Essays on International Trade and Economic Geography

Andrei Victor Potlogea

TESI DOCTORAL UPF / ANY 2016

DIRECTOR DE LA TESI
Vasco M. Carvalho i Giacomo A.M. Ponzetto
Departament d'Economia i Empresa

Universitat Pompeu Fabra Barcelona

To Susannah

Acknowledgements

Like any big project, the completion of this thesis would not have been possible without the advice and support of many others. Here I want to take the opportunity to thank all of those who have helped me along the journey of PhD research, making it both productive and enjoyable.

First of all, I would like to thank my advisors Giacomo Ponzetto and Vasco Carvalho. They have not only provided me with important insights and taught me more about economics than anyone else, but through a finely tuned combination of emotional support, honest feedback and timely pressure have guided me past my early (and late) struggles.

I owe special thanks to Gino Gancia and Jaume Ventura. Their ability to separate the essential from the superfluous and their constant focus on the big picture has taught me a great deal. Special thanks are also due to Juanjo Ganuza, for allowing me to participate in his research project on "Information, Markets and Social Decisionmaking: Theory and Applications".

Among the many other professors at UPF that have provided me with important insights or sound advice at various stages during my studies, I would like to single out Julian di Giovanni, Fernando Broner, Fabrizio Germano, Larbi Alaoui, Albrecht Glitz, Alessandro Tarozzi, Kurt Schmidheiny, Filippo Ippolito, Isaac Baley, Manuel Garcia-Santana, Sandro Shelegia and Massimo Motta.

I would like to also thank Marta Araque and Laura Agusti, who have been instrumental in helping me deal with the administrative complexities of PhD student life, particularly during the job market and my long research stays at Cambridge and LSE.

Among my peers, a first special thanks goes out to Stephan Maurer. Stephan has not only co-authored the third chapter of this thesis, but has been a constant source of support throughout the ups and downs of PhD life during the past five years. A big thank you is also due for Wenya Cheng, my collaborator on the second chapter of this thesis.

I also want to express my gratitude towards fellow PhD students at UPF, many of whom became good friends: Tom, Tanya, Oriol, Ciccio, Bruno, Stefan, Hrvoje, Thomas, Federica, Fernando, Andrea, Mrdjan, Jagdish, Emma, Gene, Felipe, Miguel Karlo and Chris. A special mention goes to Michael, who will be missed by all of us.

For my final set of thanks words are not quite enough. I would like to thank my parents, for continuing to provide the unconditional support they have offered throughout

my life. Finally, I would like to thank my wife Susannah, for reminding me that there’s a big world out there.

Abstract

This thesis provides an investigation of the effects of trade, technology and natural resource shocks on local economies and local labor markets. In the first chapter, I explore theoretically the impact of recent improvements in communication technology on the configuration of economic geography at multiple levels of spatial disaggregation. I show that a simple model of the organization of global supply chains can rationalize several salient stylized facts concerning the recent evolution of the spatial economy. In the second chapter, I empirically investigate the impact of changes in US trade policy triggered by China's WTO accession on Chinese local economies. I find that improvements in US market access had an important impact on local economic outcomes and on the spatial configuration of economic activity within China. In the third chapter I investigate the impact of large oilfield discoveries on local labor markets, with a particular focus on the effects on the economic prospects of women. I find that while large mineral endowments do not slow the process of women joining the labor force, they do lead to a higher gender wage gap.

Resumen

En esta tesis se lleva a cabo la investigación de los efectos de comercio internacional, tecnología y recursos naturales sobre las economías y los mercados laborales locales. En el primer capítulo, examino teóricamente el impacto de las recientes mejoras en las tecnologías de la telecomunicación sobre la configuración económico-geográfica en varios niveles de desagregación. Muestro que un modelo sencillo de la organización global de las cadenas de suministros puede racionalizar varios hechos estilizados relacionados con la evolución reciente de la economía espacial. En el segundo capítulo, investigo empíricamente el impacto de los cambios en la política de comercio exterior de los EEUU, desencadenados por la adhesión de China a la OMC, sobre las economías locales en China. Encuentro que el mejor acceso al mercado estadounidense tuvo un impacto importante sobre las economías locales y sobre la configuración geográfica de la actividad económica en China. En el tercer capítulo, examino el impacto de descubrimientos de grandes yacimientos petrolíferos sobre las economías locales, centrándome particularmente en las perspectivas económicas de las mujeres. Encuentro que aunque grandes yacimiento minerales no retrasan el proceso de adhesión femenina al mercado de trabajo, sí llevan a mayores diferenciales salariales entre los hombres y mujeres.

Preface

This doctoral thesis consists of three essays at the intersection of international trade, economic geography, urban economics and labor economics. The connecting thread that runs between these three essays is the focus on the analysis of the impact of various economic shocks (trade, technology and the discovery of natural resources) on local economies and local labor markets.

In the first chapter, I develop a model that explains several of the recent shifts in the location of economic activity, both across and within countries, as consequences of globalization brought about by technical progress. In the model, declining costs of long-distance communication induce a reallocation of economic activity across space. This process accounts for three key trends in the data. First, cross-country inequality has declined as many developing countries have grown rapidly. Second, economic geography has instead grown more unequal within countries. Third, rising intra-national inequality reflects the disproportionate success of skilled cities. My model explains the faster population and output growth of skilled cities, as well as their tendency to augment their initial skill advantage. Consistent with the evidence, my theory features a non-monotonic path of urban growth in developed countries. The model predicts a future shift in worldwide urban hierarchies as some developing-world cities overtake unskilled cities in industrialized countries along global supply chains.

In the second chapter, co-authored with Wenya Cheng, we study the effect of improvements in foreign market access brought by China's WTO accession on Chinese local economies. We exploit cross-city variation in these improvements stemming from initial differences in sectoral specialization and exogenous cross-industry differences in US trade liberalization that originate from the elimination of the threat of a return to Smoot-Hawley tariffs for Chinese imports. We find that Chinese cities that experience greater improvement in their access to US markets following WTO accession exhibit faster population, output and employment growth as well as increased investment and FDI inflows. The benefits of WTO membership for Chinese local economies are augmented by significant local spillovers. These spillovers operate both from the tradable to the non-tradable sector and within the tradable sector. Within the tradable sector, spillovers are transmitted primarily via labor market linkages. We find important local demand linkages from the tradable to the non-tradable sector. Most local service sectors benefit from trade liberalization. In particular, our evidence suggests that increased investment demand caused by trade liberalization drives financial sector growth. We find little effect of trade liberalization on local wages. Alongside our results on population and employment, this indicates that local labor supply elasticities are high in our setting. Our findings can be explained by a Lewis model of urbanization that combines geographic mobility with an abundant reserve of labor.

Finally, in the third chapter of my thesis, co-authored with Stephan Maurer, we use the discovery of major oil fields in the Southern US between 1900 and 1940 to test whether resource-based specialization is detrimental to women's labor market outcomes. Consistent with this hypothesis, oil discoveries are found to lead to a higher gender wage gap. However, we find no evidence that oil wealth lowers female labor force participation or has any impact on local marriage and fertility patterns. While our results indicate that oil discoveries limit female labor market opportunities in some sectors, this effect is compensated by the higher availability of service sector jobs.

Contents

List of Figures

List of Tables

Chapter 1

GLOBALIZATION AND THE SKILLED CITY

1.1 Introduction

The last five decades have brought about a substantial reconfiguration of economic geography both across and within countries. Rapid (and often export-led) growth in a set of developing countries, particularly China and India, has led to a more dispersed cross-country economic geography. Furthermore, this process of economic catch-up has been accompanied by the rapid advance of urbanization, which has seen many countries sustain large urban populations at lower levels of income than was typical in the past. In contrast to the international rebalancing of the world economy, within country economic geography has grown more unequal. In particular, many nations witnessed remarkable levels of heterogeneity in urban success, with some cities experiencing rapid growth while others suffered stagnation or even decline.

The divergence in urban fortunes mentioned above can be attributed in no small part to the emergence of a strong association between human capital and urban success[1]. Mounting evidence suggests that "skilled"[2] cities have tended to outperform their skill

[1]The relationship between human capital and local productivity and economic success is explored at length in Moretti (2004,2013).

[2]As is standard in the literature, here and elsewhere I use the concept of "skilled" cities to mean urban areas with a (relatively) high fraction of their populations exceeding a certain threshold of skill or education level.

scarce counterparts on a battery of measures of urban success (Glaeser 1994; Glaeser, Scheinkman and Shleifer 1995; Simon and Nardinelli 1996,2002; Black and Henderson 1999; Glaeser and Saiz 2004; Anderson and Ge 2004; Shapiro 2006; Da Mata et al 2007; De la Garza 2008; Liao 2010). Moreover, evidence from a series of countries indicates that skilled locations have tended to augment their skill advantage in recent decades, a phenomenon that has been described as skill polarization across space. Importantly, these regularities linking human capital and urban success have been documented for rich and poor nations alike (Anderson and Ge 2004; Berry and Glaeser 2005; Da Mata et al. 2007; Queiroz and Golgher 2008; Poelhekke 2013).

What has caused the reconfiguration of economic geography across and within countries described above? I develop a model that explains these phenomena as consequences of globalization brought about by technological progress. The model depicts a global economy in which improvements in communication technology allow skill intensive manufacturing activities to become spatially separated from the management function. This development leads to the reorganization of global supply chains, with advanced manufacturing activities gradually leaving developed nations to take advantage of lower factor costs in developing countries.[3] In turn this leads to developing nations capturing an increasing share of global supply chains and experiencing convergence with developed countries.

Moreover, this reallocation of global supply chains brought about by improvements in communication has asymmetric effects within countries. As the advanced manufacturing activities relocating to developing countries require access to good infrastructure and skilled workers that are scarce in these nations, they first tend to locate in the most advanced (and skilled) cities of these countries. This, in turn, leads these locations to experience faster growth than the rest of their countries. In contrast, in developed countries all cities are hurt by the loss of skill intensive manufacturing activities. However, the most skilled rich country locations, that have a large share of their employment dedicated to the production of sophisticated management services in which developed countries retain an unassailable advantage, benefit from a compensatory effect of glob-

[3]The main mechanism highlighted by the model places this chapter in the wider literature on offshoring (McLaren 2000; Grossman and Helpman 2002, 2004, 2005; Antras 2003; Antras and Helpman 2004; Antras, Garicano and Rossi-Hansberg 2006) and global supply chains (Feenstra and Hanson 1996; Jones and Kierzkowski 1990, 2001; Deardoff 2001a, 2001b; Kohler 2004; Fujita and Thisse 2006; Grossman and Rossi-Hansberg 2008; Baldwin and Robert-Nicoud 2014)

alization. This is because communication improvements lead to an increase in the efficiency and scale of the world economy, meaning these skilled locations can sell their management services to a larger global market. As this compensating force of globalization only benefits skilled locations in rich nations, improvements in communication will also lead to economic divergence across space in these countries[4].

Finally, the reduction of communication costs leads to urbanization and structural transformation[5] As communication costs decline and increasingly advanced stages of manufacturing take place in lower cost locations, the relative price or urban goods declines. Under the assumption that these goods are subject to elastic demand, their share of overall expenditure and employment increases, leading to an increase in global urbanization.

In the model, the mechanism outlined above is captured in a parsimonious set-up. International geography consists of two countries, North (N) and South (S), that are characterized by internationally immobile labor endowments and Ricardian productivity advantages. Workers are homogenous, and given the long-run interpretation of the model, skill acquisition is endogenous[6]. Intra-national geography consists of two cities and a non-urban hinterland. Labor is freely mobile within countries. Cities are endowed with immobile land and differ in their local (Ricardian) productivity. These differences in productivity across cities can be interpreted as differences in infrastructure, which reflects both history determined infrastructure investments as well as other "first-nature" forces (e.g. natural advantage). To reflect the relative scarcity of infrastructure in parts of the developing world, I assume that all Northern cities and one of the Southern cities benefit from a high endowment of local infrastructure while a lagging Southern city only has access to a low endowment of local infrastructure.

[4]By relating the elimination of spatial frictions to trade to the evolution of within country economic geography this chapter contributes to the strand of literature analyzing the impact of international trade integration on intra-country economic geography (Krugman and Livas Elizondo 1996; Paluzie 2001; Monfort and Nicolini 2001; Behrens, Gaigne, Ottaviano and Thisse 2006*a*, 2006*b*, 2007, 2009)

[5]The structural transformation mechanism embedded in my model is conceptually closest to studies analyzing urbanization and structural transformation in the context of open economies (Glaeser 2013, Fajgelbaum and Redding 2014, Jedwab 2014). This feature of the model also places the current chapter in the wider literatures on urbanization (Kim 2000; Kim and Margo 2004; Michaels, Redding and Rauch 2011, 2012, 2013) and structural transformation (Baumol 1967; Ngai and Pissarides 2007; Rogerson 2008; Gollin, Parente and Rogerson 2002, Matsuyama 1992).

[6]For another study analyzing endogenous skill acquisition in the context of its implications for economic geography see Toulemonde (2006).

Two commodities are produced in the world economy: a traditional good produced in the hinterland and an urban good. The urban sector has a supply chain that includes multiple stages of production (or tasks): unskilled manufacturing, skilled manufacturing and the management function (or management services). These tasks have a natural ranking in terms of their skill intensity, with management services being the most skill intensive activity in the world economy. Management services can only be produced in the North, while all stages of production of the urban good critically require access to urban infrastructure and as a result can only take place in cities.

As the focus of the theory developed in this chapter is the paramount role of human capital in the modern economy, I posit that skill intensity explains the whole bundle of characteristics of each stage of production. First, skill-intensive activities benefit disproportionately from the local availability of exogenous infrastructure. This is because the productivity of skilled workers hinges on the local availability of infrastructure to a greater extent than that of unskilled workers.[7] Second, the most skill intensive activity, management services, is subject to localization economies that encourage its clustering in only one Northern city. This location therefore naturally becomes the North's skilled city.[8]

Finally, the management services sector is key in shaping the configuration of the global value chain and determining the locations of all other activities. This is due to two main features of this sector. One is that management services do not enter the production of the urban good directly but they are inputs in the production of skilled manufacturing. The other is that it is the only activity that is subject to spatial frictions represented by international communication costs (i.e. management services can be costlessly shipped within countries, but are costly to deliver across countries). All other commodities in the world economy are posited to be freely tradable across and within countries. This assumption concerning the management input aims to capture the recent decline in the importance of physical transportation costs for goods and services coupled with the continued relevance of costs affecting the transportation of ideas

[7]This assumption of complementarity between skill and locational attractiveness is also made by Sattinger (1975) and Davis and Dingel (2014). It is equivalent to assuming that overall worker productivity is log supermodular in skill and access to local infrastructure.

[8]The assumption that management services are subject to localization economies is a simplified way of assuming that agglomeration economies are stronger for skill-intensive sectors and activities. This assumption is standard in the literature (Glaeser and Ponzetto 2010) and benefits from empirical support (Henderson 1983, Nakamura 1985, Henderson et al. 1995, Dumais et al. 2002).

and people (Glaeser and Kohlhase 2004). In turn, the persistence of substantial costs for the transfer of knowledge and ideas is more consequential for interactive, skill and idea intensive activities (Glaeser and Ponzetto 2010; Michaels, Rauch, Redding 2013).

With the set-up above I show that the model can qualitatively match the key stylized facts that characterize the evolution of global economic geography in the last four decades. In an initial state characterized by the presence of prohibitive international communication costs, the model reproduces the configuration of economic geography that prevailed at the middle of the twentieth century. As management services can only be produced in the North and the skilled manufacturing stage requires management services as an input, the presence of high communication costs that affect the international delivery of management services makes the completion of skilled manufacturing uneconomical in the South. As a result, Northern cities capture the management function and the skilled manufacturing sections of global value chains while Southern cities specialize in unskilled manufacturing.

As international communication costs gradually decline, the South becomes competitive in the production of skilled manufacturing. In particular, the advanced city of the South, that features a high endowment of infrastructure, becomes an attractive location for the production of advanced manufacturing and endogenously takes on the role of the skilled city of the South. Moreover, as the skilled manufacturing that gradually relocates from the North to the South is more skill-intensive than the previous activity mix of the South and less skill intensive than the previous activity mix of the North, improvements in international communication lead to an increase in the relative demand for skill in both countries.

The increase in the demand for skills is met via endogenous skill acquisition by an increasing share of both countries' populations. As the supply and demand for skill increase in both countries, the productive conditions in advanced cities, characterized by abundant infrastructure in the South and the presence of localization economies specific to the management function in the North, become more attractive. As a result, these skilled cities tend to grow, both in absolute terms and relative to their lagging counterparts, and concentrate an increasing share of their countries'population and output. Moreover, the growing skill intensive activities taking place in each country tend to preponderantly locate in each nation's most advanced city (due to the presence of increasingly valuable infrastructure and localization economies), and to crowd out less skill intensive activities from these locations. As a result, these locations tend to disproportionately attract skilled workers, leading to an intra-national trend of skill polarization across cities.

Aside from being able to match the four stylized facts motivating the present chapter, the model is able to rationalize some of the finer features of the observed patterns of urban growth. In particular, it can account for the non-monotonic evolution of cities in many developed countries in the past decades. In these advanced nations, a broad cross-section of cities, both skilled and unskilled, experienced urban stagnation and even decline for a prolonged period, spanning the years 1950 to 1980 (see Glaeser and Ponzetto 2010). However, starting from the early 1980s a pattern of divergent recovery has emerged, with many skilled cities experiencing urban resurgence, while skill scarce locations have lagged behind and continued to display poor performance across a battery of measures of urban success.

The model can also be used to cast an eye at the future and study the implications of continued improvements in communication technologies. If the labor cost differential between countries is sufficiently high, and communication costs are reduced below a certain threshold, the model predicts that we may observe "overtaking" along the global supply chain, with the skilled location of the South obtaining a more skill intensive industrial composition than the unskilled city of the North, and also surpassing it in terms of land valuations. This novel theoretical result may already be relevant for a set of particularly successful developing world cities, and it also highlights a mechanism that can help us account for the recent phenomenon of "reshoring".

The rest of this chapter is structured as follows. In the next section I briefly review the evidence supporting the stylized facts that motivate the current study. Section 1.3 outlines the model and presents the main results. After discussing the model, I dedicate section 1.4 to presenting an account of the recent "History of the Location of Economic Activity" seen through the lens of the model. Section 1.5 concludes this chapter.

1.2 Reviewing the Facts

The theory presented in this chapter aims to jointly account for the following stylized facts, in a unified framework that allows for the analysis of developments in both industrialized and developing nations: (1) in recent decades cross-country economic geography has experienced some rebalancing, with a select group of developing countries growing rapidly and catching up with industrialized countries; (2) world urbanization has increased sharply, being mainly driven by unprecedented rates of urbanization in the developing world; (3) within countries, cities with higher endowments of human capital, have performed better along a battery of measures of urban success, including population growth, employment growth, income growth and real estate price appreciation; (4) also within countries, a phenomenon of skill polarization across space has been documented, with skilled cities augmenting their skill advantage over their relatively skill scarce counterparts. In this section, I review the supporting evidence for these four stylized facts.

The recent cross-country rebalancing of the world economy, which has seen a number of developing countries close the income gap that separates them from industrialized nations, is perhaps the most salient of the stylized facts mentioned above. A simple reading of international GDP statistics serves as a compelling illustration of this development. As recently as 1992, the advanced group of industrialized economies within the G20 represented almost 60% of world GDP at PPP, whilst the group of emerging economies within the same club represented 20% of world GDP. Projections indicate that in 2014, the group of advanced economies within the G20 will instead account for only 46% of world GDP at PPP, while the share of the G20 emerging economies will have increased to 36%[9]. This development is driven by rapid growth in a set of large developing countries (primarily China and India, but also Brazil, Indonesia, South Africa, Turkey and Vietnam) which has also led to a reduction of global income inequality in spite of increasing inequality within nations and disappointing growth performance in other poor countries (Sala-i-Martin 2006).

The advance of urbanization has also been extremely rapid and consequential, and has even led to concerns about sustainability and about the emergence of "excessive" concentrations of population. If in 1950 only 29.4% of the world's population lived in cities, by 2010 a majority of the world's population (51.6%) resided in urban areas. The shift towards urban living was particularly strong in less developed countries, which increased their urbanization rate from 17.6% to 46% over the same period. The scale of this phenomenon has led some analysts to the conclusion that some of the mechanics of the urbanization process have changed, as many nations are now able to sustain high

[9]Reported data based on the IMF's World Economic Outlook Database.

levels of urbanization at lower levels of income than was typical in the past (Glaeser 2013). This view is also supported by the weakening of the traditional links between urbanization on one hand and industrialization (Gollin, Jedwab and Vollrath 2015) and growth (Jedwab and Vollrath 2015) on the other. Nevertheless, urbanization also continued in the world's advanced regions, where the proportion of population living in cities increased from 54.5% to 77.5% over the last half a century (Figures 1.6 and 1.7 depict the evolution of urbanization over this period for the world as a whole and for regions at various stages of development).

Against this backdrop of rapid urbanization, the last five decades have also witnessed substantial heterogeneity in urban success[10]. Moreover, as our third motivating fact reveals, local human capital endowments have been a strong predictor of urban growth. Analyzing a large sample of US metropolitan statistical areas (MSAs) over the period 1980 to 2000, Glaeser and Saiz (2004) find that a 1 percentage point increase in the share of a city's adult population with a bachelor's degree is associated with an increase in the decadal population growth rate by about half of one percent (their main finding is summarized in Figure 1.8). In a similar study, Shapiro (2006) finds that over the 1940 to 1990 period a 10% increase in a metropolitan area's concentration of college educated residents was associated with a 0.8% increase in subsequent employment growth. Glaeser, Ponzetto and Tobio (2012) also confirm the link between skills and regional growth when analyzing US counties over the last two centuries, though the correlation does seem to break down for parts of the nineteenth century; while a long-run study of UK cities undertaken by Simon and Nardinelli (1996) does find a robust connection between initial human capital endowments and subsequent city growth for a period spanning over a century. For the case of developing countries, perhaps the best known study linking human capital and city growth is the one by Da Mata et al. (2007) who, analyzing a large sample of Brazilian cities, find that a one year increase in the average number of years of schooling at the city level is associated with a 5.6% increase in the decadal growth rate over the next three decades.[11]

[10]For example, for the case of the US, Glaeser and Ponzetto (2010) document that while San Francisco and Chicago have added substantially to their populations in the period spanning 1970 to 2010 (17% and 13% respectively), in the same period Detroit has lost more than 20% of its population.

[11]De La Garza (2008) and Poelhekke (2013) argue that many of the estimates of the effect of the skill share on city growth found in the literature suffer from upward bias. After correcting for the bias, these authors still find significant effects on the skill share on subsequent city growth, although the magnitude

The final empirical regularity motivating this chapter concerns the fact that skilled cities have not only grown faster than their skill scarce counterparts, but they have also tended to maintain and augment their skill advantage over time, leading to a phenomenon of skill polarization (or skill sorting) across space. Analyzing the evolution of skill shares across a sample of more than three hundred US metropolitan areas over the period 1990 to 2000, Berry and Glaeser (2005) find that a one percentage point increase in the proportion of city's population holding a bachelors degree in 1990 is associated with a 0.13 percentage point increase the growth of a city's skill share over the next decade (their main finding is presented in Figure 1.9). Similar results have been found by Poelhekke (2013) for Germany and by Queiroz and Golgher (2008) for Brazil.

1.3 Model

1.3.1 Basic Setup

The model aims to describe the process through which the reduction of communication costs may lead to the reallocation of economic activity across and within countries, and account for the recent shifts in the configuration of economic geography. I set up a simple framework that allows me to study this process: a world economy featuring two countries, labeled North (N) and South (S). Each country contains two urban locations (or cities) and a hinterland or countryside. The cities are indexed $N1$ and $N2$ in the North and $S1$ and $S2$ in the South. Countries have fixed and exogenously given populations of identical workers L^N and L^S. As is standard in the international trade and economic geography literature, I assume that workers are immobile internationally, but are costlessly mobile across locations within countries.

Workers have a unit endowment of time and have three career-location options. They can choose to live in the hinterland and work in the traditional sector; they can choose to work as an unskilled worker in a city, or they may spend a fraction $e < 1$ of their time acquiring education and then move to a city to work as skilled workers in the urban sector.

Urban locations in both countries are characterized by two location-specific characteristics: their endowments of urban land (denoted by N^l) and of local exogenous

of the effects is substantially reduced.

infrastructure (denoted by A_l, and taken to encompass all "first nature" forces). Northern urban locations are assumed to be ex-ante identical, each having an endowment of infrastructure of $A_{N1} = A_{N2} = A > 1$. By contrast, in the South there is an advanced location, which I identify as $S2$ and which has an endowment of infrastructure similar to that of Northern cities (i.e. $A_{S2} = A > 1$) and a backward location exhibiting a lower endowment of the exogenous infrastructure, $A_{S1} = 1$. For simplicity, I assume that all urban locations, both Northern and Southern, are symmetric in their endowment of urban land, i.e. $N^{S1} = N^{S2} = N^{N1} = N^{N2} = \overline{N}$, and that urban land at each location is owned by absentee landowners.

A single final good is produced in the world economy, which I also designate as the numeraire. This commodity is assembled from two intermediates: a traditional (rural) good, indexed as good 1, which is produced in the hinterlands, and a (composite) urban good, indexed as good 2 and produced in cities. The production technology of the final good is given by:

$$Q = \left[\gamma q_1^{\frac{\epsilon-1}{\epsilon}} + (1-\gamma) q_2^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}} \tag{1.1}$$

The elasticity of substitution between intermediates in the production of final output is assumed to be greater than unity (i.e. $\epsilon > 1$). Moreover, the final good, its component intermediate goods, and all other commodities are produced under conditions of perfect competition.

Production of the traditional good employs unskilled workers via the linear production technology

$$q_1^c = \xi_{1c} L_1^c \tag{1.2}$$

where ξ_{1c} denotes the productivity with which the traditional good is produced in country $c \in \{N, S\}$. Northern productivity in the traditional sector is higher than that of the South, $\xi_{1N} > \xi_{1S}$ and the cost of producing a unit of the traditional good is determined by the productivity adjusted cost of labor in each country.

My main focus is on the production of the urban intermediate. The production process for this commodity involves the completion of two main production stages (or tasks): (basic) unskilled manufacturing and (advanced) skilled manufacturing. These tasks have a natural ranking in terms of their complexity, which is reflected in their skill intensity. I also assume that skilled manufacturing carries a larger weight in the production of the urban good. The production technology of the urban intermediate is given by:

$$q_2 = u^{\theta} s^{1-\theta} \tag{1.3}$$

where u denotes unskilled manufacturing, s denotes skilled manufacturing, and $\theta < \frac{1}{2}$.[12]. In turn, the completion of the urban stages of production involves combining the primary factors of production, labor and urban land, via standard Cobb-Douglas technologies given by:

$$u^{cn} = \left[A_{cn} L_u^{cn}\right]^{\beta} \left[N_u^{cn}\right]^{1-\beta} \tag{1.4}$$

$$s^{cn} = \left[\left(A_{cn}^{\rho} H_u^{cn}\right)^{\alpha} \left(M_u^{cn}\right)^{1-\alpha}\right]^{\mu} \left[\left(A_{cn} L_u^{cn}\right)^{\beta} \left(N_u^{cn}\right)^{1-\beta}\right]^{1-\mu} \tag{1.5}$$

where c and n index country and city respectively, L denotes unskilled labor, H denotes skilled labor, N denotes urban land while α, β, μ and ρ are parameters, with $\alpha, \beta, \mu < 1$ and $\rho > 1$.

The production processes for the urban tasks outlined above contain three important embedded features. Firstly, as production stages along the production chain of the urban intermediate become more complex and skill intensive they also become less land intensive. This assumption is standard in the urban economics literature and is in line with empirical observations. Glaeser and Ponzetto (2010) employ the same assumption while Wood and Berge (1994) and Owens and Wood (1995) note that "Primary production is usually both more land-intensive and less skill intensive than manufacturing".

Secondly, infrastructure enters the production process in a way that makes its impact on output higher in the more skill-intensive production stage. A high endowment ($A > 1$ units) of infrastructure in a particular location enhances the productivity of unskilled workers in that city by a factor of $A > 1$, but augments productivity of skilled workers by a larger A^{ρ} (where $\rho > 1$). As a consequence, cities with high endowments of local infrastructure become particularly attractive for sectors that make intensive use of skilled labor.

Finally, the skilled manufacturing stage involved in the production of the urban com-

[12]The assumption that the more advanced, skill intensive stages of the production process of the urban good contribute disproportionally to its value is largely consistent with empirical observations. Analyzing the often discussed case of the iPhone, Moretti(2013) notes:"The iPhone is made up of 634 components. The value created in Shenzen is very low, because assembly can be done anywhere in the world[...]The majority of the iPhone's value come from the original idea, its unique engineering, and its beautiful industrial design."

posite makes use of an additional factor of production, management services (labeled M). This production input can be described as a skill-intensive stage of production that is introduced into the analysis to capture the idea that the operation of complex, multi-stage production processes requires coordination and planning services provided by the management function. Moreover, by introducing this management input only the production process of the skilled manufacturing (task s) and not in that of unskilled manufacturing (task u), I make the assumption that more sophisticated production stages require greater managerial attention than more basic production tasks. Intuitively, this implies that manufacturing workers in the apparel sector require less managerial inputs than product designers, while in the case of of the software industry programmers are assumed to require more productive contact with software developers and project managers than product testers.

The management input can only be produced in the more technologically advanced North. Its production involves the primary factors of production land and labor via the technology:

$$M^{Nn} = \phi\left(\frac{M^{Nn}}{M}\right)\left[A^{\rho}_{Nn}H^{Nn}_{M}\right]^{\mu'}\left[\left(A_{Nn}L^{Nn}_{M}\right)^{\beta}\left(N^{Nn}_{M}\right)^{1-\beta}\right]^{1-\mu'} \tag{1.6}$$

The production process for the management input also possesses two features that merit to be highlighted. Management services keep to the monotonicity of sectors by skill intensity and land intensity. They are the most skill intensive and least land intensive activity in the world economy (i.e. $\mu' > \mu$) and also have the highest density of employment (Figure 1.10 offers a representation of the production chain of the final good).

Moreover, the management activity is the only one that is subject to localized agglomeration economies. This represents a parsimonious way of making the assumption that skill intensive production stages are subject to stronger agglomeration economies (and perhaps stronger co-agglomeration economies with other skilled sectors) than more basic activities. This assumption receives empirical support (see Alonso-Villar, Chamorro-Rivas and Gonzalez Cerdeira 2004). In the formulation of equation (1.6) above, localization economies are introduced via the addition of a productivity shifter in the production process for management services given by the function $\phi(\frac{M^{cn}}{M})$ with the property that $\phi'(.) > 0$ [13]. This implies that a city's productivity in delivering the management input increases with that location's worldwide market share in the management services sector.

Beyond location fundamentals and agglomeration economies, a final determinant of the configuration of economic geography in the model is given by communication and transportation costs. Both the final good and its component intermediates, the traditional good and the urban composite are costlessly tradable both within and across countries. Moreover, the outputs of the main stages of production of the urban good (unskilled task u and skilled task s) also face negligible transportation costs when delivered both nationally and internationally.

By contrast, management services are subject to negligible "communication" costs within countries, but to significant such costs when delivered across countries. Communication costs are assumed to take the standard iceberg form, with $\tau > 1$ units of the management services needing to be shipped from a location within country c for one unit of such services to be delivered to a city within country c'. These communication frictions should be given a broad interpretation, and taken to include any costs related to managing or providing advanced service inputs to a plant located remotely. They could include the opportunity cost of time incurred when middle or top managers have to visit faraway plants, or the incremental fees paid to management consultants or other skilled external service providers when they have to visit and analyze such plants.

I conclude this section with a description of the demand side of the economy. The preferences of the representative consumer (worker or landowner) are defined only over consumption of the final good, and are characterized by the utility function $U(c)$ with $U'(c) > 0$. Agents can thus choose their location, occupation and consumption such as to maximize utility. As agents are assumed to be ex-ante identical, and to face no mobility costs across locations within countries or sectors, any equilibrium will involve indifference across locations and occupations within countries.

[13] A framework employing urbanization economies generated by human capital would generate similar results to the present framework but would be more algebraically cumbersome. Moreover, the empirical literature in urban economics finds stronger evidence in favor of localization economies than urbanization economies. See for instance Nakamura (1985), Henderson (1986), Rosenthal and Strange (2004), Henderson (2003).

1.3.2 Equilibrium Definitions

In the set-up outlined above, I proceed to define an equilibrium of the world economy as follows:

Definition 1. *A (world) equilibrium is an allocation of workers across locations and sectors* $\left\langle L_1^S, H_i^{S1}, L_i^{S1}, H_i^{S2}, L_i^{S2}, L_1^N, H_i^{N1}, L_i^{N1}, H_i^{N2}, L_i^{N2} \right\rangle$ *with* $i \in \{u, s, M\}$*, a collection of factor prices* $\left\langle w_S^S, w_S^U, w_N^S, w_N^U, r_{S1}, r_{S2}, r_{N1}, r_{N2} \right\rangle$ *and a collection of commodity prices prices* $\langle p_1, p_u, p_s, p_M \rangle$ *such that:*

- *consumers are maximizing utility by their choice of location, occupation and consumption*
- *firms in all sectors - unskilled manufacturing* (u)*, skilled manufacturing* (s) *and management services* (M) *- are maximizing profits by their choice of location and input mix*
- *labor markets clear at each location for each type of labor*
- *land markets clear at the city level*
- *markets for all intermediates and tasks, including management services clear at the level of the world economy.*

The presence of external effects (localization economies) in the framework outlined in the previous section generates the possibility of existence of multiple equilibria[14]. In order to deal with the issues raised by multiple equilibria, I follow an approach that is standard in the economic geography literature. I define a concept of equilibrium stability, and focus my subsequent analysis on stable equilibria. Intuitively, in my framework a world equilibrium is defined as stable if it is robust to a locational deviation by a small but positive mass of management services providers. As in my model the management services activity is the only one that is subject to external economies, this sector represents the only source of multiple equilibria. The definition of equilibrium stability that I employ in this study is provided more formally below:

[14]Multiple equilibria are a standard feature in modern economic geography models. For example, while the presence of (sufficiently strong) localization economies tends to favor the agglomeration of the management services production in only one urban location, there always exists a symmetric Northern equilibrium in which each city hosts half of the management services sector. For a brief discussion of this issue see Krugman (1998).

Definition 2. *A (world) equilibrium is stable if there is a tendency for the equilibrium to be restored following the locational deviation of management services producers that represent a small but positive market share* Δx *in the sector from one Northern city to the other. A deviation is considered "small" if the cumulative market share of the deviating firms is not sufficient to reverse or create a tie in the ranking of Northern locations by market share in the management services sector.*

1.3.3 Key Assumptions and Discussion

In this section I delineate the scope of analysis undertaken in the remainder of the chapter. Starting from the basic framework outlined in section 1.3.1 above, I impose a series of additional parametric restrictions (Assumptions 1 to 5 below) that are meant to keep the analysis tractable, parsimonious and empirically relevant. The formal statements of these assumptions are provided in Appendix A of this chapter. A brief discussion of the robustness of the model's predictions to relaxing some of these parameter restrictions is provided in Appendix C.

Assumption 1 **- Wage Gap** The traditional sector is assumed to be sufficiently large (i.e. γ is assumed to be sufficiently large) such that in any equilibrium the traditional good is produced in both countries. As a result the relative wages between the two countries are fixed in equilibrium by their relative productivity in the traditional sector. This is an often used assumption in the international trade literature (Antras and Helpman 2004), and is aimed at preserving the analytical tractability of the model.

Assumption 2 **- Communication Costs** I assume that the presence of communication costs imposes a binding constraint on the productive possibilities of the South. For this to be the case I require that the wage gap between the two countries (given by their relative productivity in the traditional good) is sufficiently high and the expenditure share of the unskilled urban manufacturing (task u) is sufficiently small[15].

Assumption 3 **- Agglomeration Economies** The localization economies affecting the management services sector are assumed to be sufficiently strong (the function ϕ is

[15] In Appendix A of this chapter, I discuss two versions of this parametric restrictions (denoted Assumption $2a$ and Assumption $2b$). The former represents a minimal formulation of the conditions required for communication costs to be a relevant determinant of economic geography, while the latter is a more restrictive formulation that allows me to explore the full predictive possibilities of the model. For the main analysis developed below I maintain the more restrictive Assumption $2b$.

sufficiently convex) such that along our analysis there is an unique stable equilibrium (subject to a permutation of city labels) that features the entire management services sector clustered in only one Northern city. Without further loss of generality I will assume that this city is $N2$. This assumption is aimed at keeping the analysis parsimonious while helping capture the empirical observation that high-skilled tradable services activity tend to be spatially concentrated within countries.

Assumption 4 **- Infrastructure Constraints in the South** I assume that the role of urban infrastructure in raising the productivity of skilled labor is sufficiently important (i.e. ρ is sufficiently large) such that, along our analysis, the lagging location of the South, city $S1$ is never competitive in the production of the skilled manufacturing (task s). This restriction is imposed to prevent the proliferation of sub-cases.

Assumption 5 **- "Timing" Assumption** This represents a technical assumption aimed at determining the "timing" of stages in the evolution of the spatial economy. In particular, I assume that the expenditure share of the skilled manufacturing (task s) is sufficiently large such that as communication costs decline, the advanced location of the South becomes fully specialized in task s "before" the skilled Northern city sheds all employment in this activity and becomes a pure "management city". This assumption is not essential for the qualitative implications of the model and is made in order to keep the analysis parsimonious.

1.3.4 Spatial Equilibrium and Main Results

The next two sections are dedicated to discussing the predictions of the model outlined above. In this section I outline the properties of the spatial equilibria that emerge from the model and show that the model can qualitatively match the stylized facts that motivate the chapter. In the next section I present a stage by stage account of the "history of the location of economic activity" as seen through the lens of the model.

In the set-up presented above, featuring perfectly competitive markets for all commodities, spatial equilibrium requires that all activities in the world economy only take place at cost minimizing locations:

$$p_i = \min_l c_l(i) \; \forall i \in \{1, u, s, M\} \tag{1.7}$$

where l indexes locations (i.e. the hinterlands of the two countries and cities $S1$, $S2$, $N1$, $N2$). Moreover, perfect mobility within countries guarantees that wages are equalized across locations within countries for workers of the same level of skill, while the imposition of Assumption 1 of section 1.3 fixes the level of unskilled wages in both North and South:

$$w_c^U = \xi_{1c} p_1 \; c \in \{N, S\} \tag{1.8}$$

Labor market equilibrium in the presence of an educational technology that is identical in the North and South requires that skill premia in both nations are given by:

$$w_c^S = \frac{w_c^U}{1-e} \tag{1.9}$$

Finally, the production and shipping conditions that govern the delivery of the management input result in different prices for this commodity in the North and South:

$$p_S^M = \tau p_N^M \tag{1.10}$$

where τ represents international communication costs. With these preliminaries in place, we are ready to study the effect of improvements in long-distance communication technologies, reflected in the decline of τ, on the worldwide spatial configuration of economic activity. When performing this comparative static exercise I am particularly interested in tracking how reductions in international communication costs affect cities' populations, skill shares and real estate prices, as well as overall (worldwide) urbanization.

In equilibrium, urban rental rates are pinned down by the condition

$$r_l \bar{N} = (1-\beta)Y_u^l + (1-\beta)(1-\mu)Y_s^l + (1-\beta)(1-\mu')Y_M^l \tag{1.11}$$

that equates the income of landowners at each urban location with the land rental expenditures of the economic activities housed by each city (Y_i^l denotes the value of output of commodity i produced at location l). Furthermore, a city's equilibrium population and skill share are given by the scale and the composition of the activity mix that is housed by each location:

$$Pop_l = \sum_{i \in \{u,s,M\}} L_i^l + \frac{1}{1-e} \sum_{i \in \{u,s,M\}} H_i^l \tag{1.12}$$

$$\frac{H^l}{L^l} = \frac{\frac{1}{1-e} \sum_{i \in \{u,s,M\}} H_i^l}{\sum_{i \in \{u,s,M\}} L_i^l} \tag{1.13}$$

I begin the analysis of the role of communication frictions in determining the spatial configuration of economic activity by considering the case of prohibitively high communication costs for the international transmission of management services. This setting represents a simplified characterization of the circumstances of the world economy in the middle of the twentieth century, when containerization and other technological developments had already lowered the costs of shipping goods over long distances, but communication costs remained high and multinationals were rare. Proposition 1 offers a snapshot of the configuration of economic geography that can be expected under these circumstances in the context of my theory.[16]

Proposition 1. *There is a threshold of communication costs T_{max} such that if*

$$\tau > T_{max}$$

there exists only one stable equilibrium that involves unskilled manufacturing taking place exclusively in the South (i.e. both Southern cities are fully specialized in task u production), while skilled manufacturing and management services production take place only in the North, with skilled manufacturing (s) locating in both Northern cities ($N1$ and $N2$) while the management services sector clusters completely in $N2$.[17]

Moreover this equilibrium features asymmetric cities in both countries, with $S2$ and $N2$ being larger than $S1$ and respectively $N1$ in terms of both population and output (i.e. $Pop_{S2} > Pop_{S1}$,$Pop_{N2} > Pop_{N1}$,$Y_{S2} > Y_{S1}$,$Y_{N2} > Y_{N1}$) , $S2$ displaying more expensive real estate than $S1$ while $N1$ and $N2$ experience equal land prices ($r_{S2} >$

[16]The proof of this result and all subsequent propositions are relegated to Appendix B of this chapter. Moreover, for this result and all subsequent results that involve communication cost thresholds, the formal expressions characterizing these thresholds are also provided in Appendix B.

[17]The formal expression for the threshold T_{max} is provided in the discussion under the heading of Result 4 in Appendix B of this chapter.

r_{S1}, $r_{N1} = r_{N2}$). With regard to city skill shares, $N2$ displays a higher share of skilled workers in its population than $N1$ while the skill shares of Southern cities are symmetric ($\frac{H_{S1}}{L_{S1}} = \frac{H_{S2}}{L_{S2}}, \frac{H_{N1}}{L_{N1}} < \frac{H_{N2}}{L_{N2}}$).

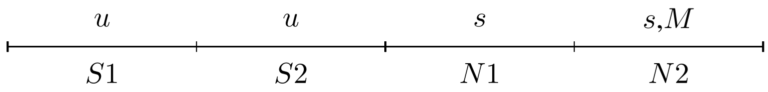

Figure 1.1: World Before Communication-induced Integration

In the presence of high communication costs it is uneconomical for Southern locations to engage in skilled manufacturing activities. This is because the advanced manufacturing requires the management input as an essential factor of production, and, in the set-up outlined above, this input is very costly to source from the North and infeasible to produce in the South. As a result, the world equilibrium features a relatively poor South whose cities are completely specialized in unskilled manufacturing, and a richer North that undertakes both skilled manufacturing and management services production. Southern cities are relatively undifferentiated, displaying the same skill share and industrial structure. However, the more advanced city in the South, $S2$ features a higher population and more expensive urban land than its counterpart $S1$, due to its greater endowment of infrastructure.

In the North, the clustering of the management sector in only one of the urban locations endogenously gives rise to cities that are differentiated in terms of both their industrial structure and their skill share. The city $N2$, which captures the entire management input production becomes the North's skilled city, while $N1$, which becomes fully specialized in skilled manufacturing (s) takes on the role of the relatively unskilled Northern city. Moreover, due to the greater density of employment that prevails in the management sector, $N2$ has a larger population than its less skilled counterpart. However, given that Northern cities are identical in terms of both exogenous infrastructure and access to management services, and that in equilibrium the sector that is on the locational margin between the two Northern cities is skilled manufacturing (s), the two cities in the North have the same rental rates for urban land.

In what follows, I explore the implications of gradually removing communication frictions associated with the international delivery of management services for the configuration of worldwide economic geography. Proposition 2 summarizes the predictions of my theory concerning urbanization and the cross-country distribution of economic activity as international economic integration deepens:

Proposition 2. *Along the equilibrium path defined by unique stable equilibria and for any $1 < \tau \leq T_{max}$, as communication costs decline the world economy is strictly growing, urbanization is strictly increasing while the compensation of Southern factors relative to factors in the North weakly increases. Moreover, above a threshold of communication costs $\tau^* \geq 1$ such that for $\tau^* < \tau \leq T_{max}$ a reduction in communication costs is associated with a strict increase in the aggregate compensation of Southern factors of production relative to Northern factors.*

As communication costs decline below a certain threshold, the production of the skilled manufactures in the South becomes attractive and the South captures market share in advanced production. This allows the world economy to operate at higher levels of efficiency, as a productive friction is lessened and the location of productive activity moves closer to a configuration determined solely by unconstrained comparative advantage. As a result of this increase in efficiency, world output increases.

Moreover, as more of skilled manufacturing is undertaken in the South, the price of task s and of the overall urban composite good begin to fall relative to the price of the traditional good. This is because the reduction of communication costs simply reflects the gradual removal of a friction that affects the production of the urban good but not of the traditional one. Given the elastic demand for the urban intermediate in the production of the final good, this results in an increase of the expenditure share of the urban good, and conversely in a decline of the expenditure share of the traditional good. This movement of the relative expenditure shares of the two sectors is reflected in their relative wage bills, and also in their relative employment levels. This is equivalent to a rise in the share of city dwellers as a proportion of total world population, or , in other words, to an increase in urbanization[18].

Proposition 2 also predicts convergence in total output (or GNP) between North and South. With a sufficiently large traditional sector, the relative wages and hence the relative aggregate wage bills of the two countries are fixed by their relative productivity in

[18] The mechanism outlined herein is thus similar to those of models of structural transformation (see Baumol 1967, Ngai and Pissarides 2007, Rogerson 2008, Michaels, Redding and Rauch 2011, 2012, 2013).

that sector. However, as a larger fraction of urban production takes place in the South as communication costs decline, Southern urban landowners will increase their share in overall land receipts, and hence the overall compensation of Southern factors grows relative to the one of the North. Finally, as worldwide urbanization increases and the South increases its weight in urban production, the size of the Southern urban system increases. Given that countries have constant population this leads to the straightforward conclusion that Southern urbanization rates must expand.

The shifts in the location of economic activity caused by declining international communication costs affect not only the cross country distribution of income and urbanization, but also the relative size of cities within countries. This is discussed in the next proposition:

Proposition 3. *Along the path defined by unique stable equilibria, for any $\tau^* < \tau \leq T_{max}$, a reduction in τ is associated with an increase in the relative size of the skilled cities ($S2$, $N2$) in both the North and the South. Formally we have:*

$$\frac{\partial}{\partial \tau}\left(\frac{Pop_{S2}}{Pop_{S1}}\right) < 0 \qquad\qquad \frac{\partial}{\partial \tau}\left(\frac{Pop_{N2}}{Pop_{N1}}\right) < 0$$

The analysis undertaken in Proposition 2 revealed that as communication costs decline the South captures a larger fraction of the value chain for the urban intermediate, and begins a process of "catch-up" relative to the North. This catch-up process does not proceed evenly, however. Due to its infrastructure advantage, the advanced Southern city $S2$ becomes competitive in skilled production "before" the backward location $S1$[19]. As a result of being able to benefit from the gradual relocation of skilled manufacturing and given the high employment density of this activity, city $S2$ displays more robust population growth than its lagging (and now relatively skill scarce) counterpart $S1$ and thus the relative size of Southern cities moves in the direction outlined by Proposition 3.

