The first one is port status, which shows little evidence of favoring stability. It is possible that this variable is not capturing all the advantages of trade openness (some inland cities benefited anyway from the free trade policy), or that becoming official port is so important, because smuggling was already at work (like in the case of Buenos Aires). A second, more comprehensive indicator, issued from Economic Geography literature is the market potential which reflects demands from importers weighted by measures of trade costs. A problem to compute such measure in this case is the absence of trade data for cities (or proxies like GDP per capita). An alternative measure is remoteness, which only considers the trade costs. This variable shows much better results than port status as will be shown later. On the other hand, remoteness is a reduced form that can reflect not only Economic Geography considerations, but also political and institutional factors.

Another related change is the diversification of the exports and its potential implications for economic activities in the Americas. Although Figures on trade are highly controversial, a detailed work based upon ships' registers by Garcia-Baquero (2003a) suggests that the export share of precious metals was reduced from a range of 73-83% in the 1747-55 period to a range of 40-56% in the 1789-1796 period. The author noted that changes are not due to increase in (nominal) prices, except for Tobacco (which represents only 5.5% of non-metallic exports of that period). The nature of the exchange remains, however, inter-industrial. For example, America imported textiles and alcohols, and exported (besides

¹¹The argument of these authors goes well beyond the geographic position and direct gain from trade. As other authors, they consider these gains too small to change the European economic growth (p. 562). Thus, they focus on an indirect impact of Atlantic trade on institutions: the generation of profits from trade allowed the surge of a bourgeoisie that claimed for better institutions, especially constrains on the executive (i.e., the power of the monarchy and allied groups). I am not able to explore this additional hypothesis due to lack of data on institutional quality in Spanish American cities. I see this as a natural extension of this work.

metals) cacao, sugar, hides, and raw materials used as colorants for textiles (cochineal, indigo).¹²

The last reform, promotion of new settlements, seems to be a successful measure, at least in terms of new foundations, as the figure 4.2 shows. This efforts were made especially (although not exclusively) in the north of Mexico and south of the United States, the Kingdom of Nueva Granada (mainly Colombia and Venezuela), Argentina and Chile. All these regions shared in common the condition of peripheries of the empire. On the other hand, these regions remained difficult to control, as the empirical evidence will show in the next sections. Actually, as Garcia-Jimeno and Robinson (2009) states, these regions were definitively incorporated several decades after the Spanish rule was finished in the Continent.

4.2.3 Shocks and city relocations

As I shall expose in the next section, the empirical identification of the persistence in the urban system is based on the response of cities to great shocks. Spanish America was exposed to many negative shocks and it is expected that the vertiginous rhythm of foundation coupled with the total unawareness of the local conditions resulted in a high rate of city abandons. Nevertheless, it is important to reiterate that the institutional framework set by the crown strongly discouraged the permanent abandon of cities. All the *mercedes* conceded were conditional on occupation of the territory. For example, if a city was destroyed by an Indian attack, it was expected that Conquistadors rebuild the city. Sunk costs associated to resettle in another location (that increase over time) should also affect negatively the abandon. Hence, we can expect that abandons are rare as response to negative shocks. An intermediate alternative was the relocation. The Council of the Indies allowed for this possibility, although the bureaucratic process was long. If the authorities of

¹²The administrated trade not only affected exports with the Peninsula, but also reprimed the development of inter-colonial trade. Fisher cite the case of wine and oil production in Peru in the late-sixteenth century, which was exported to New Spain (Mexico). The crown forbid trade between these regions in 1631 (Fisher, 1997, p. 67). These kind of measures were also abolished in the Bourbon period. Also note that, excepting some textiles (coming from Barcelona), the Bourbon reform failed to gather an industrialization of Spanish economy: they continued to export to the Americas, agricultural products. Textiles were mainly re-exports from other European countries (Fisher, 1997, p. 198).

a city finally got the permission to relocate, they tried to keep the name and title (*ciudad*, *villa*¹³) of the abandoned site to warrant the maintenance of the privileges, special status, and fiscal exemptions (Musset, 2002, p. 267).

City transfers gathered conflicts because of (1) spatial competition among cities in terms of resources (especially indigenous labor force, which was attached to the cities as suppliers of products, and subject to taxation) and (2) overlapping administrative attributions, like justice (See Musset p. 320-321 for some examples).

4.3 Empirical strategy and data

The previous section described the historical and institutional features of the Spanish colonization that justify the pertinence of studying its urban development, and specifically, city stability after shocks. It also developed some topics like trade policy or extractive activities for which some proxies are needed in the empirical specification.

This section starts with a revision of the literature on empirical tests of urban stability, which are often associated to city responses to exogenous shocks. In the next subsection, I present and justify the method chosen. I also substantiate the hypotheses suggested by the historical accounts exposed above by establishing empirical proxies. Finally I discuss the data sources.

4.3.1 First Nature and Second Nature: Elements for its analysis

First nature is the advantage of location (natural harbor, river) and second nature is man-made. Second nature can be linked to the economic dynamism created by agglomeration economies based on increasing returns and interactions among agents, by invoking knowledge spillovers, market pooling or proximity to consumers and suppliers (Krugman, 1991b). It can also be generated through local public goods that foster agglomeration like a dredged harbor, a road, railroad or a marketplace (Berliant and Konishi, 2000; Fujita and Mori,

¹³The crown gave some entitlements to cities that established a hierarchy in the urban system. When a settlement reaches the state of *ciudad*, neighbor cities in lower levels (e.g. *villa*, or no title at all) had to prioritize its trade with that *ciudad*.

1996).

Second nature forces are likely to overlay and to strengthen the forces of first nature, and every geographic pattern of production is the result of both. Among the existing theoretical models, those belonging to the New Economic Geography (NEG) tradition had the interesting feature of abstracting from first nature. Starting from two symmetric locations, these models introduce a shock (in market size, for example) that gives a little advantage to one of the locations. Depending on the trade cost levels, and on the extent of factor mobility, differences among regions are magnified (and persists as long as agglomeration economies outweigh congestion costs). In extreme cases, all individuals concentrate in one location. The study of the American colonization fits well to this idea. Some regions in the continent contained symmetric locations, in the sense that there were no important urban systems previous to the Encounter (and I shall control for those where there were some). The absence of first nature in these models permits to better isolate some properties of an agglomeration process, to identify if a NEG mechanism is at work or not. Two of them are of particular interest:¹⁴

4.3.1.0.1 Catastrophic Agglomeration. This refers to the non-linear response of agglomeration to marginal reductions in trade costs (or alternatively, changes in market size or wage differentials). Below a certain break point, marginal reduction does not change the symmetry at all. Once this threshold is surpassed, all economic activity in a region moves to other location. The kind of data available in this study represents well this situation: discrete cases of location abandon will be employed, in opposition to most of the literature, which focuses on population changes. While I do not have data on trade costs to assess this hypothesis literally, the extensive list of shocks collected allows for an evaluation of the threshold effect: a single shock should have a low probability of altering the state of a location, (especially when the city have reached some age). After a certain cumulation

¹⁴There are many other properties of NEG models that are not tested in this work: (1) The Home Market Effect, (2) Home market magnification, (3) hump-shaped agglomeration rents, (4) circular causality (self-reinforcing effects of market potential, migration and forward linkages) and (5) self-fulfilling expectations around the overlap (i.e. assess if expectations rather than history matters). See Baldwin et al. (2003) for more details on these properties.

of shocks, the state can change (e.g. passing from occupied location to abandoned). On the other hand, I do not have information on the magnitude of the shocks (e.g. deaths or destruction measures) so the results concerning this property should be seen as tentative.

4.3.1.0.2 Locational Hysteresis. This means that the agglomeration outcome at some moment in time can not be explained by only using independent variables measured at that instant. It is also necessary to look at the history of the independent variables. Specifically, one must look at the path that the agglomeration followed before it reached its current value, even if past circumstances may no longer be relevant. Therefore, it implies testing whether the information on past outcomes have a permanent effect on subsequent outcomes. A second way is to look for insensibility to shocks in more recent period, that were important in the past (Nunn, 2009; Martin and Sunley, 2006).

The literature on urban stability exploits natural experiments like temporary shocks or changes in political borders to assess the responses in terms of urban growth.¹⁵ The interest is to assess whether, once the shock or policy is removed, cities come back to growth levels prevailing in the period preceding the shock or policy change.

In the case of shocks, war destruction has been used, because they are large, temporary, variable, spatially-localized and identifiable. Studies looking at WWII bombing in Japan (Davis and Weinstein, 2002, 2008) and US bombing in Vietnam (Miguel and Roland, 2005) have found that cities recover from these negative shocks very quickly (for example the shock was dissipated in 13 years in Japan). Investigations using Germany (splited in West and Eastern Germany) as case study find different results. First, in one of the studies researchers found that West Germany cities recovered from the war shock in 17 years, but not completely (Brakman et al., 2004). In subsequent studies (using more refined measures of economic geography and other methods), they find evidence that larger negative shocks

¹⁵Other studies looks at long run evolutions of cities, and attempts to explain urban evolution variables (specifically population growth, density, or rank in the urban hierarchy) with endowments, infrastructure, educational levels, institutional quality, etc. Examples of studies include applications to the United States (Beeson et al., 2001; Simon and Nardinelli, 2002; Kim, 2000; Dobkins and Ioannides, 2001), Japan and France (Eaton and Eckstein, 1997), Italy (Bosker et al., 2008), Mediterranean basin and Europe in pre-industrial times (Long and Shleifer, 1993; Bosker et al., 2008), China (Anderson and Ge, 2005) and a worldwide study (Henderson and Wang, 2007). Most of the studies find strong persistence in the urban structure, but they lack of a specific temporary shock that allows for a clearer identification.

push cities to a low-growth equilibrium (Bosker et al., 2007, 2008).