The implications of this gradual relocation of skilled manufacturing from North to South are also not symmetric for locations in the North. As the South becomes increasingly competitive in task s, both Northern locations gradually shed skilled manufacturing activities and their affiliated jobs. However, whereas city $N1$ benefits from no

[19] In fact, under Assumption 4, $S1$ never captures any market share in skilled task production.

compensating force against this loss of market share in skilled production, this is not the case for city $N2$. To see this, note that I have shown above that a fall in communication costs will not only be associated with skilled production being relocated to the South, but also with an increase in the overall size of the urban sector. Thus, while the North-South reallocation of activity can negatively impact both Northern cities, the management services cluster in city $N2$ stands to benefit from the lessening of communication frictions, as it can now sell its product to a larger and more efficient world economy. This growth of management services then serves to cushion the potential negative impact of task s relocation for city $N2$ in the early stages of globalization and eventually allows for city $N2$ to grow even in the face of substantial offshoring to the South. This ensures more robust population growth performance for the skilled Northern city along the entire path of international economic integration, leading to divergence in urban success in the North.

Finally, I present the model's implications concerning the spatial distribution of workers by skill and the evolution of land prices across locations. These results are summarized in Proposition 4:

Proposition 4. *Along the path defined by the unique stable equilibria, for any $\tau^* < \tau \leq T_{max}$, a reduction in τ is associated with skill divergence across cities or/and divergence in the rental rate of land across cities in both North and South. Formally, $\forall \tau \leq T_{max}$:*

$$\frac{\partial}{\partial \tau}\left(\frac{H_{S2}}{L_{S2}} - \frac{H_{S1}}{L_{S1}}\right) \leq 0 \qquad \frac{\partial}{\partial \tau}\left(\frac{r_{S2}}{r_{S1}}\right) \leq 0 \tag{1.14}$$

$$\frac{\partial}{\partial \tau}\left(\frac{H_{N2}}{L_{N2}} - \frac{H_{N1}}{L_{N1}}\right) \leq 0 \qquad \frac{\partial}{\partial \tau}\left(\frac{r_{N2}}{r_{N1}}\right) \leq 0 \tag{1.15}$$

with at least one inequality in each pair (1.14) *or* (1.15) *above being strict.*

Along the path of decreasing communication costs, the configuration of the spatial economy goes through a number of stages, which are discussed in greater detail in the next section. The most typical configurations involve, within countries, either the presence of a mixed advanced city containing both its nation's more advanced urban sector and its unskilled sector, and an unskilled city specialized in the latter; or the presence of two fully specialized cities, a skilled one fully specialized in the country's most advanced sector, and an unskilled city fully specialized in the country's less skill intensive sector.

When the first type of configuration prevails, a reduction in communication costs can be expected to increase the skill share differential between cities within countries but keep the land price differential unchanged. This is because the reduction in communication costs is generally associated with growth in the skilled sector of both countries. As a result, some of the less skill intensive activities in the country's skilled city can be expected to relocate, leaving the advanced location with a greater exposure to the most skill intensive sector, and thus with a higher skill share. On the other hand, in this type of configuration, small reductions in communication costs have no impact on the sectoral composition of the lagging city, and thus leave that location's skill share unchanged. Thus, increasing skill shares in advanced locations coupled with stagnating ones in lagging cities lead us to the prediction of skill polarization across space. Moreover, when the configuration of the spatial economy involves a skilled city with a mixed industrial composition, the relative land rents between urban locations within countries are fixed by the less skilled sector, which is on the locational margin between the two cities, and are thus invariant to small changes in communication costs.

On the other hand, when both cities within a country are fully specialized, growth in the more skilled sector as communication technologies improve only translates into relative growth of the more skilled city, as in my setting the lagging cities of each country never become competitive in their respective nation's most skilled activity. As the relative weight of the skilled city in a country's value added grows and no further activity migrates out of the skilled city, this advanced location will experience congestion and an increase in real estate prices relative to the backward city.

1.4 A History of the Location of Economic Activity

In this section I aim to complement the general results of the previous section and offer a detailed, stage by stage analysis of the evolution of the worldwide spatial economy in a world of improving communications. I first discuss how the model can help us rationalize the recent shifts in global economic geography. I then cast an eye at the future and present the model's predictions regarding the potential impact of continuing globalization.

1.4.1 The Past and Present

I begin my account of the recent developments in economic geography from the spatial configuration described in Proposition 1. This snapshot of worldwide economic geography describes the state of affairs in the middle of twentieth century: relatively concentrated economic activity across countries, stark differences between the internal economic geographies of countries, with industrialized nations featuring high levels of urbanization and notable concentration of economic activity while the economic geography of developing countries is far more dispersed. Moreover, this configuration of the spatial features relatively low levels of geographical segregation of the skilled in both North and South as well as small within country disparities in the price of land.

This chapter advances the hypothesis that the reconfiguration of the spatial economy away from the state described above during the second half of the twentieth century can be attributed to improvements in communication technology. These improvements have been documented by a substantial literature. According to the IMF, the cost of a three minute telephone call between New York and London fell by more than ninety nine percent between 1930 and 2000. Tang (2006) reports the evolution of the cost of a three minute telephone conversation between the US and a larger set of countries, and finds a 70% decline after 1970 (see Figures 1.11 and 1.12). Furthermore, Laudon and Laudon (2013) document similarly steep falls in the cost of delivering data over the Internet while in an extensive report on the history of communications, Odlyzko (2000) reviews several facts concerning the cost reductions and rapid diffusion of a broad range of modern communication technologies.

In the context of the model, the first stage of communication induced globalization begins when (international) communication costs fall below the threshold at which the production of increasingly skill-intensive manufacturing goods becomes economical to undertake remotely in developing countries, while the management function remains in industrialized nations[20]. The implications of this first stage of globalization on the

[20] During this and the following stages of globalization a crucial element of the mechanism captured by the model is the re-location of advanced manufacturing to the South. In principle this re-location could occur in two ways that are equivalent from the perspective of the theory: the entry of domestic Southern firms into new activities in light of improved productive conditions brought about by improved communication; alternatively Northern firms could shift production to the South, thus engaging in offshoring. The latter mechanism is easier to document, as it associated with an observable trail of FDI: FDI flows to a greater extent to the more skilled regions of developing countries (Nunnenkamp 2002), affiliates of foreign entities tend to be more skill intensive than domestic firms (Feenstra and Hanson 1997), and FDI flows seem to be self-perpetuating (Head, Ries and Svenson 1995, O'Huallachain and Reid 1997, Smith and Florida 1994). Moreover, FDI flows seem to have a significant impact on local economic success

configuration of the spatial economy are outlined below:

Stage 1 Along the interval of communication costs given by

$$T_{spec1} < \tau \leq T_{max}$$

the spatial configuration of economic activity (i.e. the configuration that prevails at the unique stable equilibrium associated with each level of communication costs) takes the form depicted in Figure 1.2. It features skilled manufacturing (s) taking place in the locations $\{S2, N1, N2\}$, unskilled manufacturing (u) being produced in both Southern cities while management services (M) are produced in $N2$ [21]. Moreover, along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities ($S2$ and $N2$) in both countries, and skill polarization across space within countries.

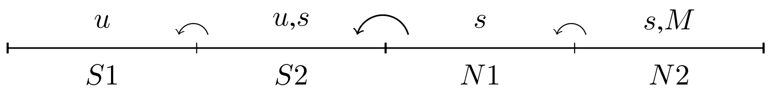

Figure 1.2: First Stage of Globalization

In this first stage of globalization, the infrastructure rich location of the South ($S2$) becomes competitive in skilled manufacturing and takes on the role of the South's skilled city. As city $S2$ gains market share in skilled manufacturing, unskilled manufacturing is crowded out, aiding the growth of city $S1$. However, the higher employment density of skilled manufacturing, guarantees that growth in city $S2$ population is faster than in $S1$, leading to the "take-off" of this location relative to the rest of the country. Moreover, as communication costs fall below T_{max} but remain substantial, the shift of skilled task production to the South is still limited enough such that the relatively unskilled activities of each country (u in the South, s in the North) remain the main consumers of urban land in both nations. As a result, these activities occur in both cities of each country and represent the main drivers of urban land prices. This in turn guar-

(Wei 1999). Some evidence can be brought in support of the former mechanism: easier access to foreign intermediates and capital goods has been found not only to increase the productivity of domestic firms (Amiti and Konings 2007; Eaton and Kortum 2001) but also allows them to increase the scope of their production (Goldberg, Khandelwal, Pavnick and Topalova 2009, 2010; Feng, Li and Swenson 2013)

[21] For the formal expression that gives the threshold T_{spec1} check the discussion under the heading Result 7 in Appendix B of this chapter.

antees that during this stage of globalization, land rental rate differentials display little change within countries. However, as highlighted in Proposition 4, in configurations of the spatial economy such as the one described in Figure 1.2 (that involve the presence of skilled cities with mixed industrial structures) the margin of adjustment to sectoral reallocation across space is the industrial composition and skill shares of cities. Thus, in this early stage of globalization the model predicts a notable trend of skill polarization across cities within countries.

While Proposition 3 establishes the *relative* performance of Northern cities, the evolution of the *absolute* size of Northern cities is ambiguous during this first stage of globalization. This is because Northern locations are subject to two competing forces. On the one hand, their weight in the overall value added of the urban sector declines as communication costs decline, which tends to make Northern cities smaller. On the other hand, the overall size of the urban sector increases bringing about an increase in overall urbanization. In turn, this increase in the size of the urban sector benefits all cities, including those of the North. It is important to note that Northern cities may decline in absolute size in the early periods of globalization. This is in fact consistent with the experience of American cities during the 1970s, which largely experienced population declines, irrespective of their skill endowments.

The mechanism described above and its implications benefit from broad empirical support. Reductions in communications costs brought about the increasing (spatial) separation of the management and production facilities of firms (Kim 1999; Duranton and Puga 2005; Henderson and Ono 2008) and contributed to the rise of multinational firms (Markusen 1995), which can be seen as an extreme case of separation of management and production. Furthermore, international economic integration has been accompanied by developing countries diversifying their economies into increasingly complex and skill intensive activities. Thus, the emerging literature on trade integration and offshoring has documented that these developments have tended to increase skill premia in the South (Csillag and Koren 2011; Mazumdar and Quispe-Agnoli 2002) and to displace unskilled workers and increase the complexity of the tasks performed by natives in the North (Ottaviano, Peri and Wright 2013; Lu and Ng 2012). Moreover, a series of recent studies (Schott 2007; Rodrik 2006; Hausmann, Hwang and Rodrik 2007) build measures of export sophistication across countries and find a trend of rapidly expanding export sophistication among developing nations.[22]

[22]One of the interesting findings in this literature is that China has a surprisingly high level of export sophistication relative too its overall level of economic development. In particular Schott (2007) discusses

Finally, the implications of recent globalization and of the reconfiguration of global supply chains have been uneven within countries. A growing literature has analyzed the impact of trade integration, and in particular import competition on local economies within countries and has found asymmetric effects (Autor, Dorn and Hanson 2013; Topalova 2007, 2010; Dauth, Findeisen and Suedekum 2014; Costa, Garred and Pessoa 2015). Furthermore, the economic diversification brought about by globalization in developing countries has also proceeded unevenly. Jarreau and Poncet (2012) build measures of export sophistication at the sub-national level in China and document not only that China's export sophistication is growing over time, but also that substantial regional disparities in export sophistication have emerged and persist within China. Moreover, they find that regions displaying greater export sophistication tend to also display more rapid economic growth.

As communication costs continue to decline and a larger fraction of skilled manufacturing shifts to the South, unskilled manufacturing is gradually crowded out from the leading Southern location $S2$. Similarly, in the North, the increased competitiveness of the South in skilled manufacturing coupled with continued growth in the management services sector leads to the gradual crowding out of skilled manufacturing from the North's skilled city $N2$. As this process unfolds, at some point the skilled city of either the South or the North may become completely specialized in their country's more skill intensive activity. Under the conditions of my set-up (in particular Assumption 5) this occurs first in the South, thus launching the second stage of globalization:

Stage 2 Along the interval of communication costs given by

$$T_{spec2} < \tau \leq T_{spec1}$$

the spatial configuration of economic activity takes the form depicted in Figure 1.3 [23]. Along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities in both countries, skill polarization across Northern cities and divergence in real estate prices across Southern cities, with skilled cities favored.

During the second stage of communication induced globalization, in the North the

the large and expanding overlap between China's exports and the export set of developed countries, a finding which is consistent with the mechanism highlighted by my theory.

[23]For the formal expression that gives the threshold T_{spec2} check the discussion under the heading Result 8 in Appendix B of this chapter.

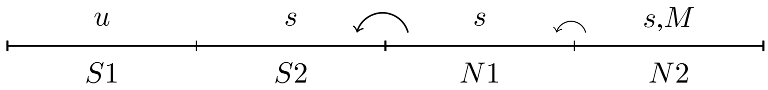

Figure 1.3: Second Stage of Globalization

margin of adjustment to the international relocation of skilled manufacturing is still the industrial structure of cities (and implicitly their skill share). However, in the South this margin of adjustment is exhausted, and any further spatial reallocation is reflected in the (relative) land prices of the two Southern cities. Thus, in this stage of international economic integration, skill polarization across space continues in the North, while a process of divergence in land prices across cities is observed in the South.

This stage of globalization corresponds to the acceleration in the growth of manufacturing hubs observed in a set of developing nations, in particular in South East Asia, starting from the 1980s. Intuitively, as the disadvantage represented by high international communication costs is gradually eroded, developing country cities with good access to infrastructure and foreign markets are increasingly able to leverage their access to large pools of cheap labor to capture an increasing market share in advanced manufacturing. As these locations become fully specialized in (relatively skill intensive) manufacturing, their continued attractiveness as production hubs puts upward pressure on rental rates for land. As a result, this stage of globalization is characterized by the continued divergence of leading Southern locations relative to their countries, but this time reflected both in faster population growth and in rapid real estate price appreciation.

Further, should the gap between the wages prevailing in the two countries be wide enough, continued improvements in communication technologies usher in a new stage in the evolution of worldwide economic geography that features a fully specialized skilled city also in the North. As the spatial economy enters this third stage of globalization, another landmark threshold is reached - the threshold of communication costs at which the ambiguity surrounding the evolution of the *absolute* size of the skilled Northern city is eliminated. This is established in the following proposition:

Proposition 5. *Along the path defined by the unique stable equilibria and for a large enough differential in labor costs between North and South, (i.e.* $\frac{\xi_{1N}}{\xi_{1S}}$ *large enough), there exists a threshold* $\bar{T}$*, with* $1 < \bar{T} < T_{max}$ *such that for every* $\tau < \bar{T}$*, any reduction* *in τ is associated with growth in the absolute size of the North's skilled city $N2$.*

This result can be most easily understood in conjunction with the characterization of the third stage of globalization, which is presented below:

Stage 3 Along the interval of communication costs given by

$$T_{ovt} < \tau < T_{spec2}$$

the spatial configuration of economic activity takes the form depicted in Figure 1.4 [24]. Along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities in both countries, divergence in real estate prices across cities in both North and South, with relatively skilled cities favored.

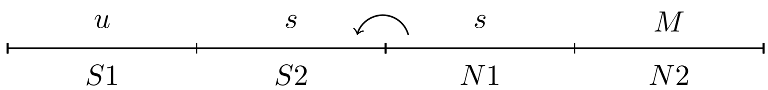

Figure 1.4: Third Stage of Globalization

The third phase of globalization outlined above is characterized by a configuration of the spatial economy in which the unskilled city of the North is the only location that remains vulnerable to increased competition from Southern locations. As a consequence of this increasing foreign competition, it experiences continued (relative) population and property price declines. Improvements in communication technology gradually erode the productive advantage enjoyed by the unskilled Northern city relative to the advanced Southern location, and cause the market share of the advanced Southern location in skilled manufacturing to continue to increase. Moreover, the interval of communication costs that characterizes the third stage of globalization can be shown to contain a threshold $\tau^{CA} = \left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha}{1-\alpha}}$ at which city $S2$'s access to cheap Southern labor becomes more valuable than location $N1$'s frictionless access to management services. As a result, below this threshold land rental rates in the South's skilled city overtake those in the lagging Northern location $N1$.

Until the outset of the third stage of globalization, reductions in communication

[24]For the formal expression that gives the threshold T_{ovt} check the discussion under the heading Result 9 in Appendix B of this chapter.

costs lead to two opposing forces that drive the changes in the absolute size of the advanced Northern location: losses of market share in skilled manufacturing and employment growth in the management services sector. This causes the evolution of the absolute size of city $N2$'s population and employment to be ambiguous during the previous two stages of globalization. At communication costs below T_{spec2} the skilled city of the North becomes fully specialized in management service and the first force is no longer operational. This removes any ambiguity regarding the change in the absolute size of city $N2$.

To complete the discussion of the third stage of globalization it is important to note that during this period, the main margin of adjustment to continued relocation of skilled manufacturing to the South is given, in both countries, by land prices. As communication frictions are reduced, we should observe divergence in the price of land across cities in both North and South. All in all, developments during this stage of globalization highlight the role played by the complementarity between international integration and agglomeration in my setting. While the relative prices of land in both countries' lagging cities decline sharply and serve as a force encouraging the dispersion of economic activity in each country, globalization also raises the value of the unique assets of each country's advanced city (infrastructure in the South, localization economies in the North). In my setting this latter force dominates and sustains an increasingly uneven economic geography in both North and South.

The discussion of the first three stages of globalization undertaken so far reveals an additional attractive feature of the theory: the model can qualitatively account for some of the finer details of the observed growth experience of US (and other developed nation) cities. Thus, if around 1970 most US cities, irrespective of skill endowments, were experiencing population declines, by the 1990s a number of skilled cities were experiencing economic and demographic recovery, while some other cities with unfavorable skill endowments and industrial structures were still exhibiting sluggish growth and even decline. This pattern of urban development, involving initial urban decline coupled with a differential recovery favoring skilled cities can be interpreted in the context of the model as a transition between the second and third stages of globalization that occurred around this period.

1.4.2 The Future

Beyond being able to account for some of the main developments in economic geography in the past few decades, the model allows us to cast an eye at the future. If the North-South wage gap is sufficiently wide, the continued fall of international communication costs opens up a novel possibility, that of "urban overtaking" along global value chains. In this scenario, the loss of skilled manufacturing in city $N1$ eventually leads to sufficiently depressed (relative) rental rates for land, making this location competitive in unskilled manufacturing, which is relatively land intensive. This leads to the emergence of a novel phenomenon, characterized by the skilled city of the South acquiring a more skill intensive industrial structure than the unskilled city of the North, and launches a new stage of globalization. In what follows, I present a more formal treatment of the urban "overtaking" result, followed by a detailed description of the fourth stage of globalization that is shaped by the emergence of this phenomenon.

Proposition 6. *Along the path defined by stable equilibria, and for a large enough differential in labor costs between North and South, (i.e. $\frac{\xi_{1N}}{\xi_{1S}}$ large enough), there exists a threshold T_{ovt}, with $1 < T_{ovt} < T_{max}$ such that if τ falls below T_{ovt} the skilled city of the South "overtakes" the unskilled city of the North along the global supply chain (i.e. in equilibrium $S2$ displays a more skill intensive industrial structure than $N1$).*

Stage 4 Along the interval of communication costs given by

$$\tau^* < \tau < T_{ovt}$$

the spatial configuration of economic activity takes the form depicted in Figure 1.5[25]. Along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities in both countries, divergence in real estate prices across cities within countries, the de-skilling of city $N1$ and skill polarization across Northern cities.

As the process of urban overtaking unfolds, the Northern backward city not only continues its relative decline in terms of population and real estate prices, but also ex-

[25]For the formal expression that gives the threshold τ^* check the discussion under the heading Result 10 in Appendix B of this chapter.

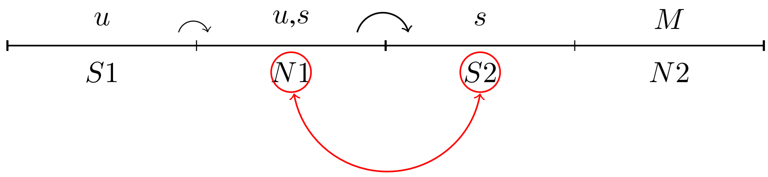

Figure 1.5: Fourth Stage of Globalization - Urban Overtaking?

periences a trend of de-skilling, as it loses jobs in skilled manufacturing and adds jobs in unskilled production. This process of de-skilling affecting city $N1$ restores the trend of skill polarization across Northern cities. The process of urban overtaking also has notable implications for Southern cities. In particular, it will tend to reinforce the divergent paths of Southern locations, as the unskilled Southern location $S1$ begins to lose market share in unskilled production to the Northern city $N1$ while, at the same time, the skilled Southern city continues to capture market share in skilled manufacturing. As a result, the changes in absolute population levels of city $S1$ become ambiguous while city $S2$ continues to grow both in absolute terms and relative to $S1$.

While the developments described above are far from becoming widespread trends , there is some evidence that "urban overtaking" may already be relevant for a set of particularly successful developing world cities. For instance, an analysis of real estate markets reveals that if in 2002 lagging US metropolises such as Detroit and leading developing world cities such as Beijing displayed comparable rental rates for prime office space[26], by 2013 a large gap in the price of renting property had appeared between the two cities. Office rents in the Chinese capital rose rapidly not only to surpass those prevailing in Detroit but also rival rents in leading developed-world cities such as New York and London, while office rents in Detroit declined as the city suffered from the relocation of the automotive industry. This is all the more remarkable given the impressive supply response of the Beijing office market in the same period.

Furthermore, beyond city outcomes, the urban overtaking result allows my theory to offer insights into other recent phenomena. The model can offer an explanation for the much discussed phenomenon of "reshoring", where firms in developed countries that have offshored part of their production to developing countries, bring some of those activities back to their home markets. In an expanded version of my theory, these develop-

[26] As in my model land only features on the production side, office space rents are probably conceptually closest to the notion of rental rates for land in my model.

ments can be rationalized as follows: in a first wave of globalization prohibitively high transportation costs for the international delivery of goods and services (i.e. an initial situation of autarky) are gradually eliminated while communication costs remain high. As a result, the North loses its unskilled manufacturing sector while the South loses its (small) management sector and skilled production sector, leading to a configuration of economic geography of the type prevailing before stage 1 of second wave globalization. As the first wave of globalization is exhausted and the second wave of (communication induced) globalization begins, the configuration of the spatial economy goes trough the stages $1-3$ described above, to finally enter stage 4 in which some unskilled manufacturing returns to the South to take advantage of cheap land and generates the pattern of spatial reallocation commonly described as reshoring.

The model can also help account for two additional recent developments in rich country labor markets: the slowdown in educational attainment growth and labor market polarization. Along the overtaking stage of the second wave of globalization, the growth sectors in the North are unskilled manufacturing and the management services, while skilled manufacturing is on the retreat. This can lead to a pattern of labor demand consistent with the empirical regularity of labor polarization (i.e. jobs being created in the most and the least skill intensive sectors, but not in middle-skill occupations) and to a slower growth in skill demand in the North.

Finally, below τ^* (i.e. for the interval $1 < \tau < \tau^*$), communication costs no longer impose a major impediment to the delivery of management services. As a result, worldwide economic geography is determined by unconstrained comparative advantage. This leads to the onset of **Stage** 5 of globalization, when the configuration of the spatial economy is given by cities $S1$ and $N1$ specializing in unskilled manufacturing, city $S2$ in skilled manufacturing and city $N2$ in the management function. During this stage of globalization, reductions in communication costs do not generate further spatial reallocation of activity across cities, which means that divergence in skill shares and land prices across cities ceases. However, urbanization continues and communication improvements are associated with proportionate growth in all cities.

1.5 Conclusion

The past fifty years have seen remarkable changes in worldwide economic geography. While urbanization has proceeded apace, the experiences of individual cities have recorded a wide array of urban successes and failures. This variety in urban performance has been particularly noted in developed countries, where old industrial cities such as Detroit or Newcastle seem caught in perpetual decline while other areas such as New York or London have been successful by reinventing themselves as centers of skill-intensive services. Urban growth hasn't been even in developing nations either, as skilled cities such as Bangalore and Shenzen have been particularly successful in exploiting the opportunities offered by globalization and have grown extremely rapidly.

In this chapter I suggest that these developments share the same cause: the spatial re-arrangement of global value chains resulting from recent improvements in communication technology. Improved communications allow increasingly skill-intensive stages of global value chains, which require substantial managerial oversight, to be carried out in remote locations, often in developing countries. This leads to improved economic conditions in these countries and to structural change that draws people from hinterlands to cities. The more advanced locations of these poorer nations benefit disproportionately from the reconfiguration of global value chains, as they leverage their better infrastructure to increasingly specialize in the more complex activities that can now be competitively undertaken in the South. In the North, the locations that house the activities that face enhanced competition from developing countries as a result of improved communication experience stagnation or even economic decline. Meanwhile, leading cities of developed countries thrive. This is because they can leverage their unassailable advantage at delivering the most skill-intensive services by selling to a larger and more integrated world economy.

My theory can also be employed to cast an eye at the future of cities. Future improvements in communication technologies will likely continue to hurt old manufacturing cities in the North, while boosting management and innovation hubs. They will also benefit most Southern urban areas, with a particularly strong effect on locations that offer conditions appropriate for skilled production. Certainly then, there is every reason to think that discrepancies in productivity and wealth across cities within countries will continue and even widen.

Finally, this chapter highlights that beyond the common challenges faced by all urban areas, cities also face particular challenges that relate to their position along global supply chains. For manufacturing cities in industrialized countries the main challenge is to upgrade to more skill intensive activities and thus mitigate the impact of foreign competition. For the leading locations of the South the challenge is to continue to capture more of the skill intensive stages of global production and perhaps eventually compete for the most advanced managerial and creative activities with the innovation hubs of industrialized countries. Naturally, the challenge the advanced locations of industrialized nations face lies in maintaining their notable productive advantage in these high skill and high value added activities. All in all, recent trends seem to point towards a world in which the parameters of the "global race" often mentioned by politicians involve greater competition between increasingly similar managerial and skilled production hubs of developed and developing nations, with countries' economic performance increasingly determined by the performance of their urban "national champions".

1.6 Appendix A: Key Assumptions

In this subsection I provide a rigorous formulation to some of the parametric restrictions I refer to in the main body of the chapter without making explicit.

1.6.1 Preliminaries and Clarifications

In this section I show that, irrespective of the other parameters of a model, a sufficiently large γ can ensure that the traditional commodity is produced in both countries in equilibrium.

Result 1 For any set of parameters $\langle \alpha, \beta, \mu, \mu', \xi_{1N}, \xi_{1S}, \theta, \epsilon, L_S, L_N \rangle$ and for any localization economies function $\phi(.)$ there exists a threshold value $\underline{\gamma}$ such that for any $\gamma > \underline{\gamma}$ it must be the case that any equilibrium features production of the traditional commodity in both countries.

Proof: From the optimization problem of final goods producers and given the CES technology describing final good assembly, the relative expenditures on the two intermediate goods are given by (Y_i denotes expenditures on intermediate i):

$$\frac{Y_2}{Y_1} = \left(\frac{1-\gamma}{\gamma}\right)^{\epsilon} \left[\frac{p_1}{p_2}\right]^{\epsilon - 1} \tag{1.16}$$

Applying the implicit function theorem to this equation it is straightforward to show that:

$$\frac{\mathrm{d}}{\mathrm{d}\gamma}\left(\frac{Y_2}{Y_1}\right) < 0 \tag{1.17}$$

Furthermore, it is also the case that:

$$\lim_{\gamma \to 1}\left(\frac{Y_2}{Y_1}\right) = 0 \tag{1.18}$$

The latter equation implies that for any $T > 0$ there exists a γ such that

$$\left[\frac{Y_2(\gamma)}{Y_1(\gamma)}\right] < T \tag{1.19}$$

But then there implies that there exists a γ^* such that:

$$\left[\frac{Y_2(\gamma^*)}{Y_1(\gamma^*)}\right] < \frac{1}{\beta\theta + (1-\theta)[\alpha\mu + \beta(1-\mu)] + \mu(1-\alpha)(1-\theta)[\mu' + \beta(1-\mu')]} \times \max\left\{\frac{\xi_{1S}L_S}{\xi_{1N}L_N}; \frac{\xi_{1N}L_N}{\xi_{1S}L_S}\right\} \tag{1.20}$$

For such a γ^* it can be shown that any equilibrium will feature traditional production in both countries. This is because, according to the equation above, such a γ induces equilibrium expenditure shares that are incompatible with the traditional good being produced in a single country. Thus, with the relative expenditure shares (between the traditional and the urban good) given by the equation above, the concentration of the traditional sector in any one of the countries would lead to wages in that country to be pushed to such elevated levels, such that at least a fraction of that nations traditional good producers would prefer to deviate to the other nation. Also, the same reasoning yields that for any $\gamma > \gamma^*$ there cannot be an equilibrium in which the entire traditional sector is hosted in only one country.

Finally, Result 1 is established by denoting $\underline{\gamma}$ to be the infimum of the set of γ^* above that have the property that the economy given by

$$\langle \alpha, \beta, \mu, \mu', \xi_{1N}, \xi_{1S}, \theta, \epsilon, L_S, L_N, \gamma^* \rangle$$

and function $\phi(.)$ does not allow for an equilibrium in which the traditional commodity is produced in only one country for any $\tau \geq 1$.

1.6.2 Formal Statements of Assumptions

Assumption 1 The traditional sector is sufficiently large such that it must be the case that it is produced in both countries in any equilibrium. We will thus assume that:

$$\gamma > \underline{\gamma}(\alpha, \beta, \mu, \mu', \xi_{1N}, \xi_{1S}, \theta, \epsilon, L_S, L_N)$$

Assumption $2a$ A necessary condition for the South to be competitive in the production of the advanced task s in the absence of communication costs. I require that the relative size (in terms of their expenditure) of the urban sectors obeys the relationship:

$$\frac{1-\theta}{\theta} > \frac{2\frac{K_1}{1+K_1}}{[(1-\mu)+\mu(1-\alpha)(1-\mu')]}\left(\frac{\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}$$

where $K_1 = A^{\frac{\beta}{1-\beta}}$

Assumption $2b$ A stricter version of Assumption $2a$ which I impose throughout my analysis in order to explore the full predictive possibilities of the model. I require that the labor cost differential between the two countries (reflected in their respective productivity in the traditional sector) is sufficiently large such that:

$$A^{\frac{\beta(1-\mu)}{\mu(1-\alpha)}}\left[\frac{\theta}{(1-\mu)(1-\theta)}\right]^{\frac{(1-\beta)(1-\mu)}{\mu(1-\alpha)}}\left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha}{1-\alpha}} \geq \left[1+\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}\right]^{\frac{(1-\mu)(1-\beta)}{\mu(1-\alpha)}}$$

By assuming a sufficiently large differential in labor costs between the two nations, I am able to illustrate the entire range of stages that the configuration of the (worldwide) spatial economy can go through as communications costs are gradually lowered. Starting from this benchmark analysis it is then straightforward to consider cases in which differentials in labor costs (and hence productivity in the traditional sector) are lower, as this will mean that the configuration of worldwide economic geography will only go through an ordered subset of the stages described in the analysis featuring large cross-country labor cost differentials.

Assumption 3 I require that localization economies are strong enough to generate clustering of the management services sector in only one Northern city in any stable equilibrium. The function $\phi(.)$ governing the strength of localization economies in the management services sector is thus assumed to have the following properties:

Property 1: $\phi(0) > 0$

Property 2: $\phi'(x) > 0$ for all $x \in [0,1]$

Property 3:

$$\frac{\phi(1)}{\phi(0)} > \left\{\mu(1-\alpha)(1-\mu')\frac{1-\theta}{\theta}\left[1+\left(\frac{\xi_{1N}}{A\xi_{1S}}\right)^{\frac{\beta}{1-\beta}}\right]\right\}^{(1-\beta)(1-\mu')}$$

Property 4: $\phi'(x) > \phi(1/2)\left(\frac{x}{1-x}\right)^{(1-\beta)(1-\mu)}$ for any x in the interval

$$x \in \left[\frac{1}{2}, \underbrace{\frac{\mu(1-\alpha)(1-\mu')\left[1+\left(\frac{\xi_{1N}}{\xi_{1S}A}\right)^{\frac{\beta}{1-\beta}}\right]}{1+\mu(1-\alpha)(1-\mu')\left[1+\left(\frac{\xi_{1N}}{\xi_{1S}A}\right)^{\frac{\beta}{1-\beta}}\right]}}_{\overline{x}}\right]$$

Assumption 4 A restriction aimed at limiting the proliferation of sub-cases: I assume that the role of infrastructure in skilled production (task s) is sufficiently important such that the lagging Southern location $S1$ can never undertake this task in equilibrium. In particular, I assume that:

$$\rho > \max\left\{\frac{(1-\beta)(1-\mu)}{\alpha\mu}\frac{\ln\left\{\frac{1-\theta}{\theta}(1-\mu)\left[1+\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}\right]\right\}}{\ln A} - \frac{\beta(1-\mu)}{\alpha\mu}, \frac{\ln\frac{\xi_{1N}}{\xi_{1S}}}{\ln A}\right\}$$

Assumption 5 A technical "timing" assumption. I assume that

$$\frac{1-\theta}{\theta} > \frac{2(1+K_1)}{[(1-\mu)+\mu(1-\alpha)(1-\mu')]}\times \left[\frac{\mu(1-\alpha)(1-\mu')}{(1-\mu)-\mu(1-\alpha)(1-\mu')} + \frac{K_1}{2(1+K_1)}\right]$$

The parametric assumption above merely affects the "timing" of the stages of specialization the world economy undertakes as international communication frictions are gradually reduced, but it has no bearing on the overall qualitative predictions of the model.

1.7 Appendix B: Proofs

In what follows, I proceed to proving the main results reported in chapter 1. Throughout our analysis I maintain Assumptions $1-5$ described above. For the purposes of this section and the rest of the Appendices to this chapter, the notions of unskilled manufacturing and task u, skilled manufacturing and task s, and management services and the "management task" or task M are used interchangeably.

1.7.1 Preliminaries: Solving the Model

I begin the discussion on solving the model from the optimization problem of final goods producers. Given the CES technology describing final good assembly, the relative expenditures on the two intermediate goods are given by (Y_i denotes expenditures on intermediate i):

$$\frac{Y_2}{Y_1} = \left(\frac{1-\gamma}{\gamma}\right)^{\epsilon}\left[\frac{p_1}{p_2}\right]^{\epsilon-1} \tag{1.21}$$

while the designation of the final good as the numeraire yields:

$$\gamma^{\epsilon} p_1^{1-\epsilon} + (1-\gamma)^{\epsilon} p_2^{1-\epsilon} = 1 \tag{1.22}$$

Moreover, given the perfectly competitive environment that prevails on the supply side of the market for intermediates, these commodities are priced at the cost of production (see (1.7)). In the case of the traditional good, this means that the equilibrium price exactly covers the compensation of unskilled workers, expressed per unit of output, at each cost minimizing location for the production of this commodity:

$$p_1 = \min_{c\in\{N,S\}} \left\{\frac{w_c^U}{\xi_{1c}}\right\}$$

where w_c^U denotes the unskilled wage rate in country c (note that free mobility within countries means that the unskilled wage is equalized across locations, both rural and urban, within countries). As Assumption 1 guarantees that the traditional good is produced in equilibrium in both N and S, the level of (unskilled) wages in the two countries is given by (1.8).

For the case of the urban intermediate, optimization by perfectly competitive producers implies that its equilibrium price is

$$p_2 = \left(\frac{p_u}{\theta}\right)^{\theta} \left(\frac{p_s}{1-\theta}\right)^{1-\theta} \tag{1.23}$$

while the expenditures on the requisite stages of production or tasks involved in production are given by

$$Y_u = \theta Y_2 \qquad\qquad Y_s = (1-\theta) Y_2 \tag{1.24}$$

Moving to the analysis of the supply side of urban tasks, the assumptions of perfect competition and costless mobility of the output of urban production across and within countries imply that these commodities are only produced at worldwide cost minimizing locations:

$$\begin{aligned} p_u &= \min_{l \in \{S1, S2, N1, N2\}} c_l(u) \\ p_s &= \min_{l \in \{S1, S2, N1, N2\}} c_l(s) \end{aligned}$$

where, as before, $c_l(i)$ represents the minimum cost of production of task i at location (city) l. In turn, optimization by profit maximizing task producers implies that these cost functions are given by:

$$\begin{aligned} c_l(u) &= \left(\frac{1}{A_l}\frac{w_l^U}{\beta}\right)^{\beta} \left(\frac{r_l}{1-\beta}\right)^{1-\beta} \\ c_l(s) &= \left[\frac{1}{\mu}\left(\frac{1}{A_l^{\rho}}\frac{w_l^S}{\alpha}\right)^{\alpha}\left(\frac{p_l^M}{1-\alpha}\right)^{1-\alpha}\right]^{\mu} \left[\frac{1}{1-\mu}\left(\frac{1}{A_l}\frac{w_l^U}{\beta}\right)^{\beta}\left(\frac{r_l}{1-\beta}\right)^{1-\beta}\right]^{1-\mu} \end{aligned}$$

where as previously established, w_l^U, w_l^S represent the unskilled and skilled wages at location (city) l while p_l^M denotes the price of management services at a location l. Note that wages for workers of a particular skill level are the same across locations within countries but differ across countries, as established in equation (1.8).

Concerning the management services sector, Assumption 3 guarantees that equilibria in which the entire sector is clustered in one of the Northern locations exist and are stable. From the demand system of the model I can then derive a simple expression for the revenues of the management services sector:

$$Y_M = \mu(1-\alpha)(1-\theta)Y_2$$

The absence of communication costs in the North means that there is a unique price for management services across locations within this country. From the supply side of the model I can derive expressions for the price of the management input at various locations:

$$\begin{aligned} p_M^N &= \frac{1}{\phi(1)}\left(\frac{1}{A^\rho}\frac{w_N^S}{\mu'}\right)^{\mu'}\left[\frac{1}{1-\mu'}\left(\frac{1}{A}\frac{w_N^U}{\beta}\right)^{\beta}\left(\frac{r_{N2}}{1-\beta}\right)^{1-\beta}\right]^{1-\mu'} \\ p_M^S &= \tau p_M^N \end{aligned} \tag{1.25}$$

where p_M^S denotes the price of the management services in the South (note that Southern locations are subject to symmetric communication costs when sourcing the management services from the North) while the term $1/\phi(1)$ reflects the fact that the the management input is produced with maximal productivity in equilibria featuring complete agglomeration of the management sector in one city ($N2$).

Finally, I focus attention on primary factor markets. Exploiting the demand side of labor markets I obtain the following expressions that govern the total remuneration of skilled and unskilled workers across locations and sectors:

$$\begin{aligned} w_l^U L_u^l &= \beta Y_u^l \\ w_l^U L_s^l &= \beta(1-\mu)Y_s^l \\ w_l^S H_s^l &= \alpha\mu Y_s^l \\ w_N^S H_M^{N2} &= \mu' Y_M \\ w_N^U L_M^{N2} &= \beta(1-\mu')Y_M \end{aligned}$$

with $l \in \{S1, S2, N1, N2\}$:

$$\sum_{l\in\{S1,S2,N1,N2\}}\sum_{i\in\{a,b\}} Y_i^l = Y_2$$

where, as before, Y_2 denotes worldwide expenditure on the urban good.

On the supply side of labor markets, the assumptions of perfect within country mobility of workers, their frictionless mobility across sectors, as well as the access of all workers to an identical education technology ensure that in any equilibrium wages adjust to make workers indifferent across occupations and locations within their country of residence:

$$w_{S1}^U = w_{S2}^U = w_S^U = \xi_{1S} p_1 \qquad w_{S1}^S = w_{S2}^S = w_S^S = \frac{w_S^U}{1-e} = \frac{\xi_{1S} p_1}{1-e} \tag{1.26}$$

$$w_{N1}^U = w_{N2}^U = w_N^U = \xi_{1N} p_1 \qquad w_{N1}^S = w_{N2}^S = w_N^S = \frac{w_N^U}{1-e} = \frac{\xi_{1N} p_1}{1-e} \tag{1.27}$$

Relative wages across countries are fixed by their relative productivity in the traditional sector (Assumption 1) while skill premia in both countries are fixed by the exogenous educational technology. Land prices adjust such that the demand for land equates the inelastic land supply in each city $l \in \{N1, N2, S1, S2\}$ according to equation (1.11).

Finally, when characterizing the evolution of global economic geography, I am particularly interested in tracking how reductions in international communication costs affect cities' populations, skill shares and real estate prices, as well as overall (worldwide) urbanization. While real estate prices in equilibrium are pinned down by equation (1.11), the expressions for a city's equilibrium population and skill share are given by equations (1.14) and (1.15).

1.7.2 Proof of Proposition 1

I proceed by first proving a series of intermediary results.

Result 2 Under the assumptions above, in any equilibrium, $S1$ must be fully specialized in the least skilled urban task u.

The proof proceeds by contradiction. Let us assume that there is an equilibrium in which $S1$ houses an activity other than u (incidentally this means that $S1$ may produce some activity s given that result 1 has already established that no task M can be produced in the South in equilibrium under my framework). This means that:

$$c_{S1}(s) \leq c_{S2}(s)$$
$$c_{S1}(s) \leq c_{N1}(s)$$
$$c_{S1}(s) \leq c_{N2}(s)$$

given that we have, by Assumption 4 that

$$\rho > \frac{\ln \frac{\xi_{1N}}{\xi_{1S}}}{\ln A} \tag{1.28}$$

which ensures that the cost of the composite given in the first bracket of the cost function of s is always higher in $S1$ than in any Northern location, then it must be the case that:

$$\left[\left(\frac{w_S}{\beta}\right)^{\beta}\left(\frac{r_{S1}}{1-\beta}\right)^{1-\beta}\right] < \left[\left(\frac{1}{A}\frac{w_S}{\beta}\right)^{\beta}\left(\frac{r_{S2}}{1-\beta}\right)^{1-\beta}\right] \tag{1.29}$$

$$\left[\left(\frac{w_S}{\beta}\right)^{\beta}\left(\frac{r_{S1}}{1-\beta}\right)^{1-\beta}\right] < \left[\left(\frac{1}{A}\frac{w_N}{\beta}\right)^{\beta}\left(\frac{r_{N1}}{1-\beta}\right)^{1-\beta}\right] \tag{1.30}$$

$$\left[\left(\frac{w_S}{\beta}\right)^{\beta}\left(\frac{r_{S1}}{1-\beta}\right)^{1-\beta}\right] < \left[\left(\frac{1}{A}\frac{w_N}{\beta}\right)^{\beta}\left(\frac{r_{N2}}{1-\beta}\right)^{1-\beta}\right] \tag{1.31}$$

But the expressions above are equivalent to:

$$c_{S1}(u) \leq c_{S2}(u)$$
$$c_{S1}(u) \leq c_{N1}(u)$$
$$c_{S1}(u) \leq c_{N2}(u)$$

Thus, in any such equilibrium, $S1$ captures must capture the entire task u production activity. However, Assumption 4 also ensures that in configurations in which $S1$ amasses the entire task u sector, then city $S2$ will be a strictly lower cost location for the production of task s. Thus in such an equilibrium, task s cannot be produced in location $S1$, leading to a contradiction and the completion of the proof.

Result 3 There cannot be an equilibrium featuring the partial agglomeration of the management services sector.

Given that I have already established that in any equilibrium M is only produced in the North, the only option for equilibria featuring partial agglomeration of the management services sector would imply that one of the Northern cities captures a market share of $\frac{1}{2} < x < 1$ in the production of management services. Before the proof proceeds let us establish the following result:

Result 3.1 In any equilibrium involving the incomplete agglomeration of M, the city featuring a market share $x > \frac{1}{2}$ in management services must be fully specialized in the production of management services.

Given that we have incomplete specialization I have that (assuming WLOG incomplete agglomeration in $N2$)

$$c_{N1}(M) = C_{N2}(M) \tag{1.32}$$

$$x_{N2} > \frac{1}{2} \Rightarrow \phi(x_{N2}) > \phi(x_{N1}) \tag{1.33}$$

It must then be the case that $r_{N1} < r_{N2}$ (the cities are identical in every respect and face the same labor costs). But from the point of view of all the other urban activities, cities $N1$ and $N2$ are symmetric so any firm specializing in any of the other activities would optimally choose to locate in $N1$ rather than $N2$. This establishes result 3.1.

Expanding and simplifying equation (1.32) above yields the following relation that must hold in any equilibrium featuring incomplete agglomeration:

$$\frac{\phi(x^*_{N2})}{\phi(1 - x^*_{N2})} = \left(\frac{r_{N2}}{r_{N1}}\right)^{(1-\beta)(1-\mu')} \tag{1.34}$$

But property 4 of the function characterizing the localization economies of the management sector ($\phi(.)$) guarantees that:

$$\frac{\phi(x_{N2})}{\phi(1 - x_{N2})} > \left(\frac{x_{N2}}{1 - x_{N2}}\right)^{(1-\beta)(1-\mu')} > \left(\frac{r_{N2}}{r_{N1}}\right)^{(1-\beta)(1-\mu')} \quad \forall x \in [\frac{1}{2}, \overline{x}] \tag{1.35}$$

where the last inequality follows from Result 3.1. But then it must be the case that $x^*_{N2} > \overline{x}$. But then we have that in the hypothesized equilibrium the following must hold:

$$\left(\frac{r_{N2}(x^*_{N2})}{r_{N1}(x^*_{N2})}\right)^{(1-\beta)(1-\mu')} = \frac{\phi(x^*_{N2})}{\phi(1-x^*_{N2})} > \frac{\phi(\overline{x})}{\phi(1-\overline{x})} > \left(\frac{\overline{x}}{1-\overline{x}}\right)^{(1-\beta)(1-\mu')} \quad (1.36)$$

However the relationship above leads to a contradiction, as the real estate price differential between cities $N2$ and $N1$ required by equation (1.50) cannot be sustained in any equilibrium. In fact it can be shown that in any equilibrium the maximum differential in land prices between the two Northern city is bounded by the relationship:

$$\frac{r_{N2}}{r_{N1}} \leq \mu(1-\alpha)(1-\mu')\frac{1-\theta}{\theta}\left[1+\left(\frac{\xi_{1N}}{\xi_{1S}A}\right)^{\frac{\beta}{1-\beta}}\right] \quad (1.37)$$

The contradiction established between the requirements of equations (1.36) and (1.37) above complete the proof of Result 3.

Following Result 3 I have established that any potential equilibrium will involve either symmetric cities in the North (it is straightforward to show that equilibria with $x^*_{N2} = \frac{1}{2}$ always exist) or completely agglomerated configurations, in which the entire management services sector is clustered in one Northern city. In the next result, I will attempt to show that there can be only one equilibrium involving complete agglomeration when $\tau > T_{max}$.

Result 4 For sufficiently high communication costs

$$\tau > \underbrace{\left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{\mu(1-\alpha)}}\left\{\frac{(1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')]}{2\frac{K_1}{1+K_1}\theta}\right\}^{\frac{(1-\beta)(1-\mu)}{\mu(1-\alpha)}}}_{T_{max}} \quad (1.38)$$

there can only be an unique equilibrium (up to a permutation of city labels in the North) in which the management services sector is fully agglomerated in only one of the Northern cities. The features of this equilibrium are as described in Proposition 1.

Again, in order to prove the above result, I first need to establish a series of intermediate results. These are outlined below.

Result 4.1 For $\tau > T_{max}$, there cannot be an equilibrium in which activity u is produced in the North.

Proof: Let us assume that we can identify an equilibrium in which u is indeed produced in the North. This would imply that in such an equilibrium, a location Ni where $i \in \{1, 2\}$ is a cost minimizing location for the production of task u yielding:

$$\left[\left(\frac{1}{A}\frac{w_N}{\beta}\right)^{\beta}\left(\frac{r_{Ni}}{1-\beta}\right)^{1-\beta}\right] \leq \left[\left(\frac{1}{A}\frac{w_S}{\beta}\right)^{\beta}\left(\frac{r_{S1}}{1-\beta}\right)^{1-\beta}\right] \tag{1.39}$$

$$\left[\left(\frac{1}{A}\frac{w_N}{\beta}\right)^{\beta}\left(\frac{r_{Ni}}{1-\beta}\right)^{1-\beta}\right] \leq \left[\left(\frac{1}{A}\frac{w_S}{\beta}\right)^{\beta}\left(\frac{r_{S2}}{1-\beta}\right)^{1-\beta}\right] \tag{1.40}$$

But then given that $T_{max} > \left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha}{1-\alpha}}$ and given Assumption 4 this implies that:

$$c_{N1}(s) < c_{S1}(s) \tag{1.41}$$

$$c_{N1}(s) < c_{S2}(s) \tag{1.42}$$

which means that in an equilibrium of the type posited, the South cannot be hosting production of any task s activity. Hence this implies that in such a posited equilibrium, the South is fully specialized in activity u. But then, due to Assumption $2b$ it must be the case that the South captures the entire task s sector, which leads us to a contradiction with our assumption that there is an equilibrium for $\tau > T_{max}$ in which u is produced in the North, and thus concludes the proof.