The second group of studies look for changes in borders. Nitsch (2003) explores the impact of the disintegration of the Austro-Hungarian empire in 1918 on Austrian urban primacy. As Vienna was the capital of the empire, and the new country was only 15% of the empire's size, a strong reduction in population should be expected. However, after some initial reduction, population stabilizes and Vienna is overdimensioned. Studies exploiting the creation and removal of borders in Germany have also confirmed the path dependency (Redding et al., 2007).¹⁶

Both literatures are confronted to the problem of initial conditions. NEG models predict a shift to a new equilibrium for certain ranges of the key parameters. Moreover, equilibria can be stable or unstable, depending on the parameters. Once random historical accidents select an equilibrium, a lock-in effect prevents from a change even when economic circumstances evolve toward another equilibrium. That is why persistence is not a good indicator to discriminate among hypotheses *once a stable equilibrium has been reached*. The main advantage of the study presented here is to start the assessment period before the stable equilibrium is reached. Hence, observing persistence after temporary shocks is informative of a path-dependence effect. Also the policy implication is less clear when initial conditions are not taken into account. Davis and Weinstein, in their working paper version, caution on this (the comment applies for all the studies mentioned in the previous paragraphs): “Our experiment asks if industries and cities, once established, are robust to enormous shocks [...] yet it is a different question whether directed Greenfield investment can permanently, alter the course of regional development” (Davis and Weinstein, 2004, p. 43). This question can be addressed by looking at new agglomerations in an initially symmetric space.

¹⁶The study on Germany already mentioned (Brakman et al., 2004) also found that in East Germany, cities did not recover at all from strategic bombing. While this can be interpreted as evidence that this shock changed the spatial pattern of city growth, the effect is confounded with the major policy change provoked by the central-planning approach in East Germany. Border changes have been used to test the impacts of the reduction in trade costs, as predicted by NEG models (See for example, Redding and Sturm, 2008, Nakajima, 2006, Wolf, 2005, Wolf, 2008, Keller and Shiue, 2008, Poeckl, 2008). Nevertheless, to test path dependency, changes must be temporary in order to verify if the system comes back to the same equilibria or not.

4.3.2 Identification strategy: Locations as unit of analysis, relocations as dependent variable

Empirical studies described above have focused on city growth to assess the stability of the urban system. Population data for colonial cities is scarce and often unreliable, especially for the first periods. On the other hand, registers with dates of city foundations, relocation, abandon or refoundation allow for an alternative method that exploit event histories without changing the basic idea behind the tests although the unit of analysis shifts from cities to potential locations. The interpretation of a multiple equilibria in the city-growth approach is that after the shock is removed, some cities are growing at lower rates with respect to the pre-shock period. An extreme case of this situation could be the total abandon of the location. Three possibilities arise: (1) Everybody died after the catastrophe (in which case the city can be considered as dead), (2) survivors have migrated to other cities, or (3) they had rebuilt the city in another location. In any event, the change reflects the end of a previous state, where the location was occupied (that I will denote c for censored) to a state where the location is abandoned (that I will denote a for abandoned). If we have the date of foundation of the city, the duration of the location in the state *occupied* can be used as dependent variable to assess the determinants of the risk (hazard rate) of changing of state in a survival model. Intuitively, the risk of changing of state is given by a ratio of the probability for a location of being abandoned (failure) over the probability that the location is not yet abandoned up until now (survival). Formally, the duration of the location is a realization of a continuous random variable T and the hazard function in time t is the following instantaneous probability:

$$\lambda(t) = \lim_{\Delta t \rightarrow \infty} \frac{\Pr(T \in [t, t + \Delta t] | T \geq t)}{\Delta t} \quad (4.1)$$

In other words, the hazard rate is the instantaneous probability for a location of being abandoned at time t per unit of time. For estimation, the simplest and most used formulation is the Proportional Hazard (PH) model:

$$\theta_{c \rightarrow a}(t|x, \nu) = \lambda(t) \nu \phi(X'\beta) \quad (4.2)$$

where $\theta_{c \rightarrow a}(t|x)$ is the conditional hazard rate at time t . It is conditional on covariates X and potentially unobserved heterogeneity denoted by ν . Proportional hazard means that covariates (including history) affect durations proportional to some baseline hazard rate $\lambda(t)$. It is called baseline hazard because it gives the shape of the hazard function common to all individuals, and depends only on time.¹⁷ The term $\phi(X'\beta)$ can be parametrized as $\exp^{X'\beta}$ which facilitates the interpretation of the results as risk ratios with respect to the baseline hazard.

$$\theta_{c \rightarrow a} = \lambda(t) \nu \exp^{X'\beta} \quad (4.3)$$

Regarding the baseline hazard, the Weibull function is often chosen because it allows for a flexible specification: $\lambda(t) = \alpha t \exp^{(\alpha-1)t}$. The parameter α accommodates the form of the baseline hazard. For example, if $\alpha > 1$ the hazard is increasing in duration time.¹⁸ First, assume that unobserved heterogeneity is negligible ($\nu \equiv 1$). After adding a random error term that is EV1 distributed (van den Berg, 2001), the baseline specification is:

$$\ln \theta_{c \rightarrow a} = \ln \alpha + (\alpha - 1) \ln t + X'\beta + \epsilon \quad (4.4)$$

To capture the effect of past outcomes I borrow the test of hysteresis often used in unemployment duration studies (Frijters et al., 2009). If previous labor market outcomes affect current labor market opportunities, a longer unemployment spell affects negatively the transition to employment (for example through depreciation of skills or stigma effects). The same test has been applied to explore hysteresis in export spells (Esteve-Pérez et al., 2006). In the colonization context, the expectation would be that during the first years of foundation, the risk of abandon is high because settlers must discover the advantages

¹⁷Alternatively, it is the hazard when all regressors are set to zero.

¹⁸This specification is more appropriate for continuous-time data. As I have discrete-time data, I also estimate PH models especially developed for this, known as binary regressions. I relegate this discussion to the section 4.4.2.

of the location (including negative shocks like earthquakes), they are newcomers without strong ties to the location, and the interactions among them are weak. If the population remain in the same location after a given period, the city locks-in there because they learn how to cope¹⁹ with the problems associated to the location, because of the sunk costs of a relocation, and because of the self-reinforcing advantages given by the local interactions. Therefore, we should expect that *the age of the city affects negatively the transition of a location*. Furthermore, as the colonization continues, the continent is occupied with new cities, and a urban network develops. Cities can better exploit scale economies in trade (export to other locations). Although inter-colonial trade data is scarce (and some of exchanges were forbidden by the crown), historians agree that it increased steadily over the centuries (Carmagnani, 2004). A urban network also facilitates temporary aid when confronted to a shock. For example, the poor Chilean Captaincy financed its army to sustain the long war against the Indians through a transfer (*situado*) from the rich Peruvian Viceroyalty. Finally, if cities are in competition for resources, in later periods of the colonization, a group of settlers has less latitude to relocate, simply because other cities have already taken the best locations. Actually, the crown established in their instructions for settlement (1559) that new cities could not be established too close to the existing ones. While the statement is admittedly ambiguous, evidence shows that representatives from existing cities evoked it in order to prevent neighbor populations from relocate after a shock (See Musset, 2002, p. 271-4 for an example in Argentina). In sum, we expect also that *cities founded in more recent periods are less prone to be abandoned, introducing also a negative effect on the probability of a transition from occupied to abandoned*. Over time, the urban system should be more and more resilient to shocks.

An important issue in econometrics of duration data is the kind of censoring of spells. A first kind, termed right censoring, happens when the end of a spell is unknown. Foundations

¹⁹Of course, methods to cope with negative shocks can vary over time. In the early periods, earthquakes were interpreted as divine punishments, and the corresponding measure was to command preys and religious ceremonies. In the eighteenth century, new measures like more compact architecture are mentioned by historians. In addition, We find the first attempts to elaborate some theories concerning earthquakes (See Musset, 2002, Petit-Breuilh, 2004 p. 222). For our purposes, all the approaches are valid ways to cope with disasters if they potentially reduce transitions to abandon.

of cities in the available datasets are recorded until 1810, when colonies started to declare themselves independent. Excepting Cuba, all Latin America was independent in 1823. I chose 1835 as a date for finish the follow-up. There are only four cases of spells ending between 1810 and 1835, and it is reasonable to think that few new cities were founded between 1810 and 1835, given that countries devoted most of their energies in organizing their functioning as independent nations. Of course, discarding censored observations would introduce a bias toward short duration spells, because censored cities were also at risk over the whole period of study. As long as the right-censoring is not informative (censored cities are not at increased risk to be abandoned), conventional duration models generate valid estimators. Left-censoring is much more complicated. This refers to spells that could exist before the start of follow-up period, so they can introduce important distortions by producing artificially shorter spells or by missing entire spells. One of the advantages of this unique natural experience is that the starting date is the year of Encounter, so left-censoring simply does not apply.