Result 4.2 For $\tau > T_{max}$, there cannot exist an equilibrium featuring complete agglomeration of the management sector in which s is produced in the South.

Result 1 and result 4.1 mean that there are only two possible configurations left for potential agglomerated equilibria. One features the South producing activity u and the North producing the entire outputs of urban sectors s and M, whereas the other possible configuration features the South capturing the entire activity u sector but also some market share in task s, while the North retains the complementary market share in task s and has a monopoly position in the production of management services.

Let us assume that we have identified an equilibrium for $\tau > T_{max}$ such that task s is produced in the South. Result 2 dictates that any such equilibrium in which s is produced in the South will feature activity s being undertakes in the South's "advanced" city $S2$. This yields the following:

$$c_{S2}(s) \leq c_{N1}(s) \tag{1.43}$$

$$(r_{S1} + r_{S2})\overline{N} = (1-\beta)\theta Y_2 + x(1-\beta)(1-\mu)(1-\theta)Y_2 \tag{1.44}$$

where x above represents the South's market share in the skilled urban task s in the posited equilibrium. From result 2 and noting the infrastructure differential between cities $S1$ and $S2$ I can write:

$$r_{S2} \geq \underbrace{A^{\frac{\beta}{1-\beta}}}_{K_1} r_{S1} \tag{1.45}$$

Plugging equation (1.45) into (1.44) yields

$$(r_{S1} + r_{S2})\overline{N} = (1-\beta)\theta Y_2 + x(1-\beta)(1-\mu)(1-\theta)Y_2 \leq \left(\frac{r_{S2}}{K_1} + r_{S2}\right)\overline{N} \tag{1.46}$$

which can be rewritten:

$$r_{S2} \geq \frac{K_1}{1+K_1}\frac{(1-\beta)\theta Y_2 + x(1-\beta)(1-\mu)(1-\theta)Y_2}{\overline{N}} \tag{1.47}$$

On the other hand, in an equilibrium of the type posited it must also be the case that:

$$(r_{N1} + r_{N2})\overline{N} = (1-x)(1-\beta)(1-\mu)(1-\theta)Y_2 + \mu(1-\alpha)(1-\mu')(1-\theta)Y_2 \tag{1.48}$$

Noting the (ex-ante) symmetric characteristics of Northern cities and restricting (without loss of generality) attention to configuration in which the complete agglomeration of the management services sector occurs in location $N2$ then I can write:

$$r_{N2} \geq r_{N1} \tag{1.49}$$

Combining the last two equations I obtain:

$$r_{N1} 2\overline{N} \leq (1-x)(1-\beta)(1-\mu)(1-\theta)Y_2 + \mu(1-\alpha)(1-\mu')(1-\theta)Y_2 \tag{1.50}$$

which can be rewritten as:

$$r_{N1} \leq \frac{(1-x)(1-\beta)(1-\mu)(1-\theta)Y_2 + \mu(1-\alpha)(1-\mu')(1-\theta)Y_2}{2\overline{N}} \tag{1.51}$$

Expanding and simplifying equation (1.43) yields:

$$r_{N1} \geq \left(\frac{\xi_{1S}}{\xi_{1N}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{(1-\beta)(1-\mu)}} \tau^{\frac{\mu(1-\alpha)}{(1-\beta)(1-\mu)}} r_{S2} \tag{1.52}$$

which can be rewritten:

$$\frac{r_{N1}}{r_{S2}} \geq \left(\frac{\xi_{1S}}{\xi_{1N}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{(1-\beta)(1-\mu)}} \tau^{\frac{\mu(1-\alpha)}{(1-\beta)(1-\mu)}} \tag{1.53}$$

Substituting $\tau > T_{max}$ into the equation above gives us:

$$\frac{r_{N1}}{r_{S2}} \geq \frac{(1-\theta)[(1-\mu) + \mu(1-\alpha)(1-\mu')]}{2\frac{K_1}{1+K_1}\theta} \tag{1.54}$$

On the other hand, dividing equations (1.51) and (1.47) yields:

$$\frac{r_{N1}}{r_{S2}} \leq \frac{(1-x)(1-\mu)(1-\theta) + \mu(1-\alpha)(1-\mu')(1-\theta)}{2\frac{K_1}{1+K_1}[\theta + x(1-\beta)(1-\mu)(1-\theta)]} \tag{1.55}$$

The incompatibility of the inequalities (1.54) and (1.55) means that I have reached a contradiction, which completes the proof of result 4.2.

In light of result 4.2 the only possibility that remains is an equilibrium configuration in which urban sector u locates exclusively in the South, while sectors M and s locate exclusively in the North. It is straightforward to check that the configuration described by Proposition 1 is indeed an equilibrium: given that the South completely specializes in u, it is indeed the lowest cost location for task u production; the North optimally captures management services production due to its substantial productive advantage in the delivery of these commodities while the presence of large ($\tau > T_{max}$) communication costs affecting the international delivery of management services makes task s production uneconomical in the South. The suggested configuration can also be shown to satisfy the requirements for locational equilibrium within countries. Finally given that I have reached the configuration of the spatial economy outlined in Proposition 1 via a process of elimination, it must be the case that this is indeed the only equilibrium featuring asymmetric Northern cities.

Result 5 Under our assumptions, symmetric equilibria are never stable in the sense of Definition 2.

Under a symmetric equilibrium, half of the management services sector is hosted by each of the Northern cities. This implies:

$$c_{N1}(M) = c_{N2}(M) \tag{1.56}$$

Expanding and simplifying the equation above:

$$\frac{1}{\phi(x)} r_{N2}(x)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}} = \frac{1}{\phi(1-x)} r_{N1}(x)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}} \tag{1.57}$$

which can be rewritten as

$$\frac{\phi(x)}{\phi(1-x)}|_{x=\frac{1}{2}} = \left(\frac{r_{N2}(x)}{r_{N1}(x)}\right)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}} \tag{1.58}$$

It can be shown that in any symmetric equilibrium it must be the case that:

$$\frac{\partial}{\partial x}\left(\frac{r_{N2}(x)}{r_{N1}(x)}\right)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}} \leq \frac{\partial}{\partial x}\left(\frac{x}{1-x}\right)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}} \tag{1.59}$$

i.e. the effect of a disturbance reflected in the partial derivative at the symmetric equilibrium is largest in a hypothetical scenario in which the North is completely specialized in management services. But property 4 of Assumption 3 guarantees that:

$$\frac{\partial}{\partial x}\left(\frac{\phi(x)}{\phi(1-x)}\right)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}} > \frac{\partial}{\partial x}\left(\frac{x}{1-x}\right)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}} \geq \frac{\partial}{\partial x}\left(\frac{r_{N2}(x)}{r_{N1}(x)}\right)^{(1-\beta)(1-\mu)}|_{x=\frac{1}{2}}$$

Thus, a locational deviation by a small (but positive) mass of M producers from one of the symmetric Northern cities in such an equilibrium makes the recipient city **more** attractive for firms in the management services sector and less attractive to firms operating in the other urban sectors. This implies that symmetric equilibria are unstable in the sense of Definition 2.

Result 6 The asymmetric equilibrium configuration outlined in Proposition 1, which features complete clustering of the management services sector in city $N2$ (or city $N1$) is stable in the sense of Definition 2.

From the analysis of undertaken in the proof of Result 3, I know that moving a small mass Δx of firms from $N2$ to $N1$ (when the M cluster occurs at $N2$) will keep $N2$ as a strictly preferred location for the production of management services. Moreover, while the disturbance caused by the move of a small mass of management services firms from $N2$ to $N1$ would leave $N2$ more attractive than $N1$ in all urban sectors, the pull of the productive conditions remaining in $N2$ would be particularly strong for management services providers, so it can be shown that the asymmetric equilibrium outlined in Proposition 1 would be restored. Thus, this equilibrium is stable in the sense of Definition 2.

Finally, combining results 4, 5 and 6 above completes the proof of Proposition 1.

1.7.3 Comparative statics of threshold T_{max}

In this section I proceed to analyze the comparative statics of T_{max}, the threshold of communication costs above which skilled task production is uneconomical in the South, with respect to the structural parameters of the model. These are summarized in Corrolary 1 below:

Corollary 1. *The threshold T_{max}, above which the production of the skilled manufacturing (s) in the South is uneconomical, has the following comparative static properties: $\partial T_{max}/\partial \xi_{1N} > 0$, $\partial T_{max}/\partial \xi_{1S} < 0$, $\partial T_{max}/\partial \theta < 0$, $\partial T_{max}/\partial \mu < 0$, $\partial T_{max}/\partial \mu' < 0$, $\partial T_{max}/\partial A < 0$.*

In line with economic intuition, increases in the relative price of Northern labor are found to cause increases of the threshold T_{max} ($\partial T_{max}/\partial \xi_{1N} > 0, \partial T_{max}/\partial \xi_{1S} < 0$). Raising the relative cost of labor in the North makes the South more attractive for the production of the skilled manufacturing, and hence a higher communication friction is required to offset this added cost advantage of the South and maintain the entire skilled manufacturing sector in the North.

The third result of Corollary 1 ($\partial T_{max}/\partial \theta < 0$) which links the expenditure share of unskilled manufacturing with the threshold T_{max} is also intuitive. An increase in the size of the unskilled manufacturing sector (and a converse decrease in the expenditure share of skilled manufacturing) implies that in a configuration of the spatial economy in which communication costs preclude the South from undertaking any advanced production and cause it to capture the entire unskilled manufacturing sector, the relative price of Southern land will be higher.[27] This makes the South relatively less attractive to skilled manufacturing producers, and thus a smaller communication friction is required to maintain the North's monopoly on skilled production outlined in Proposition 1.

The interpretation of the fourth result ($\partial T_{max}/\partial\mu < 0$) is more involved, as an increase in the expenditure share μ of the "advanced" factors of production (skilled labor and management services) has three effects. Firstly, it increases the importance of the management input for the production of skilled manufactures, such that a lower communication friction can still be sufficient to substantially impair the South's competitiveness at producing this commodity. This effect can be expected to lead to a decline in T_{max}. Further, an increase in μ tends to weaken the dispersion force represented by fixed land supplies, as it both tends to reduce land prices and the importance of land in skilled production. Given that the presence of this dispersion force is the main factor preventing the concentration of economic activity in the North, a weakening of this mechanism also lowers the level of communication costs T_{max} required to preserve the North's decisive comparative advantage in skilled production. Finally, depending on the relative sizes of α and β, raising μ either makes skilled production more (if $\alpha > \beta$) or less (if $\alpha < \beta$) labor intensive. This effect then tends to either increase T_{max} if skilled production becomes more labor intensive (as in this case the South's cheap labor advantage is augmented) or to lower T_{max} if skilled production becomes less labor intensive. The first two effects dominate the third irrespective of the direction of the latter, such that an increase in μ is always associated with a decline in the threshold T_{max}.

The effect of a rise in the land expenditure share of management services μ' on the threshold T_{max} is more straightforward: as the management services sector only operates in the North, a rise in the expenditure of this sector on urban land has the effect of worsening congestion in the North, thus making this nation less attractive for skilled

[27] In a configuration like the one outlined in Proposition 1, the relative price of land in the two countries is given by the relative sizes of the sectors located in each country and their relative land intensities. Then ceteris paribus, an increase in the size of the unskilled manufacturing sector will increase land prices in the country housing it, namely the South. Assumption 2 ensures that whenever the South is uncompetitive in skilled production it can capture the entire unskilled production sector.

production. As a result, communication costs affecting the international delivery of management services need to rise to keep the entire skilled manufacturing sector in the North. Similarly, the implications of an increase in the infrastructure differential between the advanced locations ($S2$, $N1$, $N2$) and the backward one ($S1$) generated by a rise in A are simple to ascertain. As the South hosts the infrastructure poor location, an increase in the productivity differential between this location and the rest is equivalent to a decline in the relative productive potential of the South overall. This in turn serves to lower the level of the communication costs "required" to discourage skilled production in the South.

1.7.4 Proof of Propositions 2 to 6

It is straightforward to see that proving that the spatial economy undergoes the phases described in stages 1 to 5 as communication costs decline is equivalent to proving the results highlighted in propositions $2-6$. In this section I will prove a series of results that confirm the developments outlined in the description of stages $1-5$ and that jointly constitute a proof of the main results of the chapter (propositions $2-6$).

Result 7 Along the interval of communication costs given by

$$\underbrace{\left\{\frac{(1-\theta)\left[(1-\mu)+\mu(1-\alpha)(1-\mu')\right]-\theta K_1}{2K_1\theta}\right\}^{\frac{(1-\beta)(1-\mu)}{\mu(1-\alpha)}}\left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{\mu(1-\alpha)}}}_{T_{spec1}} < \tau \leq T_{max} \tag{1.60}$$

the unique stable equilibrium involves activity s being produced in locations $\{S2, N1, N2\}$, task u being produced in both Southern cities while the management services (M) are produced in $N2$. Moreover, along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities in both countries, and skill polarization across space within countries.

Proof: In this and the following results, I will focus attention on proving the comparative static results. The proof of the existence and stability of the posited equilibria, as well as their uniqueness within the class of stable equilibria largely follows the same template as the proof of Proposition 1 undertaken in the previous section. In order to prove the comparative static results outlined above, I again first need to establish some intermediate results.

Result 7.1 For $\tau < T_{max}$ a reduction in communication costs is associated with a decline in the relative price of the urban good (i.e. $\frac{\partial}{\partial \tau}\left(\frac{p_2}{p_1}\right) > 0$).

Along the interval $T_{spec1} < \tau < T_{max}$ the equilibrium configuration outlined above implies that the following must hold:

$$\gamma^{\epsilon} p_1^{1-\epsilon} + (1-\gamma)^{\epsilon} p_2^{1-\epsilon} = 1$$

$$p_1 = \frac{w_S^U}{\xi_{1S}} = \frac{w_N^U}{\xi_{1N}}$$

$$p_2 = \left(\frac{p_u}{\theta}\right)^{\theta} \left(\frac{p_s}{1-\theta}\right)^{1-\theta}$$

$$c_{S2}(s) = c_{N1}(s) = c_{N2}(s) = p_s \tag{1.61}$$

$$c_{S1}(u) = c_{S2}(u) = p_u \tag{1.62}$$

Further, the equality $c_{N1}(s) = c_{N2}(s)$ embedded in equation (1.61) above implies that rental rates are equalized across Northern cities (i.e. $r_{N2} = r_{N1} = r_N$) whereas the equality $c_{S1}(u) = c_{S2}(u)$ implies that $r_{S2} = K_1 r_{S1}$ where $K_1 = A^{\frac{\beta}{1-\beta}} > 1$. Expanding and simplifying the equality $c_{S2}(s) = c_{N1}(s)$ embedded in equation (1.61) yields:

$$r_N = \underbrace{\left(\frac{\xi_{1S}}{\xi_{1N}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{(1-\beta)(1-\mu)}} \tau^{\frac{\mu(1-\alpha)}{(1-\beta)(1-\mu)}}}_{G(\tau)} r_{S2} \tag{1.63}$$

Moving to derive expressions for the prices of the various urban commodities in equilibrium, I obtain:

$$p_u = \left(\frac{1}{A}\frac{w_S^U}{\beta}\right)^{\beta} \left(\frac{r_{S2}}{1-\beta}\right)^{1-\beta}$$

which can be rewritten:

$$p_u = \underbrace{\left(\frac{1}{A}\frac{\xi_{1S}}{\beta}\right)^{\beta} \left(\frac{1}{1-\beta}\right)^{1-\beta}}_{K_2} p_1^{\beta} r_{S2}^{1-\beta} \tag{1.64}$$

Further, for task s I obtain:

$$p_s = \left[\frac{1}{\mu}\left(\frac{w_S^U}{(1-e)\alpha}\frac{1}{A^\rho}\right)^\alpha \left(\frac{p_M\tau}{1-\alpha}\right)^{1-\alpha}\right]^\mu \left[\frac{1}{1-\mu}\left(\frac{w_S^U}{\beta}\frac{1}{A}\right)^\beta \left(\frac{r_{S2}}{1-\beta}\right)^{1-\beta}\right]^{1-\mu}$$

which I again write in more compact format:

$$p_s = K_3 p_1^{\alpha\mu+\beta(1-\mu)} r_{S2}^{(1-\beta)(1-\mu)} p_M^{\mu(1-\alpha)} \tau^{\mu(1-\alpha)} \tag{1.65}$$

where K_3 groups an expression given entirely by parameters of the model:

$$K_3 = \left[\frac{1}{\mu}\left(\frac{\xi_{1S}}{(1-e)\alpha}\frac{1}{A^\rho}\right)^\alpha \left(\frac{1}{1-\alpha}\right)^{1-\alpha}\right]^\mu \left[\frac{1}{1-\mu}\left(\frac{\xi_{1S}}{\beta}\frac{1}{A}\right)^\beta \left(\frac{1}{1-\beta}\right)^{1-\beta}\right]^{1-\mu}$$

Undertaking the same procedure of collapsing expressions containing only parameters into constants I obtain the following expression for the price of the management input:

$$p_M = K_4 p_1^{[\mu'+\beta(1-\mu')]} r_N^{(1-\beta)(1-\mu')} \tag{1.66}$$

where I note that:

$$r_N = G(\tau) r_{S2}$$
$$G(\tau) = \underbrace{\left(\frac{\xi_{1S}}{\xi_{1N}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{(1-\beta)(1-\mu)}}}_{K_5} \tau^{\frac{\mu(1-\alpha)}{(1-\beta)(1-\mu)}}$$

I can thus rewrite (1.63) as:

$$r_N = K_5 r_{S2} \tau^{\frac{\mu(1-\alpha)}{(1-\beta)(1-\mu)}} \tag{1.67}$$

Plugging this last equation into (1.66) and continuing to collect parameters in constants I can write:

$$p_M = K_6 p_1^{[\mu'+\beta(1-\mu')]} r_{S2}^{(1-\beta)(1-\mu')} \tau^{\mu(1-\alpha)\frac{1-\mu}{1-\mu'}} \tag{1.68}$$

Whereas plugging equation (1.68) into equation (1.65) yields the following expression for the price of task s:

$$p_s = K_7 p_1^{\mu(1-\alpha)[\mu'+\beta(1-\mu')]+\alpha\mu+\beta(1-\mu)} r_{S2}^{(1-\beta)[(1-\mu)+\mu(1-\alpha)(1-\mu')]} \times \tau^{\mu(1-\alpha)[\mu(1-\alpha)\frac{1-\mu'}{1-\mu}+1]} \quad (1.69)$$

The expression for the price of the urban intermediate (good 2) can also be rewritten:

$$p_2 = K_8 p_u^{\theta} p_s^{1-\theta} \quad (1.70)$$

Plugging (1.69) and (1.64) into (1.70) yields:

$$p_2 = K_9 p_1^{1-(1-\beta)(1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}]} r_{S2}^{(1-\beta)(1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}]} \times \tau^{\mu(1-\alpha)(1-\theta)[\mu(1-\alpha)\frac{1-\mu'}{1-\mu}+1]} \quad (1.71)$$

which can be rewritten

$$\frac{p_2}{p_1} = K_9 \left(\frac{r_{S2}}{p_1}\right)^{(1-\beta)(1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}]} \tau^{\mu(1-\alpha)(1-\theta)[\mu(1-\alpha)\frac{1-\mu'}{1-\mu}+1]} \quad (1.72)$$

Imposing global market clearing conditions on labor and land markets gives us the equations:

$$\begin{aligned} L^S\xi_{1S}p_1 + L^N\xi_{1N}p_1 &= Y_1 + \beta\theta Y_2 + [\alpha\mu + \beta(1-\mu)](1-\theta)Y_2 \\ &\quad + (1-\theta)\mu(1-\alpha)[\mu' + \beta(1-\mu')]Y_2 \\ (r_{S1} + r_{S2} + r_{N1} + r_{N2})\overline{N} &= \theta(1-\beta)Y_2 + (1-\beta)(1-\mu)(1-\theta)Y_2 \\ &\quad + (1-\theta)Y_2\mu(1-\alpha)[(1-\beta)(1-\mu')] \end{aligned}$$

Taking into account the relative price of land across cities in equilibrium I can write:

$$\begin{aligned} r_{S2}(\frac{1}{K_1} + 1 + 2G(\tau))\overline{N} &= \theta(1-\beta)Y_2 + (1-\beta)(1-\mu)(1-\theta)Y_2 \\ &\quad + (1-\theta)Y_2\mu(1-\alpha)[(1-\beta)(1-\mu')] \end{aligned} \quad (1.73)$$

which can be rewritten

$$r_{S2} = \frac{(1-\beta)(1-\theta)}{\left[\frac{1}{K_1}+1+2G(\tau)\right]}\left[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}\right]\frac{Y_2}{\overline{N}} \tag{1.74}$$

Similarly the price of good 1 is given by the following expression:

$$p_1 = \frac{Y_2}{L^S\xi_{1S}+L^N\xi_{1N}}\left[\left(\frac{\gamma}{1-\gamma}\right)^{\epsilon}\left(\frac{p_2}{p_1}\right)^{\epsilon-1}+\beta\theta+(1-\theta)[\alpha\mu+\beta(1-\mu)]+\mu(1-\alpha)(1-\theta)[\mu'+\beta(1-\mu')]\right] \tag{1.75}$$

Dividing (1.74) by (1.75) leads to the equation

$$\frac{r_{S2}}{p_1} = \frac{[L^S\xi_{1S}+L^N\xi_{1N}]\overbrace{(1-\beta)(1-\theta)\left[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}\right]}^{K_{10}}}{\overline{N}\left[\frac{1}{K_1}+1+2G(\tau)\right]\left[\left(\frac{\gamma}{1-\gamma}\right)^{\epsilon}\left(\frac{p_2}{p_1}\right)^{\epsilon-1}+\beta\theta+(1-\theta)[\alpha\mu+\beta(1-\mu)]+\mu(1-\alpha)(1-\theta)[\mu'+\beta(1-\mu')]\right]} \tag{1.76}$$

Which can be rewritten

$$\frac{r_{S2}}{p_1} = \frac{[L^S\xi_{1S}+L^N\xi_{1N}]K_{10}}{\overline{N}\left[\frac{1}{K_1}+1+2G(\tau)\right]\left[\left(\frac{\gamma}{1-\gamma}\right)^{\epsilon}\left(\frac{p_2}{p_1}\right)^{\epsilon-1}+1-K_{10}\right]} \tag{1.77}$$

Plugging (1.77) into (1.72), collecting terms yields

$$\frac{p_2}{p_1} = K_{11}\left\{\underbrace{\frac{1}{\left[\frac{1}{K_1}+1+2G(\tau)\right]\left[\left(\frac{\gamma}{1-\gamma}\right)^{\epsilon}\left(\frac{p_2}{p_1}\right)^{\epsilon-1}+1-K_{10}\right]}}_{Exp}\right\}^{K_{10}}\tau^{\mu(1-\alpha)(1-\theta)[\mu(1-\alpha)\frac{1-\mu'}{1-\mu}+1]} \tag{1.78}$$

I can thus set up a function:

$$F(\frac{p_2^*}{p_1^*},\tau) = \frac{p_2^*}{p_1^*} - K_{11}Exp^{K_{10}}\tau^{\mu(1-\alpha)(1-\theta)[\mu(1-\alpha)\frac{1-\mu'}{1-\mu}+1]} = 0 \tag{1.79}$$

Applying the implicit function theorem to the function above yields:

$$\frac{\partial\frac{p_2^*}{p_1^*}}{\partial\tau} = \frac{-\frac{\partial F}{\partial\tau}}{\frac{\partial F}{\partial\frac{p_2^*}{p_1^*}}} \tag{1.80}$$

Computing the relevant partial derivatives I obtain:

$$\frac{\partial F}{\partial \tau} = K_{11} Exp^{K_{10}} \tau^{\mu(1-\alpha)(1-\theta)[\mu(1-\alpha)\frac{1-\mu'}{1-\mu}+1]-1}$$
$$\times \left\{ K_{10} \frac{2G'(\tau)\tau}{\left[\frac{1}{K_1} + 1 + 2G(\tau)\right]} - \mu(1-\alpha)(1-\theta)\left[\mu(1-\alpha)\frac{1-\mu'}{1-\mu} + 1\right] \right\} \quad (1.81)$$

$$\frac{\partial F}{\partial \frac{p_2}{p_1}} = 1 + K_{11} K_{10} Exp^{K_{10}} \frac{(\epsilon - 1)\left(\frac{\gamma}{1-\gamma}\right)^{\epsilon}\left(\frac{p_2}{p_1}\right)^{\epsilon-2}}{\left[\left(\frac{\gamma}{1-\gamma}\right)^{\epsilon}\left(\frac{p_2}{p_1}\right)^{\epsilon-1} + 1 - K_{10}\right]} \tau^{\mu(1-\alpha)(1-\theta)[\mu(1-\alpha)\frac{1-\mu'}{1-\mu}+1]} \quad (1.82)$$

Given that the right hand side of equation (1.82) is positive the sign of the expression in equation (1.80) is pinned down by the sign of the expression in the curly brackets in equation (1.81). It is straightforward to show that for $\tau > T_{max}$ this latter expression is negative which implies that $\frac{\partial \frac{p_2^*}{p_1^*}}{\partial \tau} > 0$ which completes the proof of Result 7.1.

Result 7.2 For $T_{spec1} < \tau < T_{max}$, any reduction in international communication costs is associated with an increase in world output.

Proof: The result above is straightforward and can be obtained by expressing equilibrium output via equation (1.1), expanding the expression to obtain an equation expressed in terms of the equilibrium allocations of land and labor to the production of various commodities, and totally differentiating the resulting expression by making use of the envelope theorem.

Result 7.3 For $T_{spec1} < \tau < T_{max}$, any reduction in international communication costs is associated with an increase in the relative expenditure on the urban good (i.e. $\frac{\partial \frac{Y_2}{Y_1}}{\partial \tau} < 0$).

Proof: The result above can be obtained by differentiating equation (1.8) with respect to τ and noting Result 7.1.

Thus I have so far shown that decreases in international communication costs along the interval $T_{spec1} < \tau < T_{max}$ are associated with reduction in the relative price of the urban good, growth in world output and in the expenditure share of the urban good (i.e.$\tau \uparrow \Rightarrow \frac{p_2}{p_1} \downarrow, Y \uparrow, \frac{Y_2}{Y_1} \uparrow$). In what follows I aim to show that it is also associated with an increase in the relative size of "advanced" cities in both North and South (i.e. an increase in the relative size of $S2$ and $N2$ vis-a-vis $S1$ and $N1$ respectively).

In a stable equilibrium with $T_{spec1} < \tau < T_{max}$, it has to be the case, in light of the first part of result 7 that the following conditions hold:

$$Y_u^{S1} + Y_u^{S2} = Y_u = \theta Y_2 \tag{1.83}$$

$$Y_s^{S2} + Y_s^{N1} + Y_s^{N2} = Y_s = (1-\theta)Y_2 \tag{1.84}$$

As I have already established that in equilibrium, along the relevant range of communication costs, it has to be the case that the rental rates of the two Northern cities are equalized, I can write:

$$r_{N1} = r_{N2} = r_N$$

$$\frac{(1-\beta)(1-\mu)Y_s^{N1}}{\overline{N}} = \frac{(1-\beta)(1-\mu)Y_s^{N2} + \mu(1-\alpha)(1-\beta)(1-\mu')Y_s}{\overline{N}}$$

where the latter equation can be re-ordered:

$$Y_s^{N2} = Y_s^{N1} - \mu(1-\alpha)\frac{1-\mu}{1-\mu'}Y_s \tag{1.85}$$

In equilibrium I also have that:

$$r_N = G(\tau) r_{s2}$$

$$\frac{(1-\beta)(1-\mu)Y_s^{N1}}{\overline{N}} = G(\tau)\frac{(1-\beta)(1-\mu)Y_s^{S2} + (1-\beta)Y_u^{S2}}{\overline{N}}$$

where again the latter equation can be simplified and re-ordered:

$$(1-\mu)Y_s^{N1} = G(\tau)[(1-\mu)Y_s^{S2} + Y_u^{S2}] \tag{1.86}$$

Finally, locational equilibrium across Southern cities imposes:

$$r_{S2} = K_1 r_{S1}$$

$$\frac{(1-\beta)(1-\mu)Y_s^{S2} + (1-\beta)Y_u^{S2}}{\overline{N}} = K_1\frac{(1-\beta)Y_u^{S1}}{\overline{N}}$$

where the latter equation can be simplified to:

$$(1-\mu)Y_s^{S2} + Y_u^{S2} = K_1 Y_u^{S1} \tag{1.87}$$

Thus, via the analysis above, I can set up a system of five equations and five unknowns (the unknowns are Y_u^{S1}, Y_u^{S2}, Y_s^{S2}, Y_s^{N1}, Y_s^{N2}, whereas Y_u, Y_s and Y_2 are considered known):

$$\begin{cases} (1-\mu)Y_s^{N1} = G(\tau)[(1-\mu)Y_s^{S2} + Y_u^{S2}] \\ (1-\mu)Y_s^{S2} + Y_u^{S2} = K_1 Y_u^{S1} \\ Y_s^{N1} = Y_s^{N2} + \mu(1-\alpha)\frac{1-\mu}{1-\mu'}Y_s \\ Y_u^{S1} + Y_u^{S2} = Y_u \\ Y_s^{S2} + Y_s^{N1} + Y_s^{N2} = Y_s \end{cases} \tag{1.88}$$

Solving the system of equations above yields the following expressions of the unknowns as a function of Y_2, the global value of urban output:

$$Y_u^{S1} = \frac{(1-\theta)\left[(1-\mu) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]}{[1+(1+2G(\tau))\,K_1]}Y_2 \tag{1.89}$$

$$Y_u^{S2} = \frac{\theta[1+2G(\tau)]K_1 - (1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')]}{[1+(1+2G(\tau))K_1]}Y_2 \tag{1.90}$$

$$Y_s^{S2} = \frac{1}{1-\mu}\frac{(1+K_1)(1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')]Y_2 - 2\theta K_1 G(\tau)Y_2}{1+[1+2G(\tau)]K_1} \tag{1.91}$$

$$Y_s^{N1} = \frac{1}{1-\mu}\frac{K_1 G(\tau)(1-\theta)\left[(1-\mu) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]}{1+[1+2G(\tau)]K_1}Y_2 \tag{1.92}$$

$$Y_s^{N2} = \frac{1-\theta}{1-\mu}\frac{K_1 G(\tau)\left[(1-\mu) - \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right] - \mu(1-\alpha)(1-\mu')(1+K_1)}{1+[1+2G(\tau)]K_1}Y_2 \tag{1.93}$$

Some further useful expressions are:

$$Y_s^{S2} = \frac{1+K_1}{1-\mu}Y_u^{S1} - \frac{1}{1-\mu}Y_u \tag{1.94}$$

$$Y_M^{N2} = \mu(1-\alpha)(1-\theta)Y_2 \tag{1.95}$$

Where the former equation is equivalent to equation (1.90). Finally, I am ready to move to the analysis of the populations of cities, which can be expressed as a ratio of the wage bill of the workers at each location divided by the typical wage. In the South I have:

$$Pop_{S1} = \frac{\beta Y_u^{S1}}{\xi_{1S} p_1} \tag{1.96}$$

$$Pop_{S2} = \frac{\beta Y_u^{S2} + [\alpha\mu + \beta(1-\mu)] Y_s^{S2}}{\xi_{1S} p_1} \tag{1.97}$$

Plugging equations (1.83) and (1.93) into equation (1.97) and simplifying I obtain

$$Pop_{S2} = \frac{\left[\alpha \frac{\mu}{1-\mu}(1+K_1) + \beta K_1\right] Y_u^{S1} - \alpha \frac{\mu}{1-\mu} Y_u}{\xi_{1S} p_1} \tag{1.98}$$

Dividing (1.98) by (1.96) yields

$$\frac{Pop_{S2}}{Pop_{S1}} = \frac{\left[\alpha \frac{\mu}{1-\mu}(1+K_1) + \beta K_1\right] Y_u^{S1} - \alpha \frac{\mu}{1-\mu} Y_u}{\beta Y_u^{S1}} \tag{1.99}$$

Which can be rewritten:

$$\frac{Pop_{S2}}{Pop_{S1}} = \left[\frac{\alpha}{\beta}\frac{\mu}{1-\mu}(1+K_1) + K_1\right] - \frac{\alpha}{\beta}\frac{\mu}{1-\mu}\frac{Y_u}{Y_u^{S1}} \tag{1.100}$$

Differentiating (1.100) with respect to τ I obtain:

$$\frac{\partial \frac{Pop_{S2}}{Pop_{S1}}}{\partial \tau} = -\frac{\alpha}{\beta}\frac{\mu}{1-\mu}\frac{\partial \frac{Y_u}{Y_u^{S1}}}{\partial \tau} \tag{1.101}$$

From (1.83) and (1.89) I obtain the following expression for Y_u / Y_u^{S1}:

$$\frac{Y_u}{Y_u^{S1}} = \frac{\theta[(1+K_1) + 2K_1 G(\tau)]}{(1-\theta)\left[(1-\theta) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]} \tag{1.102}$$

Differentiating (1.102) with respect to τ yields:

$$\frac{\partial \frac{Y_u}{Y_u^{S1}}}{\partial \tau} = \frac{2K_1}{(1-\theta)\left[(1-\theta) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]} G'(\tau) > 0 \tag{1.103}$$

Which implies from equation (1.101) that $\frac{\partial \frac{Pop_{S2}}{Pop_{S1}}}{\partial \tau} < 0$ which proves that along the interval of communication costs of interest ($T_{spec1} < \tau < T_{max}$) a reduction of communication costs is associated with an increase in the relative size of the advanced Southern city $S2$ (i.e. $\tau \downarrow \Rightarrow \frac{Pop_{S2}}{Pop_{S1}} \uparrow$). The proof that a similar development occurs in the North proceeds analogously:

$$Pop_{N1} = \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{N1}}{\xi_{1N} p_1} \tag{1.104}$$

$$Pop_{N2} = \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{N2} + [\mu' + \beta(1-\mu')]\mu(1-\alpha)(1-\theta)Y_2}{\xi_{1N} p_1} \tag{1.105}$$

Making use of (1.88) I can rewrite (1.105) as follows:

$$Pop_{N2} = \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{N1} + \mu(1-\alpha)(1-\theta)\left[\mu' - \alpha\mu\frac{1-\mu'}{1-\mu}\right]Y_2}{\xi_{1N} p_1} \tag{1.106}$$

Dividing equation (1.106) by (1.104) yields:

$$\frac{Pop_{N2}}{Pop_{N1}} = 1 + \frac{\mu(1-\alpha)(1-\theta)\left[\mu' - \alpha\mu\frac{1-\mu'}{1-\mu}\right]}{\alpha\mu + \beta(1-\mu)} \frac{Y_2}{Y_s^{N1}} \tag{1.107}$$

Differentiating (1.107) with respect to τ yields

$$\frac{\partial \frac{Pop_{N2}}{Pop_{N1}}}{\partial \tau} = \frac{\mu(1-\alpha)(1-\theta)\left[\mu' - \alpha\mu\frac{1-\mu'}{1-\mu}\right]}{\alpha\mu + \beta(1-\mu)} \frac{\partial \frac{Y_2}{Y_s^{N1}}}{\partial \tau} \tag{1.108}$$

To establish the sign of the expression above, I employ equation (1.92) to derive an expression for Y_2/Y_s^{N1}:

$$\frac{Y_2}{Y_s^{N1}} = \frac{(1-\mu)[(1+K_1) + 2K_1 G(\tau)]}{K_1 G(\tau)(1-\theta)\left[(1-\mu) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]} \tag{1.109}$$

which can be rewritten by grouping all the terms in parameters into a large constant term CT:

$$\frac{Y_2}{Y_s^{N1}} = CT\left[\frac{1+K_1}{G(\tau)} + 2K_1\right] \tag{1.110}$$

Differentiating the last equation with respect to τ I obtain:

$$\frac{\partial \frac{Y_2}{Y_s^{N1}}}{\partial \tau} = (1 + K_1)CT(-1)\frac{G'(\tau)}{[G(\tau)]^2} < 0 \tag{1.111}$$

Corroborating the result above with equation (1.108) leads to the conclusion that

$$\frac{\partial (Pop_{N2}/Pop_{N1})}{\partial \tau} < 0$$

which completes the proof that along the interval of communication costs covered by result 7, a reduction in communication frictions is associated with an increase in the relative size of the skilled city (city $N2$) also in the North.

I am now ready to move to the results concerning worldwide urbanization. From the identity equating the income of workers with total labor costs, I can write:

$$\begin{aligned}\xi_{1S}L^S + \xi_{1N}L^N = {} & Y_1 + \beta\theta Y_2 + [\alpha\mu + \beta(1-\mu)](1-\theta)Y_2 \\ & + (1-\theta)Y_2\mu(1-\alpha)[\mu' + \beta(1-\mu')]\end{aligned}$$

Noting that the entire world output is used up remunerating labor and land, I can also write the following accounting identity for the global remuneration of labor:

$$\begin{aligned}\xi_{1S}L^S + \xi_{1N}L^N = {} & Y - \theta(1-\beta)Y_2 - (1-\beta)(1-\mu)(1-\theta)Y_2 \\ & - (1-\theta)Y_2\mu(1-\alpha)(1-\beta)(1-\mu')\end{aligned}$$

which can be rewritten to give us the following expression for the price of the traditional good:

$$p_1 = \frac{1}{\xi_{1S}L^S + \xi_{1N}L^N}\left\{Y - (1-\beta)(1-\mu)\left[(1-\mu) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]Y_2\right\} \tag{1.112}$$

Dividing the previous equation by Y I obtain:

$$\frac{p_1}{Y} = \frac{1}{\xi_{1S}L^S + \xi_{1N}L^N}\left\{1 - (1-\beta)(1-\mu)\left[(1-\mu) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]\frac{Y_2}{Y}\right\} \tag{1.113}$$

Differentiating (1.113) with respect to τ yields:

$$\frac{\partial}{\partial \tau}\left(\frac{p_1}{Y}\right) = -(1-\beta)(1-\theta)\left[(1-\mu) + \mu(1-\alpha)(1-\mu') + \frac{\theta}{1-\theta}\right]\frac{\partial}{\partial \tau}\left(\frac{Y_2}{Y}\right) > 0 \tag{1.114}$$

Where the final inequality emerges from the fact that I have already shown in Result 7.3 that $\frac{\partial}{\partial\tau}\left(\frac{Y_2}{Y_1}\right) < 0$ which can be shown to be equivalent with $\frac{\partial}{\partial\tau}\left(\frac{Y_2}{Y}\right) < 0$. Thus I have that $\tau \downarrow \Rightarrow \frac{p_1}{Y} \downarrow \Rightarrow \frac{Y}{p_1} \uparrow \Rightarrow \frac{Y_2}{p_1} \uparrow$.

I am now ready to show that decreases in international communication costs are associated with rising world urbanization. From equation (104) it is clear that I can write, in compact form:

$$Y_s^{S2} = f(\tau)Y_s = f(\tau)(1-\theta)Y_2$$
$$Y_s^{N1} + Y_s^{N2} = [1-f(\tau)]Y_s = [1-f(\tau)](1-\theta)Y_2$$

with the property that $f'(\tau) < 0$. Moving on to computing worldwide urban population I can write:

$$\text{Urban population} = \frac{\beta\theta Y_2}{\xi_{1S}p_1} + \frac{[\alpha\mu+\beta(1-\mu)](1-\theta)f(\tau)Y_2}{\xi_{1S}p_1} + \frac{[\alpha\mu+\beta(1-\mu)](1-\theta)(1-f(\theta))Y_2}{\xi_{1N}p_1} + \frac{\mu(1-\alpha)(1-\theta)[\mu'+\beta(1-\mu')]Y_2}{\xi_{1N}p_1} \tag{1.115}$$

which can be rewritten:

$$\text{Urban population} = \frac{Y_2}{p_1}\left\{\frac{\beta\theta}{\xi_{1S}} + [\alpha\mu+\beta(1-\mu)](1-\theta)\left[\frac{\xi_{1S}+(\xi_{1N}-\xi_{1S})f(\tau)}{\xi_{1S}\xi_{1N}}\right] + \frac{\mu(1-\alpha)(1-\theta)[\mu'+\beta(1-\mu')]}{\xi_{1N}}\right\}$$

Differentiating the previous equation with respect to τ then yields:

$$\frac{\partial}{\partial\tau}(\text{Urban population}) = \frac{\partial\frac{Y_2}{p_1}}{\partial\tau}_{<0}\{\ldots\} + \frac{Y_2}{p_1}\frac{[\alpha\mu+\beta(1-\mu)](1-\theta)}{\xi_{1S}\xi_{1N}}(\xi_{1N}-\xi_{1S})f'(\tau)_{<0} < 0 \tag{1.116}$$

Which completes the proof that along the interval of interest, reductions in communication costs are related to increasing in total urban population, and hence urbanization: $\tau \downarrow \Rightarrow$ World Urban Population $\uparrow \Rightarrow$ World Urbanization $\uparrow$. I am finally ready to discuss the issue of skill polarization across space (within countries) discussed in Result 7. Thus in the South, I aim to sign the expression:

$$\frac{\partial}{\partial \tau}\left(\frac{H_{S2}}{L_{S2}} - \frac{H_{S1}}{L_{S1}}\right)$$

But for stable equilibria along the range of communication costs covered by result 7 I already know that $\frac{H_{S1}}{L_{S1}} = 0$, which yields:

$$\frac{\partial}{\partial \tau}\left(\frac{H_{S2}}{L_{S2}} - \frac{H_{S1}}{L_{S1}}\right) = \frac{\partial}{\partial \tau}\frac{H_{S2}}{L_{S2}}$$

I now derive an expression for $\frac{H_{S2}}{L_{S2}}$:

$$H_{S2} = \frac{\alpha\mu Y_s^{S2}}{\xi_{1S}p_1} \tag{1.117}$$

$$L_{S2} = \frac{\beta(1-\mu)Y_s^{S2}}{\xi_{1S}p_1} + \frac{\beta Y_u^{S2}}{\xi_{1S}p_1} \tag{1.118}$$

$$\frac{H_{S2}}{L_{S2}} = \frac{\alpha\mu Y_s^{S2}}{\beta(1-\mu)Y_s^{S2} + \beta Y_u^{S2}} \tag{1.119}$$

where I can rewrite the last equation:

$$\frac{H_{S2}}{L_{S2}} = \frac{\alpha\mu}{\beta(1-\mu) + \beta\frac{Y_u^{S2}}{Y_s^{S2}}} \tag{1.120}$$

Differentiating the previous equation with respect to τ yields the equation:

$$\frac{\partial}{\partial \tau}\left(\frac{H_{S2}}{L_{S2}}\right) = -\alpha\mu\frac{1}{\left[\beta(1-\mu) + \beta\left(\frac{Y_u^{S2}}{Y_s^{S2}}\right)\right]^2}\frac{\partial\left(\frac{Y_u^{S2}}{Y_s^{S2}}\right)}{\partial \tau} \tag{1.121}$$

Where the sign of the RHS of equation (1.121) is determined by the sign of the last partial derivative. I proceed to evaluate this sign:

$$\frac{Y_u^{S2}}{Y_s^{S2}} = \frac{(1-\mu)\left\{\theta[1+2G(\tau)]K_1 - (1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')]\right\}}{(1+K_1)(1-\theta)\left[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}\right] - \theta(1+K_1)}$$

$$\frac{\partial}{\partial \tau}\left(\frac{Y_u^{S2}}{Y_s^{S2}}\right) = \frac{2(1-\mu)K_1\theta G'(\tau)}{(1+K_1)(1-\theta)\left[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}\right] - \theta(1+K_1)} > 0$$

which implies that $\frac{\partial}{\partial \tau}\left(\frac{H_{S2}}{L_{S2}}\right) < 0$ which shows that along the interval of communication costs covered by result 7, reductions in communication costs are associated with skill polarization across southern cities. Turning our attention to the North I aim to sign:

$$\frac{\partial}{\partial \tau}\left(\frac{H_{N2}}{L_{N2}} - \frac{H_{N1}}{L_{N1}}\right)$$

However, given that $N1$ remains completely specialized in activity s along the entire interval of communication costs that forms the object of result 7 I can write:

$$\begin{aligned}\frac{H_{N1}}{L_{N1}} &= \frac{\frac{\alpha\mu Y_s^{N1}}{\xi_{1N} p_1}}{\frac{\beta(1-\mu)Y_s^{N1}}{\xi_{1N} p_1}} = \frac{\alpha\mu}{\beta(1-\mu)} \\ \frac{\partial}{\partial \tau}\frac{H_{N1}}{L_{N1}} &= 0\end{aligned}$$

which implies I can write:

$$\frac{\partial}{\partial \tau}\left(\frac{H_{N2}}{L_{N2}} - \frac{H_{N1}}{L_{N1}}\right) = \frac{\partial}{\partial \tau}\frac{H_{N2}}{L_{N2}}$$

Focusing on deriving an expression for H_{N2}/L_{N2} I can write:

$$\frac{H_{N2}}{L_{N2}} = \frac{\frac{\alpha\mu Y_s^{N2}}{\xi_{1N} p_1} + \frac{\mu' Y_M}{\xi_{1N} p_1}}{\frac{\beta(1-\mu)Y_s^{N2}}{\xi_{1N} p_1} + \frac{\beta(1-\mu')Y_M}{\xi_{1N} p_1}} \tag{1.122}$$

which can be rewritten:

$$\frac{H_{N2}}{L_{N2}} = \frac{\alpha\mu + \mu' \frac{Y_M}{Y_s^{N2}}}{\beta(1-\mu) + \beta(1-\mu)\frac{Y_M}{Y_s^{N2}}} \tag{1.123}$$

Differentiating the previous equation I obtain:

$$\frac{\partial}{\partial \tau}\frac{H_{N2}}{L_{N2}} = \frac{[\mu'\beta(1-\mu) - \alpha\mu\beta(1-\mu)]\frac{\partial}{\partial \tau}\frac{Y_M}{Y_s^{N2}}}{\left[\beta(1-\mu) + \beta(1-\mu')\frac{Y_M}{Y_s^{N2}}\right]^2} \tag{1.124}$$

Moving to obtain an expression for the final partial derivative above, I can write

$$\frac{Y_M^{N2}}{Y_s^{N2}} = \frac{\mu(1-\alpha)(1-\theta)Y_2}{\frac{1-\theta}{1-\mu}Y_2\frac{K_1G(\tau)\left[(1-\mu)-\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}\right]-\mu(1-\alpha)(1-\mu')(1+K_1)}{1+[1+2G(\tau)]K_1}}$$

which after some manipulations can be rewritten

$$\frac{Y_M^{N2}}{Y_s^{N2}} = \frac{\mu(1-\alpha)(1-\mu)\left[\frac{1+K_1}{G(\tau)}+2K_1\right]}{K_1\left[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}\right]-\mu(1-\alpha)(1-\mu')\frac{1+K_1}{G(\tau)}}$$

From the above equation and the observation that $G'(\tau) > 0$ it is clear that:

$$\frac{\partial}{\partial \tau}\frac{Y_M^{N2}}{Y_s^{N2}} < 0 \tag{1.125}$$

which implies that $\frac{\partial}{\partial \tau}\frac{H_{N2}}{L_{N2}} < 0$ which establishes our final statement from result 7 namely that along the interval of communication costs of interest, reductions in communication costs are associated with skill divergence across Northern cities. (i.e. $\tau \downarrow \Rightarrow \frac{H_{N2}}{L_{N2}} \uparrow \Rightarrow \left(\frac{H_{N2}}{L_{N2}} - \frac{H_{N1}}{L_{N1}}\right) \uparrow$).

In what follows I will move to establish the developments that prevail for the next range of (lower) communication costs, which are described as stage 2 of communication induced globalization. More precisely, I will aim to establish the following result:

Result 8 Along the interval of communication costs given by

$$\underbrace{\left\{\frac{\mu(1-\alpha)(1-\mu')}{(1-\mu)-\mu(1-\alpha)(1-\mu')}\right\}^{\frac{(1-\beta)(1-\mu)}{\mu(1-\alpha)}}\left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{\mu(1-\alpha)}}}_{T_{spec2}} < \tau \leq T_{spec1} \tag{1.126}$$

the unique stable equilibrium involves activity s being produced in locations $\{S2, N1, N2\}$, task u being produced only in Southern location $S1$ while the management services (M) are produced only in $N2$. Moreover, along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities in both countries, skill polarization across Northern cities and divergence in real estate prices across Southern cities, with relatively skilled cities always favored.

Proof: As in the previous result I will focus attention on the comparative static statements contained in Result 8 as the proof of the existence (and uniqueness within the class of stable equilibria) of the configuration described above are analogous to the proof of Proposition 1. Also similarly to Result 7 I need to establish some intermediate results (whose proofs are also analogous to the correspondent intermediate results discussed in result 7

Result 8.1 For $T_{spec2} < \tau < T_{spec1}$ a reduction in communication costs is associated with a decline in the relative price of the urban good (i.e. $\frac{\partial}{\partial\tau}\left(\frac{p_2}{p_1}\right) > 0$)

Proof: Similar to Result 7.1.

Result 8.2 For $T_{spec2} < \tau < T_{spec1}$ a reduction in international communication costs is associated with an increase in world output.

Proof: Similar to Result 7.2.

Result 8.3 For $T_{spec2} < \tau < T_{spec1}$ any reduction in international communication costs is associated with an increase in relative expenditure on the urban good (i.e. $\frac{\partial \frac{Y_2}{Y_1}}{\partial\tau} < 0$)

Proof: Similar to Result 7.3

I now focus on the main statements concerning urbanization and the relative performance of location within countries. Along the interval of communication costs covered by Result 8 stable equilibrium configurations are governed by:

$$\gamma^{\epsilon} p_1^{1-\epsilon} + (1-\gamma)^{\epsilon} p_2^{1-\epsilon} = 1$$

$$p_1 = \frac{w_S^U}{\xi_{1S}} = \frac{w_N^U}{\xi_{1N}}$$

$$p_2 = \left(\frac{p_u}{\theta}\right)^{\theta} \left(\frac{p_s}{1-\theta}\right)^{1-\theta}$$

$$c_{S2}(s) = c_{N1}(s) = c_{N2}(s) = p_s \qquad (1.127)$$

$$c_{S1}(u) = p_u \qquad (1.128)$$

Given the configuration of stable equilibria along this range of communication costs, I can write:

$$Y_u^{S1} = Y_u = \theta Y_2 \tag{1.129}$$

$$r_{S1}\overline{N} = (1-\beta)\theta Y_2 \tag{1.130}$$

$$r_{S2}\overline{N} = (1-\beta)(1-\mu)Y_s^{S2} \tag{1.131}$$

$$r_{N1}\overline{N} = (1-\beta)(1-\mu)Y_s^{N1} \tag{1.132}$$

$$r_{N2}\overline{N} = (1-\beta)(1-\mu)Y_s^{N2} + (1-\beta)(1-\mu')Y_M^{N2} \tag{1.133}$$

Furthermore, from the equation $c_{S2}(s) = c_{N1}(s)$ I obtain (by expanding and simplifying) the equilibrium condition:

$$r_{N1} = G(\tau)r_{S2} \tag{1.134}$$

which given that both locations $S2$ and $N1$ are completely specialized in task s yields the result:

$$Y_s^{N1} = G(\tau)Y_s^{S2} \tag{1.135}$$

From the symmetry of Northern cities coupled with the fact that equilibrium configurations along this range of communication costs involve task s production in both Northern cities I reach the conclusion that, again, we have $r_{N1} = r_{N2} = r_N$. This, coupled with equations (1.132) and (1.133) yields:

$$Y_s^{N1} - Y_s^{N2} = \frac{\mu(1-\alpha)(1-\theta)(1-\mu')}{1-\mu}Y_2 \tag{1.136}$$

Finally, for such configurations we have the accounting identity:

$$Y_s^{S2} + Y_s^{N1} + Y_s^{N2} = Y_s = (1-\theta)Y_2 \tag{1.137}$$

Solving the system of equations generated by equations (1.135), (1.136) and (1.137) yields:

$$Y_s^{N1} = \frac{(1-\theta)Y_2\left[(1-\mu)+\mu(1-\alpha)(1-\mu')\right]}{(1-\mu)\left[2+\frac{1}{G(\tau)}\right]} \tag{1.138}$$

$$Y_s^{S2} = \frac{1}{G(\tau)}Y_s^{N1} = \frac{(1-\theta)Y_2\left[(1-\mu)+\mu(1-\alpha)(1-\mu')\right]}{(1-\mu)\left[2G(\tau)+1\right]} \tag{1.139}$$

Moving to derive expressions for the populations of various locations along stable equilibria for the interval of communication costs of interest, I obtain, for the South:

$$Pop_{S1} = \frac{\beta Y_u^{S1}}{\xi_{1S}p_1} \tag{1.140}$$

$$Pop_{S2} = \frac{[\alpha\mu+\beta(1-\mu)]Y_s^{S2}}{\xi_{1S}p_1} \tag{1.141}$$

Thus the relative size of Southern cities along stable equilibria is then given by:

$$\frac{Pop_{S2}}{Pop_{S1}} = \frac{[\alpha\mu+\beta(1-\mu)]Y_s^{S2}}{\beta Y_u^{S1}} \tag{1.142}$$

Substituting into equation (1.141) the expression in equation (1.139) and noting that $Y_u^{S1} = Y_u = \theta Y_2$ I can write:

$$\frac{Pop_{S2}}{Pop_{S1}} = \frac{1-\theta}{\theta}\frac{[(1-\mu)+\mu(1-\alpha)(1-\mu')]}{2G(\tau)+1}\frac{[\alpha\mu+\beta(1-\mu)]}{\beta(1-\mu)} \tag{1.143}$$

Differentiating the last equation with respect to τ yields

$$\frac{\partial}{\partial\tau}\frac{Pop_{S2}}{Pop_{S1}} = -2\frac{1-\theta}{\theta}\frac{[(1-\mu)+\mu(1-\alpha)(1-\mu')]}{2G(\tau)+1}\frac{[\alpha\mu+\beta(1-\mu)]}{\beta(1-\mu)}G'(\tau) < 0 \tag{1.144}$$

Which completes the proof of the statement that decreasing international communication frictions are associated with an increase in the relative size of the advanced (skilled) city in the South (i.e $\tau \downarrow \Rightarrow \frac{Pop_{S2}}{Pop_{S1}} \uparrow$). Moving to confirm the same statement for the North, I can write:

$$Pop_{N1} = \frac{[\alpha\mu+\beta(1-\mu)]Y_s^{N1}}{\xi_{1N}p_1} \tag{1.145}$$

$$Pop_{N2} = \frac{[\alpha\mu+\beta(1-\mu)]Y_s^{N2}+[\mu'+\beta(1-\mu')]\mu(1-\alpha)(1-\theta)Y_2}{\xi_{1N}p_1} \tag{1.146}$$

Substituting for Y_s^{N2} in (1.146) from (1.136), taking the ratio of the two populations (to assess relative size) and simplifying the expression yields:

$$\frac{Pop_{N2}}{Pop_{N1}} = 1 + \frac{\mu(1-\alpha)(1-\theta)\left[\mu' - \alpha\mu\frac{1-\mu'}{1-\mu}\right]}{\alpha\mu + \beta(1-\mu)} \frac{Y_2}{Y_s^{N1}} \tag{1.147}$$

Differentiating the last equation with respect to τ yields:

$$\frac{\partial}{\partial\tau}\left(\frac{Pop_{N2}}{Pop_{N1}}\right) = \frac{\mu(1-\alpha)(1-\theta)\left[\mu' - \alpha\mu\frac{1-\mu'}{1-\mu}\right]}{\alpha\mu + \beta(1-\mu)} \frac{\partial\frac{Y_2}{Y_s^{N1}}}{\partial\tau} \tag{1.148}$$

To compute the final integral on the RHS above, I write:

$$\frac{Y_2}{Y_s^{N1}} = \frac{Y_2}{\frac{(1-\theta)G(\tau)Y_2[(1-\mu)+\mu(1-\alpha)(1-\mu')]}{(1-\mu)[2G(\tau)+1]}}$$

$$\frac{Y_2}{Y_s^{N1}} = \frac{(1-\mu)\left[2+\frac{1}{G(\tau)}\right]}{(1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')]}$$

$$\frac{\partial}{\partial\tau}\frac{Y_2}{Y_s^{N1}} = -\frac{1-\mu}{(1-\theta)[(1-\mu)+\mu(1-\alpha)(1-\mu')]}\frac{1}{[G(\tau)]^2}G'(\tau) < 0 \tag{1.149}$$

Equations (1.149) and (1.148) combined yield the result that $\frac{\partial}{\partial\tau}\left(\frac{Pop_{N2}}{Pop_{N1}}\right) < 0$ which shows that reductions in communication costs are also associated with an increase in the relative size of skilled cities also in the North.

Similarly to our proof in Result 7 I can show that

$$\frac{\partial}{\partial\tau}\left(\frac{p_1}{Y}\right) = -(1-\beta)(1-\theta)\left[(1-\mu)+\mu(1-\alpha)(1-\mu')+\frac{\theta}{1-\theta}\right] \tag{1.150}$$

$$\frac{\partial}{\partial\tau}\frac{Y_2}{Y} < 0 \tag{1.151}$$

Which leads to the same conclusion as in the case of the previous interval of communication costs studied: $\tau\downarrow\Rightarrow\frac{p_1}{Y}\downarrow\Rightarrow\frac{Y}{p_1}\uparrow\Rightarrow\frac{Y_2}{p_1}\uparrow$.

I can again express Y_s^{S2} as $Y_s^{S2} = f(\tau)Y_s$ and $Y_s^{N1}+Y_s^{N2} = [1-f(\tau)]Y_s$ with $f'(\tau) > 0$.

With the above results in place, I am ready to analyze the statements concerning urbanization contained in Result 8:

$$\text{Urban population} = \frac{\beta\theta Y_2}{\xi_{1S}p_1} + \frac{[\alpha\mu + \beta(1-\mu)](1-\theta)Y_2 f(\tau)}{\xi_{1S}p_1}$$
$$+ \frac{[\alpha\mu + \beta(1-\mu)](1-\theta)[1-f(\theta)]Y_2}{\xi_{1N}p_1} + \frac{\mu(1-\alpha)(1-\theta)[\mu' + \beta(1-\mu')]Y_2}{\xi_{1N}p_1} \tag{1.152}$$

which can be rewritten

$$\text{Urban population} = \frac{Y_2}{p_1}\left\{\frac{\beta\tau}{\xi_{1S}} + [\alpha\mu + \beta(1-\mu)](1-\theta)\left[\frac{\xi_{1S} + (\xi_{1N} - \xi_{1S})f(\tau)}{\xi_{1S}\xi_{1N}}\right]\right.$$
$$\left. + \frac{\mu(1-\alpha)(1-\theta)[\mu' + \beta(1-\mu')]}{\xi_{1N}}\right\} \tag{1.153}$$

Differentiating the previous equation yields:

$$\frac{\partial}{\partial\tau}\text{Urban population} = \underbrace{\frac{\partial\frac{Y_2}{p_1}}{\partial\tau}}_{<0}\{\ldots\} + \frac{Y_2}{p_1}\frac{[\alpha\mu + \beta(1-\mu)](1-\theta)}{\xi_{1S}\xi_{1N}}(\xi_{1N} - \xi_{1S})\underbrace{f'(\tau)}_{<0} < 0 \tag{1.154}$$

Thus I can conclude that along the interval of communication costs covered by result 8 we have that:$\tau \downarrow \Rightarrow$ World urban population $\uparrow \Rightarrow$ World Urbanization $\uparrow$.
Moving the focus of the analysis to the statements concerning the evolution of the skill compositions of various locations (and in particular to the question of skill polarization across locations within countries) I explicitly solve for the skill ratios of Southern locations:

$$\frac{H_{S1}}{L_{S1}} = 0 \tag{1.155}$$

$$\frac{H_{S2}}{L_{S2}} = \frac{\alpha\mu}{\beta(1-\mu)} \tag{1.156}$$

$$\frac{\partial}{\partial\tau}\left(\frac{H_{S2}}{L_{S2}} - \frac{H_{S1}}{L_{S1}}\right) = 0 \tag{1.157}$$

where the latter result highlighting the absence of any movements in the relative skill endowments of Southern locations (either skill polarization or skill convergence across

Southern cities). On the other hand, in the North I have:

$$\frac{H_{N1}}{L_{N1}} = \frac{\alpha\mu}{\beta(1-\mu)} \tag{1.158}$$

$$\frac{H_{N2}}{L_{N2}} = \frac{\alpha\mu + \mu'\frac{Y_M^{N2}}{Y_s^{N2}}}{\beta(1-\mu) + \beta(1-\mu')\frac{Y_M^{N2}}{Y_s^{N2}}} \tag{1.159}$$

$$\frac{\partial}{\partial\tau}\left(\frac{H_{N2}}{L_{N2}} - \frac{H_{N1}}{L_{N1}}\right) = \frac{\partial}{\partial\tau}\frac{H_{N2}}{L_{N2}} \tag{1.160}$$

Differentiating equation (1.159) with respect to τ yields

$$\frac{\partial}{\partial\tau}\frac{H_{N2}}{L_{N2}} = \frac{[\mu'\beta(1-\mu) + \alpha\mu\beta(1-\mu')]\frac{\partial}{\partial\tau}\left(\frac{Y_M^{N2}}{Y_s^{N2}}\right)}{\left[\beta(1-\mu) + \beta(1-\mu')\frac{Y_M^{N2}}{Y_s^{N2}}\right]^2} \tag{1.161}$$

Making use of equations (1.136) and (1.138) and noting that $Y_M^{N2} = \mu(1-\alpha)(1-\theta)Y_2$ I can write:

$$\frac{Y_M^{N2}}{Y_s^{N2}} = \frac{\mu(1-\alpha)(1-\mu)\left[2 + \frac{1}{G(\tau)}\right]}{[(1-\mu) - \mu(1-\alpha)(1-\mu')] - \frac{\mu(1-\alpha)(1-\mu')}{G(\tau)}} \tag{1.162}$$

Differentiating the above expression and signing the resulting expression yields:

$$\frac{\partial}{\partial\tau}\left(\frac{Y_M^{N2}}{Y_s^{N2}}\right) < 0 \Rightarrow \frac{\partial}{\partial\tau}\frac{H_{N2}}{L_{N2}} < 0 \Rightarrow \frac{\partial}{\partial\tau}\left(\frac{H_{N2}}{L_{N2}} - \frac{H_{N1}}{L_{N1}}\right) < 0 \tag{1.163}$$

where the final result shows that along the second stage of communication induced globalization described by result 8, there is still skill divergence in the North.

Finally, shifting the focus of the analysis towards urban land markets, it is easy to see that in the North land prices across cities remain equalized (as they were in the previous stage of globalization) whereas in the South we have:

$$r_{S1}\overline{N} = (1-\beta)\tau Y_2$$

$$r_{S2}\overline{N} = (1-\beta)(1-\mu)Y_s^{S2}$$

$$\frac{r_{S2}}{r_{S1}} = \frac{1-\mu}{\theta}\frac{Y_s^{S2}}{Y_2} = \frac{1-\theta}{\theta}\frac{[(1-\mu) + \mu(1-\alpha)(1-\mu')]}{[2G(\tau)+1]} \tag{1.164}$$

Differentiating equation (1.164) above with respect to τ yields:

$$\frac{\partial}{\partial\tau}\frac{r_{S2}}{r_{S1}} = -\frac{1-\theta}{\theta}\frac{[(1-\mu)+\mu(1-\alpha)(1-\mu')]}{[2G(\tau)+1]^2}2G'(\tau) < 0 \tag{1.165}$$

Where the last result indicates that along the second stage of communication induced globalization, reductions in the cost of international communications are associated with divergence in the rental rates of land across Southern cities, with the advanced (skilled) city $S2$ favored (i.e. $\tau \downarrow \Rightarrow \frac{r_{S2}}{r_{S1}} \uparrow$).
I am now ready to proceed to results covering the third stage of communication induced globalization.

Result 9 Along the interval of communication costs given by

$$\underbrace{\left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha\mu+\beta(1-\mu)}{\mu(1-\alpha)}}\left[\frac{1-\theta}{\theta K_1}(1-\mu)\left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\beta}{1-\beta}}-1\right]^{-\frac{(1-\beta)(1-\mu)}{\mu(1-\alpha)}}}_{T_{ovt}} < \tau < T_{spec2} \tag{1.166}$$

the unique stable equilibrium involves activity s being produced in locations $\{S2, N1\}$, task u being produced only in Southern location $S1$ while the management services (M) are produced only in $N2$. Moreover, along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities in both countries, divergence in real estate prices across cities in both North and South, with relatively skilled cities favored as well as absolute growth in the skilled Northern city $N2$.

Proof: As in the previous result I will focus attention on the comparative static statements contained in Result 8 as the proof of the existence (and uniqueness within the class of stable equilibria) of the configuration described above are analogous to the proof of Proposition 1. Also similarly to Result 7 I need to establish some intermediate results (whose proofs are also analogous to the correspondent intermediate results discussed in result 7

Result 9.1 For $T_{ovt} < \tau < T_{spec2}$ a reduction in communication costs is associated with a decline in the relative price of the urban good (i.e. $\frac{\partial}{\partial\tau}\left(\frac{p_2}{p_1}\right) > 0$)

Proof: Similar to Result 7.1, 8.1.

Result 9.2 For $T_{ovt} < \tau < T_{spec2}$ a reduction in international communication costs is associated with an increase in world output.

Proof: Similar to Result 7.2, 8.2.

Result 9.3 For $T_{ovt} < \tau < T_{spec2}$ any reduction in international communication costs is associated with an increase in relative expenditure on the urban good (i.e. $\frac{\partial \frac{Y_2}{Y_1}}{\partial \tau} < 0$)

Proof: Similar to Result 7.3, 8.3

I now focus on the main statements concerning urbanization and the relative performance of location within countries. Along the interval of communication costs covered by Result 9 stable equilibrium configurations are governed by:

$$\begin{aligned} r_{S1}\overline{N} &= (1-\beta)\theta Y_2 \\ r_{S2}\overline{N} &= (1-\beta)(1-\mu)Y_s^{S2} \\ r_{N1}\overline{N} &= (1-\beta)(1-\mu)Y_s^{N1} \\ r_{N2}\overline{N} &= (1-\beta)(1-\mu')Y_M^{N2} = \mu(1-\alpha)(1-\theta)Y_2(1-\beta)(1-\mu') \\ Y_s^{S2} + Y_s^{N1} &= Y_s = (1-\theta)Y_2 \\ r_{S2}\overline{N} + r_{N1}\overline{N} &= (1-\beta)(1-\mu)(1-\theta)Y \end{aligned} \tag{1.167}$$

Furthermore, it is still the case that:

$$\begin{aligned} r_{N1} &= G(\tau) r_{S2} \\ Y_s^{N1} &= G(\tau) Y_s^{S2} \end{aligned} \tag{1.168}$$

From equations (1.167) and (1.168) above I obtain:

$$Y_s^{S2} = \frac{(1-\theta)}{1+G(\tau)} Y_2 \tag{1.169}$$

$$Y_s^{N1} = \frac{G(\tau)}{1+G(\tau)}(1-\theta) Y_2 \tag{1.170}$$

whereas the value of output produced at the remaining locations, which are not involved in equilibrium in task s production is given by:

$$\begin{aligned} Y_u^{S1} &= Y_u = \theta Y_2 \\ Y_M^{N2} &= \mu(1-\alpha)(1-\theta)Y_2 \end{aligned}$$

With the above in place I am now ready to prove the main comparative static statements. I begin by accounting for equilibrium population in Southern cities:

$$Pop_{S1} = \frac{\beta\theta Y_2}{\xi_{1S}p_1} \tag{1.171}$$

$$Pop_{S2} = \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{S2}}{\xi_{1S}p_1} \tag{1.172}$$

Finding an expression for the relative size of the two southern cities for stable equilibria characterizing the third stage of communication induced globalization I can write:

$$\begin{aligned} \frac{Pop_{S2}}{Pop_{S1}} &= \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{S2}}{\beta\theta Y_2} \\ &= \frac{[\alpha\mu + \beta(1-\mu)]}{\beta\theta}\frac{1-\theta}{1+G(\tau)} \end{aligned} \tag{1.173}$$

Differentiating the last equation with respect to τ yields:

$$\frac{\partial}{\partial\tau}\left(\frac{Pop_{S2}}{Pop_{S1}}\right) = -\frac{[\alpha\mu + \beta(1-\mu)]}{\beta\theta}\frac{1-\theta}{[1+G(\tau)]^2}G'(\tau) < 0 \tag{1.174}$$

which implies that $\tau \downarrow \Rightarrow \frac{Pop_{S2}}{Pop_{S1}} \uparrow$ Similarly for the North I can write:

$$\begin{aligned} Pop_{N1} &= \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{N1}}{\xi_{1N}p_1} \\ Pop_{N2} &= \frac{[\mu' + \beta(1-\mu')]Y_M^{N2}}{\xi_{1N}p_1} \end{aligned}$$

deriving an expression for the relative size of Northern cities from the equations above I obtain:

$$\begin{aligned}\frac{Pop_{N2}}{Pop_{N1}} &= \frac{[\mu' + \beta(1-\mu')]}{[\alpha\mu + \beta(1-\mu)]}\frac{Y_M^{N2}}{Y_s^{N1}} \\ &= \frac{[\mu' + \beta(1-\mu')]}{[\alpha\mu + \beta(1-\mu)]}\left[1 + \frac{1}{G(\tau)}\right]\mu(1-\alpha) \end{aligned} \tag{1.175}$$

Differentiating the last equation yields:

$$\frac{\partial}{\partial\tau}\frac{Pop_{N2}}{Pop_{N1}} = (-1)\frac{1}{[G(\tau)]^2}G'(\tau)\mu(1-\alpha) < 0 \tag{1.176}$$

which again implies that along the range of international communication costs of interest, any reduction of these communication frictions is associated with an increase in the relative size of the skilled city in the North (i.e. $\tau \downarrow \Rightarrow \frac{Pop_{N2}}{Pop_{N1}} \uparrow$). Moving on to discuss the statement about urbanization described in Result 9, note that I can write Y_s^{S2} as $Y_s^{S2} = f(\tau)Y_s$ with $f'(\tau) < 0$ and I can also express worldwide urban population as:

$$\begin{aligned}\text{Urban population} &= \frac{\beta\theta Y_2}{\xi_{1S}p_1} + \frac{[\alpha\mu + \beta(1-\mu)](1-\theta)Y_2 f(\tau)}{\xi_{1S}p_1} \\ &+ \frac{[\alpha\mu + \beta(1-\mu)](1-\theta)[1-f(\theta)]Y_2}{\xi_{1N}p_1} + \frac{\mu(1-\alpha)(1-\theta)[\mu' + \beta(1-\mu')]Y_2}{\xi_{1N}p_1} \end{aligned} \tag{1.177}$$

which can be rewritten

$$\begin{aligned}\text{Urban population} = \frac{Y_2}{p_1}\Bigg\{&\frac{\beta\tau}{\xi_{1S}} + [\alpha\mu + \beta(1-\mu)](1-\theta)\left[\frac{\xi_{1S} + (\xi_{1N} - \xi_{1S})f(\tau)}{\xi_{1S}\xi_{1N}}\right] \\ &+ \frac{\mu(1-\alpha)(1-\theta)[\mu' + \beta(1-\mu')]}{\xi_{1N}}\Bigg\} \end{aligned} \tag{1.178}$$

Differentiating the previous equation yields:

$$\frac{\partial}{\partial\tau}\text{Urban population} = \underbrace{\frac{\partial\frac{Y_2}{p_1}}{\partial\tau}}_{<0}\{\ldots\} + \frac{Y_2}{p_1}\frac{[\alpha\mu + \beta(1-\mu)](1-\theta)}{\xi_{1S}\xi_{1N}}(\xi_{1N} - \xi_{1S})\underbrace{f'(\tau)}_{<0} < 0 \tag{1.179}$$

where the proof that ($\tau \downarrow \Rightarrow \frac{p_1}{Y} \downarrow \Rightarrow \frac{Y}{p_1} \uparrow \Rightarrow \frac{Y_2}{p_1} \uparrow$ (which also establishes the sign of the first partial derivative in equation 1.179 above) is identical to the one undertaken in the proof of Result 7. Thus I can conclude that along the interval of communication costs covered by result 9 we have that:$\tau \downarrow \Rightarrow$ World urban population $\uparrow \Rightarrow$

World Urbanization $\uparrow$.

Unlike previous results, Result 9 also contains a statement concerning the changes in the absolute level of population for the skilled city of the North, city $N2$, which I prove below:

$$Pop_{N2} = \frac{[\mu' + \beta(1-\mu')]Y_s^{N2}}{\xi_{1N}p_1} = \frac{[\mu' + \beta(1-\mu')]\mu(1-\alpha)(1-\mu')Y_2}{\xi_{1N}p_1} \tag{1.180}$$

Differentiating the previous expression with respect to τ yields:

$$\frac{\partial Pop_{N2}}{\partial \tau} = \frac{[\mu' + \beta(1-\mu')]\mu(1-\alpha)(1-\mu')Y_2}{\xi_{1N}} \underbrace{\frac{\partial}{\partial \tau}\left(\frac{Y_2}{p_1}\right)}_{<0} < 0 \tag{1.181}$$

which yields the result that reductions in communication costs along the third stage of communication induced globalization lead to absolute growth in the size of the Northern skilled city (i.e. $\frac{\partial Pop_{N2}}{\partial \tau} < 0$ which is equivalent to $\tau \downarrow \Rightarrow Pop_{N2} \uparrow$).

Result 9 also implies that along the third stage of globalization we should observe a stop of skill divergence across cities, within countries, in both North and South. This is shown below:

$$\begin{aligned}
\frac{H_{S1}}{L_{S1}} &= 0 \\
\frac{H_{S2}}{L_{S2}} &= \frac{\alpha\mu}{\beta(1-\mu)} \\
\frac{H_{N1}}{L_{N1}} &= \frac{\alpha\mu}{\beta(1-\mu)} \\
\frac{H_{N2}}{L_{N2}} &= \frac{\mu'}{\beta(1-\mu')} \\
\frac{\partial}{\partial \tau}\left(\frac{H_{S2}}{L_{S2}} - \frac{H_{S1}}{L_{S1}}\right) &= 0 \\
\frac{\partial}{\partial \tau}\left(\frac{H_{N2}}{L_{N2}} - \frac{H_{N1}}{L_{N1}}\right) &= 0
\end{aligned}$$

Finally, moving to the analysis of movements in the price of land triggered by improving communications:

$$r_{S1}\overline{N} = (1-\beta)\theta Y_2 \tag{1.182}$$
$$r_{S2}\overline{N} = (1-\beta)(1-\mu)Y_s^{S2} \tag{1.183}$$

Computing the ratio of the rental rates of the two southern locations:

$$\begin{aligned}\frac{r_{S2}}{r_{S1}} &= \frac{(1-\beta)(1-\mu)\frac{1-\theta}{1+G(\tau)}Y_2}{(1-\beta)\theta Y_2}\\ &= \frac{1-\theta}{\theta}\frac{1-\mu}{1+G(\tau)}\end{aligned} \tag{1.184}$$

Differentiating the last equation yields:

$$\frac{\partial}{\partial\tau}\left(\frac{r_{S2}}{r_{S1}}\right) = -\frac{1-\theta}{\theta}\frac{1-\mu}{[1+G(\tau)]^2}G'(\tau) < 0 \tag{1.185}$$

which implies that $\tau \downarrow \Rightarrow \frac{r_{S2}}{r_{S1}} \uparrow$. Shifting focus to the North I can write:

$$\begin{aligned}r_{N1}\overline{N} &= (1-\beta)(1-\mu)Y_s^{N1}\\ &= (1-\beta)(1-\mu)(1-\theta)\frac{G(\tau)}{1+G(\tau)}Y_2\end{aligned} \tag{1.186}$$

$$\begin{aligned}r_{N2} &= (1-\beta)(1-\mu')Y_M^{N2}\\ &= (1-\beta)(1-\mu')\mu(1-\alpha)(1-\theta)Y_2\end{aligned} \tag{1.187}$$

Computing the ratio of rental rates for the two Northern cities yields:

$$\frac{r_{N2}}{r_{N1}} = \frac{1+G(\tau)}{G(\tau)}\frac{\mu(1-\alpha)(1-\mu')}{1-\mu} \tag{1.188}$$

differentiating with respect to τ

$$\frac{\partial}{\partial\tau}\left(\frac{r_{N2}}{r_{N1}}\right) = -\frac{\mu(1-\alpha)(1-\mu')}{1-\mu}\frac{G'(\tau)}{[G(\tau)]^2} < 0 \tag{1.189}$$

which yields the conclusion that $\tau \downarrow \Rightarrow \frac{r_{N2}}{r_{N1}} \uparrow$ which completes the proof of the statements contained in Result 9. A similar approach can be used to show that along this stage of international economic integration, rental rates for land rise in absolute terms in three cities $S1$,$S2$ and $N2$.

Result 10 Along the interval of communication costs given by

$$\underbrace{\frac{\left[\frac{\theta}{(1-\mu)(1-\theta)}\right]^{\frac{(1-\beta)(1-\mu)}{\mu(1-\alpha)}} A^{\frac{\beta(1-\mu)}{\mu(1-\alpha)}} \left(\frac{\xi_{1N}}{\xi_{1S}}\right)^{\frac{\alpha}{1-\alpha}}}{\left[1+\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}\right]^{\frac{(1-\mu)(1-\theta)}{\mu(1-\alpha)}}}}_{\tau^*} < \tau < T_{ovt} \tag{1.190}$$

the unique stable equilibrium involves activity s being produced in locations $\{S2, N1\}$, task u being produced only in location $S1$ in the South and location $N1$ in the North while the management services (M) are produced only in $N2$. Moreover, along this interval, any reduction in communication costs is associated with increased urbanization and worldwide GDP, faster increases in Southern GDP, growth in the relative size of advanced cities in both countries, divergence in real estate prices across cities in both North and South, with relatively skilled cities favored as well as the de-skilling of city $N1$ and skill polarization across Northern cities.

Proof: As in the previous results I will focus attention on the comparative static statements contained in Result 8 as the proof of the existence (and uniqueness within the class of stable equilibria) of the configuration described above are analogous to the proof of Proposition 1. Also similarly to Result 7 I need to establish some intermediate results (whose proofs are also analogous to the correspondent intermediate results discussed in result 7

Result 10.1 For $\tau^* < \tau < T_{spec2}$ a reduction in communication costs is associated with a decline in the relative price of the urban good (i.e. $\frac{\partial}{\partial \tau}\left(\frac{p_2}{p_1}\right) > 0$)

Proof: Similar to Result 7.1, 8.1, 9.1.

Result 10.2 For $\tau^* < \tau < T_{spec2}$ a reduction in international communication costs is associated with an increase in world output.

Proof: Similar to Result 7.2, 8.2, 9.2.

Result 10.3 For $\tau^* < \tau < T_{spec2}$ any reduction in international communication costs is associated with an increase in relative expenditure on the urban good (i.e. $\frac{\partial \frac{Y_2}{Y_1}}{\partial \tau} < 0$)

Proof: Similar to Result 7.3, 8.3, 9.3

I now focus on the main statements concerning urbanization and the relative performance of location within countries. Along the interval of communication costs covered by Result 10 stable equilibria are governed by the following key equations:

$$c_{S1}(u) = c_{N1}(u) = p_u$$
$$c_{S2}(s) = c_{N1}(s) = p_s$$
$$c_{N2}(M) = p_M$$

Making use of the above equations, stable equilibria in the fourth stage of globalization (which is characterized by result 10) can be characterized by the following system of equations:

$$Y_u^{S1} + Y_u^{N1} = Y_u \tag{1.191}$$
$$Y_s^{S2} + Y_s^{N1} = Y_s \tag{1.192}$$
$$r_{N1} = \left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}} r_{S1} \tag{1.193}$$
$$r_{N1} = G(\tau) r_{S2} \tag{1.194}$$
$$r_{S2}\overline{N} = (1-\beta)(1-\mu)Y_s^{S2} \tag{1.195}$$
$$r_{N1}\overline{N} = (1-\beta)(1-\mu)Y_s^{N1} + (1-\beta)Y_u^{N1} \tag{1.196}$$
$$r_{S1}\overline{N} = (1-\beta)Y_u^{S1} \tag{1.197}$$

In the remainder of the proof of Result 10 I proceed analogously with the proofs of results $7-9$ above. I first solve the system defined by equations (1.191) to (1.197) in order to find expressions for the value of output produced at each location:

$$Y_u^{S1} = \frac{[\theta + (1-\theta)(1-\mu)]}{1 + \left[1 + \frac{1}{G(\tau)}\right]\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}} Y_2 \tag{1.198}$$

$$Y_u^{N1} = \frac{\theta\left[1 + \frac{1}{G(\tau)}\right]\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}} - (1-\theta)(1-\mu)}{1 + \left[1 + \frac{1}{G(\tau)}\right]\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}} Y_2 \tag{1.199}$$

$$Y_s^{S2} = \frac{\theta + (1-\mu)(1-\theta)}{1-\mu} \frac{\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}{G(\tau) + [1+G(\tau)]\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}} Y_2 \tag{1.200}$$

$$Y_s^{N1} = \left\{(1-\theta)\frac{G(\tau)\left[1 + \left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}\right]}{G(\tau) + [1+G(\tau)]\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}} - \frac{\theta}{1-\mu}\frac{\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}{G(\tau) + [1+G(\tau)]\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}\right\} Y_2 \tag{1.201}$$

Noting the I can write Y_s^{S2} in compact form as $Y_s^{S2} = f(\tau)Y_s$ with $f'(\tau) < 0$ I can rewrite the expressions of the output produced at each location as follows:

$$Y_s^{S2} = f(\tau)Y_s \tag{1.202}$$

$$Y_s^{N1} = [1 - f(\tau)]Y_s \tag{1.203}$$

$$Y_u^{S1} = \frac{1 + \frac{1-\theta}{\theta}(1-\mu)[1-f(\tau)]}{1 + \left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}} Y_u \tag{1.204}$$

$$Y_u^{N1} = \frac{\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}} - \frac{1-\theta}{\theta}(1-\mu)[1-f(\tau)]}{1 + \left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}} Y_u \tag{1.205}$$

Making use of the above notation I proceed to the proof of the main statements of Result 10. Deriving expressions for the equilibrium populations of various locations, I can write:

$$Pop_{S2} = \frac{[\alpha\mu + \beta(1-\mu)]f(\tau)Y_s]}{\xi_{1S}p_1} = \frac{[\alpha\mu + \beta(1-\mu)]f(\tau)(1-\theta)Y_2]}{\xi_{1S}p_1} \tag{1.206}$$

$$Pop_{S1} = \frac{\beta Y_u^{S1}}{\xi_{1S}p_1} = \frac{\beta}{\xi_{1S}p_1}\frac{1 + \frac{1-\theta}{\theta}(1-\mu)[1-f(\tau)]}{1 + \left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}\theta Y_2 \tag{1.207}$$

Computing the relative size of Southern cities in equilibrium:

$$\frac{Pop_{S2}}{Pop_{S1}} = \frac{[\alpha\mu + \beta(1-\mu)]}{\beta}\left[1 + \left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}\right]\frac{(1-\theta)f(\tau)}{\theta + (1-\theta)(1-\mu)[1-f(\tau)]} \tag{1.208}$$

Noting that $f'(\tau) < 0$ it is straightforward to see that differentiating the expression above with respect to τ leads to $\frac{\partial}{\partial\tau}\left(\frac{Pop_{S2}}{Pop_{S1}}\right) < 0$ which proves the statement that reductions in communication costs are associated with increases in the size of the skilled city in the South along the fourth stage of globalization. Moving the discussion to the North:

$$Pop_{N1} = \frac{\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}} - \frac{1-\theta}{\theta}(1-\mu)[1-f(\tau)]}{1 + \left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}\frac{\beta Y_u}{\xi_{1N}p_1} + [1-f(\tau)]\frac{Y_s}{\xi_{1N}p_1}[\alpha\mu + \beta(1-\mu)] \tag{1.209}$$

$$Pop_{N2} = \frac{\mu(1-\alpha)(1-\theta)Y_2[\mu' + \beta(1-\mu')]}{\xi_{1N}p_1} \tag{1.210}$$

Computing the relative size of Northern cities in equilibrium:

$$\frac{Pop_{N2}}{Pop_{N1}} = \frac{\mu(1-\alpha)(1-\theta)[\mu' + \beta(1-\mu')]}{CT_0\beta\theta + [1-f(\tau)](1-\theta)\left\{\beta(1-\mu) + \alpha\mu - \frac{\beta(1-\mu)}{1+\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}\right\}} \tag{1.211}$$

where CT_0 is a constant term that collects parameters. From the expression above it is again straightforward to see that $\frac{\partial}{\partial\tau}\left(\frac{Pop_{N2}}{Pop_{N1}}\right) < 0$ implying that along the fourth stage of (communication induced globalization) reductions in communication costs are associated with increases in the relative size of the skilled city (i.e. $\tau \downarrow \Rightarrow \frac{Pop_{N2}}{Pop_{N1}} \uparrow$)

Moving to discuss the statement concerning worldwide urbanization, in equilibrium I can write:

$$\text{Urban Population} = \frac{\beta Y_u^{S1}}{\xi_{1S}p_1} + \frac{\beta Y_u^{N1}}{\xi_{1N}p_1} + \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{S2}}{\xi_{1S}p_1} + \frac{[\alpha\mu + \beta(1-\mu)]Y_s^{N1}}{\xi_{1N}p_1} + \frac{[\mu' + \beta(1-\mu')]Y_M^{N2}}{\xi_{1N}p_1} \tag{1.212}$$

Substituting for Y_u^{S1}, Y_s^{S2}, Y_u^{N1}, Y_s^{N1}, Y_M^{N2} above and collecting terms yields the expression:

$$\text{Urban Population} = \frac{Y_2}{p_1}\left\{CT_1 + f(\tau)(1-\theta)\left(\frac{1}{\xi_{1S}} - \frac{1}{\xi_{1N}}\right)\left[\alpha\mu + \beta(1-\mu) - \frac{\beta(1-\mu)}{1+\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}\right]\right\} \tag{1.213}$$

Differentiating the previous equation yields:

$$\begin{aligned}\frac{\partial \text{Urban Population}}{\partial \tau} &= \underbrace{\frac{\partial}{\partial \tau}\left(\frac{Y_2}{p_1}\right)}_{<0}\{\ldots\} \\ &+ \frac{Y_2}{p_1}\underbrace{f'(\tau)}_{<0}(1-\theta)\left(\frac{1}{\xi_{1S}} - \frac{1}{\xi_{1N}}\right)\left\{\alpha\mu + \beta(1-\mu) - \frac{\beta(1-\mu)}{1+\left(\frac{A\xi_{1S}}{\xi_{1N}}\right)^{\frac{\beta}{1-\beta}}}\right\} < 0\end{aligned} \tag{1.214}$$

Which completes the proof of the statement that reductions of communication costs are accompanied by increasing worldwide urbanization along the fourth stage of (communication induced) international economic integration.

The proofs concerning the presence of skill polarization across cities in the North (with city $N1$ actually experiencing de-skilling), as well as continued land price divergence across locations in both North and South are straightforward and similar to the ones in the previous results and are hence omitted. Furthermore, it can be shown that along the fourth stage of globalization, reductions in communication frictions are guaranteed to be accompanied by growth in the levels of population in cities $S2$ and $N2$, as well as their respective absolute rental rates (proofs available on request).

Result 11 Along the interval of communication costs given by

$$1 < \tau < \tau^* \tag{1.215}$$

the unique stable equilibrium involves activity s being produced in the advanced Southern city $S2$, task u being produced only in locations $S1$ and $N1$, while management services (M) are produced only in $N2$. Moreover, along this interval, any reduction in communication costs does not generate any spatial reallocation of activities across cities, such that divergence in skill shares and land prices across cities cease. However, urbanization continues, and reductions in communication costs are associated with proportionate growth in all cities (i.e. the relative size and land prices between any two cities remain constant).

Proof: Similar to Results $7-10$ above. The configuration of the world economy reached a “costless communication” steady state, where there are no further reallocation of market share in any sector across locations, and as such the relative size of cities, their relative rental rates and their skill shares remain constant. However, reductions in communication costs still affect the urban-rural margin, and as a result urbanization continues, and the world economy continues to grow. However all cities grow at the same rate.

Results $7-11$ jointly imply that the statements contained in propositions $2-6$ in the main body of chapter 1 are correct (proof of these results is equivalent to joint proof of propositions $2-6$), and also reflect that stages 1 to 5 discussed in the main text offer a correct and complete description of the evolution of worldwide economic geography as international communication costs decline.

1.8 Appendix C: Robustness and Generality of Results

In this section I briefly discuss the robustness of the predictions of my theory to changes in the modelling specification and assumptions. In particular I stress which of the model's parametric restrictions are crucial for the results obtained above and which can be relaxed without notable changes to the qualitative predictions of the theory.

Among the parameter restrictions of the model contained within Assumptions 1 to 5, only Assumptions 2 and 3 are essential for the central results derived in sections 1.3 and 1.4. Thus, for the broad predictions of the model to come to pass, I require that the management services sector is subject to agglomeration economies that are sufficiently strong to encourage the clustering of the entire sector in only one city and that the productive conditions in the two countries are such that below a certain threshold of communication costs the South becomes competitive in skilled urban production. If these assumptions are met the model delivers the result that for some interval of international communication costs, reductions in communication frictions are associated with increases in urbanization, North-South convergence and divergence between cities within countries (in terms of population, land prices and/or skill shares).

However, some of the more detailed predictions of the model also depend on the other parameter restrictions I imposed in my analysis. For instance, the theory predicts persistent divergence among Southern cities along the entire path of international economic integration. This result hinges on Assumption 4 which ensures that infrastructure is sufficiently important for skilled manufacturing such that the infrastructure scarce Southern location $S1$ can never become a suitable location for this activity. Should this assumption be relaxed, then a phase of urban divergence across Southern locations of the type described above would be followed by a phase of urban convergence when the backward Southern city also begins to attract skilled manufacturing[28]. It is important to note that relaxing Assumption 4 is likely to make the urban divergence results in the North stronger, as any relative increase in the production possibilities of the South (and eliminating a constraint on city $S1$ would represent such an increase) expands the scope for it to capture a greater proportion of global value chains, and as a result increases the vulnerability of the unskilled Northern city to Southern competition.

[28]Another feature of the model that is important in determining the path of economic geography in the South is the asymmetry in infrastructure endowments between Southern cities. This assumption is realistic and presents substantial benefits in terms of tractability.

The remaining parametric restrictions, Assumption 1 and Assumption 5 are imposed in order to improve tractability (Assumption 1) and keep the analysis parsimonious (Assumption 5). Relaxing the latter assumption is straightforward and can be shown to have no impact on the main qualitative results reported in the previous two sections. Assumption 1 may also be relaxed in an expanded framework. Such a setup would lose analytical tractability but would yield similar results.

Among the other features of the model, one that is important in underpinning our urbanization growth result (though not our urban divergence results) is the greater than unity elasticity of substitution between the traditional and the urban goods. This assumption represents a simple way of embedding into the model the realistic feature that as globalization and development proceed, a greater fraction of worldwide expenditure is spent on advanced urban goods. An alternative way of implementing the same feature would have been the introduction of non-homothetic preferences. With non-homothetic preferences and the designation of the urban intermediate as the "advanced good" globalization also leads to an increase in the expenditure share for urban goods as it increases income levels.

Finally, while in this chapter I have focused on the role of communication technologies, a careful analysis of the main mechanism of my model reveals that the theory is amenable to substantial generalization. Thus, under the condition that some essential assumptions of the model are maintained (i.e. the ranking of sectors by skill intensity and by the strength of agglomeration/localization economies match or are strongly positively correlated; the North has comparative advantage in the production of advanced and skill intensive activities) any mechanism that leads to the relocation of some "middle skill" activities from the North (where they represent the least skilled pre-globalization activities) to the South (where they in turn represent the most skilled activities), can produce similar results. Alternative mechanisms that can produce the type of North-South relocation of stages of production present in my model include North-South technological transfer, North-South capital mobility, FDI or Southern TFP growth due to institutional reforms.