As already mentioned, testing hysteresis is affected by the problem of initial conditions. If any unobserved heterogeneity (also denoted *frailty* in the duration econometrics literature) is present, there is a risk that the negative duration associated to city age may be spurious. Assume that (1) each location has a specific hazard rate, but all of them are constant in time and (2) those cities having high hazard rates are not negligible. As they exit in earlier periods, they sharply reduce the time at risk for the calculation of the aggregate hazard rate of those periods, and can result in a hazard rate falling in time (Cameron and Trivedi (2005) provides a numerical example (p. 611)). The problem is highly reduced in this study, because I observe locations from the birth, and because I am controlling for a potentially important characteristic associated to initial conditions, which is Pre-Columbian civilizations present in the region. In addition, inspection of the data shows abandons in later periods of the colonization, in regions supposedly endowed with better initial conditions. The case of Guatemala city, is illustrative of this. Spaniards had to move the city two times, the first time in 1541 and the second time in 1775, which suggests that being located in a region where one of the Ancient civilizations developed (The Mayas) does

not help too much. Of course, there can be other unobserved characteristics that could affect my findings. Introducing fixed effects in a duration model results often in incidental parameter problems, so the control is made mostly by using analog methods to a random effects estimation. A parametric method considers ν in equation (4.3) as a strictly positive random variable following some distribution (researchers often use Gamma), with mean equals to 1 (the average level of frailty) and a variance σ^2 to be estimated from the data. A location above(below) the average level leaves relatively fast(slow) the state of *occupied*. As the variance σ^2 is an estimated parameter, it is possible to test if this variance is zero, in which case one can consider that there is no evidence of unobserved heterogeneity.²⁰

4.3.3 Data

The construction of the spells is based on historical accounts coming from mainly two sources. The first is a list of 954 records of cities collected by Romero (1989) for a book commissioned by the Spanish Government as part of the commemoration activities of the 500 years of the Encounter. It contains information on dates of foundation, current country, alternative names of the cities, and sometimes information on relocations. The information is collected from several other sources, which are carefully cited by the author. The text is recognized as an important contribution by other historians (for example, Sanz, 2004), and it is to my knowledge, the most comprehensive one.²¹ I have painstakingly checked each observation using several sources to confirm reliability, to gain insights on specific cities, and to match them with geographic coordinates. These sources included primary sources (de Alcedo, 1786; Lopez-de Velasco, 1574), toponymic compendia to detect changes in names (Calderon, 1990), a dictionary of colonizers' biographies (Manueco Baranda, 2006),

²⁰A second non-parametric estimation is proposed by Heckman and Singer (1984). The central assumption is that there is a number of different *types* of locations (in their terminology, they are *mass points* in the distribution of the individual heterogeneity). All locations are allocated to the mass points according to probabilities. In practice, the hazard function had intercepts for each of these kinds of locations. Unfortunately, this method often exhibits identification problems (see Eberwein et al., 2002, p. 253, and van den Berg, 2001, p. 3418-19). Finally, availability of multiple spells for a single individual (which is not my case) allows for other econometric methods to deal with potential unobserved heterogeneity (van den Berg, 2001).

²¹de Solano (1990) mentions that city foundations in Spanish America were more than 2,000 but he does not provide specific sources for this estimation.

an online Encyclopedia of the Mexican government on municipalities (INAFED, 2005), and a long list of texts referring to specific cities or regions in Spanish America. The complete list is too long to be presented here (more than 60 books, 3 Thesis, 180 journal articles and 36 manuscripts), but it is available from the author. This research allows me to detect 79 cases where foundations were mistakenly recorded two times, because the city just changed names. In 7 cases, it was not possible to establish the current country. More importantly, for 223 records I found no trace of geographical coordinates and sometimes not even a reference in historic or geographical textbooks. As it is not possible to identify the events experienced for these locations in order to build reliable spells (or at least determine if these settlements truly existed), I discard them. Cross-checking with other sources for the remaining cities gave very similar dates for foundations, even for the earliest dates. In my opinion, this suggests that the elaborated institutional setting established by the crown, as explained in section 4.2.2.1 was in general respected. The establishment of a city was a formal process, for which a document of foundation was enacted in most cases.

The second main source of information is the book by the geographer Alain Musset (2002). He identifies and extensively describes relocations of cities in Spanish America, some of them identified *in situ*. The work is highly systematic, with a clear definition of the kind of events (permanent abandons, temporary abandons with refoundations), tables summarizing frequency of transitions by regions, names of the cities and their location in maps. He also discarded undocumented or irrelevant cases (for example, relocations at very short distances). Additional information on the distance of the relocation, date of relocation is also provided but not for all settlements. He also documents the causes of the relocation (e.g. an Indian attack, an earthquake, bad climate, etc), as well as other shocks that did not trigger relocations. Once again, I cross-checked and complemented the information for each footloose city and its spells with a long list of additional sources. In addition to the sources already mentioned, I search for episodes of shocks in Encyclopedias and textbooks about armed conflicts, riots and pirate attacks (Childs Kohn, 2007; Burg, 2003; Lucena, 2005), about epidemic events (Childs Kohn, 2008; Livi Bacci, 2005; Lovell, 1992) and about natural disasters (Petit-Breuilh, 2004, Global Volcanism Program of the

Smithsonian National Museum).

Information from these sources were combined, resulting in a database with 719 cities. Most of these cities (509) did not experience any transition during the studied period, while the remaining 210 are footloose cities. For 9 cities of the latter group, foundation date could not be established.

Information for the explanatory variables is collected from several sources. First, port status is taken from Ramos (1980). He distinguishes between official ports (with permission to trade with the Metropolis) and ports that operated illegally. These status changed over time due to trade reforms and I coded the variable accordingly. Second, I created a dummy identifying regions belonging to the main Pre-Columbian civilizations. The dummy is coded at the first subnational level inside of each country (e.g. Mexican states, Peruvian provinces, and so on). I also made dummies for each of the following civilizations: Inca, Maya, Aztec, others in Mexico (Tarascan, Metztitlan, Chalchihuites). Information on the coverage of the empires comes from Cartwright (1963), Kuznar (1996), Williams (2005), Stanish (1997) and FAMSI (2009). Third, sources of minerals (gold and silver) are taken from a report on mineral facilities from the U.S. Geological Survey (Bernstein et al., 2006). The list includes geographical coordinates which allows to calculate a geodesic distance between each city and the closest mining center. Note that the information is about current mineral facilities. I would prefer information on the mines discovered and exploited by the colonizers, but this information is not systematically available. Finally, I searched for geographical coordinates for each city. Two geographical databases were employed to match names of the cities: The World Gazetteer (World-Gazetteer.com) and GeoNames (geonames.org). Differences in names forced me to look for the right match for each city case by case. Following this procedure I was able to identify information for almost all cities. Unfortunately, 20 footloose cities were not identified. They will be considered in the baseline analysis, where geographical information is not used, but they will be discarded in the robustness checks when remoteness and distance to mining centers are introduced. I estimate that discarding these cases should not introduce any selection bias, as they are distributed in 14 countries and correspond to different periods of foundation.

The remoteness is a composite index that considers the position of a city with respect to potential markets. It is built taking into account the most probable consumer centers for a Spanish American settlement.²² Naturally, cities in the Spanish Americas are included. Other destinations in North American colonies are also taken into account. Specifically, cities in regions corresponding to the following current US States: Maine, Massachusetts, New Hampshire, Vermont, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, Virginia, North Carolina, South Carolina, Georgia and District of Columbia. I also consider main port cities in Europe (recall that smuggling was important, casting doubts on the enforcement of the monopoly imposed by the crown) reported by Acemoglu et al. (2005).²³

4.4 Results

Given the novelty of the dataset, I begin this section with a detailed presentation of the transitions and shocks.

4.4.1 Descriptive statistics

4.4.1.0.3 Transitions. The 210 footloose cities generate 378 transitions and 165 censored cases. Table 4.1 summarizes the kind of spells and the evolution of the cities. There are 305 transitions going from occupied location to abandoned location ($\theta_{c \rightarrow a}$) and 73 going from abandoned to occupation ($\theta_{a \rightarrow c}$), suggesting cyclical transitions for some settlements.

Therefore, a city can pass through several states. A first case is temporary abandon of a location (denoted *Temporary site-abandon* in the table). For example, in 27 cities

²²Denoting R market destinations by j and exporter city by i , remoteness is defined as $rem_{ij} = \left[\sum_j^R (distance_{ij})^{-1} \right]^{-1}$. Bilateral distance is calculated by using the great circle formula.

²³They include 13 Atlantic ports in their study, but other ports are mentioned. The complete list is: Plymouth, London, Bristol, Glasgow, Liverpool, King's Lynn, Newcastle upon Tyne, Aberdeen, Amsterdam, Dordrecht, Middelburg, Rotterdam, Rouen, Bordeaux, Nantes, Seville, Santander, Cádiz, Porto, Lisbon, Edinburgh, Dublin, Antwerpen, Hamburg and Bremen. I added one non-European destination, Manila (Philippines), because all the trade between Spanish possessions in Asia and the Peninsula was made through the famous *Galeón de Manila* which arrived to the Pacific port of Acapulco (Mexico). Merchandises were transported from there to the Pacific port of Veracruz (Mexico) and finally sent to Spain.

the population left the location after foundation. For these cities, the next spell was a refoundation in the same place. Those refoundations are distributed in the rows under the group *From abandoned to occupied*, in the second column of spells. 11 out of the 27 cities never experienced additional transitions. I denote these cases as *Refoundation, censored*. The remaining 16 were re-established in the same location (category *Refoundation*), but they will suffer another transition to abandon afterwards, generating a third spell for these cities. As the cities are rebuilt in the same location, I consider them as censored in the regressions. They are like the Nagasaki and Hiroshima cases in the study about bombing impact in Japan (Davis and Weinstein, 2002). Similarly, cases of *Semi-Abandon, Censored* are also considered as censored. These are 3 cities that were partially abandoned according to the information of historical accounts. Some of them never recovered important levels of population, so they could be evidence of multiple equilibria, but there is no data on population to make a formal test. Furthermore, historical accounts are precise concerning discrete changes (abandons, refoundations) but not with respect to reductions in population. Consequently, the 11 spells corresponding to semi-abandons will not be included in the regressions.

The cases that are of interest for this study correspond to 240 spells reflecting *Permanent Site-Abandons*. They groups 4 possible cases. The first is *Abandoned, Censored*, that is, dead cities (and hence, dead locations), which totals 42 spells. Looking at the intersection between the column 1 and the row *Abandoned, Censored*, we note that 28 cities disappeared forever after their foundation. The remaining 14 passed for other transitions before being finally abandoned. The remaining cases to be included in the regressions are relocations of different nature. In 10 cases (that I termed *Abandoned, Delocation*), the cities were abandoned, and during a certain period citizens stayed in a neighboring settlement, but they finally refounded their original city in another place. 188 spells represent cases of immediate relocation, most of them (139) to a definitive settlement. The latter are denoted *Delocation, Censored*.