1.9 Appendix D: Figures

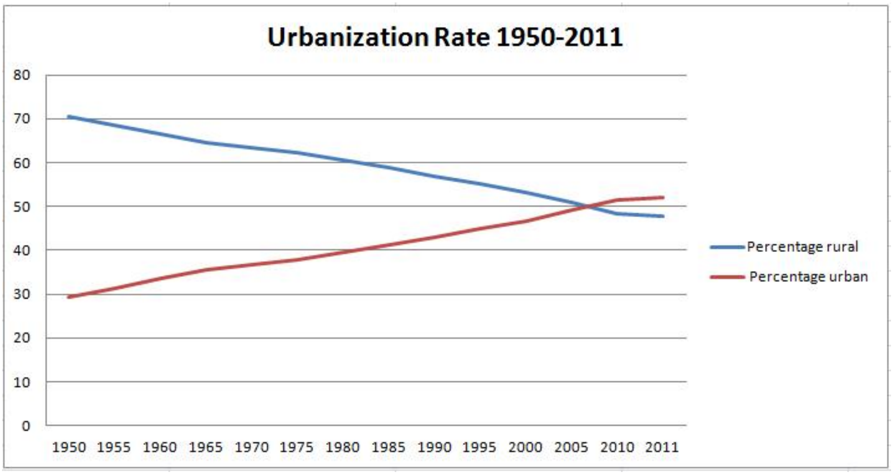

Figure 1.6: Evolution of Worldwide Urbanization 1950-2011

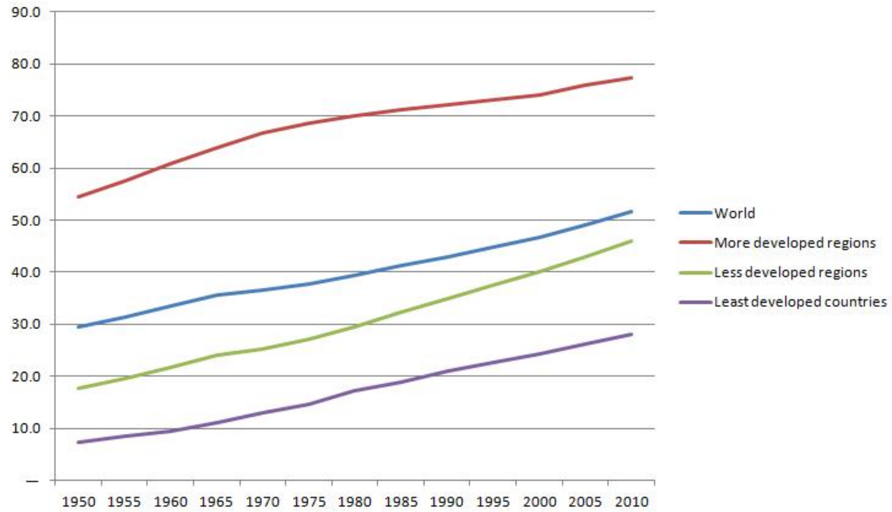

Figure 1.7: Evolution of Urbanization in Regions of Various Levels of Development 1950-2010

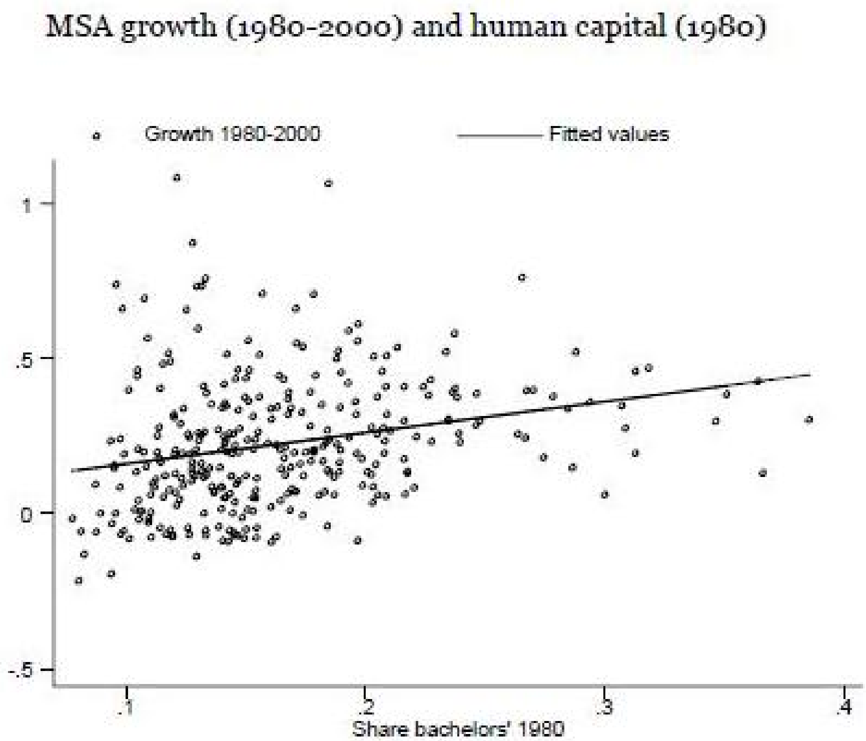

Figure 1.8: Skills and City Growth

Source - Glaeser and Saiz (2004)

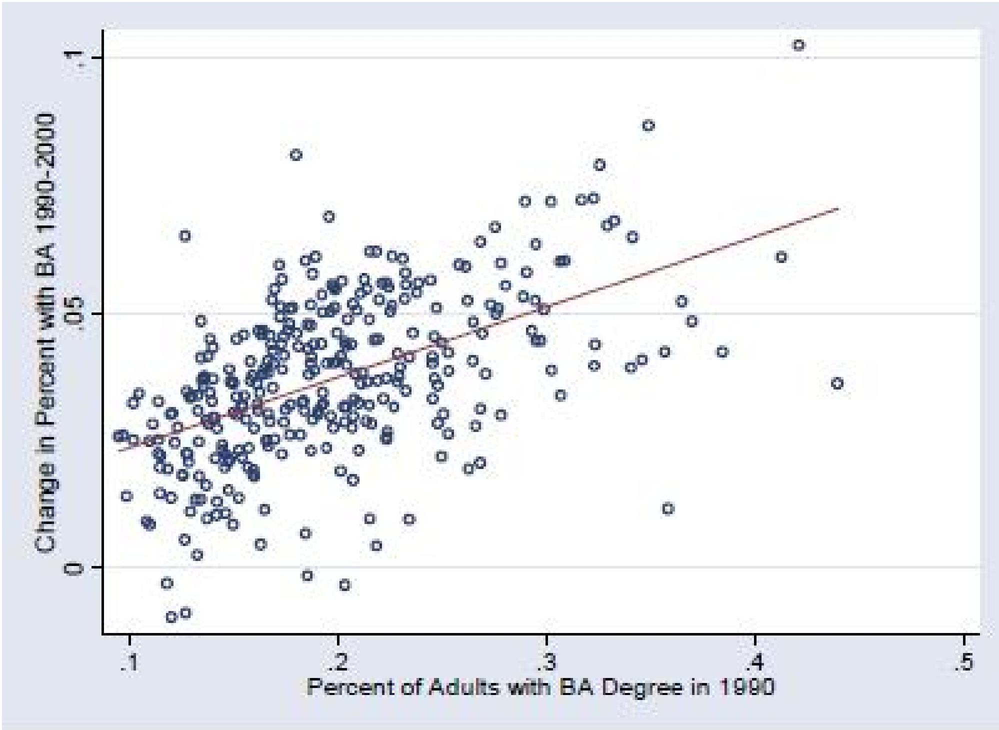

Figure 1.9: Skill Divergence Across US MSAs

Source: Berry and Glaeser(2005)

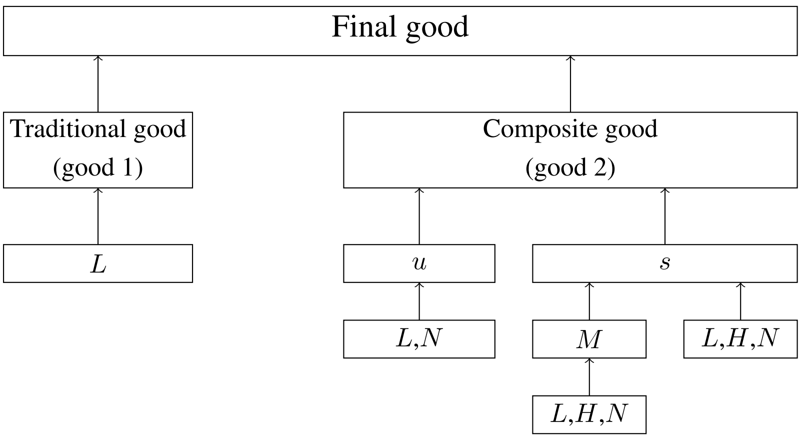

Figure 1.10: Structure of Production

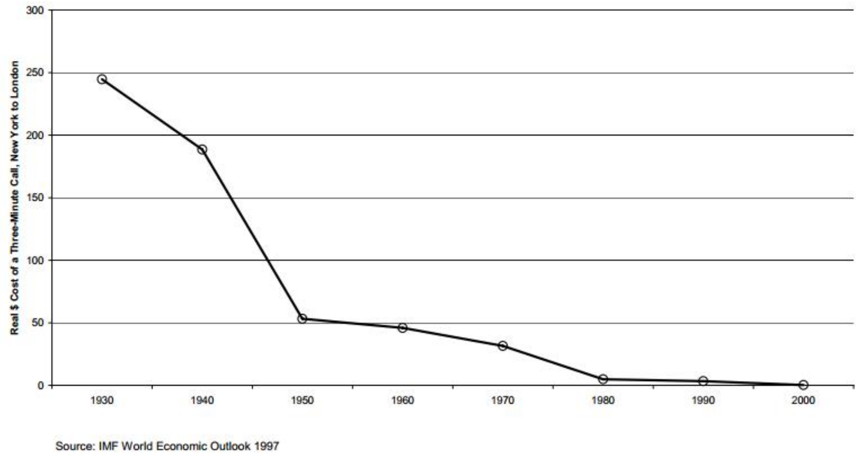

Figure 1.11: Secular Decline in Communication Costs

Figure 1.12: Investment Cost and Rates for Three Minute International Calls

Chapter 2

TRADE LIBERALIZATION AND ECONOMIC DEVELOPMENT: EVIDENCE FROM CHINA'S WTO ACCESSION

Joint with Wenya Cheng, University of Manchester

2.1 Introduction

China's integration into the world economy has been one of the defining economic events of the past three decades. Between 1990 and 2010 China's exports at current prices expanded almost 35-fold while the world's share of imports from China increased from 2 to 11 percent. The liberal international trading environment of recent decades and China's integration into the institutions of world trade, most notably the World Trade Organization (WTO), likely played a role in its trading success (Ghosh and Rao 2010). Much of China's export boom took place after its WTO accession in 2001, with China's export to GDP ratio expanding from 20% to more than 36% between 2001 and 2007.

Most of the existing literature has analyzed China's integration into the world economy through the prism of its trading partners. Chinese import competition has been particularly explored: a number of studies have identified negative effects on import competing industries and regions in both developed and developing economies (Autor, Dorn and Hanson 2013; Costa, Garred and Pessoa 2015; Pierce and Schott 2015). However, the impact of trade integration on China itself is of equal consequence. As it integrated into the world economy, China experienced sustained rapid economic growth, structural transformation, and the largest episode of rural-to-urban migration ever recorded. Given the size of China's economy and the magnitude of its international trade, the effects of integration into the world economy on China itself may be quantitatively important from a global perspective. Moreover, if the trade regimes of China's main trading partners during this period played a role in its exporting and overall economic success, any assessment of the global welfare impacts of these policies needs to take into account their effect on economic outcomes in China.

In this chapter, we study the effects of improvements in foreign market access caused by China's WTO accession on Chinese local economies. We focus our analysis on cities because they represent integrated local economies and labor markets. We relate changes in local economic outcomes from 1998 to 2007 across Chinese cities to changes in their foreign market access. Identifying variation emerges from two sources. First, cities differ in their initial industry specialization. Second, China's WTO membership improved its access to US markets, and the magnitude of this US trade liberalization exhibits plausibly exogenous variation across industries (Pierce and Schott 2015).

Chinese local economies display substantial variation in sectoral composition. The share of local employment in manufacturing ranges from 26% in the bottom quartile to more than 43% in the top quartile. Within manufacturing there is also broad geographic variation in sectoral specialization, and many manufacturing sectors display a high degree of spatial concentration. For example, in 1998, 32% of employment in "Ovens and furnaces", 38% of employment in "Industrial process control equipment" and 31% of "Sports goods" employment was concentrated in just 3 cities while the share of local employment in "Games and Toys" across cities ranged from 0% to 17.4%. Following Bartik's (1991) approach we construct city-level measures of improvements in foreign market access as the average of sector-level market access improvements weighted by each industry's initial share of total employment in the city. By construction, our measure of city-level trade liberalization varies with the relative size of the local manufacturing sector and with the relative importance of different industries within manufacturing.

As Chinese cities display great variation in the composition of manufacturing and WTO accession was associated with significant variation in the intensity of trade liberalization across sectors, differences in the composition of local manufacturing account for about 70% of the variation of our measure of improvements in access to foreign markets at the local level.

Our identification strategy relies on a source of exogenous cross-industry variation in the benefits of WTO membership first highlighted by Handley and Limao (2015) and Pierce and Schott (2015). WTO membership brought about a meaningful improvement in China's access to foreign markets even though it was not associated with a substantial reduction in the tariffs applied to Chinese exports by major trading partners. In particular, the level of expected tariffs and the dispersion of the tariff distribution faced by Chinese exporters to the US both declined sharply.[1] This was because membership of the WTO triggered the award of permanent Most Favored Nation (MFN) status by the US to China, which substantially lowered the likelihood that the trading environment between the two countries would deteriorate sharply.

WTO membership eliminated the threat that the US would revert to imposing the punitive Smoot-Hawley tariff schedule on Chinese exporters. Before WTO accession, China's Most Favored Nation status and its associated low tariffs were subject to annual renewal in the US Congress. Discussions on this topic were often politically contentious. While Congress never failed to renew China's Most Favored Nation status, the likelihood of non-renewal was perceived as significant and economic agents in both countries cited it as an important barrier to bilateral trade. WTO accession permanently set US tariffs on Chinese goods at low MFN levels. Crucially, the Smoot-Hawley tariff schedule that would have prevailed if China's MFN status had not been renewed displayed broad variation in tariffs across different product categories. This implies that elimination of the threat of MFN non-renewal was much more consequential for some products and sectors than others and resulted in significant cross-industry variation in US market access improvements brought about by WTO membership.

The most important feature of this change in US trade policy is its plausible exogeneity to economic conditions in China at the beginning of the twenty-first century.

[1] In the existing literature (Handley and Limao 2012; Handley 2014; Handley and Limao 2014; Pierce and Schott 2015), declines in expected tariffs and reductions in the dispersion of the tariff distribution are typically bundled together and described as reductions in "Trade Policy Uncertainty".

Most (eighty nine percent) of the variation in US market access improvements at the product level come from variation in the Smoot-Hawley tariff schedule, which was set 70 years prior to China's WTO accession. This effectively rules out any simultaneity concerns that may have arisen if the specifics of the trade policy change were influenced by considerations pertaining to China's comparative advantage and recent economic performance.

Moreover, the improvement in market access caused by permanently fixing tariffs at the low levels applicable to WTO members had an important effect on China's subsequent export activity, as prior work has established (Handley and Limao 2015; Pierce and Schott 2015). This ensures that the US trade policy reform we rely on for identification indeed represented a significant positive shock for Chinese manufacturing sectors. Our identifying variation comes from changes in US trade policy resulting from China's WTO accession, which means we are only able to study the impact of improvements in access to US markets over this period. However, given the US's status as China's largest trading partner (accounting for 19% of China's exports and 8% of its imports), the improvement in US market access we analyze likely had an important contribution to the overall foreign market access improvements experienced by China over this period.

We are, to the best of our knowledge, the first to causally identify the effect of foreign trade liberalization on local economies in China. Our focus on the analysis of local economies allows us to make several contributions to the existing literature. First, it allows us to deliver a more complete assessment of the effects of trade liberalization on economic outcomes in China. We are able to study not only the effects of US market access improvements on the local tradable sector, but also the transmission of these effects to the local non-tradable sector. Moreover, our methodology allows us to assess the importance of local spillovers and agglomeration forces within the tradable sector in shaping the overall magnitude of the reform's impact on China's urban economies. Second, detailed firm level data allow us to explore the specific channels of spillover transmission. Finally, studying city-level outcomes offers an answer to the difficulty of mapping industry-specific trade shocks into aggregate outcomes. Looking at country-level quantities creates a degrees-of-freedom problem because there are few observations and many potential confounds. Our focus on differences across cities solves this problem by increasing the number of observations available for study.

We find that WTO accession had substantial positive effects on Chinese local economies. Cities that experienced greater improvements in US market access display faster population, employment and output growth. However, we find no effects of trade liberalization on local wage growth. Our findings are consistent with a simple theoretical framework in which low frictions to geographic mobility and an abundant reserve of rural labor (in the spirit of Lewis 1954) imply that cities most affected by trade liberalization adjust to this positive shock by drawing labor from the surrounding hinterland.

The estimated effects of WTO accession on local economies are large. In our preferred specification, moving a city from the 25th to the 75th percentile of exposure to US trade liberalization is associated with an 11% increase in city population, a 12% gain in city GDP and a 23% increase in broad employment at the city level between 1998 and 2007. Back of the envelope calculations based on our estimates indicate that US trade liberalization can account for up to half of the population growth and three quarters of the manufacturing employment growth recorded by the average Chinese city between 1998 and 2007.

We also study the impact of improvements in access to foreign markets on several other economic outcomes at the city and the (spatially coarser) prefecture levels.[2] Our results indicate that local economies that benefit from greater improvements in market access experience an acceleration of investment activity in the period following WTO accession. Part of the growth in investment activity in these locations is financed via increasing FDI inflows. The number of local exporters also rises. Suggestive evidence indicates that the value of exports and the number of firms in these locations also increase.

We find that local spillovers had an important contribution to the overall effect of US market access improvements on local economies. Our analysis of employment across broad sectors reveals that improvements in market access have the largest impact on the (tradable) manufacturing sector. However, WTO accession also has an important impact on local (non-tradable) services. The impact of improvements in US market access for the service sector is more than half as large as for the tradable sector. Given that at the start of our period of analysis the tradable sector accounts for a somewhat larger share of employment in the typical Chinese city than services, our estimates indicate that for each two local manufacturing jobs created or saved by improvements in market access, an additional job is created or saved in the local service sector. This local multiplier is

[2] A prefecture is an administrative unit that includes a main city and its hinterland.

markedly lower than that found by Moretti (2010) for the US, but is nevertheless sizable.

In light of this finding we conduct a detailed analysis of local spillovers from the reform. First, we focus on the effects of market access improvements within the tradable sector. Exploiting our detailed firm-level data we relate outcomes across prefecture-industry cells to US market access improvements affecting co-located sectors. We find that the typical local manufacturing sector benefits across a broad range of performance metrics from being co-located with other sectors that experience important improvements in market access, even when controlling for measures of own-sector US trade liberalization caused by WTO accession.

These within-manufacturing spillovers are large. For the "average" manufacturing sector located in a city with average characteristics, a back of the envelope calculation based on our preferred estimates indicates that only about 40% of the effect of WTO accession on local employment can be attributed to own-sector market access improvements, while the rest is due to local spillovers. Building on the work of Ellison, Glaeser and Kerr (2010) we also study the channels through which local spillovers within manufacturing are transmitted. We find that spillovers transmitted via labor market linkages account for virtually the entire effect of within-manufacturing spillovers identified in our setting.

In the second part of our local spillover analysis we further investigate the transmission of the effects of WTO accession to the non-tradable sector. We first confirm that demand linkages from the tradable to the non-tradable sector were an important avenue for the transmission of the trade liberalization shock. Tertiary sector employment grew faster in cities with a higher exposure to manufacturing sectors that both experienced important improvements in US market access and were heavy users of services in their input mix. We then proceed to explore which non-tradable activities stood to benefit the most from WTO membership. We find that improvements in market access had broad-based effects on the local non-tradable sector and entailed substantial benefits for most service sectors, including finance, education, government and catering services.

We complete our study of local spillovers from the tradable to the non-tradable sector with a more in-depth analysis of the financial sector. Results concerning the impact of the reform on the financial sector are of particular interest since, when coupled with our findings on local investment, they raise the prospect of an investment- financial development channel in the transmission of the trade shock to local economies. In this interpretation, improvements in market access bring about an increase in investment demand in affected locations, and the local financial sector expands in response. We provide additional evidence supporting the operation of this channel by verifying that financial sector growth was more rapid in cities displaying higher exposure to financially dependent sectors. Using the standard Rajan and Zingales (1998) measure of financial dependence we construct a city-level index of financial dependence. Consistent with an investment-financial development channel, we find that improvements in US market access are, ceteris paribus, associated with larger increases in financial sector employment and in the city-level stock of debt in locations where manufacturing is more financially dependent.

Our findings of high local labor supply elasticities and significant migration in response to WTO accession stand in contrast with the results of much of the existing literature that analyzes the effect of trade shocks on local labor markets (Topalova 2007, 2010; Autor, Dorn and Hanson 2013; Kovak 2013). Moreover, our findings are perhaps surprising given the continued importance of the Chinese *hukou* (or household registration) system during our period of analysis. We provide a brief discussion of the potential drivers of our results and put forward two explanations for why local labor supply elasticities may be high in our setting: (1) particularities of China with respect to labor supply abundance; (2) the nature of the shock under analysis, which differs substantially from those studied in previous work. Existing work mostly focuses on negative, import-competition shocks, while we analyze a positive market-access shock induced by trade policy.

China displays a number of unique features during our period of analysis. The literature analyzing China's labor markets concludes that at least until very recently the Chinese economy has indeed operated in a Lewis (1954)-type regime, in which the abundance of cheap migrant labor from rural areas has limited wage growth and has fueled the growth of the export sector (Yao 2010; Chan 2012).[3] Furthermore, in spite of the strictures of the *hukou* system, China has experienced the largest rural to urban migration in history over the last three decades (Chen, Jin and Yue 2010).

The second potential explanation for the high local labor supply elasticities we find

[3]In fact, the debate about whether or not China has reached the "Lewis Turning Point" continues even today.

in our setting relates to the sign of the shock we analyze. Unlike most prior studies, we study the impact of a positive trade shock on local labor markets. As Glaeser and Gyourko (2005) noted, housing (and implicitly labor) supply elasticities are likely to be much higher in the face of positive shocks than in the face of negative shocks because housing is a durable good. This asymmetry in housing supply elasticities to different types of shocks may in turn help account for the differences between our findings and those of prior work.

To shed additional light on the drivers of our results on population and employment we make use of data at multiple levels of spatial aggregation to study migration patterns. We find that most migration in response to trade liberalization takes place within prefectures, consistent with the fact that the *hukou* system imposes fewer restrictions on within-prefecture migration (Baum-Snow et al. 2015). By contrast, migration across prefectures is limited. These results indicate that the constraints of the *hukou* system are important, but were likely not binding in our setting. Cities had access to sufficient labor in their immediate hinterlands to be able to absorb the trade shock without a sharp increase in local wages. Our results from these checks also indicate that some but not all of the economic effects of market access improvements we detect at the city level reflect within-prefecture reallocation of economic activity towards central cities.

The rest of this chapter is structured as follows. Section 2.2 relates the present study to the existing literature. Section 2.3 outlines our methodology and data sources, while Section 2.4 reports and discusses our results on the local economic effects of WTO accession. Section 2.5 analyzes the contribution of local spillovers to the overall effects of US trade liberalization on local economies in China. Section 2.6 discusses our finding of large local labor supply elasticities. Section 2.7 assesses whether improved access to US markets had heterogeneous effects on cities with different initial characteristics. Section 2.8 implements a series of robustness checks and alternative specifications to address a series of concerns about omitted variable bias, measurement and data quality that may affect our baseline analysis. Section 2.9 provides concluding remarks.

2.2 Related Literature

This chapter contributes to several strands of existing literature. The first is the literature analyzing China's integration into the world economy, with a focus on the episode of China's entry into the WTO. Much of the work in this strand of literature focuses on the effects of China's entry into the world trading system on its trading partners (Bloom, Draca and Van Reenen 2015; Bloom, Romer, Terry and Van Reenen 2015; Di Giovanni, Levchenko and Zhang 2014; Amiti and Khandelwal 2011; Andersen, Barslund, Hansen, Harr and Jensen 2013; Rumbaugh and Blancher 2004; Walmsley, Hertel and Ianchovichina 2001) though some studies also focus on the effects on China itself (Brandt, Van Biesenbroeck, Wang and Zhang 2012; Khandelwal, Schott and Wei 2012; Ianchovichina and Martin 2004).

Moreover, the current study also fits into a closely related but conceptually broader literature that analyzes the effects of WTO membership and accession on trade and broader economic outcomes (Rose 2004a; Rose 2004b; Subramanian and Wei 2007; Tomz, Goldstein and Rivers 2007; Liu 2009; Rose 2010; Dutt, Mihov and Van Zandt 2013; Grant and Boys 2012; Staiger and Tabellini 1999; Li and Wu 2004; Tang and Wei 2009)[4]. Our chapter provides additional evidence that WTO accession (and other episodes of trade liberalization) may have an important impact on trade flows and on economic development in new member countries. Furthermore, our results provide a cautionary note that the magnitude of effective trade liberalization may be large and corresponding economic benefits substantial even in settings in which traditional metrics of trade barriers (such as tariffs or NTBs) remain largely unchanged.

We also contribute to the body of work in labor, trade, and development economics that assesses the local labor market effects of trade liberalizations and other trade related shocks (Borjas and Ramey 1995; Chiquiar 2008; Topalova 2007, 2010; McCaig 2011; Kovak 2013; Autor, Dorn and Hanson 2013; Fukase 2013; Costa, Garred and Pessoa 2014; Dix-Carneiro 2014; Dix-Carneiro and Kovak 2015)[5]. Relative to this literature contribute the analysis of a novel type of trade policy shock represented by changes in tariff expectations and in the dispersion of the distribution of potential tariffs. This type of reform is likely to be of increasing interest to researchers given the changing nature of modern trade agreements. These tend to increasingly emphasize issues such as in-

[4]For a review of the literature on the economic impacts of WTO accession and membership see Anderson (2014).

[5]In turn, this strand of literature can be seen as part of a wider body of work on local economic dynamics due to local exogenous shocks. Other, non-trade related papers in this literature include Black et al. (2005), Moretti (2010), Chodorow-Reich et al (2012), Wilson (2012), Shoag (2012), Serrato and Windenger (2014) and Zou (2015).

vestment and intellectual property protection relative to traditional considerations like tariffs and other trade protections, which is unsurprising given the reduced magnitude and diminished role of the latter.

This chapter also adds to the emerging literature on trade policy uncertainty (Handley and Limao 2012,2014; Handley 2014; Pierce and Schott 2015; Limao and Maggi 2015; Feng, Li and Swenson 2014). This literature has focused on industry-level effects of reductions in expected tariffs and in the dispersion of potential tariffs and has mainly investigated outcomes in developed countries, particularly the US. To the best of our knowledge, we are the first to employ a local economies approach to study the implications of improvements in market access brought about by reductions in trade policy uncertainty. Our approach is complementary to that of existing work. It also allows us to study the contribution of local spillovers to the overall impact of trade liberalization on economic outcomes in China.

An additional contribution of this chapter in the context of the trade policy uncertainty literature is its focus on a major developing country experiencing a positive shock to its foreign market access as a result of a reduction in trade policy uncertainty. Most of the existing literature has focused on assessing the effects of import competition, spurred by reductions in trade policy uncertainty, on developed country outcomes.

Finally, our study is also related to the broader literatures on investment under uncertainty (Bernanke 1983; Dixit 1989; Bloom et al. 2007; Roberts and Tybout 1997; Impullitti et al 2013) and economic policy uncertainty (Rodrik 1991; Baker et al. 2013.) as well as to the literature assessing the effects of international trade integration on intra-country economic geography (Krugman and Livas Elizondo 1996; Paluzie 2001; Monfort and Nicolini 2001; Behrens, Gaigne, Ottaviano and Thisse $2006a$, $2006b$, 2007, 2009; Overman and Winters 2011).

2.3 Methodology and Data

Our main focus is on assessing the causal impact of improvements in foreign market access brought by China's WTO accession on Chinese local economies. We estimate specifications of the type:

$$y_{ct} = \alpha + \beta TradeLib_{ct} + \gamma_t + \delta_c + \epsilon_{ct} \tag{2.1}$$

where y_{ct} is a measure of local economic outcomes and $TradeLib_{ct}$ is a measure of local exposure to foreign trade liberalization. This empirical approach has the advantage that it allows us to study the total effects of foreign trade liberalization on economic outcomes in China, inclusive of indirect effects that stem from the transmission of the trade shock to the non-tradable sector and of any amplification (dampening) effects caused by local spillovers (i.e., agglomeration or congestion forces).

Our focus on local economies also brings with it a complication that stems from the geographic mobility of factors in a within country setting. In this context, it becomes unclear which set of local economic outcomes are most relevant for capturing the economic effects of improvements in foreign market access. To clarify matters, before discussing our empirical strategy we provide a brief theoretical discussion of the expected local effects of trade liberalization. A more formal treatment is provided in the Appendix of this chapter.

2.3.1 Theoretical Discussion

Imagine a national economy (China) composed of N local economies or cities. Production in this economy takes place in multiple (S) sectors. Cities are heterogeneous in their sectoral specialization. This heterogeneity may stem from multiple sources. It may result from differences in local natural advantage (i.e. extractive industries and related activities tend to locate close to mineral resources). Alternatively, it may stem from agglomeration forces and path dependence, with a particular industry locating in a particular region "by accident" and remaining there due to agglomeration economies. This distinction notwithstanding, the simplest formalization of heterogeneity in sectoral specialization across cities is provided by a specific factors model, in which each sector requires a sector specific factor in its production function and there is an exogenous geographic distribution of specific factors across space.

In this chapter we study a set-up in which, initially, foreign trade restrictions impose sector specific trade barriers given by $\{b_1, b_2, \ldots, b_S\}$, which are eliminated upon China's entry into the WTO. This results in positive trade shocks that are heterogeneous across sectors, with industries that faced higher initial foreign trade barriers standing to benefit more, ceteribus paribus, from WTO membership. Moreover, heterogeneity in sectoral composition across cities coupled with asymmetric shocks to different sectors resulting from trade liberalization imply that the benefits from trade liberalization are also heterogeneous across local economies. We expect local economies that specialize in the sectors most positively affected by trade liberalization to display increases in output and increases in factor demand. Depending on factor mobility, increases in local factor demand in turn lead to increases in local factor prices (wages, rents), increases in local factor quantities (population, employment) or a combination thereof.[6]

The discussion above reveals that improvements in local economic conditions as a result of exposure to foreign trade liberalization should be reflected in (one or more of) increases in output, population, employment, wages and aggregate capital stock (the latter resulting from mobility of capital across space). These are the main local economic outcomes we will focus on in our empirical study of the impact of improvements in foreign market access on Chinese local economies.

2.3.2 Measuring Local Exposure to Trade Liberalization

To estimate the causal effect of improvements in foreign market access on local economic outcomes via specifications of the type described in equation (2.1) we require a measure that captures plausibly exogenous variation in trade liberalization across Chinese local economies. To obtain such a measure, we proceed in two steps. In the first, we follow Pierce and Schott (2015) and Handley and Limao (2015) and exploit changes in US trade policy triggered by China's WTO accession to derive an exogenous measure of US trade liberalization at the product level. In the second step, we employ a two stage aggregation procedure to construct a plausibly exogenous measure of improvements in US market access at the level of Chinese local economies. We describe these two steps of the construction of our main variable of interest in greater detail below.

[6]Note that in contexts in which factor mobility is important, movements in aggregate measures of factor prices (such as average wages) are difficult to interpret, as they may simply reflect compositional effects brought about by factor migration.

2.3.2.1 WTO Accession, US Trade Policy and Product-Level Trade Liberalization

Policy Background[7] China's WTO accession was not associated with a substantial reduction in the tariffs applied to Chinese exporters by major trading partners. Overall, China already benefited from low tariffs from its partners because it enjoyed Most Favored Nation (MFN) status or due to bilateral trade agreements. However, WTO accession triggered a change in the US trade policy regime towards China that amounted to a significant improvement in access to US markets for Chinese exporters.

The United States operates two different tariff schedules applicable to imports: the MFN tariff schedule and the Smoot-Hawley tariff schedule.[8] The former features low tariffs (about 4% on average) and is applicable to members of the WTO and to countries that have been awarded MFN status. The latter features much higher tariffs (31% on average), originally set under the Smoot-Hawley Tariff Act of 1930, and is applicable to a small set of countries considered to be "non-market" economies.

Since the US trade act of 1974, US presidents have been allowed to grant MFN tariff rates to non-market economies on a temporary basis subject to Congressional approval. China was first awarded MFN status in 1980, and its status was renewed every year until China's WTO accession 2001. Throughout this period, while MFN renewal kept the tariffs faced by Chinese producers low, the need for annual renewal of China's MFN status in the US Congress was an important source of uncertainty surrounding the continuation of the low tariff regime.

The likelihood that Congress would fail to renew China's MFN status was not negligible. In fact, China came close to having its MFN status revoked on a number of occasions. For instance, after the Tiananmen Square protests there was pressure to revoke China's MFN status, and Congress voted on such a bill every year in the 1990s. Bills to revoke China's MFN status were passed by the House of Representatives on three occasions (1990, 1991 and 1992 but were not confirmed by the Senate). The average share of the vote in the House in favor of revoking China's MFN status between

[7]The discussion of the policy background and some of the anecdotal evidence provided draw on discussions in Pierce and Schott (2015); and Handley and Limao (2014)

[8]The MFN tariff schedule is also sometimes referred to as the "Normalized Trade Relations (NTR)" tariff schedule or as "column 1 tariffs". The non-MFN or Smoot-Hawley tariff schedule is also referred to as the "column 2" or "non-NTR" tariff schedule.

1990 and 2001 was 38%.

Anecdotal evidence from the time indicates that the risk of Congress removing China's MFN status (particularly during periods of tensions between the two countries) was taken seriously by policymakers and market participants in both countries. Thus, in a 1994 report by the U.S. General Accounting Office, U.S. firms "cited uncertainty surrounding the annual renewal of China's most-favored-nation trade status as the single most important issue affecting U.S. trade relations with China " and indicated that "uncertainty over whether the U.S. government will withdraw or place further conditions on the renewal of China's most-favored-nation trade status affects the ability of U.S. companies to do business in China"(U.S. GAO 1994). In a similar vein, in 1997 the Chinese Foreign Trade Minister urged the U.S. to abandon trade status reviews: "The question of MFN has long stymied the development of Sino-U.S. economic ties and trade (...) [It] has created a feeling of instability among the business communities of the two countries and has not been conducive to bilateral trade development".

Measuring Product Level Trade Liberalization Upon its entry into the WTO in 2001, China was granted Permanent Most Favored Nation status by the US, which meant that it would benefit from automatic MFN status without annual renewal by Congress. This finally eliminated the risk of large spikes in tariffs faced by Chinese exporters to the US before 2001. Crucially, while non-MFN tariffs were universally higher than MFN tariffs, the *gap* between the two tariff schedules varied broadly across product categories. As a result, the possibility of non-renewal of China's MFN status was more problematic for exporters of products that stood to experience larger tariff spikes in the event of non-renewal. Conversely, we would expect producers of these commodities to benefit the most from the award of permanent MFN status to China following its WTO accession.

We follow Pierce and Schott (2015) and draw on this feature of the pre-WTO US trade policy regime to construct a measure of the restrictiveness of pre-2001 US trade policy at the level of individual products. This measure, named the "Normalized Trade Relations gap" by Pierce and Schott (2015) quantifies the pre-WTO implicit US trade barriers faced by Chinese exporters at the level of individual products as the gap between the Non-MFN and MFN tariffs applicable to each product. Formally, we define

$$TariffGap_{k1998} = Non\_MFNtariff_{k1998} - MFNtariff_{k1998} \tag{2.2}$$

Where:

- $TariffGap_{k1998}$ denotes the gap between Smoot-Hawley and MFN tariffs for product k at the start of our period of analysis (1998).

- $Non\_MFNtariff_{k1998}$ denotes Smoot-Hawley tariffs for product k at the start of our period of analysis (1998).

- $MFNtariff_{k1998}$ denotes MFN tariffs for product k at the start of our period of analysis (1998).

This product level measure of the constraints imposed by the pre-WTO US trade regime displays a number of attractive features. As shown in Figure 2.1, it is characterized by substantial variation across product categories, with a standard deviation above 15 percentage points. It is also plausibly exogenous to product and sector level outcomes in China. This is because most (about eighty nine percent) of the variation in tariff gaps arises from variation in non-MFN rates that were set 70 years prior to China's WTO accession. Even if we believed that MFN tariffs were set to protect US sectors currently more vulnerable to Chinese competition this would bias results against finding an effect of improvements in US market access caused by WTO accession. In this case we would in fact observe that products in which China has comparative advantage would face higher MFN tariff rates and *lower* tariff gaps and thus experience smaller improvements in US market access post-2001.

We define US post-WTO trade liberalization at the product level as the interaction of product tariff gaps and a post-2001 dummy:

$$TradeLib_{kt} = TariffGap_{k1998} * Post_t \tag{2.3}$$

This measure of the change of US trade policy at the level of individual products is a strong predictor of growth in Chinese exports to the US post-2001 (Pierce and Schott 2015; Handley and Limao 2015), which reassures us that it captures a significant posi-

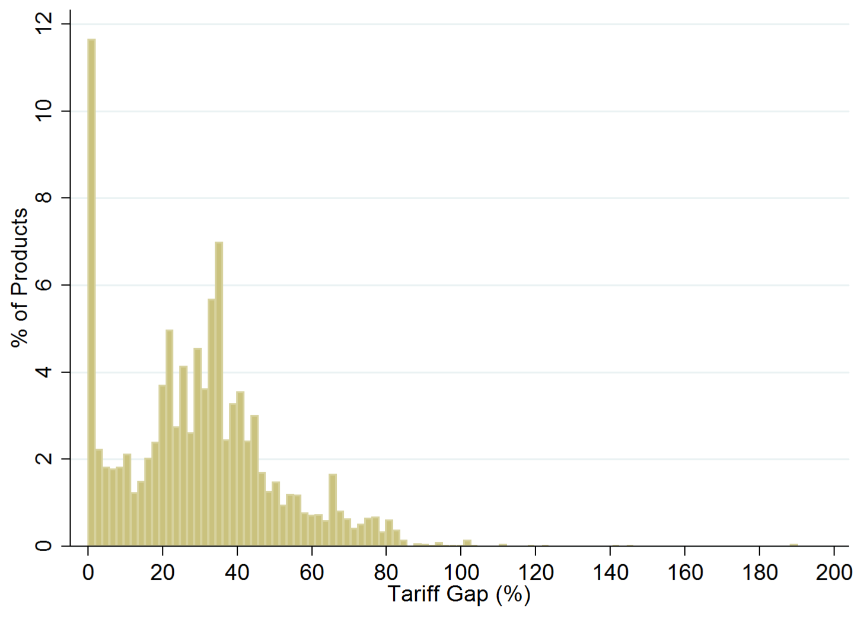

Figure 2.1: The Distribution of Product-level Tariff Gaps

tive trade shock for the manufacturers of affected products.[9]

2.3.2.2 Industry Level and City-Level Trade Liberalization

In the second step of constructing city level measures of exposure to US trade liberalization we first aggregate the product level tariff gaps obtained above to the sectoral level, making use of conversion tables provided by UN Statistics. More formally, we define initial period (1998) tariff gaps at the industry level as the simple mean of the product level tariff gaps, applicable to the products belonging to each sector. Formally,

$$TariffGap_{i1998} = \frac{\sum_{k \in i} TariffGap_{k1998}}{\sum_{k \in i} 1} \tag{2.4}$$

where $TariffGap_{i1998}$ denotes the average gap between Smoot-Hawley and MFN tariffs at the sector level in the initial period of our analysis (1998). Analogously to the previous section, we define sector level improvements in US market access caused by

[9] We also test the relevance of product level tariff gaps for predicting Chinese exports after 2001 and confirm the relevance of the analyzed US trade policy change.

China's WTO accession as:

$$TradeLib_{it} = TariffGap_{i1998} * Post_t \tag{2.5}$$

where i indexes industries and $Post_t$ again represents a post-WTO dummy.

We proceed to build city-level measures of exposure to the constraints of the US pre-WTO trade regime by aggregating sectoral-level tariff gaps to the city level via the methodology of Bartik (1991)[10]. Using this approach, city-level exposure to market access uncertainty is defined as an index in which sectoral level trade constraints are weighted according to each sector's pre-reform (in our case 1998) share in the city's overall employment.[11] More formally, we define city-level tariff gaps as:

$$TariffGap_{c1998} = \frac{\sum_i Employment_{i,c,1998} * TariffGap_{i1998}}{TotalEmployment_{c,1998}} \tag{2.6}$$

Where

- $Employment_{i,c,1998}$ is employment in sector i in city c in the initial time period (1998).

- $TotalEmployment_{c,1998}$ is total employment in city c in the initial period (1998).

The city-level measure of pre-WTO US trade barriers defined above has the nature of a scaled index as defined by Topalova (2007, 2011). This is because the sectoral employment numbers used to weight the importance of sector-level market access uncertainty in the construction of the city level measure do not add up to the denominator of the index. Indeed, the sectoral employment figures used in the numerator of our index only sum to total city-level *manufacturing* employment, whereas in the computation of our index we normalize by total city-level employment. As a result, variation in our city

[10]Strictly speaking, the region-level measure of exposure to initial US trade barriers we define in equation (2.6) and use throughout our analysis is defined at the spatially coarser prefecture level. We do this for two reasons. First, matching firm locations to prefectures can be performed with less risk of error than matching at the city level. Second, using prefecture level measures of US trade liberalization gives us direct comparability of results between our main specifications and prefecture-level specifications used in the study of some additional outcome variables as well as in our more detailed discussion of migration in section 2.6. Results are unaffected when we define measure of US trade liberalization at the "city proper" level.

[11]For a discussion of some of the limitations of this methodology see Monte (2015).

level tariff gap measures comes from two sources: variation in the relative size of manufacturing employment in total local employment; and variation in the composition of manufacturing employment. Alternative measures of US trade barriers at the city level that neutralize variation coming from the first source (variation in the size of the manufacturing sector) shall be used in robustness checks performed in Section 2.8.

We define our measure of improvements in US market access associated with China's WTO accession as

$$TradeLib_{ct} = TariffGap_{c1998} * Post_t \tag{2.7}$$

where c indexes cities and, as before $Post_t$ represents a post-WTO dummy. This measure represents our main variable of interest when estimating specifications of the type given by equation (2.1). Figure 2.2 maps the magnitude of US trade liberalization associated with China's WTO accession across prefectures that are part of our sample. Visual inspection reveals substantial variation in exposure to US market access improvements across Chinese prefectures. While there is some clustering of areas standing to benefit most from WTO accession (particularly in the South-East and South), areas that face substantial exposure to US trade liberalization can be found across multiple provinces in our sample and also in inland regions. All in all, our city-level measure of US market access improvements displays sufficient variation to allow for the effects of trade liberalization to be disentangled from confounding factors pertaining to China's geography.

Our measure of trade liberalization only captures changes in US trade policy resulting from China's WTO accession, which means we are only able to study the impact of improvements in access to US markets over this period. However, given the US's status as China's largest trading partner, the improvement in US market access we analyze likely made an important contribution to the overall foreign market access improvements China experienced over this period.

2.3.3 Geographic Measurement

To assess the local economic impact of foreign market access improvements we require an appropriate definition of local economies. Conceptually, we are interested in the

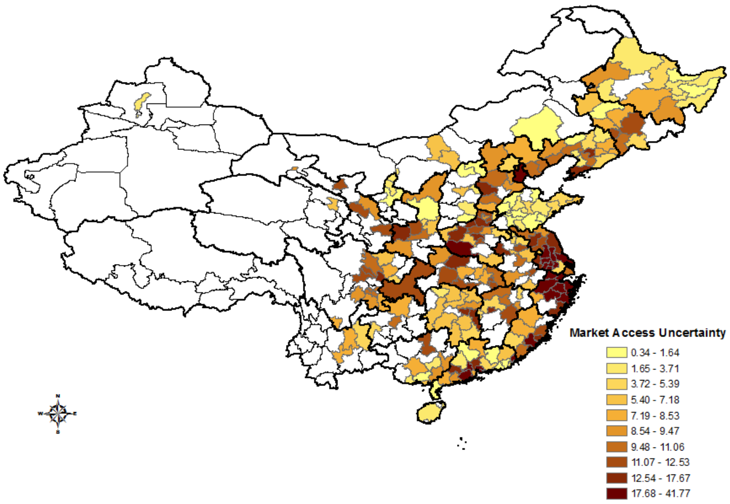

Figure 2.2: Improvements in Market Access Across Prefectures

analysis of integrated local economies or local labor markets, broadly corresponding to the notions of Metropolitan Statistical Areas (MSAs) or Commuting Zones (CZ) in the United States. Due to the complexity of China's territorial administration system, finding an empirical counterpart for the notion of an integrated local economy in the Chinese context is not straightforward. In this section we clarify a few issues regarding the spatial units that form the object of our analysis.

China's administrative system is structured along five levels of local government: the province, prefecture, county, township and village. Our study is focused on spatial units of analysis that belong to the first three categories, namely provinces, prefectures and counties. China's territory is organized into 33 provincial level units, four of which are represented by the provincial level cities of Beijing, Tianjin, Shanghai and Chongquing.[12] These large cities are included in our main analysis, though we check that our results are robust to their exclusion. Provinces are organized into prefecture

[12]China's administrative system includes Taiwan as a provincial level unit (the relevant literature often describes Taiwan as a "claimed province"). If Taiwan is excluded, China's administrative system comprises 32 provincial level units.

level units, with 332 such units covering the entire territory of the country.

Confusingly, most of these prefecture level units (284 out of 332) carry the title of "prefecture-level cities". However, in spite of their name, these administrative units are not in fact cities, but much larger spatial units, often covering areas greater than 10 thousand square kilometers. These units are composed of a large central city and the surrounding hinterland, which may itself contain smaller cities. In order to avoid confusion between "prefecture-level cities" and cities as commonly understood we will revert to the terminology that prevailed before the administrative reforms of the 1980s and call these administrative units *prefectures* for the rest of this chapter.

Our main source of spatial economic data, the China City Statistical Yearbooks (CSY) contains information at two level of spatial disaggregation: the prefecture and the urban ward of the prefecture (*shixiaqu*). This latter notion (the *shixiaqu*) is defined by the National Bureau of Statistics (NBS) to correspond to the central city of the prefecture. Urban wards are broadly comparable to the concept of metropolitan statistical area (MSA) used in the urban economics literature focusing on the United States. We follow the existing literature (Anderson and Ge 2005; Soo 2005; Peng 2010; Lin, Cheng and Yang 2013; Lin 2015) in regarding urban wards as the most credible definition of integrated local economies and focus our main analysis on these units.[13] For ease of exposition we call urban wards *cities* for the rest of the chapter.[14]

For the purposes of some of our robustness checks that make use of data from the Census it is also important to understand how the spatial units featured in the City Statistical Yearbooks map into China's sub-prefectural administrative units. From an administrative perspective, Chinese prefectures are sub-divided into county level units. These are of three types: counties (*xian*), county-level cities (*shi*) and urban districts. The area constructed by aggregating all urban districts within a prefecture broadly matches the central city (*shixiaqu*) of the prefecture defined by the NBS, for which data is reported in the China City Statistical Yearbooks.

To illustrate the administrative organization of the typical Chinese prefecture, Figure 2.3 provides the example of the prefecture of Wuhan. The map depicts the 13 county level units of the prefecture of Wuhan, which together had a population of about 9.7

[13]Some of our discussion of the growth and reallocation effects of improvements in US market access, as well as our spillover analysis will make use of data at the coarser prefecture level.

[14]When the distinction between prefectures and cities is not important, we often make use of the term *localities*.

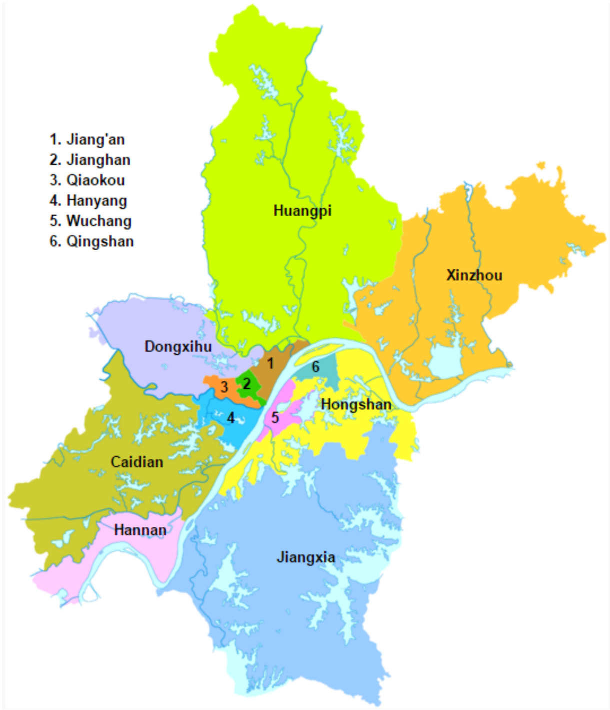

Figure 2.3: Administrative Organization of the Prefecture of Wuhan

million in 2010. The units numbered 1 to 6 represent the urban districts of the prefecture, and their union constitutes the city of Wuhan which had a population of about 6.4 million in 2010.

Due to data limitations, our final sample contains 226 cities, 4 with provincial level status and 222 central cities of prefectures.

2.3.4 Estimation

Our main analysis relates changes in economic outcomes at the level of Chinese cities between 1998 to 2007 to US market access improvements caused by China's WTO accession. We employ a standard difference-in-differences research design (see equation 2.1). While our source of identification should address any simultaneity concerns, our use of the Bartik (1991) methodology in the construction of city-level exposures to US trade liberalization means that our identification strategy is still subject to the threat of omitted variable bias.

Performing a simple balancedness analysis reveals that our city-level measures of

US market access improvements are correlated with initial city characteristics (see table 2.A.1). We find that cities subject to greater exposure to US trade liberalization were more likely to contain Special Economic Zones, be located on the coast or closer to ports. They also displayed higher GDP and GDP per capita, a higher capital stock, and higher average wages. We find no association between exposure to improvements in US market access and initial population, employment and infrastructure variables (railway and highway density). All in all, our results indicate that WTO accession may have benefited locations that were already wealthier and more developed in 1998.

To mitigate concerns related to omitted variable bias, we augment the simple specification given in equation (2.1) with a battery of controls. In our preferred city-level specifications we estimate models of the type:

$$y_{ct} = \alpha + \beta TradeLib_{ct} + \rho Z_{ct} + \theta * Post_t * X_{c1998} + \gamma_t + \delta_c + \epsilon_{ct} \quad (2.8)$$

where $Post_t$ is a dummy that equals 1 for the post-reform period (after 2001) and 0 otherwise, Z_{ct} are time-varying controls at the city level, γ_t and δ_c are respectively time and city fixed effects, while the terms $\theta * Post_t * X_{c1998}$ control for the potentially time-varying effects of initial (1998) city characteristics.

Time-varying controls include an index for the average applied export tariffs at the city-level (computed in a similar way, via the Bartik 1991 methodology, as the city level tariff gaps), and a dummy for a city's special economic zone (SEZ) status aimed at capturing the local economic effects of becoming a SEZ during our period of analysis[15]. Our battery of controls for the time-varying effects of initial city characteristics include the city-level initial manufacturing share of employment, initial SEZ status of the city, a dummy for coastal status, distance to the nearest port, initial highway density, initial railway density, the initial (1998) value of the outcome variable (to control for potential mean reversion) as well as a control for pre-trends in the outcome variable. In all regressions that control for mean reversion in the dependent variable, we instrument for the lagged dependent variable with further lags (1997 values) of the same variable.

Our main outcome variables are those revealed by our simple theoretical framework (and by the urban economics literature) as measures of local economic success: pop-

[15]For a more detailed discussion of the role of SEZ status in fostering development see Wang (2013) and Alder, Shao and Zilibotti (2016).

ulation, employment, output and average wages at the city level. We also study some additional economic outcomes aimed at capturing local investment and the internationalization of local economies. Finally, to control for potential correlation in the error term among neighboring prefectures, standard errors are clustered at the province level in all our city-level specifications. In robustness exercises presented in section 2.8 we implement several additional checks aimed at addressing concerns related to omitted variable bias.

2.3.5 Data Sources

Data on actually applied (MFN) and counterfactual (Smoot-Hawley) tariffs for the period 1998 to 2001 is obtained from Feenstra, Romalis and Schott (2002). We complement this with data on actually applied US tariffs for the period 2001 to 2007 obtained from the TRAINS database accessible via WITS. Tariff data from both sources is available at the 8 digit harmonized system (HS) level, and we aggregate it to HS-6 level by taking simple averages.

Measures of manufacturing employment at the city-industry level, required for the computation of the city-level measures of market access improvements, were constructed based on the Annual Surveys of Industrial Firms (ASIF) covering the period 1997-2007. These surveys are designed to include the universe of Chinese manufacturing firms with sales in excess of 5 million RMB or about 800 thousand US dollars. Data include firm sector (4 digit CIC classification), employment, location (6 digit *guo biao* codes - county level units) as well as balance sheet information. Coverage of the surveys is extensive: more than 145 thousand firms are included in the survey in 1998 and more than 311 thousand in 2007. Compared with the universe of of Chinese firms (which can be obtained from the economic censuses for selected years) firms included in the ASIF accounted for 91 percent of gross manufacturing output, 71 percent of manufacturing employment, 97 percent of exports and 91 percent of total fixed assets. Thus, these surveys provide a reasonable basis for determining the sectoral composition of Chinese local labor markets.

To construct city-level measures of US trade liberalization we require that our city-sector employment data and our sector level tariff data are expressed in terms of the same industrial classification. We perform the match between the 4 digit ISIC industrial classification and the 4 digit CIC classification via the conversion table developed by Dean and Lovely (2010).[16]

Finally, data on most outcome and control variables used in this chapter is available from Chinese City Statistical Yearbook 1995-2007. The yearbooks contain data at two levels of spatial disaggregation: (1) prefecture level cities (prefectures) and (2) the urban wards of prefecture level cities (cities). We focus our analysis on the city level but employ data at the prefecture level to analyze some outcome variables and in our discussion of migration patterns in section 2.6. Measures of cities' distance to the nearest port were computed using GIS data from the China City Center at the University of Michigan supplemented with data from the World Port Index. We also construct some additional outcome variables (alternative measure of manufacturing employment, city-level balance sheet variables) by aggregating the firm level data from the ASIF to the prefecture level. For the implementation of some robustness checks concerning our city population findings, we employed county-level census tabulations from the 2000 and 2010 censuses, compiled by China's National Bureau of Statistics (NBS).

2.4 WTO Accession and Local Growth

2.4.1 Main Results: Population, Output, Employment and Wages

To obtain an initial assessment of the association between improvements in US market access and local economic performance in China over the period 1998 to 2007 we first implement the simple specification given by equation (2.1). Table 2.1 presents our findings on our main variables of interest: population, output, employment and wage growth. We report results for two measures of local employment available from the China City Statistical Yearbooks: "Total Employment" and "Total Staff".[17]

Our results point towards a large effect of improvements in access to US markets

[16] Another difficulty related to the process of matching sectors across different industrial classifications emerges from the fact that the CIC industrial classification (which is used in the ASIF) experienced a two changes during the period of our analysis. As a result, in order to obtain a consistent panel of observations at the city-sector level, it was necessary to match CIC codes across time. This match was performed via the conversion tables developed by Brandt, van Biesebroeck and Zhan (2012).

[17] The exact definitions of all of the variables used in this chapter are available in the Appendix. In the case of the local employment measures, the main difference between the two measures used is that "Employment" constitutes a broader measure of employment than "Total Staff".

VARIABLES	(1) ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(Avg. Wage City)
City Trade Lib	0.0203***	0.0167***	0.0406***	0.0149***	-0.00757**
	(0.00308)	(0.00519)	(0.00835)	(0.00463)	(0.00300)
Observations	452	447	452	452	452
R-squared	0.417	0.918	0.403	0.135	0.934
Number of cities	226	226	226	226	226
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Controls	No	No	No	No	No

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.1: Baseline Outcomes, No Controls

on local economic outcomes in China. Cities that benefit from greater improvements in trading conditions with the US experience faster population, output and employment growth in the period following China's WTO accession. Surprisingly, we find a weak but statistically significant negative association between improvements in US market access and local wage growth. The effects of WTO accession are highly statistically and economically significant. Taking a city from the 25th to the 75th percentile of exposure to US market access improvements caused by WTO entry is associated with a 15% increase in city population, 12% increase in GDP and 28% increase in broad employment over the period 1998 to 2007.

A crucial assumption for the validity of our difference-in-differences empirical design is that cities experiencing varying levels of exposure to US trade liberalization were evolving along parallel trends before China's 2001 WTO accession. While data limitations prevent us from rigorously testing this assumption for all our outcome variables, the China City Statistical Yearbooks do contain data on city population and employment going back as far as 1992. We proceed to implement a placebo test by relating the evolution of population and employment at the city level over the period 1992 to 1997 to the intensity of effective trade liberalization brought about by WTO accession at the local level. Effectively we are assuming that China's WTO accession took place in 1992 and we are studying the effects of this "reform" on local population and employment growth.

Our results are presented in Table 2.2. We find no relationship between exposure to

VARIABLES	(1) ln(City Pop.)	(2) ln(City Emp.)
City Trade Lib.	0.00399	0.00304
	(0.00239)	(0.00402)
Observations	438	425
R-squared	0.103	0.003
Number of cities	225	225
City FE	Yes	Yes
Year FE	Yes	Yes
Controls	No	No

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.2: Placebo Test for Pre-trends in Outcome Variables

post-WTO improvements in US market access and population and employment growth at the city-level between 1992 to 1997, which lends support to the idea that cities were evolving on parallel trends before WTO accession.

In table 2.3 we present the results of re-running the analysis above using our preferred specifications given by equation (2.8). We find similar results to those obtained from the specifications without controls. Employment growth at the city level is strongly related to improvements in US market access, with point estimates somewhat lower than in the prior specification. Improvements in trading conditions with the US also cause faster population and output growth. The magnitudes of the already small coefficients in the wage regressions decline further and become statistically insignificant. This suggests that a substantial fraction of the negative association between improved US market access and local average wage growth is attributable to omitted variable bias in the previous specifications.[18] The estimated effects of US market access improvements on Chinese local economies remain quantitatively large. Back of the envelope calculations indicate that US trade liberalization caused by China's WTO accession can account for up to half of the growth in population and three quarters of the growth in manufacturing

[18]The evidence is consistent with mean reversion in average wages at the city level. Given that the intensity of trade liberalization brought by WTO accession was greater for initially more developed cities, this may explain the significant negative association between improvements in US market access and local wage growth.

employment of the average Chinese city over the period 1998 to 2007.

VARIABLES	(1) ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(Avg. Wage City)
City Trade Lib.	0.0156***	0.0165**	0.0320***	0.0174***	-0.00428
	(0.00370)	(0.00642)	(0.00466)	(0.00399)	(0.00377)
City Avg. Export Tariff	0.0137	-0.0921	0.128*	0.0630	-0.143**
	(0.0765)	(0.0943)	(0.0733)	(0.0687)	(0.0717)
Observations	440	428	440	440	440
R-squared	0.550	0.925	0.518	0.415	0.955
Number of cities	220	214	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.3: Baseline Outcomes with Controls

The coefficients on the competing variable measuring cities' exposure to tariff barriers imposed by trading partners across time are most often statistically insignificant and often have counter-intuitive positive coefficients implying that cuts in tariff *levels* bring about detrimental economic effects at the city level.

Relating our findings to the simple theoretical framework developed in section 2.3.1 points to the conclusion that Chinese cities had access to an abundant supply of labor during our period of analysis. The adjustment of local economies to improvements in US market access occurred primarily on the quantity margins, with population and employment growing strongly. On the other hand, adjustment on the price margin represented by local wages does not seem to have been important. These findings are consistent with a Lewis (1954) type setting in which local labor supply elasticities are high because barriers to geographic mobility are small and cities have access to abundant reserves of labor in their surrounding hinterland. Labor abundance of the type required by a Lewis (1954) framework is a reasonable description of economic realities in China during this period (Yao 2010; Chan 2012). We provide a more detailed discussion of the issue of geographic mobility of labor in section 2.6.

We need to be careful in interpreting our wage results. In the presence of large migratory responses of the type we find in our setting, it is difficult to disentangle the effect of improvements in market access on wages from any compositional shifts in local labor markets that occur as a result of trade liberalization. Our findings are consistent with a scenario in which improvements in US market access bring about increases in both employment and wages, but the effect on the latter is confounded by compositional changes brought about by migration. For instance, if the sectors that grow most as a result of the reform tend to be low-skilled, low wage sectors, this may bring down city-level average wages even if all individual wages increase.

Moreover, if cities that benefit most from improvements in access to US markets draw increasingly marginal unskilled labor from the surrounding countryside, this may again have the effect of reducing observed average wages at the city level, even in an environment characterized by wage growth for all individuals. Our results suggest that these mechanisms may be important given the surprising negative association we often find between exposure to US trade liberalization and local wage growth. Unfortunately, our aggregate wage data do not allow us to explore these issues further.

2.4.2 Investment, Exports and FDI

Building on our findings of significant effects of WTO accession on major economic indicators, we seek to identify further markers of its impact on local economies. Given that one of the main effects of China's WTO accession was arguably a reduction in the uncertainty of the economic environment faced by Chinese firms, the results of a large body of work on investment under uncertainty (Bernanke 1983; Dixit 1989; Bloom et al. 2007; Roberts and Tybout 1997; Impullitti et al 2013) would lead us to expect an increase in investment in the locations most affected by improvements in US market access. Using data on the stock of fixed assets at the city level from the China City Statistical Yearbooks, we aim to verify the presence of this effect. Table 2.4 presents the results.

Our findings confirm that improvements in US market access had a positive effect on local investment. In our preferred specifications including all controls we find that a one standard deviation higher exposure to US trade liberalization is associated with a highly significant 14% increase in the stock of fixed capital at the city level over the

VARIABLES	(1) ln(Fix Assets City)	(2) ln(Fix Assets City)
City Trade Lib	0.0113	0.0196***
	(0.00750)	(0.00538)
City Avg. Export Tariff		-0.202
		(0.124)
Observations	452	440
R-squared	0.738	0.798
Number of cities	226	220
City FE	Yes	Yes
Year FE	Yes	Yes
Controls	No	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.4: Investment

period 1998 to 2007.[19] This faster accumulation of fixed capital in cities that benefited more from WTO membership represents indirect evidence of increased investment activity at these locations.

Increased investment activity is not the only effect we would expect from improvements in trading conditions with the US. Reductions in US protection may induce more Chinese firms into paying the fixed costs associated with exporting, and increase corresponding trading activity. It may also increase the propensity of foreign firms to integrate China into their supply chains either by establishing plants in China or by investing in already existing Chinese firms. Both of these strategies for integrating China into production chains should be reflected in increases in FDI.

We test these hypotheses in turn with data from two sources. The China City Statistical Yearbooks include a measure of the “Number of new FDI contracts”.[20] Using firm level data from the Annual Survey of Industrial Firms (ASIF) we also construct two prefecture level aggregates that are useful in assessing the effects of the US trade

[19]The estimates concerning the size of the effects are calculated based on the fact that the standard deviation of our variable of interest, the City-Level trade liberalization, is 7.3 (variable measured in percentage points).

[20]This measure is available for a restricted sample of 189 cities.

liberalization on FDI activity at the level of local Chinese economies: aggregate paid in capital owned by entities from Hong Kong, Macau and Taiwan; and aggregate paid in capital owned by foreign entities.[21] We proceed to relate the evolution of these variables over the 1998 to 2007 period to our city-level measures of improvements in US market access brought by China's entry into the WTO.

	(1)	(2)	(3)
VARIABLES	ln(FDI Contr. City)	ln(Pref HK K)	ln(Pref Foreign K)
City Trade Lib	0.0276***	0.0481***	0.0224**
	(0.0104)	(0.00883)	(0.00879)
City Avg. Export Tariff	-0.402	-0.353***	-0.510***
	(0.267)	(0.132)	(0.164)
Observations	378	427	429
R-squared	0.371	0.644	0.811
Number of cities/pref.	189	217	216
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.5: FDI Contracts and Foreign Capital

Table 2.5 outlines the results. Our findings suggest an important role for WTO membership in promoting FDI growth. Cities exposed to greater improvements in US market access experience faster growth in the number of local FDI agreements. A one standard deviation increase in exposure to US market access uncertainty before WTO Accession is associated with a more than 20% increase in the number of local FDI agreements. Moreover, prefectures that experience greater improvements in their access to US markets as a result of WTO accession exhibit more rapid growth in the value of equity owned by foreign entities.[22] A one standard deviation greater exposure to US trade liberalization is associated with a 35% increase in the local stock of equity owned by

[21]For the purposes of Chinese statistics, Hong Kong, Macau and Taiwan are not considered foreign territories.

[22]For the dependent variables constructed on the basis of the ASIF, we are only able to obtain a time series covering the period 1998 to 2007. As a result, in the prefecture level regressions reported in table 2.5 and in the regressions reported in table 2.6 we do not control for pre-trends in the outcome variables and do not instrument for the lagged dependent variable with further lags of the dependent variable. Results without the lagged dependent variable terms are similar.

residents of Hong Kong, Macao and Taiwan, and a more than 16% increase in the stock of equity owned by other foreigners.[23]

We also study the impact of improved US market access on exporting. We employ data from the ASIF to construct prefecture level aggregate manufacturing exports. We also track the evolution of the number of local exporting firms over the period 1998 to 2007. Results are reported in table 2.6. We find only suggestive evidence that reductions in US trade barriers lead to increases in the value of exports at the prefecture level. However, we identify a highly statistically and economically significant relationship between improvements in trading conditions with the US and growth in the number of local firms engaged in exporting activities. These results suggest that improved access to US markets had an effect on the extensive margin of exporting, but did not affect the trading activities of existing exporters. Given that the largest and most productive firms were already likely to export even before WTO accession, our findings are consistent with a scenario in which the relevant margin of adjustment to the trade shock was entry into exporting by smaller and less productive firms. In turn, these firms make a relatively small contribution to the growth of exports, which may explain why our analysis lacks the power to detect a significant impact of improvements in US market access on export volumes.

2.4.3 The Structure of Local Economies

In this section we investigate whether trade liberalization had an impact on the composition of employment across broad sectors at the level of Chinese local economies. This analysis serves two goals. First, it allows us to assess whether the positive shock to the tradable sector represented by China's WTO accession had a knock on impact on the non-tradable sector at the local level. This is important because ignoring spillovers to the non-tradable sector may lead to a substantial underestimate of the benefits of trade integration if there are significant local multipliers.

Second, this exercise serves as a consistency check that tests if our results so far can indeed be attributed to WTO accession and its implications for US trade policy.

[23] While official Chinese data sources clearly distinguish between capital owned by residents from Hong Kong, Macao and Taiwan and capital owned by foreigners, in practice, much of the capital featured as originating from Hong Kong, Macao and Taiwan is likely to be owned by foreigners because investments into China from abroad are often routed through these locations.

VARIABLES	(1) ln(Pref. Exports)	(2) ln(Pref. No. Exporters)
City Trade Lib	0.0106	0.0231***
	(0.00806)	(0.00749)
City Avg. Export Tariff	-0.359*	-0.291***
	(0.191)	(0.0994)
Observations	440	452
R-squared	0.813	0.344
Number of prefectures	221	226
City FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.6: Export Activity

Intuitively, we expect improvements in US market access to be associated with a particular pattern of shifts in sectoral composition at the level of Chinese localities. As the US policy change represented a shock to the tradable sector we expect its effects to be strongest for this sector. Moreover, in the presence of strong local demand linkages we may expect improvements in trading conditions with the US to be associated also with growth in the (largely non-tradable) tertiary sector (services). Ex ante, we do not expect the agricultural (primary) sector, in which China lacks comparative advantage, to benefit substantially from improved access to US markets. In fact this sector may contract as workers and other resources are drawn to other sectors that derive greater benefits from trade liberalization.

We test these hypotheses by employing our preferred empirical specification to study the evolution of city-level employment across broad sectors: primary, secondary and tertiary. We also study in greater detail the evolution of employment in the narrower manufacturing sector.[24]

The results of this exercise are reported in Table 2.7 and are consistent with our

[24] Secondary sector employment is a broader aggregate than manufacturing, also including mining activities.

VARIABLES	(1) ln(Prim. Emp)	(2) ln(Sec. Emp)	(3) ln(Ter. Emp)	(4) ln(Manu. Emp)
City Trade Lib	-0.00898	0.0234***	0.0139***	0.0299***
	(0.0137)	(0.00736)	(0.00501)	(0.00695)
City Avg. Export Tariff	0.342	0.0313	0.173*	0.0366
	(0.447)	(0.122)	(0.105)	(0.119)
Observations	440	440	440	440
R-squared	0.769	0.603	0.702	0.637
Number of cities	220	220	220	220
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.7: Structure of Employment

predictions. Within strongly "treated" locations, the secondary sector benefits the most from WTO accession, and manufacturing employment grows strongly. However, we also find evidence of substantial spillovers from tradable to non-tradable sectors. Employment in the tertiary sector also expands sharply after WTO accession in cities previously most exposed to US trade protection. Our point estimate in the tertiary sector employment regression is more than half as large as the corresponding coefficient for secondary employment. Given that in the average Chinese city the secondary sector accounted for about 51% of employment while the tertiary sector accounted for 41% at the start of our period of analysis, our estimates imply that for each two jobs created or saved in the tradable sector as a result of WTO accession, one job was created or saved in the local non-tradable sector over the period 1998 to 2007.[25] This estimate of the local multiplier is markedly smaller than the one identified by Moretti (2010) for the US. It is still sizable, however, which points to the conclusion that the knock on impact of trade liberalization on non-tradable activities may add substantially to the overall economic

[25] The local (service sector) multiplier is computed as

$$\text{Local Multiplier} = \frac{\text{Tradable Emp Share} \times \text{Coeff Tradable}}{\text{Non-tradable Emp Share} \times \text{Coeff Non-tradable}} \approx 0.48$$

gains from improved market access.

As expected, the local primary sector does not benefit from the elimination of the constraints imposed by pre-WTO US trade policy. In fact, point estimates suggest that it may have experienced slower growth in locations that benefit from greater reductions in exposure to US market access uncertainty.

2.5 Trade Liberalization and Local Spillovers

Building on our finding of sizable spillovers from the tradable to the non-tradable sector in the context of the positive trade shock caused by China's WTO accession, in this section we aim to provide a detailed assessment of the role of local spillovers in shaping the propagation of the shock to Chinese urban economies. Our research design focusing on local economies allows us to specifically test for the presence of local spillovers and to obtain estimates of their quantitative importance.

The empirical exercise in this section brings us closer to the literature that estimates the magnitude of local spillovers and agglomeration economies and assesses the effects of place based policies (Black et al. 2005; Greenstone, Hornbeck and Moretti 2010, Moretti 2010; Chodorow-Reich et al. 2012; Wilson 2012; Shoag 2012; Kline and Moretti 2013; Serrato and Windenger 2014; Allcott and Keniston 2015; Zou 2015 etc.). Unlike some of the studies in this literature, in which the shock under analysis can be considered to affect directly only one sector (or a small number of sectors), our setting presents the additional challenge that WTO accession brings about asymmetric shocks to most manufacturing sectors.

We proceed in two parts. In subsection 2.5.1 we focus on the role of local spillovers in driving the transmission of the shock brought by US trade liberalization within the tradable sector of local economies. In subsections 2.5.2 and 2.5.3 we turn our attention to studying the transmission of the effects of improved foreign market access from the tradable to the local non-tradable sectors. Subsection 2.5.2 provides an overview of non-tradable sector responses to WTO accession while subsection 2.5.3 is dedicated to a more detailed analysis of the impact of US trade liberalization on a non-tradable activity that is of particular interest given some of our earlier findings: the local financial sector.

2.5.1 Local Spillovers within the Manufacturing (Tradable) Sector

Interactions between manufacturing sectors at the local level can have the nature of agglomeration or congestion forces. The growth of a sector can lead to other sectors being crowded out, to the extent that they are competitors for scarce inputs such as land. On the other hand, growth in some sectors can lead to positive spillovers to other sectors via either forward or backward linkages. In this subsection we provide an assessment of the interaction of these forces with the trade-policy shocks that form the object of this chapter.

To assess the importance of local spillovers within the tradable manufacturing sector, we relate changes in outcomes at the level of prefecture-industry cells to both own-sector improvements in US market access and changes in the exposure to US market access uncertainty of co-located sectors. Before we proceed to this exercise, we use the opportunity provided by conducting our analysis at the level of prefecture-industry cells to perform a cross-check concerning the importance of reductions in expected US trade barriers for sector-level outcomes. We thus first estimate specifications of the type:

$$y_{ict} = \alpha + \beta * TradeLib_{it} + \gamma_{ic} + \delta_t + \epsilon_{ict} \tag{2.9}$$

where y_{ict} represent outcomes at the level of prefecture-industry cells, $TradeLib_{it}$ represents our industry level measure of improvements in US market access brought about by WTO accession (given by equation 2.5), γ_{ic} represent prefecture-industry fixed effects and δ_t are time fixed effects. We cluster standard errors at the industry level.

The results of this exercise are presented in Table 2.8. While this analysis suffers from limited power, our findings provide additional evidence in support of the role of improved trading relations with the US in promoting sectoral level growth. The evidence is consistent with the structure of employment, output and exports at the city-level shifting towards sectors that stand to benefit from the largest drops in exposure to US market access uncertainty in light of China's WTO accession. Moreover, we find statistically significant relationships between our sector-level measures of the trade shock brought about by WTO membership and growth in the number of firms and the number of exporters across prefecture-industry cells.

We proceed to a first assessment of the role of local inter-sectoral spillovers within manufacturing. We augment the specification in equation (2.9) with a term aimed at

VARIABLES	(1) Ln(Emp)	(2) Ln(Output)	(3) Ln(No firms)	(4) Ln(No Exp)	(5) Ln(Fix Asset)	(6) Ln(Exp.)
Industry Trade Lib	0.00438	0.00759	0.00727**	0.00526**	0.000376	0.00434
	(0.00527)	(0.0110)	(0.00347)	(0.00220)	(0.00524)	(0.0113)
Observations	28,378	28,383	28,383	28,383	28,310	28,383
R-squared	0.865	0.880	0.888	0.882	0.863	0.831
Pref-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: All outcomes at the prefecture-industry level

Standard errors clustered at the industry level

*** p<0.01, ** p<0.05, * p<0.1

Table 2.8: Prefecture-Industry Effects of Industry-Level Trade Liberalization

capturing the extent of US market access improvements experienced by the "neighboring sectors" of each prefecture-industry cell. The "neighbors" of a prefecture-industry cell are defined as other such cells located in the same prefecture. We thus estimate empirical models of the type:

$$y_{ict} = \alpha + \beta_1 * TradeLib_{it} + \beta_2 * TradeLib_{-ict} + \gamma_{ic} + \delta_t + \epsilon_{ict} \quad (2.10)$$

where the "spillover term" $TradeLib_{-ict}$ is given by

$$TradeLib_{-ic1998} = \frac{\sum_{j \neq i} Employment_{j,c,1998} * TariffGap_{j1998}}{TotalEmployment_{c,1998}} * Post_t$$

All other notation retains its previous meaning. The logic of our "spillover terms" is that each prefecture-industry cell interacts with the surrounding economy, and as a result it is exposed to the trade policy (and other) shocks that affect it. The computation of the spillover measures is analogous to that of our city-level trade liberalization measures (i.e., it is an employment-weighted average of the sector-level market access improvements affecting local industries), but excludes each prefecture-industry's own sector exposure to trade liberalization. When estimating specifications of the type outlined in equation (2.10) we double cluster standard errors by prefecture and industry. The results of this exercise are presented in table 2.9.

We find strong evidence of local spillovers that shape the transmission of the trade shock represented by WTO accession to local economies in China. Moreover, these spillovers are positive. The typical prefecture-industry derives substantial benefits when the surrounding local economy experiences significant improvements in US market access. US trade liberalization affecting the surrounding economy leads to faster growth in employment, exports, numbers of firms and exporters as well as increases in investment activity across prefecture-industry cells. We also find suggestive evidence that improvements in US market access affecting the surrounding local economy are associated with output and sales growth at the level of the typical prefecture-industry cell.

Our findings suggest that local spillovers are quantitatively large. The indirect effects of improved US market access, operating via co-located sectors, on the typical prefecture-industry cell dominate the direct effects of the own-sector market access improvements for most outcomes of interest. Back of the envelope calculations suggest that less than 40% of the overall effect of US trade liberalization on employment at the level of the typical prefecture-industry cell are attributable to the own sector trade shock, and the rest can be attributed to local spillovers. The corresponding share of the effects of the own-sector shock for exports is less than 20% while virtually the entire effect of WTO accession on investment at the level of the typical prefecture-industry cell operates via spillovers from "treated" neighboring sectors.[26]

Overall, our results indicate that local agglomeration forces outweigh local congestion and augment the effects of trade liberalization. This finding is consistent with our results from the city level analysis, which found little evidence of important local congestion effects.[27]

While the analysis above provides evidence of large positive local spillovers, it remains silent on the mechanisms through which these spillovers operate. In order to improve identification and shed additional light on the particular mechanisms of intersectoral interaction, we proceed to a more detailed investigation of the various channels of transmission of the US trade policy shock that are conflated in our previous spillover specifications. The logic of this exercise is as follows. We expect a local sector to derive major indirect benefits from WTO accession when the neighboring local economy

[26]We calculate the share of the effects that can be attributed to the "own sector" US trade shock as

$$\text{Direct share} = \frac{\text{Coeff Industry Trade Lib} \times \text{Average Industry Trade Lib}}{\text{Coeff Industry Trade Lib} \times \text{Average Industry Trade Lib} + \text{Coeff Rest of City Trade Lib} \times \text{Average Rest of City Trade Lib}}$$

[27]Our results are also consistent with the analysis of Au and Henderson (2006), who find that a large fraction of Chinese cities were undersized in the run-up to our period of analysis.

VARIABLES	(1) Ln(Emp)	(2) Ln(Output)	(3) Ln(No firms)	(4) Ln(No Exp)	(5) Ln(Fix Asset)	(6) Ln(Exp.)
Industry Trade Lib	0.00405	0.00755	0.00707***	0.00491***	0.000193	0.00362
	(0.00358)	(0.00742)	(0.00236)	(0.00149)	(0.00357)	(0.00761)
Rest of City Trade Lib	0.0180***	0.00258	0.0108***	0.0194***	0.0102**	0.0402***
	(0.00468)	(0.00461)	(0.00391)	(0.00291)	(0.00427)	(0.00855)
Observations	26,142	26,150	26,150	26,150	26,056	26,150
R-squared	0.017	0.538	0.222	0.087	0.166	0.058
Number of pref-ind.	13,071	13,075	13,075	13,075	13,028	13,075
Pref-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: All outcomes at the prefecture-industry level

Standard errors double clustered at the industry and prefecture level

*** p<0.01, ** p<0.05, * p<0.1

Table 2.9: Spillovers at the Prefecture - Industry Level

experiences a large improvement in its access to US markets and when the sector under analysis is strongly "linked" with the surrounding local economy.

Following through with this intuition, we build on the work of Ellison, Glaeser and Kerr (EGK, 2010) and construct measures of the indirect shocks affecting local sectors as a result of WTO accession. We separate out the indirect effects transmitted via input-output, labor and technology linkages. To these three types of linkages studied by EGK (2010) we add a fourth, search linkages, that may be relevant in our setting. In what follows we discuss the main channels through which local sectors could benefit indirectly from improvements in US market access and set out our proposed measures of these indirect trade policy shocks. These measures are computed at the level of prefecture-industry cells and allow us to disentangle what type of linkages are most important for the local diffusion of the trade shocks associated with China's WTO accession.

Output Linkages Perhaps the most straightforward way in which a local industry may benefit indirectly from improved trading conditions with the US is if it is a supplier or client of co-located sectors that experience large improvements in their access to US markets. As these nearby sectors grow as a result WTO accession, we can expect their demand for inputs to grow, to the benefit of local suppliers (a similar argument can be made for input linkages). We focus on output linkages and follow EGK (2010) in defining the output link between two sectors, i and j, as the share of sector i's output that is typically sold to sector j. To compute the output shares of various sectors relative to a given sector i we make use of the Chinese input-output tables. We then proceed to compute a measure of the magnitude of the demand linkages we expect a local sector to experience as a result of China's WTO accession as:

$$Outputlink_{ict} = \frac{\sum_{j \neq i} Emp_{jc1998} * TariffGap_{j1998} * Outputshare_{ij}}{\sum_{j \neq i} Emp_{jc1998}} * Post_t \tag{2.11}$$

Intuitively, we expect WTO accession to have greater effects on a local sector via the output linkages channel when industries that are traditional clients of that sector have an important local presence and experience large improvements in US market access as a consequence of China's WTO accession.

Labor Linkages Another channel through which local sectors in China could be indirectly affected by WTO accession is via labor linkages. If industries located in the same city and that make use of the same type of labor as a given sector are subject to large positive trade shocks, we may expect that sector to experience some crowding out effects. Conversely, if the growth of surrounding sectors brought about by trade liberalization brings more workers of the type needed by the sector to the city, this could have important positive spillovers, via thick labor market effects. In order to assess the importance of this channel, we follow EGK (2010) and measure the labor linkages between each pair of sectors i and j as the correlation between the sectors' occupational share vectors:

$$LaborCorrelation_{ij} = Correl(Share_{io}, Share_{jo}) \tag{2.12}$$

where $Share_{io}$ is a vector containing the shares of each occupation o in sector i employment. In line with EGK (2010) we use the 1998 version of the US National Industrial-Occupation Employment Matrix (NIOEM) to compute the $Share_{io}$ vectors.[28] Once we've computed pairwise labor linkages between all sectors, we construct a measure of

[28] Industrial-Occupation Employment Matrices similar to the NIOEM are not available for China, and as a result we are forced to use the US NIOEM. However, this could provide the benefit of additional exogeneity to our analysis, as the US NIOEM can be considered a benchmark for the occupational requirements of various sectors.

the indirect impact of the reform on a given sector i, mediated via labor linkages as

$$Laborlink_{ict} = \frac{\sum_{j \neq i} Emp_{jc1998} * TariffGap_{j1998} * LaborCorrelation_{ij}}{\sum_{j \neq i} Emp_{jc1998}} * Post_t \tag{2.13}$$

Intuitively, we expect a sector to be subject to larger spillovers transmitted via labor linkages if industries that usually employ a similar labor force have an important local presence and experience large improvements in US market access as a result of WTO accession.

Technology Linkages Another mechanism through which a local sector may benefit from improvements in US market access affecting the surrounding economy is represented by technology linkages. If nearby industries with which a particular sector shares similar or complementary technology grows as a result of WTO accession, we can expect that sector to benefit from positive technology spillovers. To test for this channel in our setting we follow EGK(2010) and make use of the technology matrix developed by Scherer (1984). This matrix captures how R&D activity in one industry flows out to benefit another industry. Similarly to EGK (2010), we construct a pairwise measure of the technological benefits derived by sector i from R&D activity undertaken in sector j, $Tech_{ij}$.[29] We then build an aggregate measure of the potential benefits a local sector may derive via technology linkages from growth of the surrounding local economy resulting from US trade liberalization:

$$Techlink_{ict} = \frac{\sum_{j \neq i} Emp_{jc1998} * TariffGap_{j1998} * Tech_{ij}}{\sum_{j \neq i} Emp_{jc1998}} * Post_t \tag{2.14}$$

The logic of the aggregate measure above is similar to the ones developed to capture output and labor linkages: we expect a sector to reap greater benefits from WTO accession via technology linkages if industries that are likely to generate relevant knowledge spillovers have a strong local presence and experience large improvements in their access to US markets.

[29] Our measure of sectoral pairwise technology linkages is akin to the $TechIn_{i \leftarrow j}$ measures constructed by EGK (2010). Again, as in the case of labor linkages, measures of technology linkages for the Chinese case are not available, so we use the linkages measure on US data as a benchmark.

Search Linkages To the three types of linkages identified in EGK (2010) we add another, "Search Linkages", that may be relevant in our setting.[30] Theory as well as some of the evidence provided in the previous sections suggests that one effect of WTO accession may be the integration of Chinese producers into global value chains. As US market access improves for a particular sector, we can expect foreign firms to engage in search activities aimed at identifying potential Chinese partners in that sector. As a result, cities that have a heavy exposure to sectors that experience large improvements in trading conditions vis-a-vis the United States may be expected to be the object of more intense search activities. Due to these local search activities, we may in turn expect firms located in these cities to have a higher likelihood of being integrated into global value chains, even when conditioning on the own sector improvements in US trading conditions brought about by the WTO accession. Moreover, we may expect these indirect effects to be strongest for firms that have similar clients to the nearby sectors that experience large improvements is US market access.

In order to check for the operation of this mechanism, we first devise a pairwise measure of "client similarity" between sectors. We first construct, for each sector, an "adjusted output share" vector that reflects the proportion of the output sold outside the own sector that is delivered to each of the other sectors.

$$AdjSales\_Share_{ij} = \begin{cases} 0 \text{ if } j = i \\ \frac{Sales\_Share_{ij}}{1-Sales\_Shareii} \text{ if } j \neq i \end{cases} \tag{2.15}$$

Then, for each pair of sectors we could construct a $Sales\_Similarity_{ij}$ index according to the formula

$$Sales\_Similarity_{ij} = Correl_{\forall k \neq i,j}(Sales\_Share_{ik}, Sales\_Share_{jk}) \tag{2.16}$$

According to this measure, two sectors are considered to have similar clients if, ignoring themselves and each other, their adjusted output share vectors are similar. For each prefecture-industry cell we build an aggregate measure of exposure to WTO accession

[30]For a more detailed treatment of the role of search frictions in trade see Chaney (2014).

via "search linkages" as

$$Searchlink_{ict} = \frac{\sum_{j \neq i} Emp_{jc1998} * TariffGap_{j1998} * Sales\_Similarity_{ij}}{\sum_{j \neq i} Emp_{jc1998}} * Post_t \tag{2.17}$$

Intuitively, we expect a prefecture-industry cell to derive larger benefits from WTO accession via search linkages when sectors with which that industry shares a substantial fraction of its clients have a strong local presence and experience large improvements in their access to US markets following China's WTO accession.

After computing the above measures of prefecture-industry cells' indirect benefit from WTO accession via various channels we proceed to assess the importance of these linkages in the transmission of our trade shock. We augment our baseline empirical model in equation (2.9) above with the four "spillover terms" described above and estimate specifications of the type:

$$\begin{aligned} y_{ict} = \beta_0 + \beta_1 TradeLib_{it} + \beta_2 Outputlink_{ict} + \beta_3 Laborlink_{ict} \\ + \beta_4 Techlink_{ict} + \beta_5 Searchlink_{ict} + \rho Z_{ct} + \gamma_{ic} + \delta_t + \epsilon \end{aligned} \tag{2.18}$$

The results of this exercise are presented in table 2.10. Additional results for alternative specifications are presented in tables 2.B.1 and 2.B.2.[31] We find strong evidence in support of the operation of labor market linkages, with the $Laborlink_{ict}$ terms highly significant across specifications. Prefecture-Industry cells whose surrounding local economies experience large improvements in US market access and which employ similar types of labor as the bulk of the surrounding economy exhibit rapid growth in employment, output, sales and exports. They also experience entry, entry into exporting and increases in investment activity.

Quantitatively, spillovers transmitted through labor linkages account for virtually the entirety of the (positive) local spillovers previously identified via the simple specifications given by (2.10). This finding is somewhat surprising, as labor market linkages were perhaps more likely to produce substantial congestion effects, with sectors

[31]Table 2.B.1 includes results from specifications that add a battery of sector-specific tariff policy variables as controls, while specifications in Table 2.B.2 include both tariff policy controls and lagged dependent variables that control for potential mean reversion. Results are similar.

VARIABLES	(1) Ln(Emp)	(2) Ln(Output)	(3) Ln(No firms)	(4) Ln(No Exp)	(5) Ln(Fix Asset)	(6) Ln(Exp.)
Ind Trade Lib	0.00427	0.00392	0.00455*	0.00233	0.00120	-0.00226
	(0.00403)	(0.00781)	(0.00270)	(0.00154)	(0.00405)	(0.00805)
Lib via Output Link	0.164	-0.360	0.346**	-0.0214	0.323	-0.369
	(0.161)	(0.285)	(0.142)	(0.109)	(0.198)	(0.414)
Lib via Labor Link	0.0537***	0.0368***	0.0303***	0.0529***	0.0318***	0.140***
	(0.0109)	(0.0133)	(0.00882)	(0.00736)	(0.0104)	(0.0221)
Lib via Tech Link	0.0145	-0.291	0.153	0.129	0.200	0.850***
	(0.168)	(0.272)	(0.0988)	(0.0997)	(0.143)	(0.321)
Lib via Search Link	-0.0783**	0.0403	0.00773	-0.00988	-0.0725**	-0.124**
	(0.0319)	(0.0415)	(0.0198)	(0.0141)	(0.0306)	(0.0620)
Observations	24,108	24,114	24,114	24,114	24,036	24,114
R-squared	0.029	0.557	0.242	0.114	0.178	0.068
Number of pref-ind.	12,054	12,057	12,057	12,057	12,018	12,057
Pref-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: All outcomes at the prefecture-industry level
Standard errors double clustered at the industry and prefecture level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.10: Alternative Spillover Channels

crowded out when demand for relevant workers from other industries increases as a result of the reform. We find that the opposite is true, which is nevertheless consistent with some of our earlier findings that indicated a limited role for congestion forces in our setting (e.g., our city-level wage results).

The positive spillovers operating through labor linkages may reflect thick market effects. Labor matches improve for sectors that benefit from bigger local workforces because relevant workers are drawn to the local economy by growth in labor-linked sectors. Our labor linkage findings may also reflect the effects of knowledge spillovers, as workers benefit from being in close proximity with a larger pool of other workers engaged in the same occupations. This type of knowledge spillovers among workers are different in nature from the type of technological spillovers among firms and sectors that we aim to capture with our technology linkages terms. However, it is possible that the $Laborlink_{ict}$ spillover terms capture some of the variation that we would have liked to pick up in our technology spillover terms ($Techlink_{ict}$), which may explain the weaker results found for the latter.

We also find suggestive evidence that output and technology linkages play a role in shaping the transmission of the trade shock brought about by WTO accession to local economies. The evidence is particularly strong in the specifications that include trade policy controls and allow for mean reversion in the dependent variables (see table 2.B.2). However, we find little support for search linkages as an important channel of transmission of our trade policy shock of interest to regional economies in China.

2.5.2 Local Spillovers to the Non-tradable (Services) Sector

In this section we explore in greater detail the transmission of the trade policy shock induced by WTO accession to the non-tradable sector of local economies. Our results in section 2.4.3 provide suggestive evidence that local service sectors derive significant benefits from improvements in US market access affecting nearby manufacturing activities. Here we aim to shed additional light on the mechanism through which spillovers from the tradable to the non-tradable sector take place, as well as to assess which non-tradable activities stand to benefit the most from WTO membership.

While the availability of data on the service sector is significantly more limited than for manufacturing, we can make use of our detailed data for manufacturing firms to test for the most theoretically salient potential channel of transmission of the trade shock of interest to local services: demand linkages from the manufacturing sector to the local service sector. As local manufacturing grows as a result of improved trading conditions with the US, we can expect the demand for local services by manufacturing firms to increase and bring about growth in these activities.

To test for the operation of this mechanism, we make use of the Chinese Input-Output tables which contain information on service use by various sectors. We construct a measure of the predicted demand shocks affecting the local service sector as a result of improvements in US market access as

$$ServiceOutputlink_{ct} = \frac{\sum_j Emp_{jc1998} * TariffGap_{j1998} * Outputshare_{sj}}{Emp_{c1998}} * Post_t \tag{2.19}$$

where the $Outputshare_{sj}$ variables are defined analogously to the $Outputshare_{ij}$ variables used in the computation of output linkages in the previous section; namely as the share of service sector output sold to manufacturing sector j. Intuitively we expect the local service sector to experience larger demand shocks as a result of WTO accession when nearby manufacturing makes heavy use of services as inputs and experiences substantial improvements in access to US markets. We proceed to relate the evolution of tertiary sector employment across cities to this measure of expected local service sector demand shocks by estimating specifications of the type:

$$TertiaryEmp_{ct} = \beta_0 + \beta_1 ServiceOutputlink_{ct} + \rho Z_{ct} + \theta * Post_t * X_{c1998} + \gamma_c + \delta_t + \epsilon_{ct} \quad (2.20)$$

The results of this exercise are presented in Table 2.11 and provide strong evidence of demand linkages between manufacturing and local service sectors. Our measure of local demand shocks due to WTO accession is a strong predictor of service sector employment growth at both the city and prefecture levels. A one standard deviation increase in the magnitude of the predicted local demand shocks induced by trade liberalization is associated with an increase in tertiary employment of more than 13% at the prefecture level and more than 21% at the level of central cities.

After confirming the presence of substantial linkages between manufacturing and the local service sector, we proceed to analyze in greater detail which activities within the service sector stand to benefit the most from WTO accession. This task is facilitated by the China City Statistical Yearbooks which provide a breakdown of tertiary (service) sector employment into constituent subsectors.[32] We relate changes in employment for each activity within the service sector across cities to improvements in US market access using our preferred city level specifications given by (2.8). The results of this exercise are outlined in table 2.B.3.

Our findings indicate that the effects of WTO accession, mediated by local spillovers, on activities within the service sector are broad-based. Most non-tradable activities (Construction; Finance; Government; Education and Social Services; Sales and Catering) display rapid growth at the locations most affected by WTO membership. Public Utilities; Geological Prospecting, Water Conservation, Scientific Research and Poly-

[32]Due to changes in the breakdown of tertiary sector employment into constituent sectors across different yearbooks, we are forced to perform some aggregation of subsectors. We are left with the following subsectors on which we conduct our analysis: Public Utilities; Construction; Finance; Government; Geological Prospecting, Water Conservation, Scientific Research and Polytechnic Services; Education and Social Services; Sales and Catering; Real Estate, Leasing and Commercial Services

VARIABLES	(1) ln(Pref Tertiary Emp.)	(2) ln(City Tertiary Emp.)
Lib via Service Output Link	0.0833***	0.126***
	(0.0176)	(0.0267)
City Avg. Export Tariff	0.198**	0.208***
	(0.100)	(0.0771)
Observations	438	438
R-squared	0.713	0.548
Number of cities/pref.	219	219
City FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.11: Spillovers to the Service Sector via Local Demand Linkages

technic Services; and Real Estate, Leasing and Commercial Services are the exceptions. The Sales and Catering and Construction sectors are the largest beneficiaries of WTO membership. This is intuitive given that these activities can be considered among the least tradable and thus most likely to completely capture the increase in local demand brought about by WTO accession. Moreover, our findings concerning the construction sector are reassuring in light of our population and investment findings in section 2.4.

Among the activities for which we find little evidence of gains from WTO membership, the findings concerning the Real Estate, Leasing and Commercial sector are perhaps the most surprising, while the other two sectors (Public Utilities; Geological Prospecting, Water Conservation, Scientific Research and Polytechnic Services) can be considered to be intrinsically less sensitive to local economic conditions. The results concerning the Financial sector are perhaps the most interesting in light of our previous findings, and we proceed to discuss them in greater detail in the next section.

2.5.3 Local Spillovers and Financial Sector Growth

In the context of our results concerning investment in section 2.5, our finding of substantial growth in financial sector employment in locations most affected by the US trade policy commitment is significant. Taken together, these two findings raise the prospect of the operation of an investment-financial development channel in the transmission of our trade shock of interest to local economies. In this scenario, improvements in US market access may bring about an increase in local investment demand, as entrepreneurs move to take advantage of the opportunities provided by improved trading conditions with the US (or alternatively incumbents in affected sectors move to enter export markets and expand capacity). In turn, growing investment activity may result in an increase in demand for credit and other financial services. The local financial sector expands to meet this demand.

To shed light on the plausibility of this scenario, we proceed in three steps. First, we build on the work of Rajan and Zingales (1998) and construct an index of financial dependence of the manufacturing sectors of Chinese local economies. This index is computed as a local weighted average of the financial dependence of the constituent manufacturing sectors, with weights represented by pre-reform (1998) city-level employment in each sector. Formally our measures of local manufacturing financial dependence are defined as:

$$FinDep_{c1998} = \frac{\sum_j Emp_{jc1998} * FinDep_j}{Manuf.Emp_{c1998}} \tag{2.21}$$

where $FinDep_j$ represents the financial dependence of sector j according to Rajan and Zingales (1998).[33]

Second, we construct two additional variables that can help us track whether developments in the locations most affected by the reform are consistent with investment demand driven financial sector growth: total liabilities of the local manufacturing sector and total debts of the local manufacturing sector. These variables are built for every location by aggregating firm level balance sheets available from the ASIF.