The vast majority of footloose cities had few spells. Looking at the row *Total Censored*, we note that 110 out of the 210 only exhibit one spell. The city of Arauco in Chile, attacked

by the natives and rebuilt several times by Spaniards, exhibit 11 transitions.

Table 4.1: Transitions

Kind of Transition	SPELLS											TOTAL
	1	2	3	4	5	6	7	8	9	10	11	
I. From occupied to abandoned $\theta_{c \rightarrow a}$	1	2	3	4	5	6	7	8	9	10	11	TOTAL
<i>a. Subtotal Temporary site-abandon</i>	27	3	13	5	5	1	4	1	1	0	0	54
Abandoned, Censored (AC)	28	6	5			1	1	1				42
Abandoned, Delocation (AD)	7		3									10
Delocation (D)	33	4	3	1	5	2	1					49
Delocation, Censored (DC)	110	16	7	2	1	2		1				139
<i>b. Subtotal Permanent site-abandon</i>	178	26	18	3	6	4	2	2	1	0	0	240
Semi-Abandoned	1	1	2		2		1					7
Semi-Abandoned, Censored	3											3
Semi-Abandoned, Delocated	1											1
<i>c. Subtotal Semi-Abandoned</i>	5	1	2	0	2	0	1	0	0	0	0	11
Subtotal Spells $\theta_{c \rightarrow a}$ ($a+b+c$)												305
II. From abandoned to occupied $\theta_{a \rightarrow c}$												
Refoundation		19	8			5	1	2				35
Refoundation, Censored		11	2	5		1		3		1		23
Refoundation, Delocated		7		3								10
Ref., Delocated and Censored		1	1	1								2
Repopulation		1		1								2
Repopulation, Censored						1						1
<i>d. Subtotal Spells $\theta_{a \rightarrow c}$</i>	0	39	2	18	0	7	1	5	0	1	0	73
TOTAL SPELLS												378
<i>e. Subtotal Censored</i>	0	110	28	9	8	1	4	0	4	0	1	165
<i>f. cities no longer in transitions</i>	0	31	147	180	189	197	198	203	204	209	209	
<i>Total of Footloose Cities</i>	210	210	210	210	210	210	210	210	210	210	210	210
($a + b + c + d + e + f$)												

Sources: Author's calculations.

4.4.1.0.4 Shocks. Spells of abandon $\theta_{c \rightarrow a}$ can be associated with several potential causes. Table 4.2 displays these 305 spells by kind of reason. I distinguish two main groups. One group is composed of external shocks, big enough to gather an abandon. The second group are a series of reasons that reflect more internal processes in the cities, often smooth processes. Although carefully constructed, this approach has inevitably some caveats. As explained in section 4.3.3, the classification is established mainly based on Musset (2002) and many other authoritative texts, but some error due to missing information can not be ruled out. A smooth case could in reality be the result of a shock, but the historical accounts did not detect this. Similarly, a shock can be an excuse to definitively abandon a place that was losing population for a long period.

We note that most of the cases are attributed to shocks (200 out of the 305), with a predominance of conflicts (137 cases). Within this category, Indian attacks were by far the most important reason: 101 locations were abandoned (at least temporarily) due to this cause. The other important reason is conflicts among European colonizers (wars, pirate attacks and scrimmage between Spaniards conquerors as described in section 4.2.2.1). Natural disasters also affected urban stability in 63 cases. Finally, we note that for 105 cases reasons are either vague or endogenous. For example, reduction in population (2 cases) or local economy (2 cases) are not informative of the underlying cause of abandon. Also exodus might be slow, which prevents adequate identification. The date of abandon in those cases could be just an official confirmation of a situation started a long time ago.

Finally, in Table 4.3 the information on previous tables is crossed to select those spells that correspond to the kind of transition and the reason that are of interest for this study. After discarding cases of semi-abandon, we are left with 294 spells. Among them, 195 are cases of abandon due to shocks. Finally, 150 among them are cases of permanent abandon of a location. Despite the extensive research, it was impossible to obtain data on foundation for 9 footloose cities, which affects 11 of these spells, so the definitive identification is based on 139 spells of permanent abandon due to shocks (plus their corresponding censored cases).

Table 4.2: Shocks

REASON	SPELLS											TOTAL
	1	2	3	4	5	6	7	8	9	10	11	
conflicts - colonizer	29	2	2			1		1				35
conflicts - indians	66	6	15		6	2	3	1	2			101
conflicts - unknown			1									1
Subtotal Conflicts	95	8	18	0	6	3	3	2	2	0	0	137
Fire	1											1
Drought		1										1
Earthquake	17	1	1	1								20
Flood	8	4	4		1							17
Hurricane	2		1		1							4
Unknown	16											16
Volcano	4											4
Subtotal Nat. Disasters	48	6	6	1	2	0	0	0	0	0	0	63
a. SHOCKS	143	14	24	1	8	3	3	2	2	0	0	200
economics - inputs	2	1	1		1		1					6
economics - local	1		1									2
economics - spatial position	7	1	1									9
endowments - gral	23	3	2		1	1						30
endowments - resources	11	3	1									15
others - politics	5				1		2					8
others - population				1	1							2
others - sickness	2	1										3
unknown	16	7	3	1	1	1	1					30
b. OTHERS	67	16	9	2	5	2	4	0	0	0	0	105
Reconstruction		2				1						3
Refoundation		36	2	17		5	1	5		1		67
Repopulation		1		1		1						3
c. REC. and REF.	0	39	2	18	0	7	1	5	0	1	0	73
d. Censored	0	110	28	9	8	1	4	0	4	0	1	165
e. no longer in transitions	0	31	147	180	189	197	198	203	204	209	209	
<i>Total of Footloose Cities (a + b + c + d + e)</i>	210	210	210	210	210	210	210	210	210	210	210	

Sources: Author's calculations.

Table 4.3: Transitions and documented reasons

Transitions	Conflict	Disaster	SHOCKS	Endowments	Others	Unknown	OTHERS	TOTAL
Temporary abandon	43	2	45	1	6	2	9	54
AC	22	3	25	8	4	5	17	42
AD	8	0	8	1	0	1	2	10
D	18	6	24	12	3	10	25	49
DC	42	51	93	22	14	10	46	139
Definitive abandon	90	60	150	43	21	26	90	240
TOTAL	133	62	195	44	27	28	99	294

Sources: Author's calculations.

4.4.1.0.5 Durations. Prior to estimations, I describe the durations using the Kaplan-Meier (KM) survival curves.²⁴ Figure 4.3 depicts the curves stratified by status of port, and only non-censored spells are considered to ease readability (all spells will be taken into account in the regressions). Some specific cases of cities relocated at the end of the period are also shown. Both curves suggest high number of abandons in the first years, and certain stabilization in the mortality of locations afterwards, which is consistent with hysteresis. Although port locations have less probability of abandon during certain periods, the difference is small, and the result reverses later. This is due to three cases of port settlements in Peru, Panama and Cuba that were abandoned after 150 years, and 2 ports locations abandoned circa 200 years after foundation in Chile and the United States. Other non-port locations are still alive at this time, and disappear much later. It is also interesting to note that cities established in regions previously dominated by Pre-Columbian civilizations do not exhibit any advantage in terms of stability: 1 location in Peru (Inca empire), 3 locations in Guatemala (Mayan civilization) and 1 in Ecuador (Inca empire) were abandoned even after 150 years of Spanish foundation.

²⁴KM is a non-parametric estimator of the survivor function $\hat{S}(t)$, which considers the number of cases at risk at time t (r_j) and the cases that experienced the event at time t (d_j). The formula is the following: $\hat{S}(t) = \prod_{j|t_j \leq t} \left(\frac{r_j - d_j}{r_j} \right)$

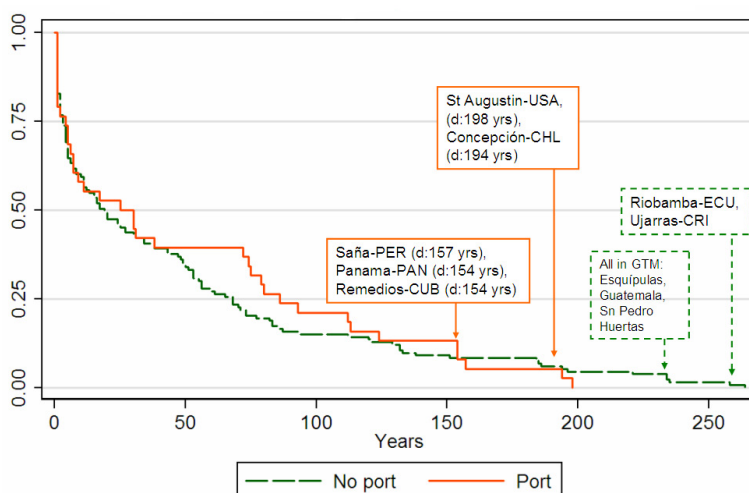


Figure 4.3: Kaplan-Meier survival functions (Definitive abandons only).

4.4.2 Econometric results

Our main hypotheses are that city age and urban network contribute to the stability of the location chosen for a city, which suggests resilience (ability of a city to contain negative impacts in the aftermath of a shock). Furthermore, data is consistent with multiple equilibria if, in addition to resilience, more instability to shocks is found for early periods of colonization, where the equilibrium is still not achieved.

Table 4.4 shows the regressions considering several groups of data, econometric methods and covariates. In the first three regressions, I use only data from the 210 footloose cities. This means that only 139 spells described in the section 4.4.1.0.4 and Table 4.3 (plus their respective censored cases) are taken into account. These cities captured the attention of historians, which provided detailed accounts on the shocks they suffered, the dates of transitions, etc. The first regression is based on a parametric Proportional Hazard (PH) model, using a Weibull distribution to estimate the baseline hazard. The coefficient for city age is negative and significant, which means that it reduces the probability of transition from *occupied* to *abandoned*. The coefficient suggests that a one year rise in city age is associated with a 5.4% lower hazard rate (0.946). Non-linearity was identified for this variable, as the squared term is significant. Nevertheless, its magnitude is quite

small. The existence of urban network (proxied by the time elapsed between Encounter and the date of foundation) also contributes to the stability of a chosen location. Locations for cities founded in later periods of the colonization were less prone to be abandoned, but the coefficient is small. As I explained in the section 4.2.2.2, the Bourbon reforms were successful in founding new cities in the periphery of the empire. Nevertheless, these were the regions where the settlements were particularly difficult, and relocations remained important. Overall, the negative coefficient suggest a modest advantage of establishing a new city in the latter period due to the support of the existing cities. By contrast, the number of disasters is important: An additional shock is associated to a 25.3% increase in the hazard rate for a location. I fail to find a non-linear effect in this regression. Locations that are ports do not have differentiated effects in their stability. Admittedly, the variable is too raw to capture the advantages of being integrated to trade, because the dummy reflects the first nature only (a natural harbor). We know from the historical references that many of these ports became important only at the end of the period, when the Bourbon trade reforms were applied. A more sophisticated version of this variable should consider the timing of the conversion of a natural harbor into an official port. I come back to this later.

Table 4.4: Baseline regressions

Variables	Sampling	FOOTLOOSE CITIES				ALL CITIES				Founded until 1600
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
<i>City age</i>	Coeff.	-0.0556 ^a	-0.1081 ^a	-0.1051 ^a	-0.0591 ^a	-0.0597 ^a	-0.1404 ^a	-0.0591 ^a	-0.1260 ^a	
	s.e.	(0.0053)	(0.0124)	(0.0122)	(0.0051)	(0.0051)	(0.01435)	(0.0051)	(0.0145)	
HR/Odds ratio		0.9459	0.8975	0.9002	0.9425	0.9419	0.8689	0.9425	0.8815	
$(City\ age)^2$	Coeff.	0.0001 ^a	0.0001 ^a	0.0001 ^a	0.0001 ^a	0.0001 ^a	0.0002 ^a	0.0001 ^a	0.0001 ^a	
	s.e.	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
HR/Odds ratio		1.0001	1.0001	1.0001	1.0001	1.0001	1.0001	1.0001	1.0001	
<i>Urban network</i>	Coeff.	-0.0027 ^b	-0.0028 ^b	-0.0028 ^a	-0.0079 ^a	-0.0079 ^a	-0.0079 ^a	-0.0079 ^a	0.0240 ^a	
	s.e.	(0.0011)	(0.0026)	(0.0012)	(0.0012)	(0.0012)	(0.0013)	(0.0012)	(0.0044)	
HR/Odds ratio		0.9973	0.9971	0.9972	0.9921	0.9920	.9920	0.9921	1.0243	
<i>N. of Shocks</i>	Coeff.	0.2262 ^b	0.2386 ^b	0.2751 ^b	0.5812 ^a	0.5891 ^a	0.5738 ^a	0.5813 ^a	0.2722 ^a	
	s.e.	(0.1060)	(0.1098)	(0.1206)	(0.1005)	(0.0999)	(0.1018)	(0.1005)	(0.1149)	
HR/Odds ratio		1.2538	1.2695	1.3166	1.7883	1.8024	1.7750	1.7884	1.3128	
$(N. of\ Shocks)^2$	Coeff.	-0.0147	-0.0168 ^c	-0.0195 ^c	-0.0403 ^a	-0.0417 ^a	-0.0423 ^a	-0.0403 ^a	-0.0208 ^a	
	s.e.	(0.0095)	(0.0101)	(0.0110)	(0.0081)	(0.0081)	(0.0087)	(0.0081)	(0.0098)	
HR/Odds ratio		0.9854	0.9832	0.9805	0.9604	0.9590	0.9585	0.9604	0.9794	
<i>Port status</i>	Coeff.	-0.0595	-0.4523	0.4756	-0.0710	-0.1177	-0.2072	-0.0709	0.2352	
	s.e.	(0.2235)	(0.4501)	(0.4733)	(0.2032)	(0.2077)	(0.4560)	(0.2032)	(0.4981)	
HR/Odds ratio		0.9422	0.6361	0.6215	0.9314	0.8888	0.8128	0.9315	1.2652	
<i>Mining proximity</i>	Coeff.				-0.0008 ^a	-0.0008 ^a	-0.0006 ^b	-0.0008 ^a	0.0004	
	s.e.				(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	
HR/Odds ratio				0.9991	0.9991	0.9993	0.9993	0.9991	1.0004	
<i>Remoteness</i>	Coeff.				1.5975 ^a	1.4623 ^b	1.6693 ^b	1.5975 ^a	-0.5436	
	s.e.				(0.5715)	(0.6582)	(0.5688)	(0.5714)	(0.7034)	
HR/Odds ratio				4.9407	4.3161	5.3087	4.9411	4.9411	0.5806	
<i>Pre - Columbian</i>	Coeff.				0.0107	4 dummies	0.0067	0.0107	0.1457	
	s.e.				(0.1781)	for empires	(0.1785)	(0.1780)	(0.2045)	
HR/Odds ratio				1.0108	(Non-sign.)	1.0067	1.0108	1.0108	1.1568	
Method		PH	PH cloglog	PO logit	PH	PH	PH cloglog	PH	PH cloglog	
Baseline hazard	Weibull	281	11227	11227	686	686	34703	686	18837	
Log Likelihood		-218.66	-415.16	-421.25	-285.32	-284.22	-514.24	-285.32	-375.77	

^a, ^b, and ^c represent respectively statistical significance at the 1%, 5% and 10% levels. PH refers to Proportional Hazard. Step function refer to a method where the baseline hazard is estimated by using time dummies for each spell (See the text for more details).

Despite its popularity, the PH Weibull model has two caveats. First, its theoretical development was made for the case of continuous-time data, while most of the economic episodes (including location survival) are discrete time-to-event variables. Second, and much more important, the parametric estimation may result in inconsistent estimation of the parameters if the functional form of the baseline hazard is misspecified (Cameron and Trivedi, 2005). A way to overcome these issues is the use of binary regressions combined with a step function to calculate the baseline hazard. In such models, each observation is no longer the duration, but a variable coded 0 if the location survives a given year, and 1 if the location is abandoned that year (in probabilistic terms, $P(Y = 1)$). Consequently, for each location ℓ , there are as many rows as years at risk, denoted κ . The baseline hazard is estimated by introducing time dummies D_κ for each spell length (in other words, a dummy equals to 1 in the year κ for location ℓ if it is at risk, and 0 for the rest of the years at risk). A discrete PH model usually estimated is the complementary log-log link (*cloglog*), which expresses the log-log survival as a linear function of regressors. Denoting $1 - P(Y = 1)$ the probability of a location of surviving a given year conditioned on survival of previous years, the estimated regression becomes:

$$\log[-\log(1 - P(Y = 1))] = \sum_{\kappa} B_\kappa D_{\kappa(t)} + X'\beta + \epsilon_\ell \quad (4.5)$$

The interpretation of the regressors is the same as in the Weibull PH model. Results for this specification are presented in the second column of Table 4.4 (Note that the number of observations now represents the locations ℓ times the years at risk for each spell). Overall, they confirm the main findings. The impact of city age is larger, and now a non-linearity in the number of disasters is also identified. Another advantage of a discrete model is that it allows for time-varying regressors. Consequently, the port status dummy is recoded as 1 only starting the year when the port became officially authorized by the crown to trade (as indicated by Ramos, 1980. Ports used for smuggling trade are also coded as 1, starting in dates estimated by the same author. Most of these ports became official after the Bourbon trade reforms). The coefficient is much bigger but not significant at conventional levels, confirming that locations hosting ports were no more stable, as the Figure 4.3 suggests.

It is also possible to employ a logit specification instead of cloglog, and the exponential is an odds ratio instead of a hazard rate. The model is termed as *discrete time proportional odds*, because the odds ratio is assumed to be constant over time. The dependent variable is the probability of being abandoned instead of the survival (i.e., $P(Y = 1)$ instead of $1 - P(Y = 1)$). Results displayed in column 3 are similar to the cloglog estimation.

Columns 4 to 7 of Table 4.4 display regressions including the sample of censored cities (those for which I did not find any trace of relocation events in historical records). Besides the increase in observations, its inclusion allows for additional regressors that considers geographical position. Nonetheless, this comes at a cost, because georeferenced data was not found for 20 footloose cities. Moreover, the number of shocks may be less well recorded for censored cities, especially the smaller ones.²⁵ Consequently, the magnified impact for this variable must be taken with caution.

Regressions using PH Weibull method (columns 4 and 5) confirm previous results concerning the effects of city age, urban network, and the non-significant effect of the port status dummy. Regarding the new regressors, we remark that there is no gain in stability for a city established in a region previously belonging to an advanced Pre-Columbian civilization. Moreover, using four dummies to consider the major civilizations separately (Aztec, Inca, Mayan and Others) does not improve this result: None is significant at conventional levels. The negative and significant coefficient for mining proximity suggests that wealthiest regions contributed to urban stability. Nevertheless, the coefficient is small (more on this below). The coefficient for remoteness is much more important. As I will explain later, the interpretation of this variable can be associated to a combined effect of political and trade policies related to the Bourbon reforms. Column 6 shows the coefficients for a regression using the *cloglog* specification. Results are almost the same, with city age reaching its higher impact: Remaining one additional year in a location reduces the probability of abandon by 13.1% with respect to the baseline hazard. Also remoteness exhibit the largest negative impact on urban instability, with a hazard rate of 5.3.

²⁵Shocks for big censored cities (like Mexico city, Lima, Quito, Santiago, Veracruz, Cartagena de Indias, etc) seem well documented. As indicated before, information for footloose cities is also very detailed, irrespective of the size.