Finally, we augment our preferred empirical specification with an interaction term between city-level exposure to US trade liberalization and our measure of local financial dependence. We use this expanded empirical model to study the evolution of financial sector employment, total liabilities of the local manufacturing sector and total debts of

[33] As sectoral financial dependence is available in the 3 digit ISIC revision 2 sectoral classification in Rajan and Zingales (2008), we have to perform a matching and aggregation procedure with our city-sector employment data, which is available at the level of the 4 digit ISIC Revision 3 classification. More details about this procedure are available in the Data and Variable Construction Appendix.

the local manufacturing sector across cities. Formally, we estimate specifications of the type:

$$\begin{aligned} y_{ct} = \alpha + \beta_1 TradeLib_{ct} + \beta_2 TradeLib_{ct} * FinDep_{c1998} + \rho Z_{ct} \\ + \theta * Post_t * X_{c1998} + \gamma_t + \delta_c + \epsilon_{ct} \end{aligned} \tag{2.22}$$

Intuitively, if WTO accession brings about demand driven financial sector growth, we would expect to observe that improvements in trading conditions with the US are associated with both increases in aggregate borrowing and expansions in financial sector employment at the local level. Moreover, we would expect these effects to be stronger, ceteris paribus, for locations with a large exposure to financially dependent sectors. We present the results of implementing the specifications given by (2.22) above in Table 2.B.4.[34]

Our findings support the hypothesis that improvements in trading relations with the US resulted in an investment demand driven expansion of the financial sector. Locations that benefit more from the elimination of some of the "trade cooling" features of the pre-WTO US trading regime experience larger increases in manufacturing sector borrowing and larger expansions in financial sector employment. Moreover, once we add the interaction term between the extent of US market access improvements and local financial dependence to our analysis, we find that these effects occur only in locations that display relatively elevated levels of financial dependence. This finding adds additional weight to our interpretation of results as reflecting the operation of an investment demand channel through which WTO membership brings about financial sector growth.

2.6 Migration and Local Labor Supply Elasticities

Our results in section 2.4 indicate that the adjustment of local economies to US trade liberalization occurred primarily on the quantity margin. Employment and population grew sharply, while effects on the price (i.e. wage) margin were limited. These results stand in contrast with the findings of previous work that investigates the local labor

[34]To make sure that our interaction term of interest in specifications of the type given by (2.22) does not pick up differential trends in the outcome variables for locations with different levels of financial dependence, we control for the potentially time varying effects of initial (1998) city-level financial dependence in these regressions.

market effects of international trade shocks (Topalova 2007, 2011; Kovak 2013; Autor, Dorn and Hanson 2013 etc.). Typical findings in this literature are that trade shocks have sizable price (i.e., wage) effects on local labor markets but muted quantity (i.e., employment and/or population) effects. In this section we provide a brief discussion of the potential drivers of our different results and their implications.

As previously mentioned, our wage results are difficult to interpret in the presence of large migratory responses of the type we find in our setting. In what follows we focus our discussion on the potential determinants of the large migration flows and the associated high local labor supply elasticities revealed by our analysis. There are at least two particularities of our setting that may help account for this finding. The first is that we are, to the best of our knowledge, the first to study the effect of a trade liberalization shock across local labor markets in China. China displays some unique features during our period of analysis. In particular, the balance of opinion in the literature analyzing China's labor markets is that at least until very recently the Chinese economy has operated in a Lewis (1954)-type regime, in which the abundance of cheap migrant labor from rural areas has limited wage growth and has fueled the growth of the export sector (Yao 2010; Chan 2012).[35] This view is supported by the fact that, in spite of the strictures of the *hukou* (or household registration) system China experienced the largest rural to urban migration in history over the last three decades (Chen, Jin and Yue 2010).

A second potential explanation for the difference between our results and those of most existing work relates to the sign of the shock we analyze. Unlike most prior studies, we study the impact of a positive trade shock on local labor markets. As Glaeser and Gyourko (2005) noted, housing (and implicitly labor) supply elasticities are likely to be much higher in the face of positive shocks than in the face of negative shocks because housing is a durable good. This type of asymmetry in housing supply elasticities to different types of shocks may in turn help account for the high local labor supply elasticities we find.

Our findings may still, however, be considered surprising given the continued importance of the *hukou* system during our period of analysis.[36] To shed additional light

[35] In fact, the debate about whether or not China has reached the "Lewis Turning Point" continue even today.

[36] However, it is important to note that a significant reform of the *hukou* system took place between 1997 and 2002. This reform brought a substantial relaxation of the constraints imposed by the system, which may help account for our findings. For more details see Wang (2004).

on this issue we use data at different levels of spatial aggregation to perform a more detailed investigation of migration patterns. We first check if a substantial fraction of the migration effects we identify at the city level reflect within-prefecture migration. To do this, we re-run the analysis of our main local outcomes of interest but use prefectures as our geographic unit of analysis. Intuitively, if a significant share of the migration response to US trade liberalization occurs within prefectures, we would expect to see the effects of improvements in foreign market access on population growth to be smaller at the prefecture level. Results are presented in table 2.C.1. We find that the relationship between improved foreign market access and local population growth is much weaker at the prefecture level, which is consistent with most of the migration we detect in our city level analysis being within prefecture. This finding is reassuring, given that the restrictions imposed by the hukou system are less severe for within prefecture migration (see Baum-Snow, Brandt, Henderson, Turner and Zhang 2015).

We also proceed to analyze patters of cross-prefecture migration in response to China's WTO accession. For each prefecture in our sample we construct a measure of the US market access improvements experienced by neighboring locations after WTO accession. We compute this measure as the average of prefecture-level exposures to US trade liberalization for all prefectures located in the same province as the prefecture under analysis:

$$NeighborTradeLib_{ct} = \frac{\sum_{t \in Prov; t \neq c} TariffGap_{c1998}}{\sum_{t \in Prov; t \neq c} 1} * Post_t \tag{2.23}$$

We then proceed to estimate specifications of the type:

$$\begin{aligned} y_{ct} = \alpha &+ \beta_1 TradeLib_{ct} + \beta_2 NeighbourTradeLib_{ct} + \rho Z_{ct} \\ &+ \theta * Post_t * X_{c1998} + \gamma_t + \delta_c + \epsilon_{ct} \end{aligned} \tag{2.24}$$

for our main outcome variables of interest at the local level. These specifications add our measure of neighbors' improved US market access as an additional variable to our preferred empirical set-up. If improvements in US market access bring about substantial inter-prefecture migration, we would expect to find a negative coefficient on the $NeighborTradeLib_{ct}$ variable in the population regressions; as prefectures suffer from population diversion effects towards nearby locations that experience large positive shocks as a result of WTO accession. The results of this exercise are presented in table 2.C.2. We find limited evidence of cross-prefecture migration related to US trade liberalization. The relevant coefficient in the population regressions is statistically insignificant.

The results of tables 2.C.1 and 2.C.2 also help us assess whether our findings at the city level reflect growth effects caused by improved foreign market access or spatial reallocation of economic activity in response to trade liberalization. The implications of our results are mixed. Our findings on population and employment in table 2.C.1 point towards an important role for within-prefecture reallocation of economic activity in response to US trade liberalization. However, our findings of employment growth and increased investment activity (see table 2.C.3) in prefectures most exposed to trade liberalization indicate that not all our city-level results can be accounted for by within prefecture reallocation. In turn, results in table 2.C.2 suggest a limited role for cross-prefecture reallocation of economic activity as a result of WTO accession. Overall, while the analysis of the aggregate effects of WTO membership is difficult in the absence of a quantitative general equilibrium model, the balance of our results indicates that WTO accession had a positive aggregate effect on the Chinese economy.

All in all, our local labor market findings deliver an optimistic message but also a cautionary note. While import competition studied by previous work generates geographically concentrated losses and sluggish spatial reallocation of factors in developed country settings, at least in the case of China improvements in access to foreign markets seem to bring about widely shared benefits and rapid reallocation of factors in response to the new economic environment. Moreover, our results indicate that congestion effects are small, and thus have only a minor impact on the overall welfare implications of trade liberalization. However, the fact that much of the migration effects of the reform seem to occur within prefectures raises the concern that the *hukou* system does indeed generate significant spatial mobility frictions. In the case of the event we study, within-prefecture migration seems to have been sufficient for adequate adjustment to the US trade policy shock to take place. Should other large macroeconomic shocks occur in the future, however, the constraints generated by the *hukou* system could become binding and generate substantial welfare losses.

2.7 Heterogeneous Effects

In this section we explore whether improvements in access to US markets had heterogeneous effects across cities with different initial characteristics. In particular, we aim to assess whether proximity to a port, the significance of SOEs in the local economy and the presence of a SEZ within city boundaries were important in determining the extent to which cities could benefit from improvements in trading conditions with the US.

We begin by exploring the role played by proximity to a trading gate represented by a port.[37] Intuitively, we expect that cities closer to such trading posts should benefit more from WTO membership as they have easier access to the now more accessible US market. In order to test this hypothesis we augment our preferred specification with an interaction term between our city-level measures of US trade liberalization and a measure of distance to the nearest port. Thus, we estimate models of the type:

$$\begin{aligned} y_{ct} = \alpha + \beta_1 TradeLib_{ct} + \beta_2 TradeLib_{ct} * Dist\_Port + \rho Z_{ct} \\ + \theta * Post_t * X_{c1998} + \gamma_t + \delta_c + \epsilon_{ct} \end{aligned} \tag{2.25}$$

Tables 2.D.1 and 2.D.2 present the results of this exercise. The evidence supports the hypothesis that WTO accession brought larger benefits, ceteribus paribus, to cities located closer to international trading gates. We find strong evidence that cities located further away from ports exhibit slower growth in output than otherwise comparable cities subject to similar exposure to US trade liberalization but located closer to ports. We also find suggestive evidence that these locations exhibit slower population, employment and investment growth (at the prefecture level, the finding of smaller benefits in terms of employment growth for locations further away from trading gates is statistically significant at conventional levels).

We proceed to analyze the role played by the local presence of SOEs in determining the response of cities' economies to easing constraints imposed by the post-WTO accession US trading regime. Evidence from existing work (Brandt, Van Biesenbroeck, Wang and Zhang 2012; Feng, Li and Swenson 2014) indicates that SOEs in China tend to benefit less from trade liberalization (and associated reforms) than non-SOEs. Trans-

[37]For a more detailed analysis of the role of trading gates in driving patterns of specialization and the spatial configuration of economic activity in a Chinese context see Cosar and Fajgelbaum (2014).

lated into our setting, this may lead us to expect smaller benefits from improved access to US markets for locations where SOEs have a stronger presence. It is even possible that locations with heavy exposure to SOEs may lose from WTO accession, as trade liberalization may encourage entry into the most positively affected sectors by more efficient private firms. In turn, these entrants might crowd out the SOEs that dominate production in cities with large SOE presence and lead to a decline in the economic fortunes of these locations. To shed some light on these issues we proceed to estimate specifications of the type

$$y_{ct} = \alpha + \beta_1 TradeLib_{ct} + \beta_2 TradeLib_{ct} * SOE\_share_{c1998} * Post_t + \rho Z_{ct} + \theta * Post_t * X_{c1998} + \gamma_t + \delta_c + \epsilon_{ct} \quad (2.26)$$

where our preferred empirical model has been augmented with an interaction term between our city-level trade liberalization measure and cities' initial (1998) share of employment accounted by SOEs.

Results are presented in Tables 2.D.3 and 2.D.4. Our findings support the idea that locations with large SOE presence benefit less from improvements in trading conditions with the US. We find evidence that, ceteribus paribus, locations with a higher share of their employment in SOEs display lower growth in investment and output as a result of WTO accession than comparable cities with reduced SOE exposure. We also find suggestive evidence that these locations exhibit slower population and employment growth. The magnitude of the coefficients on the interaction term is often large, and thus consistent with the idea that some local economies with particularly large SOE presence may have been hurt by improved access to US markets.

Finally, we complete this section with an analysis of the role of cities' SEZ status in shaping the local economic impact of WTO accession. A priori, the effects of SEZ status are ambiguous, as it is straightforward to describe potential mechanisms that may cause SEZ status to be act as a complement or substitute for the liberalization of the US trading regime. Thus, it is conceivable that cities that contained SEZs and benefited from the corresponding regulatory (and tax) advantages did not experience a binding constraint from the features of the pre-WTO US trade regime, and as a result stood to benefit (relatively) less from trade liberalization. However, it is equally possible that WTO accession brought about an increased level of internationalization of the Chinese economy, with cities that contained SEZs being particularly well placed to benefit from this development. In a similar vein to the analyzes above, we aim to shed light on this issue by estimating an empirical model of the type:

$$y_{ct} = \alpha + \beta_1 TradeLib_{ct} + \beta_2 TradeLib_{ct} * SEZ_{c1998} + \rho Z_{ct} + \theta * Post_t * X_{c1998} + \gamma_t + \delta_c + \epsilon_{ct} \tag{2.27}$$

where SEZ_{c1998} is a dummy variable indicating whether city c contained a SEZ at the start of our period of analysis (1998). The results of this exercise are outlined in Tables 2.D.5 and 2.D.6. Overall, our results offer only limited evidence in support of cities' SEZ status playing a role in the response of local economies to improvements in US market access. Moreover, our findings are mixed. Cities that contain a SEZ within their boundaries benefit less from WTO membership than comparable non-SEZ locations in terms of employment growth, but exhibit larger gains from trade liberalization in terms of output and investment.

2.8 Robustness and Alternative Specifications

In this section we revisit our city-level analysis and implement a number of robustness checks and alternative specifications that aim to address a number of concerns regarding omitted variable bias, measurement as well as issues pertaining to data quality. We organize our discussion in 3 parts: Section 2.8.1 reports robustness checks aimed at mitigating concerns related to omitted variable bias and potential outliers. Section 2.8.2 proposes an alternative measure of city-level exposure to US trade liberalization that arguably better captures China's patterns of comparative advantage and the importance of US markets for China's industrial sectors. Finally, section 2.8.3 aims to address some data quality concerns and implements a number of cross-checks employing census data.

2.8.1 Robustness Checks

2.8.1.1 Dropping Provincial Level Cities

In our baseline analysis in section 2.4 we study a sample of 226 cities over the period 1998 to 2007. Among these we include the 4 provincial level cities of Beijing, Tianjin, Shanghai and Chongquing. However, a sizable literature in urban economics (Ades and Glaeser 1995, Davis and Henderson 2003) has found that biases towards politically favored cities may be important drivers of local economic development; and recent work by Chen, Henderson and Cai (2015) has identified markers of sizable political biases towards provincial-level cities in China. To address the concern that our results may be driven by provincial level cities, in Table 2.E.1 we report results obtained from implementing our baseline empirical specification on a sample that excludes these cities. All our main results go through unaffected.

2.8.1.2 Controlling for the Initial Share of Employment in SOEs

From the mid 1990s, Chinese authorities began to cut the formerly close ties that bound government and state owned enterprises (Naughton 2007). As a result, SOEs faced increased product market competition and pressure, on the one hand, and reduced access to funding from government banks, on the other. SOEs adjusted to these shifts in policy by downsizing and restructuring. This process of restructuring was encouraged by the government as part of a shift of the overall policy regime towards greater emphasis on deepening economic reforms. Indeed, according to observers of China, this period marks a shift from commitment to a policy of "reforms without losers" to the willingness of Chinese authorities to accept "reform with losers".

In turn, the process of SOE restructuring had important implications for urban economies across China. Due to the scale of the downsizing and the important role played by SOEs in urban labor markets at the time, for a few years official statistics show that aggregate formal urban employment may have actually declined. Given the proximity of this reform to our period of analysis, we check the robustness of our population and employment findings to controlling for the time-varying effects of each city's initial exposure to SOEs, proxied by each city's initial (1998) share of employment in SOEs.

Results are presented in Table 2.E.2. We find that controlling for the initial SOE share of employment reduces our coefficient of interest in the city population regression by about a third, but it remains highly statistically significant. For the case of the broad employment regressions, the coefficient of interest actually increases in magnitude by about a fifth and remains highly significant. Surprisingly, the introduction of the SOE controls significantly alters the results in our regression on narrow employment, with our coefficient of interest declining sharply in magnitude and becoming statistically insignificant. All in all, our results remain consistent with improvements in US market access having sizable effects on economic development across Chinese localities.

2.8.1.3 Further Controls for Initial Sectoral Composition

One concern raised by the shift-share (or Bartik 1991) methodology employed in this chapter is that results may be driven by underlying trends in the outcome variables of interest that are associated with differences in pre-reform employment composition used in the computation of our measures of US market access improvement. One approach used in the literature to mitigate this concern (see McCaig 2011) is to control for the potentially time varying effects of differences in initial sectoral composition measured at a higher level of sectoral aggregation than that used in the computation of city-level shocks. We perform this exercise by adding controls for the initial shares of 2-digit ISIC manufacturing sectors interacted with a time dummy to our baseline specifications.

Results are presented in Table 2.E.3. Again, all of our findings go through virtually unchanged, with the magnitude of the coefficients preserved. The only substantial change in the coefficients of interest occurs in the population regressions, where it declines by about a third, but remains highly significant.

2.8.1.4 IV Strategy to Account for Variation in the Size of The Non-tradable Sector

Another potential concern regarding our empirical strategy relates to the construction of our city-level measures of US trade liberalization. These metrics have the nature of scaled indices that vary both with the relative size of the local manufacturing sector and with its composition. Formally, our baseline measure of city-level exposure to US trade liberalization brought by China's WTO accession is given by

$$TradeLib_{ct} = \frac{\sum_i Employment_{i,c,1998} * TariffGap_{i1998}}{TotalEmployment_{c,1998}} * Post_t$$

where crucially in the computation of the index the final normalization is performed by dividing by *total* city employment. As a result of normalizing by total city employment our measure of improvements in foreign market access is negatively correlated with the size of the local non-tradable sector. To the extent that the size of the local non-tradable sector is in turn correlated with our dependent variables of interest, the coefficients on our variable of interest may be biased.

To mitigate this concern, we follow the strategy suggested by Topalova (2007) and separate out the variation in our variable of interest that is due to cities' sectoral composition *within* manufacturing, from the variation emerging from the overall size of the manufacturing sector relative to non-manufacturing. To do this, we implement IV specifications where we employ an unscaled measure of exposure to US trade liberalization given by

$$Tr\_TradeLib_{ct} = \frac{\sum_i Employment_{i,c,1998} * TariffGap_{i1998}}{ManufacturingEmployment_{c,1998}} * Post_t \qquad (2.28)$$

as an instrument for our baseline scaled measure. Note that in the computation of the unscaled measures of city-level exposure to potential US tariff hikes, manufacturing employment at the city level replaces overall employment in the denominator. Results from the estimation of these alternative specifications are reported in Table 2.E.4. Our main results concerning population, employment and investment go through virtually unchanged (if anything the employment results are strengthened). The only exception is represented by the city-level output regressions, where the magnitude of the coefficient on our variable of interest declines by about half and is no longer statistically significant at conventional levels.

2.8.1.5 Controlling for changes in Non Tariff Barriers - The Multi-Fiber Agreement (MFA)

While China's accession to the WTO did not bring substantial changes to the *applied* tariff policy of its major trading partners, it did bring about changes in the non-tariff barriers faced by Chinese exporters. In particular, upon accession to the WTO China became eligible to the provisions of the Multi-Fiber Agreement which had been agreed by WTO members and stipulated gradual phasing out of quotas for a range of products (mostly textiles).[38] To the extent that exposure to the phasing out of quotas is correlated with exposure to US trade liberalization related to China's WTO accession, this may

[38] For more details on the Multi-Fiber Agreement see Brambilla et al. (2009)

pose a threat to our identification. To alleviate this concern we recompute our measures of city-level US trade liberalization and exclude sectors affected by the phasing out of quotas from the computation. This alternative measure of improvements in US market access (which we denote $TradeLib\_Non - MFA_{ct}$) should therefore be uncorrelated with declines in exposure to export quotas at the level of local economies. We then proceed to re-run our preferred city level analysis with $TradeLib\_Non - MFA_{ct}$ as our main explanatory variable of interest. We present our results in Table 2.E.5. All of our main results are robust to this check, with the magnitudes of the coefficients of interest increasing in all regressions.

2.8.2 Alternative Measure of Local Exposure to the Reform

A potential limitation of our baseline analysis is that our main measure of improvements in access to US markets fails to take into account China's patterns of comparative advantage, as well as any considerations related to the importance of US markets for various Chinese sectors. For each industry, the removal of uncertainty surrounding access to US markets can be considered equivalent the elimination of a constraint. However, for some sectors the initial constraint may not have been binding, as China may have not been a competitive exporter in those sectors even in the absence of the trade dampening features of the US pre-WTO trading regime. Furthermore, even for sectors in which China did have comparative advantage, we expect the effect of improvements in US market access to be more significant for sectors that are heavily dependent on exports to the US.

To address this concern, we propose an alternative measure of city-level improvements in US market access. We alter our baseline measure by weighting the contribution of each sector to the index by the sector's initial exposure to the US market.[39] This mod-

[39] A similar approach to measuring the exposure of local labor markets to trade policy reforms is employed in Kovak (2013) who weighs changes in import tariffs during Brazil's trade liberalization by the sectoral import penetration when building his regional level tariff measures for Brazil. He finds that this modified measure is a much better predictor of price changes across sectors in Brazil than a baseline measure that does not take into account the "intensity of the treatment" at the sectoral level.

ified measure of US trade liberalization is given by:

$$Exposure\_TradeLib_{ct} = \frac{\sum_i Employment_{i,c,1998} * TariffGap_{i1998} * Exposure_{i,1998}}{TotalEmployment_{c,1998}} * Post_t \quad (2.29)$$

The sectoral level additional weights employed above, $Exposure_{i,1998}$ are described by the expression:

$$Exposure_{i,1998} = \frac{Exports_{US,i,1998}}{Output_{i,1998}} \quad (2.30)$$

where $Exports_{US,i,1998}$ denotes the value of China's exports to the US in sector i at the beginning of our period of analysis (1998), while $Output_{i,1998}$ denotes sector i's initial period total output.

We proceed to re-run the main stages of our analysis using the alternative measure of local exposure to US trade liberalization defined above. The results of this exercise are reported in tables 2.E.6 to 2.E.9.

Our findings from this exercise largely match our baseline results. Cities more exposed to US market access improvements experience faster population, employment and output growth as well as increased investment activity. The local tradable (secondary) sector and the tertiary (non-tradable) sector benefit from the reform in equal measure. We find no evidence that the primary sector benefits from WTO membership, with point estimates for agriculture being negative. The detailed analysis of non-tradable sector employment again reveals that reductions in US market access uncertainty contribute to broad based growth across tertiary sector activities.

Perhaps the most striking difference relative to our baseline analysis is that we now identify a substantially stronger negative relationship between exposure to US market access improvements and local average wage growth. However, this finding is not robust to the introduction of further controls, as the results of table 2.E.7 show. This table reports the results of a specification that controls for the initial composition of employment at the level of 2-digit ISIC sectors (i.e. this specification is comparable with that undertaken in Robustness Check 3 - see table 2.E.3). All in all, we conclude that our main findings are robust to specifications that employ the proposed alternative measure of US market access improvements.

2.8.3 Cross-Checks Using Census Data

In this section we aim to address some issues related to the quality of the data used in our baseline analysis. Of particular concern is the fact that the city and prefecture population counts reported in the City Statistical Yearbooks often capture only cities' *de jure* populations, i.e. the number of people with local *hukou* registration. Given that the last two decades have seen substantial non-*hukou* migration within China, discrepancies between the *de jure* and the *de facto* populations of Chinese cities can be substantial, with potentially important implications for our results. Moreover, the presence of this issue also raises concerns about the reliability of the employment measures provided in the China City Statistical Yearbooks.

To address these concerns we turn to census data, which should capture the de facto population of China's administrative units.[40] We study the evolution of population and employment, as measured in the censuses, across prefectures and focus on the period covered by the last two "long censuses", namely 2000 to 2010[41]. Moreover, the use of census data also allows us to extend our analysis to two other variables that are of interest in light of our previous results: migration and unemployment.

Unfortunately, the study of migration permitted by census data is limited, as we are only able to observe the local stock of long-distance migrants, namely the number of individuals within a prefecture who report coming from a different *province*. We compute (long distance) migrant shares at the level of Chinese prefectures by dividing the stock of out-of-province migrants by the total population of the prefecture. We also compute local unemployment rates for Chinese prefectures. The study of local unemployment is of interest in its own right but also aids the interpretation of some of our previous results, particularly those related to employment and wages.

The results of our census based cross-checks for population and employment, as well as our new results on migration and unemployment are outlined in Table 2.E.10.[42]

---

[40]We only have reasons to expect that census data will be superior to CSY data for the population numbers. However, given the concerns about China's employment numbers (see Banister 2005) we find it useful to also run Census cross-checks for employment.

[41]As our census data is available in county tabulations format only and given that matching counties to central cities may be associated with additional measurement error, the results reported in this section are at the prefecture level only. Preliminary results at the level of multiple definitions of central cities are available from the authors upon request and are similar to the findings reported for prefectures.

[42]The results in Table 2.E.10 come from estimating specifications similar to our preferred set-up with controls (see equation (2.8)). However, since we do not have access to pre-reform census data, we are

When interpreting these findings it is important to note that they come out of regressions that are run on prefecture-level outcomes. As a result they are only comparable to the results reported in Table 2.C.1.

Our findings confirm that improvements in access to US markets were associated with faster population and employment growth. While our estimates from the population regressions are similar in magnitude to the ones found in the analysis using data from the City Statistical Yearbooks (but are now statistically significant), the magnitude of our coefficient on interest in the employment regressions declines sharply. However, it remains highly statistically significant and economically meaningful. This casts some doubt on the reliability of employment numbers in the China City Statistical Yearbooks but otherwise provides additional support for our main findings.

We also find that prefectures that experience larger improvements in their trading conditions with the US exhibit increases in the share of local populations represented by (long distance) migrants. Coupled with our populations findings, our census based analysis provides support for the view that the US trade policy reform brings about long-distance migratory flows towards prefectures that benefit from the largest market access improvements. Moreover, these results add to the evidence that improved US market access spurs economic development and leads to local population increases primarily via the migration channel.

Interestingly, we fail to identify any relationship between exposure to the US trade liberalization and local unemployment rates (the point estimate is negative but small and statistically insignificant). In light of our other findings, we are led to conclude that trade liberalization associated with WTO membership is reflected in more affected Chinese local economies by increases in local labor demand that are largely accommodated via in-migration. As a result of this strong migration response, liberalization induced increases in labor demand are not reflected in tighter local labor market conditions. This latter fact is supported by our inability to detect any effects of improvements in access to US markets on either local wage growth or unemployment rates.

unable to control for pre-trends in outcome variables in these specifications.

2.9 Concluding Remarks

In this study we have sought to shed light on the role played by improvements in foreign market access in sustaining growth and modernization in a developing country. To do so, we have exploited plausibly exogenous variation across Chinese local economies in the magnitude of market access improvements brought about by China's WTO accession.

Our findings deliver several important lessons. The first is that the study of the effects of international economic integration is incomplete without a balanced analysis of both the winners and the losers from deepening globalization. While much of the existing work focuses on the adverse effects of increased import competition resulting from liberalization, we reveal the existence of substantial economic benefits from increased trade integration in the context of a large surplus economy. Moreover, our optimistic message about the opportunities provided by trade liberalization is strengthened by two additional considerations. The first is that the magnitude of the overall effects of improved market access can be large, as agglomeration effects augment the impact of liberalization on the tradable sector and there are substantial spillovers from the tradable to the non-tradable sector. The second is that, at least in the case of China, the spatial reallocation of factors required for the benefits of trade integration to be fully realized and widely shared seems to have occurred rapidly and without substantial congestion costs.

A second message delivered by our findings is the importance of accounting for trade policy uncertainty when assessing the overall restrictiveness of a trade policy regime and its potential effects on the economic prospects of trade partners. This insight is particularly timely as it may contribute to an improved understanding of the changing nature of modern trade agreements, such as the Trans-Pacific Partnership (TPP) and the Transatlantic Trade and Investment Partnership (TTIP). These increasingly tend to emphasize reducing regulatory and policy uncertainty and focus on issues such as investment and intellectual property protection, predictability of the policy environment and harmonization of regulatory standards. Moreover, a deeper understanding of trade policy uncertainty may also aid in the study of episodes of potential break-up of trade agreements, such as the proposed exit of the United Kingdom from the EU single market.

A final lesson from our results is that large episodes of trade integration can have a substantial impact on the internal economic geography of countries. Our findings indicate that WTO accession had a role in generating differential growth across different regions of China, as well as spatial reallocation of economic activity. This should be of interest to policymakers, particularly where environmental or other considerations require territorial planning.

Our study also leaves several important issues unaddressed. The first concerns explaining why the effects of large macroeconomic shocks such as China's entry into the WTO "stay local" and can be identified by analyses of local economies like the one undertaken in this chapter. Our findings indicate a relatively elevated level of factor mobility, so it is not immediately clear why new jobs created in growing sectors should remain in those sectors' historic clusters. The answer to this question is likely to involve a prominent role for the agglomeration and spillover effects that we found to be important in the transmission of the effects of WTO accession to local economies. More research is required to determine how these forces operate and how they interact with different types of economic shocks under various conditions. A deeper understanding of these forces could contribute towards methodological improvements involving the shift-share (or Bartik) instruments frequently used to analyze local labor markets.

A second open question in light of our findings is how spatial economic considerations may influence our assessment of the gains from opening up to international trade. Our results suggest that agglomeration forces and frictions to spatial mobility may have a material impact on the relevant welfare calculations. Significant departures from standard welfare analysis of trade liberalization may be required in environments in which agglomeration economies/ local spillovers are important. In these situations, adjustments to trade shocks are likely to involve "people following jobs" rather than "jobs following people". The importance of such considerations is compounded if there are large mobility frictions, as in these circumstances the welfare costs associated with the large movements of people required by adjustments to trade liberalization may be first order.

The considerations above naturally lead to questions about the settings in which adjustments to trade shocks are likely to occur most easily. Here our results suggest that frictions to spatial and sectoral mobility may interact to produce complex patterns of adjustment to trade shocks. In many developing countries geographic mobility of labor may be low as poor residents are more dependent on local support networks for their livelihoods. On the other hand, spatial and sectoral mobility are co-determined, and this leads to concerns about adaptability to trade shocks for developed countries. As these countries occupy the higher rungs of global value chains, more of their workforces are likely to exhibit highly specific skills, making inter-sectoral and spatial mobility more difficult. By contrast, in developing countries, workers often lack sector-specific skills, which lowers the costs of sectoral and spatial reallocation. Moreover, land use restrictions also play a role in shaping geographic mobility in response to major economic shocks, and these tend to be both more restrictive and better enforced in developed countries.

Last but not least, our analysis leaves unanswered an important, if technical, question about the exact mechanism driving the effects of improvements in access to US markets in our setting. As we briefly discussed in the introduction, WTO accession brought about the removal of the upper tail of the distribution of potential US tariffs faced by Chinese exporters. This in turn led to both a decline in expected tariffs (termed an "expected mean effect" by Handley and Limao 2014) and a compression of the tariff distribution (termed a "pure risk effect" by Handley and Limao 2014). It would be interesting to perform a decomposition of the economic impact of the reform studied in this chapter among these two effects, which are conflated in our current analysis.

2.10 Appendix A - Balacedness Analysis

VARIABLES	(1) ln(Pop.)	(2) ln(Emp.)	(3) Econ. Zone	(4) Coastal	(5) Rail. Dens.	(6) Highway Dens.	(7) Dist. to Port	(8) ln(GDP)	(9) ln (GDP/capita)	(10) ln(Fix. Asset)	(11) ln(Avgwage)
City Trade Lib.	0.0140	-0.0165	0.0256***	0.0117*	-0.254	0.189	-0.126**	0.0517***	0.0358***	0.0489***	0.0151***
	(0.0110)	(0.0157)	(0.00216)	(0.00665)	(0.151)	(0.166)	(0.0510)	(0.00895)	(0.00706)	(0.00849)	(0.00238)
Constant	14.86***	13.26***	0.0988**	0.0932	21.52***	13.05***	5.344***	23.35***	8.507***	22.63***	8.659***
	(0.133)	(0.266)	(0.0420)	(0.0734)	(2.260)	(2.213)	(1.056)	(0.163)	(0.104)	(0.157)	(0.0305)
Observations	226	226	226	226	226	226	226	219	219	226	226
R-squared	0.019	0.018	0.154	0.044	0.012	0.007	0.043	0.179	0.184	0.153	0.184

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.A.1: Correlations Between Initial Characteristics and City-Level Trade Liberalization

2.11 Appendix B - Local Spillovers

2.11.1 Detailed Specifications - Spillovers Within Manufacturing

VARIABLES	(1) Ln(Emp)	(2) Ln(Output)	(3) Ln(No firms)	(4) Ln(No Exp)	(5) Ln(Fix Asset)	(6) Ln(Exp.)
Ind Trade Lib	0.00405	0.000546	0.00321	0.00162	-0.00106	-0.0116
	(0.00400)	(0.00892)	(0.00251)	(0.00156)	(0.00387)	(0.00879)
Lib via Output Link	0.160	-0.329	0.346***	-0.0220	0.334*	-0.305
	(0.152)	(0.284)	(0.108)	(0.0979)	(0.180)	(0.373)
Lib via Labor Link	0.0527***	0.0352***	0.0284***	0.0523***	0.0295***	0.136***
	(0.0108)	(0.0132)	(0.00866)	(0.00715)	(0.0100)	(0.0215)
Lib via Tech Link	-0.00817	-0.354	0.103	0.113	0.134	0.700**
	(0.171)	(0.282)	(0.0952)	(0.0954)	(0.149)	(0.310)
Lib via Search Link	-0.0864***	0.0370	-0.00698	-0.0165	-0.0863***	-0.147**
	(0.0316)	(0.0413)	(0.0185)	(0.0140)	(0.0305)	(0.0620)
Ind Export Tariff	0.0144	-0.0713	0.0166	0.0215**	-0.0138	-0.0559
	(0.0402)	(0.0525)	(0.0223)	(0.0104)	(0.0399)	(0.0556)
Ind Input Tariff	0.00624	0.00920	0.0139***	0.00732***	0.0147**	0.0409***
	(0.00643)	(0.00948)	(0.00364)	(0.00272)	(0.00605)	(0.0155)
Ind Import Tariff	0.000973	-0.00208	-0.000512	-0.00243	-0.000521	-0.0178
	(0.00593)	(0.00838)	(0.00369)	(0.00193)	(0.00613)	(0.0119)
Observations	24,108	24,114	24,114	24,114	24,036	24,114
R-squared	0.032	0.560	0.256	0.120	0.184	0.072
Number of pref-ind.	12,054	12,057	12,057	12,057	12,018	12,057
Pref-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: All outcomes at the prefecture-industry level.
Standard errors double clustered at the industry and prefecture level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.B.1: Detailed Spillover Specifications, Prefecture - Industry Regressions, Controls

VARIABLES	(1) Ln(Emp)	(2) Ln(Output)	(3) Ln(No firms)	(4) Ln(No Exp)	(5) Ln(Fix Asset)	(6) Ln(Exp.)
Ind Trade Lib	0.000792	-0.00706	0.00219	0.00278*	-0.00994**	0.0108
	(0.00405)	(0.00820)	(0.00251)	(0.00165)	(0.00433)	(0.00952)
Lib via Output Link	0.239	-0.0684	0.419***	0.0465	0.615***	0.476
	(0.170)	(0.255)	(0.125)	(0.103)	(0.200)	(0.438)
Lib via Labor Link	0.0590***	0.0630***	0.0337***	0.0592***	0.0404***	0.257***
	(0.0107)	(0.0129)	(0.00867)	(0.00778)	(0.0103)	(0.0286)
Lib via Tech Link	0.592***	0.491*	0.206*	0.203*	0.989***	2.226***
	(0.207)	(0.293)	(0.107)	(0.121)	(0.231)	(0.458)
Lib via Search Link	0.0134	0.118***	0.0122	-0.00427	0.00648	-0.0927
	(0.0289)	(0.0392)	(0.0195)	(0.0156)	(0.0326)	(0.0769)
Ind Export Tariff	0.0127	-0.0660	0.0202	0.0273**	-0.0246	0.0339
	(0.0342)	(0.0480)	(0.0243)	(0.0123)	(0.0329)	(0.0762)
Ind Input Tariff	0.00705	0.00852	0.0133***	0.00651**	0.0135**	0.0405**
	(0.00536)	(0.00892)	(0.00364)	(0.00269)	(0.00543)	(0.0176)
Ind Import Tariff	-0.000333	-0.00570	-0.000841	-0.00219	-0.00310	-0.0114
	(0.00433)	(0.00717)	(0.00349)	(0.00200)	(0.00431)	(0.0139)
Observations	24,108	24,114	24,114	24,114	24,036	24,114
R-squared	0.143	0.626	0.272	0.140	0.299	0.191
Number of pref-ind.	12,054	12,057	12,057	12,057	12,018	12,057
Pref-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Mean Reversion	Yes	Yes	Yes	Yes	Yes	Yes

Note: All outcomes at the prefecture-industry level

Standard errors double clustered at the industry and prefecture level

*** p<0.01, ** p<0.05, * p<0.1

Table 2.B.2: Detailed Spillover Specifications, Prefecture - Industry Regressions, Controls, Mean Reversion Terms

2.11.2 Local Spillovers to the Service Sector

VARIABLES	(1) ln(Pub Ut E.)	(2) ln(Const E.)	(3) ln(Fin E.)	(4) ln(Gov E.)	(5) ln(Geosci E.)	(6) ln(Trans Com E.)	(7) ln(Educ Soc E.)	(8) ln(Sale Cat E.)	(9) ln(R Est E.)
City Trade Lib.	-0.00175	0.0206**	0.0125***	0.0147***	0.00354	0.0143**	0.0176***	0.0287***	0.00707
	(0.00507)	(0.00964)	(0.00272)	(0.00244)	(0.00589)	(0.00630)	(0.00300)	(0.00484)	(0.00732)
City Avg. Export Tariff	-0.0716	-0.00669	-0.0754	0.0483	0.0674	-0.0311	0.0870	0.0338	0.143
	(0.0712)	(0.198)	(0.0550)	(0.0383)	(0.0734)	(0.112)	(0.0560)	(0.129)	(0.126)
Observations	442	446	446	446	443	446	446	446	438
R-squared	0.286	0.371	0.474	0.620	0.764	0.401	0.531	0.736	0.748
Number of cities	224	226	226	226	225	226	226	226	224
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.B.3: Detailed Analysis of the Service Sector

VARIABLES	(1) ln(City Liab.)	(2) ln (City Debt)	(3) ln(City Fin. Emp)	(4) ln(City Liab.)	(5) ln (City Debt)	(6) ln(City Fin. Emp)
City Trade Lib	0.0135	0.0252**	0.0124***	-0.0170	-0.0314	-0.00566
	(0.0107)	(0.0118)	(0.00386)	(0.0212)	(0.0268)	(0.00916)
City Avg. Export Tariff	-0.232**	-0.606**	-0.0734	-0.230**	-0.613**	-0.0893
	(0.100)	(0.241)	(0.0760)	(0.104)	(0.276)	(0.0852)
City Trade Lib * City Fin Dep.				0.0659**	0.103**	0.0218
				(0.0295)	(0.0411)	(0.0161)
Observations	452	402	446	452	402	446
R-squared	0.744	0.280	0.474	0.757	0.310	0.490
Number of pref_con	226	219	226	226	219	226
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.B.4: Borrowing and Financial Sector Growth

2.12 Appendix C - Migration Specifications

2.12.1 Checks for Within-Prefecture Migration

VARIABLES	(1) Ln(Pref Pop)	(2) Ln(Pref GDP)	(3) Ln(Pref Emp.)	(4) Ln(Pref Staff)	(5) Ln(Avg. Pref Wage)
City Trade Lib	0.00229	0.00334	0.0199***	0.0149***	-0.00374*
	(0.00179)	(0.00481)	(0.00486)	(0.00453)	(0.00200)
City Avg. Export Tariff	0.149*	-0.00767	0.0891	0.0732	-0.112**
	(0.0835)	(0.0689)	(0.1000)	(0.0663)	(0.0504)
Observations	440	426	440	440	440
R-squared	0.418	0.946	0.492	0.474	0.985
Number of prefectures	220	213	220	220	220
Pref FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.C.1: Checks for Within Prefecture Migration & Reallocation, Prefecture-Level Regressions, Controls

2.12.2 Checks for Migration Across Prefectures

VARIABLES	(1) Ln(Pref Pop)	(2) Ln(Pref GDP)	(3) Ln(Pref Emp.)	(4) Ln(Pref Staff)	(5) Ln(Avg. Pref Wage)	(6) Ln(Fix Assets Pref)
City Trade Lib	0.00357*	0.00523	0.0210***	0.0153***	-0.00404**	0.00841*
	(0.00197)	(0.00484)	(0.00472)	(0.00379)	(0.00191)	(0.00508)
Neighbor City Trade Lib	-0.00245	-0.00474	-0.00356	-0.00147	0.000897	0.00814
	(0.00185)	(0.00795)	(0.00891)	(0.00723)	(0.00374)	(0.0132)
City Avg. Export Tariff	0.142*	-0.00925	0.0893	0.0728	-0.111**	-0.136
	(0.0836)	(0.0703)	(0.0997)	(0.0643)	(0.0500)	(0.0890)
Observations	436	422	436	436	436	436
R-squared	0.415	0.945	0.767	0.472	0.986	0.867
Number of prefectures	218	211	218	218	218	218
Pref FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.C.2: Migration and Reallocation Regressions,Cross-Prefecture Specifications, Controls

2.12.3 Reallocation Check: Investment

VARIABLES	(1) Ln(Fix Assets Pref)	(2) Ln(Fix Assets Pref)
City Trade Lib	0.00411	0.0113*
	(0.00771)	(0.00615)
City Avg. Export Tariff		-0.143
		(0.0900)
Observations	452	440
R-squared	0.834	0.861
Number of prefectures	226	220
Pref FE	Yes	Yes
Year FE	Yes	Yes
Controls	No	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.C.3: Investment Regressions, Prefecture Level

2.13 Appendix D - Heterogeneous Effects

VARIABLES	(1) Ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(Avg. Wage City)	(6) Ln(Fix Assets City)
City Trade Lib	0.0157***	0.0186***	0.0329***	0.0178***	-0.00422	0.0197***
	(0.00387)	(0.00609)	(0.00510)	(0.00405)	(0.00399)	(0.00624)
City Trade Lib * Dist Port	-3.62e-05	-0.00326**	-0.00210	-0.000701	-9.60e-05	-0.00153
	(0.000772)	(0.00132)	(0.00131)	(0.00104)	(0.000933)	(0.00239)
City Avg. Export Tariff	0.0136	-0.114	0.117*	0.0578	-0.144**	-0.282**
	(0.0763)	(0.0980)	(0.0709)	(0.0666)	(0.0709)	(0.127)
Observations	440	428	440	440	440	440
R-squared	0.550	0.933	0.631	0.444	0.957	0.806
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.D.1: Heterogeneous Effects - Distance to Nearest Port, City Level, Controls

VARIABLES	(1) Ln(Pref Pop)	(2) Ln(Pref GDP)	(3) Ln(Pref Emp.)	(4) Ln(Pref Staff)	(5) Ln(Avg. Pref Wage)	(6) Ln(Fix Assets Pref)
City Trade Lib	0.00242	0.00419	0.0198***	0.0148***	-0.00327*	0.0117*
	(0.00177)	(0.00432)	(0.00564)	(0.00445)	(0.00191)	(0.00623)
City Trade Lib * Dist Port	-0.000301	-0.00299**	-0.00523***	0.000281	-0.000917	-0.00148
	(0.000426)	(0.00130)	(0.00185)	(0.00108)	(0.000771)	(0.00209)
City Avg. Export Tariff	0.147*	-0.0301	0.0676	0.0752	-0.119**	-0.159
	(0.0834)	(0.0782)	(0.0981)	(0.0655)	(0.0535)	(0.102)
Observations	440	426	440	440	440	440
R-squared	0.419	0.948	0.779	0.475	0.987	0.864
Number of pref.	220	213	220	220	220	220
Pref FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level

*** p<0.01, ** p<0.05, * p<0.1

Table 2.D.2: Heterogeneous Effects - Distance to Nearest Port, Prefecture Level, Controls

VARIABLES	(1) Ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(Avg. Wage City)	(6) Ln(Fix Assets City)
City Trade Lib	0.0178***	0.0227***	0.0324***	0.0270***	-0.00589	0.0275***
	(0.00527)	(0.00667)	(0.00588)	(0.00473)	(0.00537)	(0.00592)
City Trade Lib * SOE share	-0.0123	-0.0353***	-0.00279	-0.0553***	0.00861	-0.0539***
	(0.0148)	(0.0134)	(0.0186)	(0.0142)	(0.0146)	(0.0186)
City Avg. Export Tariff	0.00766	-0.119	0.126*	0.0282	-0.136**	-0.319**
	(0.0751)	(0.0941)	(0.0689)	(0.0550)	(0.0639)	(0.138)
Observations	440	428	440	440	440	440
R-squared	0.552	0.933	0.627	0.500	0.957	0.813
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.D.3: Heterogeneous Effects - Initial SOE Share of Employment, City Level, Controls

VARIABLES	(1) Ln(Pref Pop)	(2) Ln(Pref GDP)	(3) Ln(Pref Emp.)	(4) Ln(Pref Staff)	(5) Ln(Avg. Pref Wage)	(6) Ln(Fix Assets Pref)
City Trade Lib	0.00226	0.00590	0.0200***	0.0195***	-0.00387**	0.0173**
	(0.00174)	(0.00420)	(0.00511)	(0.00520)	(0.00195)	(0.00679)
City Trade Lib * SOE share	0.000210	-0.0200	-0.00258	-0.0366**	0.000953	-0.0513***
	(0.00663)	(0.0128)	(0.0241)	(0.0161)	(0.00707)	(0.0164)
City Avg. Export Tariff	0.149*	-0.0299	0.0862	0.0486	-0.111**	-0.203**
	(0.0859)	(0.0754)	(0.0982)	(0.0647)	(0.0494)	(0.103)
Observations	440	426	440	440	440	440
R-squared	0.418	0.946	0.766	0.509	0.986	0.870
Number of pref.	220	213	220	220	220	220
Pref FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level

*** p<0.01, ** p<0.05, * p<0.1

Table 2.D.4: Heterogeneous Effects - Initial SOE Share of Employment, Prefecture Level, Controls

VARIABLES	(1) Ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(Avg. Wage City)	(6) Ln(Fix Assets City)
City Trade Lib	0.0259***	0.00953	0.0536***	0.0191	-0.00499	0.00977
	(0.00763)	(0.0112)	(0.00754)	(0.0129)	(0.00730)	(0.0182)
City Trade Lib * SEZ	-0.0128	0.00857	-0.0253***	-0.00204	0.000858	0.0110
	(0.00899)	(0.0116)	(0.00870)	(0.0136)	(0.00813)	(0.0161)
City Avg. Export Tariff	0.00184	-0.0863	0.111	0.0616	-0.143*	-0.263**
	(0.0772)	(0.0957)	(0.0723)	(0.0689)	(0.0735)	(0.118)
Observations	440	428	440	440	440	440
R-squared	0.556	0.931	0.639	0.443	0.957	0.806
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.D.5: Heterogeneous Effects - Initial SEZ Status, City Level, Controls

VARIABLES	(1) Ln(Pref Pop)	(2) Ln(Pref GDP)	(3) Ln(Pref Emp.)	(4) Ln(Pref Staff)	(5) Ln(Avg. Pref Wage)	(6) Ln(Fix Assets Pref)
City Trade Lib	0.00349	-0.00771	0.0285***	0.0186**	-0.00641	0.00253
	(0.00394)	(0.00972)	(0.00887)	(0.00926)	(0.00431)	(0.0145)
City Trade Lib * SEZ	0.00349	-0.00771	0.0285***	0.0186**	-0.00641	0.00253
	-0.00139	0.0123	-0.00916	-0.00427	0.00305	0.00988
	(0.00406)	(0.00772)	(0.00857)	(0.00737)	(0.00373)	(0.0130)
City Avg. Export Tariff	0.148*	-0.00277	0.0854	0.0708	-0.111**	-0.143
	(0.0832)	(0.0727)	(0.0983)	(0.0652)	(0.0515)	(0.0934)
Observations	440	426	440	440	440	440
R-squared	0.419	0.946	0.767	0.476	0.986	0.864
Number of pref.	220	213	220	220	220	220
Pref FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.D.6: Heterogeneous Effects - Initial SEZ Status, Prefecture Level, Controls