Regression in column 7 presents the results of a PH Weibull model assuming a Gamma-distributed²⁶ unobserved heterogeneity. The estimated coefficients are almost identical to those in column 4, and the variance estimated is negligible (4.46e-07) and statistically insignificant (*s.e.* = 0.0005). Nonetheless, a note of caution is in order. Other alternative methods (Gamma frailty using a cloglog specification, non-parametric estimation as proposed by Heckman and Singer (1984)) did not converge (as often happens in practice, see Eberwein et al., 2002; Cameron and Trivedi, 2005). In this study, I rely more on the nature of the experience (creation and following of a urban system) than on these econometric methods to argue that initial conditions are not affecting the results. In every case, it is clear that the historical context evolved, affecting the relative importance of each determinant. In column 8, I present a regression similar to that of column 6, with the particularity that uses only spells from cities founded until 1600. Whilst most of the significances and signs are preserved, magnitudes can be quite different, with remoteness exhibiting even a positive (non-significant) contribution to urban stability.

Therefore, and as a final exercise, I run cloglog regressions like that of column 8, by adding each city foundation at a time, starting in 1533 (when the Inca empire was taken by Francisco Pizarro). Results should be seen as exploratory and speculative. Moreover, a major caveat is that the number of observations is low for initial periods, preventing in many cases to obtain convergence of the estimations. All in all, I got 284 coefficients. In Figures 4.4 to 4.7, estimated coefficients are plotted against the corresponding last foundation date included in each regression. Hollowed circles are coefficients that are not significant at conventional levels.

The urban network (defined as the time elapsed between the Encounter and the date of foundation of each city) intends to capture the increasing coverage and control of the crown over its Spanish American possessions. In the context of the PH models, it plays the role of scaling observations according to their sequence in the 343-years period, with respect to the baseline hazard.²⁷ The values for coefficients (depicted in Figure 4.4) are

²⁶Using an inverse-Gaussian distribution gives almost the same results.

²⁷A baseline hazard takes into account time in terms of the duration of spells, but not of its moment in the historical context. In other words, it does not distinguish between a duration of two years of a city

striking for their variation. Regressions considering earlier periods only results in very high positive contributions to urban instability. For example, a regression using spells from cities founded between 1492 and 1542 exhibit a significant coefficient of 0.0675. In terms of hazard rates, for a city founded in that period, a progress of one year in the colonization process increases in 7% the probability to abandon its location. The same regression taking all spells from cities founded until 1600 (see column 8 in Table 4.4) still gives a significant positive coefficient, although now much lower (0.024), and the hazard rate is only 1.024. In this initial period, colonizers ignoring several aspects of the chosen locations, and looking essentially for gold and silver mines, are founding cities at a fast pace. As they learn how to cope with external shocks and develop ties to the new city that goes beyond simply extracting minerals, the advance of the colonization process reflects more the interest to settle permanently in a place. Actually, the coefficient becomes non-significant when the regression incorporates spells from cities founded until 1644. This situation is maintained after adding all cities founded until 1729. Starting from there the coefficient is negative and significant, although small. As a consequence, a new foundation can rely on a system of cities (especially neighbor cities) and a common knowledge developed for almost 250 years of making cities. Nevertheless, those cities are settled in the hardest places, as the next paragraph indicates.

While the Urban Network variable attempts to localize spells in time, the Remoteness variable localizes spells in space (Figure 4.5). Coefficients for regressions using older data exhibit erratic values, perhaps attributable to the relatively low number of observations. Circa 1650s, adding subsequent observations result in monotonic increases in the magnitude of the coefficient. A regression including spells from cities founded until 1680 is the first exhibiting a significant coefficient for remoteness. The magnitude increases over time, because most of the new cities founded in the Bourbon period are localized in the periphery of the empire, and they are often negatively shocked by Indian attacks or natural disasters. As the decision centers are far away from these spots, it may had been difficult to obtain resources to cope with these problems. They are also isolated from the main trade

founded in 1500 and another city also with a duration of two years, but founded in 1750.

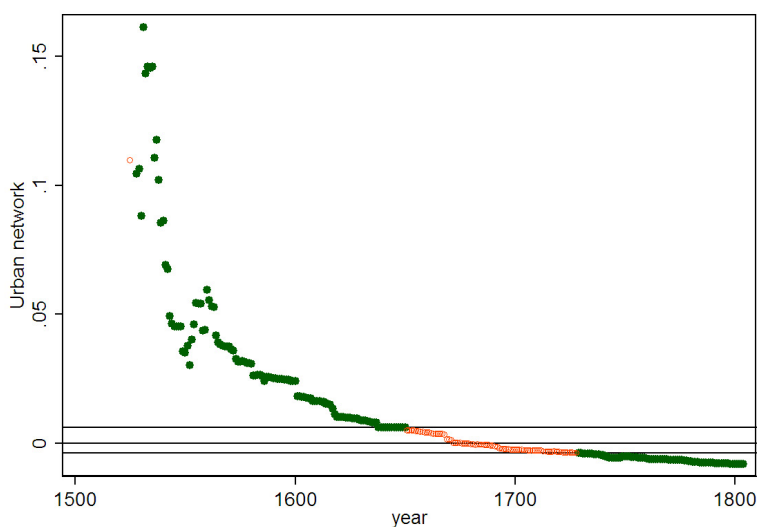


Figure 4.4: Coefficients for *urban network* variable.

routes, in a period where trade became an important source of economic stimulus. In sum, this variable seems to be capturing several effects at the same time, and it is difficult to disentangle them.

Figure 4.6 also shows interesting results. Regressions using spells from cities founded until 1560 suggest that proximity to mining resources increased urban instability. This is consistent with the political tensions generated in the beginning of the colonization among conquerors for the appropriation of silver and gold mines. After that period, and coinciding with the consolidation of the institutional framework imposed by the crown, the coefficient is no longer significant. This result remains for regressions including foundations until 1737. Adding subsequent observations turns the contribution of mining proximity in the opposite direction: being closer to a mining center reduces urban instability, although the coefficient is small. Interestingly, Fisher (1997) established that around 1730s, mining production started a period of growth that was sustained for the rest of the century. He also highlighted that new investments, especially in New Spain (Mexico), fostered the local economies. We may think this favorable economic conditions for the mining sector attracted population to cities linked to this production. On the other hand, Carmagnani (p. 111-117) noted that during the last quarter of the century, important revolts exploded

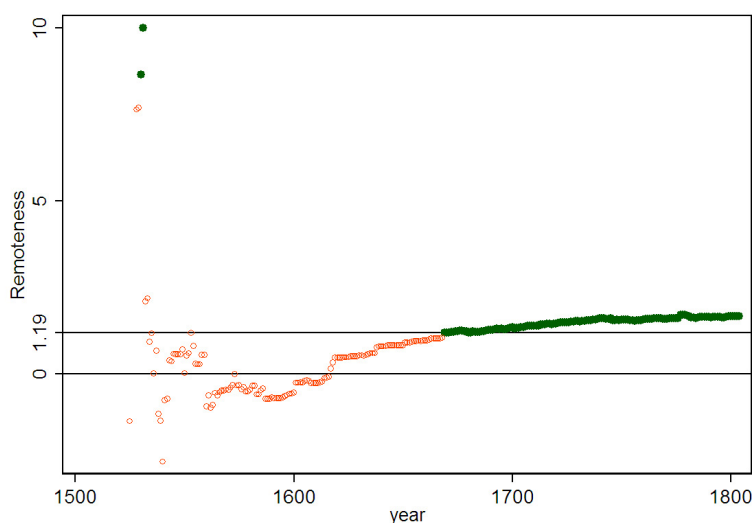


Figure 4.5: Coefficients for *remoteness* variable.

in Spanish America, especially around mining centers, because of the Bourbon tax reforms. My dataset recorded these uprisings. However, not a single city was relocated or abandoned during this period due to these revolts. Moreover, most of these grievances did not appear to explicitly defy Spanish sovereignty (although some historians see them as precursors of Independence wars).

The last variable presented is the city age (Fig 4.7), which corresponds to the test of hysteresis. In contrast to the other variables, it exhibits a strong stability across periods. During the first decades of the colonization, the variable is quite negative, because cities of that time were spots in a new and unknown territory for settlers: Each additional year of permanence in a location entailed an accelerated learning about endowments, institutions, and how to cope with negative shocks. Nonetheless, adding subsequent spells determines that a century after Columbus arrival, the Spanish American urban system exhibited a stable persistence with one additional year of presence in a location reducing the probability of abandon in around 15%.

Results for others coefficients are not presented because they do not exhibit changes over the periods. The *Port dummy* is never significant. The variable for *Number of Shocks* is always positive. The quadratic term is often significant and negative suggesting that while

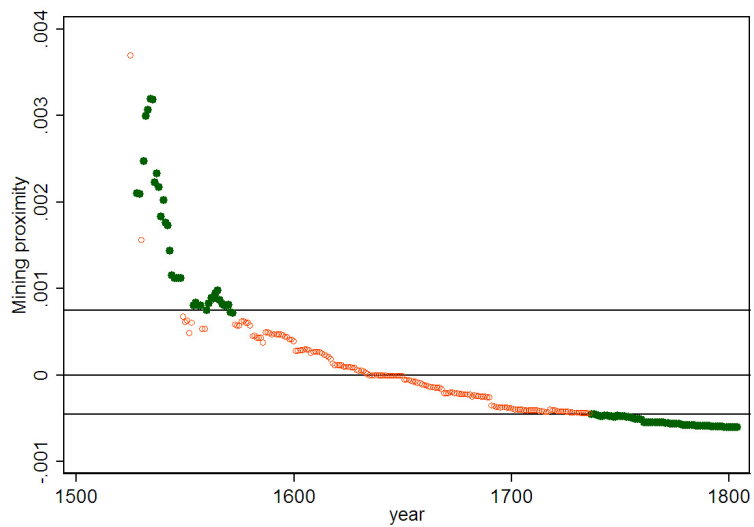


Figure 4.6: Coefficients for *proximity to mining centers* variable.

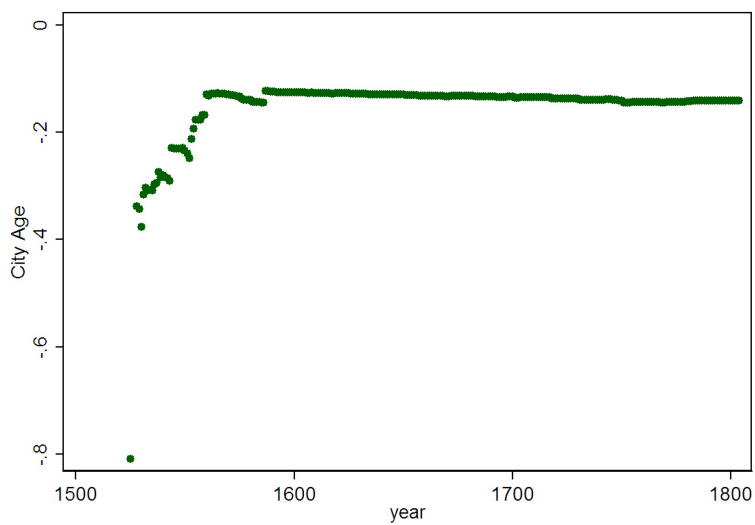


Figure 4.7: Coefficients for *city age* variable.

disasters affect negatively the stability of a location, the effect may be weaker with a high number of shocks. These results are not very suggestive of catastrophic agglomerations, because a single shock can change the state of a location, and the threshold effect, if exists, goes in the opposite direction, that is, reducing the impact of cumulative numbers of shocks. Of course, the impossibility of determining the magnitude of the shocks is a major limitation.

The analysis presented in these graphs is speculative but suggests interesting avenues for future research, which I sketch now. Firstly, several of the variables exhibit significant impacts on urban stability. Nevertheless, they are all proxies that represent many forces acting simultaneously. For example, remoteness seems to represent, at the same time, the impact of being isolated from the decision centers, and the impact of being isolated from trade routes. On the trade side, a more sophisticated version of this kind of variable may exploit data on sectoral production and trade in the line of market potential calculations (series on trade volumes and prices are becoming available for later periods, see Williamson, 2008; Fisher, 1997; Garcia-Baquero, 2003b, among others). On the political side, information on institutions, elites, demographic composition of the population, etc, may help to create a more direct assessment of the political influence of a city. Secondly, other econometric methods could be applied to assess the impact of shocks and check the robustness of the results found here. More detailed data on the magnitude of shocks, could allow for the implementation of a *Treatment Effect* approach. Thirdly, this study has found important differences between initial and later periods of the colonization. It seems that the Bourbon reforms had major impacts on the colonies. It worths to assess the impact of such ambitious thrust of institutional and economic change. A promising way could be exploiting the timing of the reforms and its spatial variation across cities. Fourth, this study has established that hysteresis is at work, using a comprehensive coverage in time and space for Spanish America. The scarcity of data was overcome by using a parsimonious test of negative duration dependence, and relying on information of duration of locations and changes due to exogenous shocks. Researches should move to more sophisticated ap-

proaches in more limited units of space or time spans where more data is available²⁸, and attempt to explain how a location becomes a successful or failed city. Exploring evolutions of population growth, migration, economic activities, trade orientation, wage determinants, etc would shed light of precise mechanisms of adjustment of the spatial economies, that determined positively or negatively the abandon of a location. Lastly, extensions beyond the Independent period may shed light on the current urban structure, and explores some aspects like urban primacy and industrialization.

4.5 Conclusions

In this article I looked at the creation and evolution of a urban system to assess its resilience to shocks. The Spanish colonization of the Americas provides a natural experience to identify hysteresis in urban settlements and control for initial conditions. I have documented the stability of location choices made by colonizers over more than 300 years. I followed the history of each city from its birth, along its multiple settlements and eventually its abandon. 210 footloose cities were identified, that is, cities that either were abandoned forever or changed locations. Using survival analysis, I test for hysteresis, and I found that remaining one additional year in a spot reduced the probability of abandon between 5% and 13%. Other factors are also affecting urban stability, but its contribution is conditional on the stages of political and economic development of the empire. In the earlier periods of the Conquest, political disorders together with an orientation to extractive activities seem to explain a high urban instability, with proximity to mining contributing to this. In later periods, where the empire stabilizes, demographic decline start to reverse, and new economic activities appears, mining proximity is no longer a source of instability, and proximity to great political and economic centers starts to matter.

On the eve of the Latin American Independence, the young countries carried as heritage from Spanish rule, a stable urban system. Many locations, chosen in the hurry of controlling

²⁸For example, tax records or censuses are available in specific regions of Latin America (See for example Dell (2009) for Peruvian data, Livi Bacci (2005) for Paraguay, Garcia Jimeno (2005)) or for big cities in Latin America for the later periods of the colonization.

the territory, are today's main Latin American cities. Natural disasters are still hitting these countries, sometimes affecting negatively economic growth. Nowadays, Is it possible to observe city relocations? Damage provoked by events like 9/11 attacks in New York or the Hurricane Katrina in New Orleans do not seem to trigger massive abandons (although abandoning New Orleans is still discussed and return to the city is slow as shown by Paxson and Rouse, 2008).²⁹ The technological level in the sixteen century was certainly lower enough to observe such unique experience. Results must be interpreted with caution because of natural limitations of historical data. Future research can extend this work in several ways. Probably the most important pending task is deeper investigation on the relative contributions of institutions, trade and geography as determinants of cities' growth and decline.

²⁹Nonetheless, sometimes geography is still imposing limits to reconstruction. In 2008, the Chaitén volcano in the south of Chile forced to evacuate all the population of the regional capital, as well as other nearby towns. As the town was in a narrow plain between the sea and the volcano, the location seemed a bad long-run choice, and the catastrophe gave the opportunity to correct this. The Chilean government designated other city in the region as regional capital and started to relocate Chaitén 11 kms to the north.

4.6 Appendix.

Table 4.5: Chronology of main events of Spanish rule in the Americas

Year/Period	Event
1492	Columbus reaches Guanahi Island (Bahamas) and later Juan Island (Cuba) and La Hispaniola Island (Santo Domingo - Haiti).
1504	Law of Quinto Real enacted.
1507	First epidemic outbreak documented in the New World (Smallpox in Hispaniola Island).
1511	Audiencia of Santo Domingo is created to administrate and apply justice in the New World, and in response to the increasing chaos in the Conquest.
1517	Carlos V becomes king. Yucatan (Mexico) is discovered.
1519	Territories of the New World are no longer property of the king, but of the empire. First groups of African slaves sent to La Hispaniola.
1521	Tenochtitlan (Mexico) taken by Hernan Cortés. A smallpox outbreak facilitated the fall of the city.
1524	Creation of Council of the Indies.
1533	Francisco Pizarro takes Cuzco (Peru), emperor Atahualpa executed (1572, Tupac Amaru I, last Inca emperor is executed).
1541	Santiago, the capital city of the southeast territory in the Americas (Chilean Captaincy), is founded.
1542	“New Laws” enacted, restricting privileges of the Conquistadors, and protecting the Indians. Searching for El Dorado, Francisco de Orellana crosses the Amazonas river.
1556	Charles V abdicated and Philip II becomes King.
1559	Instructions for settlement enacted.
1574	First book with information on geography of Spanish America and city foundations (López de Velasco).
1701-14	War of the Spanish Succession. Change in the dynasty from Hapsburg to Bourbon.
2nd half of 18th Century	Bourbon reforms (Free trade decrees enacted in 1765 and 1778).
1786	Publication of The Geographical and Historical Dictionary of the Americas (Captain De Alcedo).
1803-15	Napoleonic wars.
1808-14	Peninsular war detonated independence revolutions throughout Latin America (1808–1823).

Sources: Livi Bacci (2005), Carmagnani (2004), Manueco Baranda (2006).

General Conclusion

This thesis studies the agglomeration forces posit in the economic literature, with special focus on the concepts developed in the New Economic Geography (NEG). A variety of methods and empirical contexts is proposed in order to gain insights on the different ways through which NEG mechanisms operate, as well as to explore the reliability of results.

The NEG mechanisms explored are the impact of market access on wages at international (Chapter 1) and intranational (Chapter 2) levels, the impact of market access on migration (Chapter 3) and the existence of hysteresis in the evolution of agglomerations (Chapter 4).

Major problems to understand the agglomeration forces are the circular causation and endogeneity. Consequently, applications where economic setting favours a reasonable and plausible strategy of identification were privileged. In Chapter 1, the recent wave of globalization is used as a case study of increasing integration among countries to measure the impact of market access on wages over a period of more than 20 years. Panel econometric methods help reducing the concerns of omitted variable bias and endogeneity. The second and third chapters apply NEG models to the Brazilian case. Brazil performed an unanticipated and deep trade reform in the early nineties. In Chapter 2, the same effect of market access on wages is tested, by using individual data and computing market access for each Brazilian state, in order to control for spatial sorting of skills and productivity differences. In Chapter 3, NEG forces are studied through the potential positive impact of market access on migration. Again, panel econometrics is preferred to test this effect, which is confirmed. In addition, and for a reduced sampling (due to data limitations), an impact at industrial level is also found. Finally, Chapter 4 presents a new method to assess

the hypothesis of hysteresis in agglomerations. The economic setting is carefully chosen to offer a compelling case for exogeneity in the creation and early evolution of agglomerations. Specifically, the cities founded by Spaniards in the Americas are used as natural experiments to test their resilience to big exogenous shocks. A hysteresis test applied to duration data is performed, confirming the resilience.

Common findings

Beyond specific results and conclusion exposed in each chapter, there are three major common findings, concerning (1) the robustness of results, (2) the moderating effect of industrial, firm and individual heterogeneities, and (3) the specificities of the agglomeration forces in shaping economic outcomes in developing countries.

The results, coming from different cases and methods, **converge in the identification of NEG forces**. At the world level (Chapter 1), elasticities for the market access impact on wages are found between 10% and 37%. At intranational level in Brazil (Chapter 2) the coefficients ranges between 7.9% and 23.8%. Interestingly, others authors (Hering and Poncet, 2009; Mayer 2008; Bouhol and Serres, 2008) have found similar magnitudes in other contexts like Chinese provinces, or a panel of OECD countries.

Results on the migration response to market access (Chapter 3) or city survival (Chapter 4) can not be easily compared, as no other study implemented the same methodologies presented in this thesis. In the case of migration, it is reassuring that the impact of market access is found after considering two different sources of microdata (PNAD household survey, Brazilian Census) and two different methodological approaches (panel econometrics for aggregated manufacturing, cross-section for disaggregated industrial sectors). In the case of footloose cities, it is found that remaining one additional year in a location reduced the probability of abandon of this location between 5% and 13%.

The fact that NEG mechanisms are robust to the introduction of controls at several levels should not hide the impact of heterogeneity. **The expression of the agglomeration economies is affected by industrial, firm, and individual heterogeneity.**

Three examples illustrate this (there are many others in the chapters). First, industries may exhibit different degrees of horizontal differentiation, scope for exploiting increasing returns or potential for technological upgrading, as shown by the variability in the wage elasticities in regressions from Chapter 1 (for instance, textiles and paper products exhibit less robust results with respect to *Machinery Electric* or *Professional and Scientific Products*). Second, firm productivity impacts wages, and reduces the market access elasticities (although the impact is small: from 14% to 11.2% for the aggregate market access; from 22.8% to 20.1% for the international market access) as shown in Chapter 2. Third, differences in skill levels affect the individual response to market access differentials, with low educated migrants being more sensitive than high educated, as shown in Chapter 3. Fourth, in the last chapter, the methods for controlling unobserved heterogeneity suggest that coefficients are not affected, which constitutes the only case in the studies presented here where heterogeneity is not moderating agglomeration effects.

These findings should not surprise. Over almost three decades of theoretical developments in Economic Geography, it is possible to find a myriad of models uncovering the moderating effect of industrial heterogeneity (e.g. Zeng, 2006), firm heterogeneity (e.g. Baldwin and Okubo, 2006) and individual heterogeneity (e.g. Tabuchi and Thisse, 2002).

Finally, the results of this thesis suggest that **NEG models are doing well in explaining spatial economies in developing countries, when they are assessed together with comparative advantage**. NEG models, like New Trade Theory models, were initially conceived to explain exchanges among similar countries. Moreover, the focus on intraindustry trade in the 1970s reflects the focus on relationships between developed economies, relegating comparative advantage explanations for the North-South trade. Consequently, developing countries offer an interesting setting to explore the combined effect of mechanisms associated to comparative advantage and NEG. Here some examples picked out of this thesis. In chapter 1, results from wage equations indicate that 11 sectors do not exhibit any reaction to market access. Among them, we find low-tech industries like Textile and Apparel, which are often mentioned as sector with higher comparative advantage for (some) developing countries. Conversely, high-tech sectors exhibit a strong wage response,

and this are sectors supposedly of high comparative advantage for developed countries. However, it is important to recall that a formal test differentiating between comparative advantage explanations and NEG mechanisms is not presented there, and other sectors like agriculture, mining or services are not included in the analysis. In chapter 2, several controls for endowments were introduced in the wage regressions. In some cases, the coefficient of market access was reduced (e.g. in the control at municipal level, the elasticity fell from 16.2% to 9.5%). In chapter 3, Census data was employed to build sector-specific migration rates. The coefficients obtained were used to build counterfactuals of migration levels under different regimes of integration. Sectors where Brazil holds a comparative advantage (like Food and Beverages, Wood products or Furniture) exhibit strong migration responses. In chapter 4, a variable measuring city proximity to mining centers plays an important role in urban stability. During earlier periods of colonization, it contributes to the instability, probably due to enhancing conflicts among colonizers. In more recent periods, however, the coefficient reverses (reduces urban instability), making mining proximity a comparative advantage for a city.

Some issues for further research

This thesis filled a gap in the empirical agenda on Agglomeration economies, but many new issues remain. Moreover, as new theoretical and econometric developments appear, some new issues can be incorporated to the agenda. Some of them will have to wait until adequate data become available.

New forms of Globalization. A growing literature is looking into the “trade in tasks” induced by the break in the production chain across locations. This implies a redefinition of globalization as the formation of international teams, where the distribution of skill levels among countries determines the kind of offshoring, and derives new implications for wage inequality (Antràs et al., 2006). In this context, the cost of communicating knowledge is another measure of globalization, complementary to the physical trade costs. To extend our understanding of this process, studies about the evolution of world geography should

benefit from redefining the object under study, shifting from industries to specific tasks or services.

The argument is evident in an international setting (like in Chapter 1), but it would be also interesting to explore if such conceptual framework could also provide insights on economic outcomes inside of countries with strong regional asymmetries in terms of human and physical capital, like China or Brazil. For instance, internal migration inside of sectors could be better explained as a “contracted” migration (job transfers), where communication costs justifies relocating workers belonging to a same production process (and potentially, to the same firm), but in different positions in the hierarchy of production (managers, operators), according to their skill levels.

New interactions between labor market and NEG mechanisms. Labor markets imperfections affect the adjustment of the spatial economies, as shown by the recent literature combining matching models with urban theories (Zenou, 2009, Zenou, 2000). Although several NEG models containing this and other imperfections in the labor market exist (see for example, Amiti and Pissarides, 2005), empirical applications are scarce. In the study of migration of Chapter 3, the coefficients for regional unemployment were not statistically significant, as often happen in empirical works according to the survey made by Greenwood (1997). For this author, a measure of labor turnover could be more appropriate to capture the probability of getting a job, because migrants “are more concerned by rates at which hiring for new jobs is taking place”. Future works should consider better measures of matching.

Another dimension of labor markets to be incorporated is the legal framework. Wage determination and labor reallocations can be affected by regulations of employment protection, collective relations and social security (Botero et al., 2004). This can have important effects on the expected effects of trade reforms (Kambourov, 2009), and could explain the scarce evidence of labor reallocation found in Chapter 1. Empirical evidence for Brazil also points to a low sector mobility (Menezes-Filho and Muendler, 2007).

New interactions between institutions and NEG mechanisms. Social interac-

tions arising from trade and from socialization are intertwined, affecting the path of agglomerations and the quality of institutions, and ultimately economic development. Moreover, circular causation and multiple equilibria are common features of these approaches (Nunn, 2009). A reasonable strategy of identification of these effects is a formidable challenge. Like the empirical approaches launched by Daron Acemoglu and co-authors on institutional change, NEG studies can benefit from exploring long-run processes, digging into “the origin of spatial interaction” (Keller and Shiue, 2007). Results for Chapter 4, suggest that colonization episodes are plagued of high political instability at the start of the conquest due to the tensions generated by the appropriation of silver and gold mines. The new societies that emerged after this period were highly heterogeneous, depending on the kind of resources available in each region (Bruhn and Gallego, 2008), the political centrality in the empire (Lucena, 2006), and the framework conditions imposed in issues like trade policy or taxation (Fisher, 1997; Carmagnani, 2004). The long-run impact of these variables on economic outcomes can be assessed in a framework where initial conditions can be reasonably controlled.

The four chapters of this thesis have illustrated that the mechanisms proposed by the New Economic Geography are at work, explaining agglomeration outcomes and affecting economic performance. The first three show that, through a variety of settings, the impact of a central variable in NEG models, the market access, is strongly influencing labor markets. The last chapter provides empirical evidence of path dependency in the creation and evolution of agglomerations. Although new studies are needed to overcome remaining limitations, all aspects of the agenda on empirical economics set a decade ago were addressed here. Moreover, studies presented in this thesis reduce an existing gap in terms of applications to developing countries.

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Résumé

Cette thèse analyse les implications empiriques des économies d'agglomération. De nombreuses limitations dans les études existantes sont surmontées. Les applications dans les pays en développement sont privilégiées, en particuliers ceux qui ont expérimenté une plus forte intégration à l'économie mondiale du fait de l'ouverture commerciale ou des colonisations. Les applications s'intéressent plus particulièrement aux mécanismes proposés par la Nouvelle Économie Géographique (NEG).

Le chapitre 1 étudie l'évolution de l'économie géographique mondiale en testant l'impact de l'accès aux marchés comme variable explicative de la structure spatiale des salaires pour 27 industries sur la période 1980-2003. L'équation de salaire est estimée en panel pour chacune des industries. Les coefficients sont positifs et significatifs dans 16 secteurs. Les secteurs de haute technologie sont particulièrement robustes.

Les chapitres 2 et 3 se concentrent sur l'impact de l'ouverture commerciale sur les régions brésiliennes. Le chapitre 2 confirme l'impact positif de l'accès aux marchés sur les salaires à l'aide de données individuelles et des entreprises. Comme l'existence de différentiels de salaires devrait entraîner à terme la mobilité des facteurs, le chapitre 3 évalue l'hypothèse d'un effet significatif et positif de l'accès aux marchés sur les flux de migration bilatéraux. L'utilisation des données individuelles permet de construire des mesures de migration au niveau industriel et par niveau de qualification. Les résultats confirment l'impact positif de la variable d'intérêt, mais soulignent aussi l'importance des coûts à la migration et le biais de sélection dans la réduction des flux migratoires.

Enfin, le chapitre 4 propose une étude empirique sur le rôle de l'histoire dans la formation des agglomérations. Il se base sur les épisodes des fondations des villes espagnoles dans le continent américain. Pendant le processus de colonisation, de très grands chocs (guerres, catastrophes naturelles), ont généré des variations importantes suivant la localisation des villes. Des phénomènes d'hystérèse peuvent être identifiés à l'aide des modèles de durée. Les résultats suggèrent une très forte instabilité des villes au début de la conquête, attribués aux désordres politiques. Plus tard, la maturité institutionnelle conduit à une plus forte stabilité urbaine.

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Mots-clés :

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