2.14 Appendix E - Robustness Checks and Alternative Specifications

2.14.1 Robustness Checks

VARIABLES	(1) ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(City Fix Asset)	(6) ln(City Avg Wage)
City Trade Lib	0.0163***	0.0168**	0.0316***	0.0181***	0.0197***	-0.00450
	(0.00355)	(0.00663)	(0.00459)	(0.00393)	(0.00659)	(0.00378)
City Avg. Export Tariff	0.0382	-0.0933	0.128*	0.0878	-0.254**	-0.155**
	(0.0725)	(0.0939)	(0.0726)	(0.0670)	(0.121)	(0.0745)
Observations	432	420	432	432	432	432
R-squared	0.562	0.931	0.653	0.462	0.804	0.957
Number of cities	216	210	216	216	216	216
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.1: Robustness 1: City-Level Main Regressions, No Provincial Cities, Controls

VARIABLES	(1) Ln(City Pop)	(2) ln(City Emp)	(3) ln(City Staff)
City Trade Lib	0.0105***	0.0320***	0.00405
	(0.00403)	(0.00456)	(0.00299)
City Avg. Export Tariff	0.00216	0.127*	0.0404
	(0.0780)	(0.0685)	(0.0593)
Observations	440	440	440
R-squared	0.559	0.627	0.531
Number of cities	226	226	226
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
SOE Control	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.2: Robustness Check 2 - Controlling for the Initial Share of Employment in SOEs

VARIABLES	(1) ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(City Fix Asset)	(6) ln(City Avg Wage)
City Trade Lib	0.0110***	0.0169**	0.0322***	0.0123***	0.0193***	-0.000280
	(0.00290)	(0.00675)	(0.00513)	(0.00429)	(0.00551)	(0.00317)
City Avg. Export Tariff	-0.106	-0.189**	0.0826	-0.0485	-0.371***	0.000146
	(0.0920)	(0.0921)	(0.0968)	(0.0672)	(0.107)	(0.0430)
Observations	440	428	440	440	440	440
R-squared	0.613	0.939	0.699	0.575	0.843	0.966
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Composition Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.3: Robustness Check 3 - Further Controls for Initial Sectoral Composition

VARIABLES	(1) ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(City Fix Asset)	(6) ln(City Avg Wage)
City Trade Lib	0.0129***	0.00799	0.0327***	0.0161***	0.0150**	-0.00177
	(0.00313)	(0.00740)	(0.00596)	(0.00503)	(0.00728)	(0.00447)
City Avg. Export Tariff	0.0113	-0.0773	0.110*	0.00618	-0.185	-0.146**
	(0.0665)	(0.0966)	(0.0608)	(0.0513)	(0.182)	(0.0642)
Observations	440	428	440	440	440	440
R-squared	0.549	0.929	0.627	0.442	0.804	0.957
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.4: Robustness Check 4 - IV Strategy to Account for Variation in the Size of the Non-tradable Sector

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ln(City Pop)	ln(City GDP)	ln(City Emp)	ln(City Staff)	ln(City Fix Asset)	ln(City Avg Wage)
Non-MFA City Trade Lib	0.0230***	0.0272***	0.0453***	0.0233***	0.0235**	-0.00819**
	(0.00470)	(0.00849)	(0.00741)	(0.00655)	(0.00939)	(0.00379)
City Avg. Export Tariff	-0.0157	-0.108	0.0604	0.0191	-0.321***	-0.147**
	(0.0795)	(0.0982)	(0.0712)	(0.0643)	(0.110)	(0.0738)
Observations	440	428	440	440	440	440
R-squared	0.552	0.932	0.626	0.436	0.803	0.957
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.5: Robustness Check 5 - MFA Robustness

2.14.2 Alternative Specifications

VARIABLES	(1) ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(City Fix Asset)	(6) ln(City Avg Wage)
City Exposure Trade Lib	0.184***	0.238***	0.275***	0.229***	0.195***	-0.0990***
	(0.0595)	(0.0424)	(0.0699)	(0.0684)	(0.0732)	(0.0366)
City Avg. Export Tariff	-0.0663	-0.168	-0.0663	-0.0151	-0.373***	-0.137**
	(0.0848)	(0.111)	(0.0801)	(0.0558)	(0.109)	(0.0676)
Observations	440	428	440	440	440	440
R-squared	0.562	0.933	0.617	0.479	0.806	0.958
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.6: Alternative Specification: City-Level Main Regressions, Controls

VARIABLES	(1) ln(City Pop)	(2) ln(City GDP)	(3) ln(City Emp)	(4) ln(City Staff)	(5) ln(City Fix Asset)	(6) ln(City Avg Wage)
City Exposure Trade Lib	0.113***	0.263***	0.241***	0.127***	0.272***	-0.0114
	(0.0373)	(0.0560)	(0.0645)	(0.0396)	(0.0884)	(0.0328)
City Avg. Export Tariff	-0.148	-0.222**	-0.0686	-0.0940	-0.408***	-0.00282
	(0.0995)	(0.103)	(0.102)	(0.0701)	(0.110)	(0.0463)
Observations	440	428	440	440	440	440
R-squared	0.610	0.940	0.669	0.569	0.845	0.966
Number of cities	220	214	220	220	220	220
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral Controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.E.7: Alternative Specification: City-Level Main Regressions, Standard Controls and Sectoral Controls

VARIABLES	(1) Ln(City Prim. Emp)	(2) Ln(City Sec. Emp)	(3) Ln(City Ter. Emp)	(4) Ln(City Manu. Emp)
City Exposure Trade Lib	-0.0693	0.248**	0.210***	0.214*
	(0.158)	(0.108)	(0.0405)	(0.120)
City Avg. Export Tariff	0.409	-0.139	0.0464	-0.177*
	(0.391)	(0.105)	(0.0713)	(0.103)
Observations	412	440	440	440
R-squared	0.695	0.506	0.528	0.540
Number of cities	206	220	220	220
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.8: Alternative Specification: City-Level Structure of Employment Regressions, Controls

VARIABLES	(1) ln(Pub Ut E.)	(2) ln(Const E.)	(3) ln(Fin E.)	(4) ln(Gov E.)	(5) ln(Geosci E.)	(6) ln(Trans Com E.)	(7) ln(Educ Soc E.)	(8) ln(Sale Cat E.)	(9) ln(R Est E.)
City Exposure Trade Lib	0.0720	0.122	0.114***	0.171***	0.0655	0.129**	0.211***	0.192*	0.102*
	(0.0636)	(0.121)	(0.0367)	(0.0170)	(0.0590)	(0.0523)	(0.0492)	(0.0945)	(0.0526)
City Avg. Export Tariff	-0.00660	-0.200	-0.176*	-0.0473	0.0582	-0.141	-0.0228	-0.224	0.108
	(0.0973)	(0.277)	(0.0862)	(0.0561)	(0.0745)	(0.153)	(0.0843)	(0.189)	(0.166)
Observations	442	446	446	446	443	446	446	446	438
R-squared	0.292	0.364	0.470	0.631	0.765	0.399	0.545	0.728	0.749
Number of cities	224	226	226	226	225	226	226	226	224
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** p<0.01, ** p<0.05, * p<0.1

Table 2.E.9: Alternative Specification: Detailed Analysis of the Service Sector, Controls

2.14.3 Census Cross-Checks

VARIABLES	(1) Ln(Pop. Census)	(2) Ln(Emp. Census)	(3) Migration Rate	(4) Unemp. Rate
City Trade Lib	0.00257*	0.00481***	0.204*	-0.000715
	(0.00135)	(0.00137)	(0.107)	(0.00727)
City Avg. Export Tariff	0.0187	0.0327	-1.592*	0.106
	(0.0219)	(0.0352)	(0.842)	(0.202)
Observations	448	448	448	448
R-squared	0.501	0.458	0.468	0.832
Number of cities	224	224	224	224
City FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Standard errors clustered at the province level
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.E.10: Census Cross Checks, Prefecture Level

2.15 Appendix F - A Simple Model

Our empirical setting and results can be rationalized via a simple Jones (1975) style specific factors model (Kovak 2013, has more recently employed a specific factors model to analyze the impact of Brazil's trade liberalization in the 1980s).

Imagine a country with C cities indexed by $c \in \{1, 2, \ldots, C\}$. Production takes place many sectors indexed by $i \in \{1, 2, \ldots, I\}$. Aside from cities, there is also a countryside (hinterland) where a traditional good is produced. The traditional good is designated as the numeraire, and is produced in the countryside with productivity ω.

Output in each sector is produced using labor and an industry specific factor of production denoted by T_i. Labor is costlessly mobile across sectors and locations, and the labor force of the country is considered to be sufficiently large such that the countryside is never empty. The production technologies of each sector are described by production functions of the type:

$$y_i = AL_i^{\alpha_i} T_i^{1-\alpha_i} \tag{2.31}$$

Sectoral-specific capital is considered to be completely immobile across space. Each location c is characterized by a vector $\langle \overline{T_{1c}}, \ldots, \overline{T_{Ic}} \rangle$ of endowments of sectoral specific capital.

The prices of all commodities are determined on the international market and are given by the vector $\{P_1, P_2, \ldots P_I\}$. In order to access the international market, domestic producers are faced with sectoral specific tariffs. The product specific tariffs faced by each product take the iceberg form, are stochastic and given by:

$$\tau_i = \begin{cases} \tau_{iH} \text{ with probability } \gamma \\ \tau_{iL} \text{ with probability } 1 - \gamma \end{cases} \tag{2.32}$$

where $\tau_{iH} > \tau_{iL} > 1$. We can write $\tau_i = 1 + t_i$ where t_i represents the ad valorem tariff.

With the set-up above, solving for the endogenous variables of interest (employment at the city-industry level, total employment/ population and the rental rates of the specific factors yields):

$$L_{ic} = \left\{ \frac{\alpha_i A \left[\tau_{iL} + \tau_{iH} - E(\tau_i)\right] P_i}{\omega \tau_{iH} \tau_{iL}} \right\}^{\frac{1}{1-\alpha_i}} \overline{T}_{ic} \tag{2.33}$$

$$L_c = \sum_{i=1}^{I} \left\{ \frac{\alpha_i A \left[\tau_{iL} + \tau_{iH} - E(\tau_i)\right] P_i}{\omega \tau_{iH} \tau_{iL}} \right\}^{\frac{1}{1-\alpha_i}} \overline{T}_{ic} \tag{2.34}$$

$$r_{ic} = (1 - \alpha_i) \left(\frac{\alpha_i}{\omega} \right)^{\frac{\alpha_i}{1-\alpha_i}} \left\{ \frac{\alpha_i A \left[\tau_{iL} + \tau_{iH} - E(\tau_i)\right] P_i}{\omega \tau_{iH} \tau_{iL}} \right\}^{\frac{1}{1-\alpha_i}} \tag{2.35}$$

The US policy change induced by China's WTO accession we study in this chapter can be modeled as a decline in the probability of high tariffs γ. Studying the evolution of prefecture-industry employment and city-level outcomes as a result of China's WTO accession yields:

$$\hat{L_c} = \frac{L_{1c}}{L_c} \hat{L_{1c}} + \frac{L_{2c}}{L_c} \hat{L_{2c}} + \cdots + \frac{L_{Ic}}{L_c} \hat{L_{Ic}} \tag{2.36}$$

$$\hat{L_{ic}} \approx -\frac{\Delta\gamma}{1 - \alpha_i} g(\Delta t_i) \tag{2.37}$$

where $g(.)$ in an increasing function and $\Delta\gamma = \gamma_L - \gamma_H$ with $\gamma_H > \gamma_L$, γ_H the initial high probability and γ_L the new reduced probability of high tariffs. Moreover if we set $\alpha_i = \alpha \forall i$ we obtain:

$$\hat{L_c} = -\frac{\Delta\gamma}{1 - \alpha} \left[\frac{L_{1c}}{L_c} g(\Delta t_1) + \ldots + \frac{L_{Ic}}{L_c} g(\Delta t_I) \right] \tag{2.38}$$

Which gives us the prediction that cities specialized in sectors subject to bigger tariff gaps before 2001 can be expected to grow faster in population and employment after China's WTO accession. Note that in the absence of an estimate of $\Delta\gamma$ the simple model above only makes "sign" predictions, while being silent on the magnitude of the coefficients in our regression models in the previous section.

2.16 Appendix G - Data and Variable Construction

2.16.1 China Outcomes and Controls

City-level data are taken mainly from the 1999 and 2008 China City Statistical Yearbooks (CSY). The CSY reports various socio-economic outcomes, including local GDP, population, employment by sector, average number and average wage of staff, average net fixed asset during the year and number of new FDI contracts, for more than 200 prefecture-level cities in China in the preceding year. Data are available at 2 levels of spatial disaggregation: the prefecture-level city and the urban ward of prefecture city (Shixiaqu). The number of prefecture-level cities included in CSY increases over time as existing counties or prefectures were upgraded into cities. Yet only 228 and 266 cities do not report report missing values of our key variables in the 1999 and 2008 CSY respectively. Our final sample includes a balanced panel of 226 cities after dropping missing values.

Sectoral-level and sectoral-city-level variables are computed from the 1998 and 2007 Annual Surveys of Industrial Firms (ASIF). The ASIF include all state-owned enterprises and non-state owned enterprises with sales over 5 million RMB. Firms report their zip codes, 4-digit CIC codes, ownership, export status and more than 60 financial variables from their balance sheets and profit statements. The 4-digit CIC codes are based on the 1996 and 2002 Chinese Industrial Classification (410 industries) and matched across years using the industry concordance provided by Brandt, Biesebroeck and Zhang (2012). The CIC codes are then matched with 4-digit ISIC Rev.3 codes with the use of the correspondence table developed by Dean and Lovely (2009). The firm-level data is aggregated to create a balanced panel of city-industries at 4-digit ISIC-level for 2 spatial levels. All variables are deflated to real values before aggregation. Output and input deflators are provided by Brandt, Biesebroeck and Zhang (2012). Additional city-level variables, including total manufacturing employment, employment share of state-owned enterprises, number of exporters, total export value, total equity by regional sources, total liabilities and total debt, are also computed from the 1998 and 2007 ASIF by simple aggregation.

As a robustness check, we use the 2000 and 2010 Tabulations on Population Census by County to re-calculate total population and total employment at 2 levels of spatial disaggregation. The data also allow us to calculate the migration rate and unemployment rate for each prefecture-level city and its urban ward. Migration rate is defined as the share of population who reported to have migrated from another province. The unemployment rate is the number of individuals searching for jobs divided by the size of population aged between 15 and 64 excluding students, home makers, retired people, disabled and reported not working for other reasons.

City's distance to port is obtained from China's GIS Map with county boundaries for the year 1999. We measure the length of the straight line from the center of a county to its nearest port, and define a city's distance to port as the median distance among all counties located in that city.

2.16.2 Trade Variables

Tariff Gaps

We obtained US column 1 and column 2 tariffs at 8-digit HS for the year 1998 from Feenstra et al. (2002). We assume that column 2 tariffs are the tariff rates that would have been imposed on Chinese exports if China's MFN status is revoked while column 1 tariffs are the applied tariff rates faced by Chinese exporters. Our product-level tariff gap is the average difference between US column 1 and column 2 tariffs at 6-digit HS. Sectoral-level tariff gaps are defined as the simple average of 6-digit tariff gaps at 4-digit ISIC. The concordance between 6-digit HS and 4-digit ISIC Rev. 3 is provided by the UN Statistics. Sectoral-city employment used to compute city-level tariff gaps (equation 2.6) and all our measures of city-level US trade liberalization is from the 1998 ASIF while total city employment in 1998 is from the 1999 CSY.
To control for the removal of quotas due to the provisions of the Multi Fiber Agreement (MFA) in 2004, we recompute city-level tariff gaps assuming that the sectoral-level tariff gap and employment of ISIC industries 1711, 1721, 1722, 1723, 1729, 1730, 1810 and 2430 are zero.

Tariffs

Our control variables include city-level tariff shocks arising from changes in tariffs on China's imports and exports. China's import values and export values are obtained from

UN Comtrade at 6-digit HS product levels for each import origin and export destination. Data on tariffs are available at the World Integrated Trade Solution (WITS) at 8-digit HS. Product concordances for HS1996, HS2002 and HS2007 are provided by UN Statistics Division. Our calculations for city-level tariff shocks involve two steps. First, we aggregate China's 8-digit product tariffs to 4-digit ISIC. Applied tariffs on Chinese exports (export tariffs) from 149 trading partners are aggregated to 4-digit ISIC by first taking simple average to 6-digit HS and then weighted by countries' import shares in 1998. Tariffs on Chinese imports are divided into two types: tariffs on imported final goods (output tariffs) and tariffs on imported intermediate inputs (input tariffs). Output tariffs are average 6-digit HS tariffs weighted by the product import shares in 1998. Input tariffs are weighted averages of final goods tariffs, where weights are 4-digit industry cost shares. The breakdown of industry input cost shares is from the 2002 Chinese Input-Output Table. Second, city-level tariffs are computed in a similar way as city-level tariff gaps (equation 2.6), except that sectoral tariff gaps are replaced by sectoral tariffs. Sectoral-city employment used to compute city-level tariffs is taken from 1998 ASIF while total city employment is obtained from the 1999 CSY.

2.16.3 Local Spillovers

Output Share

Industry output shares used to compute output and search linkages are taken from the 2002 Chinese Input-Output Table. We aggregate the output shares of 112 CIC industries to 69 3 to 4 digit ISIC using the correspondence table developed by Dean and Lovely (2009).

Labor Correlation

Following Ellison, Glaeser and Kerr's (2010) methodology, we compute a measure of similarity in occupational labor requirements for pairwise industries using the 2012 Industry-Occupation Matrix (IOM) published by the US Bureau of Labor Statistics. The IOM reports employment in 277 occupations at 4-digit NAICS. We first map the 4-digit NAICS manufacturing industries to 4-digit ISIC using the concordance table provided by the UN Statistics Division. Then we compute the occupational shares for each industry and calculate the pairwise correlation of occupational shares between every two 4-digit ISIC industries.

Technology Flow

Our measure of technology outflow uses the technology flow matrix developed by Scherer (1984). The matrix estimates the inter-industry R&D benefits arising from supplier-customer relationships or potential utilization of patented inventions for 38 US manufacturing industries during the 1970s. Following Ellison, Glaeser and Kerr's approach, we convert the R&D flows between 38 industries to 4-digit ISIC using total industry sales obtained from the 1998 ASIF. To be more specific, if R^*_{mn} is the dollar amount of R&D that industry m benefits from industry n , and i (resp., j) is a 4-digit ISIC industry that is part of industry group m (resp., n) and accounts for a fraction w_i (resp., w_j) of the total industry sales in that industry group, then $R_{ij} = w_i w_j R^*_{mn}$.

Financial Dependence

Rajan and Zingales (1998) calculate the median level of external financing for 36 ISIC industries in the US during the 1980s. External dependence is defined as the fraction of capital expenditures not financed with cash flow from operations. We use their measure of sectoral external dependence for all companies to compute our index of financial dependence for manufacturing sectors.

2.16.4 List of Variables

This section explains the definitions of outcome and control variables taken from the 1999 and 2008 City Statistical Yearbooks (CSY), and 2000 and 2010 Tabulations on Population Census by County (TPC). All CSY variables are available for the entire prefecture-level city and the urban ward of the city, unless stated otherwise. The TPC variables are computed at the city-level.

City Statistical Yeabooks

Variable Name	Definition
Pop	Total registered population
GDP	Local GDP in 10,000 RMB
Emp	Total employed persons. Employed persons refer to individuals who are engaged in social working and receive remuneration payment or earn business income, including total staff and workers, re-employed retirees, employers of private enterprises, self-employed workers, employees in private enterprises and individual economy, employees in township enterprises, employed persons in the rural areas, and other employed persons (including teachers in the schools run by the local people, people engaged in religious profession and the servicemen, etc.). Please refer to variable of 'Staff' for the definition of 'staff and workers'.
Prim Emp	Total employed persons in primary sector
Sec Emp	Total employed persons in secondary sector, which includes mining, construction and manufacturing industries
Ter Emp	Total employed persons in tertiary sector
Manu Emp	Total employed persons in manufacturing sector
Manu Share	Manufacturing share of employed persons
Staff	Average number of staff and workers. Staff and workers refer to individuals who work in (and receive payment therefrom) enterprises and institutions of state ownership, collective ownership, joint ownership, share holding, foreign ownership, and ownership by entrepreneurs from Hong Kong, Macao, and Taiwan, and other types of ownership and their affiliated units, excluding the retired persons invited to work in the units again, teachers in the schools run by the local people and foreigners, and persons coming from Hong Kong, Macao and Taiwan and working in the state-owned economic units.
Avg Wage	Average wage of staff
Fix Asset	Average net fixed asset during the year in 10,000 RMB
New FDI Contr	Number of new FDI contracts

Variable Name	Definition
Emp Elecc	Total employed persons in public utilities (urban ward only)
Emp Consc	Total employed persons in construction (urban ward only)
Emp Finc	Total employed persons in finance and insurance (urban ward only)
Emp Govc	Total employed persons in government or party agencies, social organizations (urban ward only)
Emp Geoscic	Total employed persons in geological prospecting, water conservatory management, scientific research, polytechnic services (urban ward only)
Emp Trancomc	Total employed persons in transport, storage, post, telecommunications, computer and software (urban ward only)
Emp Educsocc	Total employed persons in education, social services, health care and social welfare (urban ward only)
Emp Salecatc	Total employed persons in wholesale, retail, accommodation and catering (urban ward only)
Emp Estatec	Total employed persons in real estate, leasing and commercial services (urban ward only)

Annual Surveys of Industrial Firms

Variable Name	Definition
Emp	Total employment
Output	Real industrial output value. Firm-level industry outputs are deflated with Brandt, Biesebroeck and Zhang's (2012) 4-digit CIC output deflators, then aggregated to 4-digit ISIC for each city.
Sales	Real industry sales. Firm-level industry sales are deflated with Brandt, Biesebroeck and Zhang's (2012) 4-digit CIC output deflators, then aggregated to 4-digit ISIC for each city.
No of Firms	Number of manufacturing firms
No of Exp	Number of exporting firms
Fix Asset	Net fixed assets
Exp Value	Total export value

Tabulations on Population Census by County

Variable Name	Definition
Pop	Total population
Emp	Total employed persons
Migration Rate	Number of individuals who reported to have migrated from another province divided by total population
Unemp Rate	Number of individuals searching for jobs divided by the size of population aged between 15 and 64 excluding students, home makers, retired people, disabled and reported not working for other reasons

Chapter 3

FUELING THE GENDER GAP? OIL AND WOMEN'S LABOR AND MARRIAGE MARKET OUTCOMES

Joint with Stephan E. Maurer, London School of Economics

3.1 Introduction

Across the globe and over time, differences in female labor force participation are substantial (Olivetti 2013). Economic research into the causes of these differences has highlighted the role of both supply-side[1] and demand-side factors[2], as well as that of changing social norms.[3] One prominent theory to explain the cross-country differences

[1]Goldin and Katz (2002) and Albanesi and Olivetti (2009) document the importance of medical advances such as contraceptives and infant formula; Jones, Manuelli and McGrattan (2003) and Greenwood, Seshadri and Yorukoglu (2005) focus on the role of labor-saving technological progress in the production of household goods. Finally, Attanasio, Low and Sanchez-Marcos (2008) emphasize declining child care costs. Also see Goldin(1990, 2006) for overviews of female labor force participation in the US.

[2]Ngai and Petrongolo (2014) highlight the importance of the structural transformation from manufacturing into services and the increased marketization of home services. Other papers that employ structural transformation arguments to describe gender roles and their evolution include Voigtlaender and Voth (2013), Akbulut (2011) and Alesina, Giuliano and Nunn (2013). Do, Levchenko and Raddatz (2012) and Gladdis and Peters (2014) focus on the importance of trade integration as a shifter of gender-specific demands.

[3]See for example Fernandez (2011, 2013), Sharabi (1988) and World Bank (2004). Klasen and Pieters (2015) analyze the determinants of continued low female labor force participation in India, and find

in integrating women into the labor market links low female labor force participation to natural resource specialization. According to this theory, first proposed by Ross (2008), heavy exposure of an economy to mineral resource extraction activities can depress both employment opportunities for women as well as their incentives to participate in the labor market. In turn, a more limited involvement of women in the labor market may bring about a number of other malign effects, including a diminished influence for women in the political process. In essence, the argument made by Ross (2008) amounts to positing another facet of the "resource curse": resource wealth may undermine or slow down economic and social development by hindering the economic and political emancipation of women. Recent media coverage of the shale gas boom in the Midwestern United States partly echoes this view, depicting boom-towns with a male-dominated environment which is unfriendly towards women (see, for example, the newspaper articles by Sheerin and Bressanin, 2014 and Eligon, 2013).

In this chapter, we empirically estimate the causal effect of resource based specialization on female labor and marriage market outcomes in a within country, developed nation setting. Using county-level data on major oil discoveries in the US South between 1900 and 1940 and labor market data from the census, we employ a difference-in-difference research design, comparing oil rich counties to those without major oil deposits, before and after the discovery of the respective oil fields. We find that oil discoveries constitute substantial shocks to local economies that lead to increased urbanization, a larger and younger population and sectoral reallocation of employment from agriculture into oil mining and manufacturing. However, these changes do not translate into lower female involvement in the labor market: We find that neither the female labor force participation rate nor the female employment rate change, and women's labor supply at the intensive margin remains unaffected as well, while male labor force participation increases only slightly.

While these results indicate that the effects of oil discovery shocks on quantities transacted in local labor markets are small, we find a substantial impact on the local price of labor that differs by gender. Oil discoveries are associated with substantial wage rises, with average wages in oil rich counties being around 32 log points higher than in baseline counties after oil discovery. However, the benefits associated with these dis-

evidence of adverse factors operating through both demand-side and supply-side channels, as well as through conservative social norms.

coveries accrue chiefly to men, whose average wages increase by around 36 log points, while the corresponding effect for women amounts to only 11 log points and is not statistically significant. While our wage results are based on a 1940 cross-section only, they are strongly corroborated by a panel analysis of occupational income scores: Men on average find occupations that pay substantially better, while the median income of the occupations in which women work remains virtually unchanged. The findings concerning wages and occupational income scores thus lead to the conclusion that oil discoveries might have constituted substantial male biased shocks to local labor markets, but their effects operated largely through prices (e.g. wages) and not through quantities (e.g. gender specific labor force participation, employment or the gender ratio).

In order to understand the channels that can help account for the absence of participation effects in local labor markets, we study the evolution of employment in 4 major sectors by gender and find that men reallocate from agriculture into oil mining and manufacturing, while women reallocate from agriculture into services. The increased absorption of women into the locally expanding service sector might thus be one explanation for our failure to detect any changes in female labor force participation and employment. It also seems that the new service sector jobs are on average not much better-paying than the occupations women had before, while the sectoral reallocation that is present for men is one towards better-paying occupations and sectors.

Finally, drawing on a sizable literature linking women's labor market success to other socioeconomic outcomes, we also study whether oil discoveries can be found to have any impact on women's marriage market outcomes. Consistent with the absent labor force participation effect, we also do not find any relation between oil discoveries and marriage rates, fertility, or women's age at first marriage.

All in all, our findings are consistent with two separate interpretations. One interpretation, that emerges from focusing on our labor force participation and employment results, suggests that the initial male-biased demand shock (oil and manufacturing grow, employing more men) is absorbed in the longer run as the local economy grows, becomes more urbanized and demands more services that tend to employ women. This is in line with the mechanism described in Ross (2008, 2012), where segregated labor markets and, importantly, the absence of a sector that can absorb "excess" female labor are both essential conditions for oil to have the effect of lowering female labor market participation.

A second interpretation of our results, that emerges from placing an emphasis on our wage findings, may point to the conclusion that the discovery of oil may indeed amount to a male-biased shock to local labor markets, but one that operates mostly through prices (wages) rather than quantities (labor force participation, employment rates or the gender ratio). However, this interpretation leaves a series of substantive questions unanswered. A first such question concerns the mechanism that could lead to the labor market demand and supply shocks brought about by the discovery of oil to operate in a way that affects only wages but not the amount of labor supplied by different groups of workers. Another important open question in this context is whether widening gender pay gaps can be expected to produce some of the same malign socioeconomic developments that have been linked with low rates of female labor force participation.

In a broader context, our findings also highlight that an initial gender-biased demand shock that affects one sector (or a subset of sectors) of the economy need not necessarily lead to gender-biased outcomes in the aggregate: If such a shock (for example via backward or forward linkages to other sectors or via income effects) generates further growth in other sectors, we may not observe differential changes for male and female aggregate outcomes.

We are not the first to study the relationship between resource wealth and female labor market outcomes. In a cross-country setting, Ross (2008) found a negative relationship between oil production and female employment. However, Norris (2010) and Kang (2009) argue that this analysis suffers from measurement error and problems due to omitted variables, in particular due to not controlling sufficiently for cultural values and political institutions.

Our empirical set-up is able to address these and other issues: By analyzing a within country sample, we are able to avoid some of the issues concerning the pre-existing differences between the "treated" and "untreated" units of analysis, which is substantially more difficult in the cross-country set-ups of previous studies. Moreover, by exploiting the time dimension of our panel, we can more cleanly disentangle the impact of oil wealth on the outcomes of interest than was possible in some of the existing work. The scope of the US census also allows us to go beyond mere labor force participation and study a variety of other related outcomes. These include employment by sectors, different measures of earnings, and demographic outcomes such as marriage and fertility, which enables us to shed some light on the mechanisms at play. Finally, by focusing on discoveries of large oil fields as our explanatory variable, we avoid the endogeneity concerns that might arise in relation to employing other measures of resource specialization of local economies, such as the amount of natural resources actually extracted or the amount of resource revenues derived by a local economy.

A closely related paper in this respect is the contemporaneous study by Kotsadam and Tolonen (2014), who analyze the implications of openings and closings of mineral mines in Sub-Saharan and find negative employment effects for women. However, there are several important differences between their setting and ours: Firstly, while their mines are relatively short-lived, our perspective is more a medium to long run one. More importantly, as documented by Kotsadam and Tolonen, the relatively quick depletion of mines in their sample leads to local boom and bust cycles. The oil wealth in our sample, on the other hand, had very broad and long-lasting growth implications: Oil discoveries led to persistent structural changes in local economies, away from agriculture and towards manufacturing and urbanization. Thus, our setting is arguably closer to the theoretical mechanisms described by Ross (2008).

Beyond the literature analyzing the determinants of women's socioeconomic outcomes discussed above, the present article is also related to the body of work assessing the long-run economic impact of mineral wealth, and in particular to the strand of literature investigating the "Resource Curse" hypothesis (for example Corden and Neary 1982; Auty 1993 ; Sachs and Warner 1999, 2001; Engermann and Sokoloff 1997; Papyrakis and Gerlagh 2004; Humphreys et al. 2007; Lederman and Maloney 2007; Brunnschweiter and Bulte 2008; Lei and Michaels 2013). Moreover, our study is particularly closely related to the strand of literature investigating the economic impact of natural resources in within-country settings (Pratt 1980, Papyrakis and Gerlagh 2007; Black, McKinnish and Sanders 2005; Domenech 2008; Michaels 2011; Aragon and Rud 2013, Caselli and Michaels 2013 ; Furchtgott-Roth and Gray 2013).

The rest of this chapter is organized as follows. Section 3.2 discusses the channels through which oil discoveries could influence women's labor and marriage market outcomes. Section 3.3 proceeds to describe the data we use in this study and our empirical strategy, while Section 3.4 presents our results. Robustness checks are performed in Section 3.5, and section 3.6 concludes.

3.2 The Impact of Oil Wealth on Women's Labor Market Outcomes

Before we proceed to the main body of our analysis, in this section we aim to provide a brief discussion of the mechanisms through which oil wealth could affect the labor market outcomes of women. Existing work (see for example Ross 2008 and 2012), has identified both demand side and supply side channels that could lead to mineral wealth having an adverse impact on women's involvement in the labor market.

Focusing first on the effects of oil wealth on the demand side of labor markets, the literature has highlighted that large mineral endowments tend to encourage economic specialization in natural resource extraction and its associated sectors. Moreover, to the extent that resource extraction activities compete for scarce inputs (land, labor, capital) with other, non-related sectors, large resource endowments may be associated with these latter sectors being crowded out. As resource mining and its associated activities tend to display heavily male labor forces, while many of the sectors at risk of being crowded out by resource extraction exhibit greater gender balance, this readily yields a scenario in which resource wealth tends to crowd women out of the labor market by reducing the demand for female labor.

Oil wealth can also affect the supply side of labor markets by reducing women's incentives to participate in the workplace. Thus, the discovery of large mineral resource deposits may lead to a sharp rise in the demand for male labor which translates into substantially higher male wages. Given that a sizable literature in labor economics (e.g. Goldin 1990) has documented the existence of a substantial negative elasticity of married women's labor supply with respect to their husband's wages, this yields another channel through which oil wealth can depress female involvement in the labor market.

It is important to stress, however, that the channels of transmission of resource shocks to the labor market discussed above were proposed in the context of a literature that focuses on cross-country analyses. In such cross-country settings national labor markets can be considered as "closed", as international migratory flows are usually quite small relative to the size of national workforces and can thus be safely omitted from the analysis. By contrast, in a within country context of the type we analyze in the present study, the assumption of a "closed" labor market becomes notably less attractive, as within country migratory flows can be important relative to the size of sub-national labor markets. Once the importance of migratory flows between sub-national units, in our case US counties, is recognized, it becomes clear that the mechanisms outlined above might be upset by the operation of the migration margin. This is because any cross-county differences brought about by the presence of mineral wealth may be arbitraged away by migratory flows. As a result, great care has to be taken when attempting to transfer the predictions of the cross-country theoretical frameworks briefly outlined above to the study of US counties undertaken in this chapter.

With the above caveat in mind, it is important to note that it is quite straightforward to construct a theory of regional economies that retrieves many of the qualitative predictions made by the cross-country theoretical frameworks outlined above. The conceptual framework we adopt to guide our empirical work is a modified version of the one outlined in Moretti (2010). In our framework, we assume that the optimizing agents are represented by households which are made up of one man and one woman (i.e. we impose that marriage markets clear at all times) and which choose their location in order to maximize joint household utility. In the simplest setting we consider the case in which the economy contains two sectors, a male sector and a female sector. Moreover, in keeping with Moretti (2010) we assume that households have intrinsic preferences defined over locations, which implies that shocks affecting regional economies can have a differential impact on the welfare of inframarginal households.

In a setting of this type we can interpret the discovery of oil wealth at the county level as an increase in the local productivity of the male sector. This will tend to put upward pressure on male wages in the newly oil-rich county. In response to this, we can expect households from other counties to migrate to the county benefiting from an oil discovery. However, as moving households also contain women, this will tend to symmetrically increase the supply of both male and female labor. Given that women, at least in the first instance, do not benefit from a proportional increase in the demand for their labor services, we may expect female wages to experience a relative decline. In the presence of reservation wages, this may, in turn, discourage female participation in the labor market. All in all, should this scenario come to pass, we may expect to observe diverging wage rates and labor force participation rates between men and women (with participation rates for the latter potentially declining) in counties that benefit from oil discoveries, which is in line with the predictions concerning the effects of oil wealth derived from cross-country theoretical frameworks.

However, as the discussion above should make clear, the prediction that oil wealth has a negative impact on women's labor market outcomes is by no means a general result. It is in fact quite straightforward to construct scenarios in which oil wealth can be expected to have no impact on women's labor market success. The simplest such scenario would involve a context in which labor markets are not segregated by gender and female and male labor are perfect substitutes. In such a context oil discoveries (or for that matter any other shocks to labor markets) would not have a gender biased effect on local labor market opportunities. A perhaps more realistic setting in which we would expect the effects of oil discoveries on labor market opportunities for women to be subdued would involve the presence of a sector that finds itself on the employment margin between hiring male or female labor. If this sector is sufficiently large and it is not hurt (or is even helped) by the discovery of oil, then it could absorb the excess female labor that results from the composition of employment in other parts of the economy shifting in favor of men. A prime candidate for such a role is the service sector, in which women are thought to have a comparative advantage and which is unlikely to be crowded out by the oil sector and sectors connected to it (in fact the service sector may indeed benefit from the discovery of resource wealth).

Finally, it is important to note that the final setting discussed above can be slightly altered to lead to the result that oil discoveries may *enhance* labor market opportunities for women. In a context in which oil extraction and its connected sectors are not very male biased or simply are not labor intensive, such that their growth does not represent a substantial shock to local labor markets, it could nonetheless be the case that oil discoveries increase local incomes (say through higher profits for local capitalists, or rents or royalties for local landowners). If preferences are non-homothetic and services play the role of the "advanced goods", then a rise in local incomes may lead to a substantial increase in the demand for services. In turn, women are habitually thought to have a comparative advantage in the delivery of many of these services, such that the overall result of oil discoveries in such a scenario may in fact be an expansion of labor market opportunities for women.[4]

[4]Ross (2008) makes a similar argument based on a Dutch Disease story: If oil leads to a depression of the traded goods sector, but an increase in non-traded goods, then the openness of the non-traded goods sector towards women will be crucial.

If oil discoveries affect female labor force participation, it is likely that this also translates into changes in their position in the marriage market. Research has shown that women respond to improved labor market opportunities by postponing (Jensen 2012) and sometimes even foregoing marriage (Buchman, DiPrete and McDaniel 2008). Some studies have also found associations between elevated female labor force participation rates and increases in the incidence of divorce (Michael 1985, Bremmer and Kesselring 2004). Alongside delayed marriage, female involvement in the labor market has also been linked to lower fertility rates. Potential explanations for this link include increased opportunity costs of women's time and the role of time spent in activities such as education and training (Brewster and Rindfuss 2000).

3.3 Data and Empirical Strategy

This section describes the dataset we employ in our empirical verification of the link between major oil field discoveries and women's socioeconomic outcomes and also sets out the empirical specifications that we estimate in the following section.

We begin by drawing on the dataset built by Michaels (2011). This dataset was constructed on the basis of the Oil and Gas Journal Data Book (2000), a document which lists the names of all US oil fields larger than 100 million barrels. In line with Michaels (2011) we call these simply "large" oil fields. For each of these large oil fields, the data book details the amount extracted by 1999 and the amount that was projected to have remained at that time. The dataset allows us to build an almost exhaustive picture of major oil field discoveries over the period 1890 to 2000. Large oil fields are first discovered in the US South after 1890. After that, the hazard rate of discovery of new fields is found to increase sharply in the period between 1890 and 1930 and to fall quite rapidly in the subsequent decades (see Figure 3.1).

The case of the US South is interesting in its own right, as it remained noticeably underdeveloped relative to the North for an extended period of time (Wright 1986, Caselli and Coleman 2001) and has traditionally tended to display more conservative social norms on a series of issues, including gender (Rice and Coates 1995, Twenge 1997). However, it can also serve to inform the discussion concerning the links between resource specialization and female outcomes in a wider context.

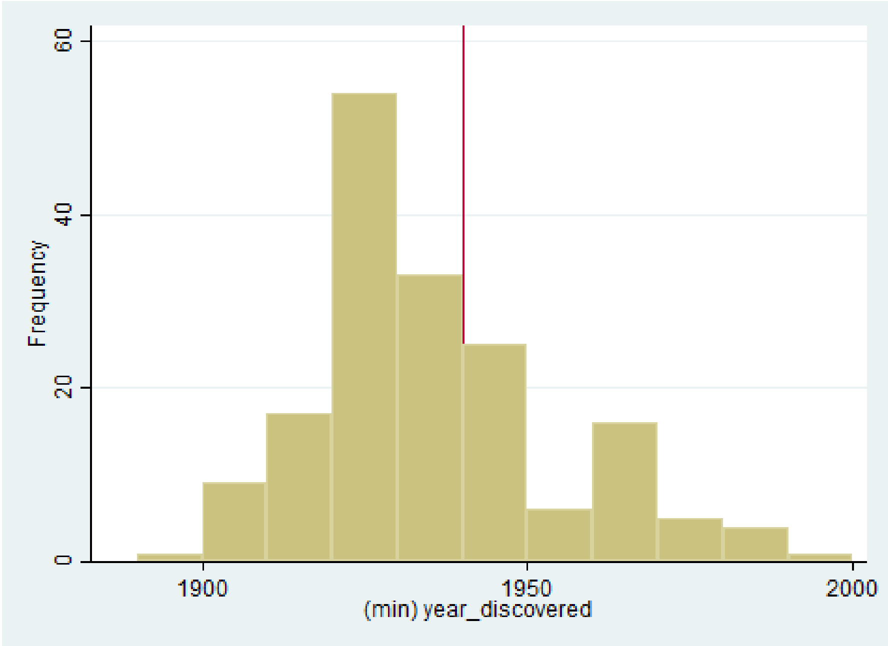

Figure 3.1: Number of Large Oil Fields Discovered, by Decade

Due to data limitations, we restrict the timeframe of our analysis to the period 1900 to 1940. However, this period is also particularly interesting for our analysis: Firstly, during this period, oil extraction is still a relatively labor intensive sector, such that in counties that benefit from large oil discoveries the oil sector employs a notable share of the labor force. To the extent that oil extraction itself is a sector that heavily employs men (which can be shown to indeed be the case), then the growth of the oil sector in oil-rich counties could itself be a "gender biased" shock to local labor markets, which could lead to some of the dynamics described in the previous section. In the final few decades of the twentieth century however, the oil sector becomes less and less labor intensive, such that it is not an important employer even in oil-rich counties, and as a result its importance as a "gender biased" factor affecting local labor markets is likely to be much smaller. Secondly, the case of the US in the first half of the twentieth century, when it was a substantially poorer and more conservative country than it is today, is more informative than an analysis carried out over a more recent time period for assessing the potential impact of similar resource shocks in some of today's developing countries.

Due to the time profile of new oil field discoveries, our period of interest contains more than two thirds of the major oil field discovery events recorded over the entire period 1890 to 2000. The maps depicted in Figures 3.2 to 3.6 show the evolving geography of oil discoveries in the period 1900 to 1940. They are based on county shape files of the United States available through the National Geographic Information System.

Michaels (2011) identifies oil-rich counties by matching major oil fields with the counties located above them by making use of the Oil and Gas Field Code Master List (2004). A county is defined as oil abundant if it lies above at least one large oil field. As a result of the matching of counties and oil fields, a total of 222 oil abundant counties are identified in the United States, about 150 of which are found in three adjacent states in the Southern US: Texas (107 counties), Oklahoma (24 counties) and Louisiana (19 counties). In order to focus our analysis on a comparable set of counties (i.e. counties that are similar along metrics other than oil abundance), we follow Michaels (2011) in restricting the sample to counties that are within 200 miles of the oil abundant counties of Texas, Oklahoma and Louisiana. This leaves us with a panel of 774 counties, 171 of which are oil abundant and 119 of which experience a major oil discovery event during the period 1900 to 1940. [5]

To estimate the impact of oil abundance on our variables of interest, we estimate two main types of specifications. For the outcome variables of interest that we can observe over multiple time periods in our sample we estimate regressions of the form:

$$y_{ct} = \alpha_c + \tau_t + \beta DiscoveredOilField_{ct} + \eta NeighborOilField_{ct} + X_c'\gamma_t + u_{ct} \quad (3.1)$$

where y_{ct} measures outcomes in county c at time t, as described below, while α and τ are county and time fixed effects, respectively, and X_c is a set of county level controls based on the Michaels (2011) dataset. Our variable of interest, $DiscoveredOilField_{ct}$, equals 1 if the county is oil abundant and its oil field has already been discovered and 0 otherwise. We also include a control variable for counties that border counties with a discovered oil field: $NeighborOilField_{ct}$ is 1 if any of the neighbors of county c has a discovered oil field by time t, and 0 otherwise. This variable is included in the regression

[5] Since we include all counties within 200 miles of the oil abundant counties in the 3 mentioned states, we also include 21 oil abundant counties in Alabama, Arkansas, Florida, Kansas, Mississippi and New Mexico, giving a total of 171 oil abundant counties. However, we operate with a more limited sample for earlier time periods, particularly for the year 1900. In particular, we drop all counties in Oklahoma and New Mexico in 1900, as these were still territories and underwent substantial territorial reorganizations afterwards.

to control for potential spillover effects associated with a neighbor discovering a large oil field.

For a smaller set of outcomes of interest, data limitations force us to perform the analysis of the impact of oil discoveries on a cross-section of counties observed in the year 1940. In these cases we estimate empirical specifications of the form:

$$y_c = \alpha + \beta DiscoveredOilField_c + \eta NeighborOilField_c + X_c'\gamma + s_c + u_c \quad (3.2)$$

where y_c measures outcomes in county c in the census year 1940, X_c is the same set of county level controls employed in specification (3.1) and s_c is a state-level fixed effect. In this context, our explanatory variable of interest, $DiscoveredOilField_c$, equals 1 if the county is oil abundant and its oil field has already been discovered by 1940 and 0 otherwise. Similarly to the previous specification, the control variable $NeighborOilField_c$ takes a value of 1 if a neighboring county has a discovered oil field in 1940 or zero otherwise.

The same set of control variables (included in the vector X_c) is used across all our specifications. These include: longitude, latitude, average annual rainfall, an indicator for arid counties, an indicator for semi-arid counties, distance to nearest ocean and distance to nearest navigable river. These variables are not affected by the oil industry and control for potentially spurious determinants of outcomes that might be correlated with our treatment. In the panel data specifications (specification of the form (3.1) outlined above) we allow the effect of these control variables to be potentially time-varying by interacting them with decadal time dummies.

Having discussed the right hand side variables of our main regression models, we now move to describe the construction of our outcome variables, denoted by y_{ct} in our panel specifications and by y_c in our cross-sectional specifications. The outcome variables are constructed using census data from the Integrated Public Use Microdata Series (IPUMS). The dependent variables we study using our panel data specification (specification (3.1) above) include: the log of county population older than 14, county-level urbanization rate (measured as urban population divided by overall county population), average age at the county level, the sex ratio at the county level (measured as the ratio of the local male population to the local female population), the share of the labor force at the county level employed in the 4 broadly defined sectors of agriculture, oil extraction, manufacturing and services, the share of the labor force at the county level employed in the aforementioned 4 sectors by gender, the labor force participation rate at the county level by gender (defined as men or women in the labor force/ total number of men or women of working age in the county, where working age is defined as older than 14), the employment rate at the county level by gender (defined as employed men and women/ total number of men or women in the labor force at the county level), county average occupational income scores by gender, the county level marriage rate (define as the share of women of marriage age who report being married), the average age at first marriage for women at the county level, fertility (defined as the number of children ever born) and fertility of women over 40 years of age.[6]

With our more limited cross-sectional specification for the census year 1940 (specification (3.2) described above) we study the following dependent variables: average wages at the county level by gender; and two measures of labor supply intensity of employed women at the county level, namely average number of weeks worked per year and average number of hours worked per week.

When constructing our outcome variables, we collapsed the individual-level data contained in IPUMS at the county-year level, using the dataset's person weights to improve representativity. All the regressions reported in the next section are in turn weighted using the county population in each year as weights (the one exception being those regressions that have population as outcome variable). Furthermore, to address concerns that emerge from the fact that county boundaries experience changes during our period of analysis, we drop county$*$year observations from our sample when the surface area of a county in the respective year differs by more than 5% from the same county's surface area in 1940.

As previously noted, the empirical strategy outlined above presents several advantages over previous work analyzing the consequences of natural resource specialization on women's outcomes. Firstly, it relies on a source of variation in resource abundance that is not subject to endogeneity concerns that arise in connection with other previously used measures such as contemporaneous oil production. In addition, due to using the information about the timing of oil field discoveries, we can employ a difference-in-

[6]For most of these variables we have a full panel of counties covering the period 1900 to 1940. However, our dataset does not include information on employment status for the years 1900 and 1920, on fertility (measured as the number of children ever born) for the years 1920 and 1930 and for the female age at first marriage before 1930.

difference-style research design, comparing the evolution of oil-rich counties before and after discoveries to that of non-oil counties. Focusing on a set of counties from the same country (and even the same region) also helps us to address issues due to differences in institutions that are hard to control for in cross-country panels that previous studies have used. In our set-up, such institutional differences should be relatively small and not a major threat to identification. Finally, the case of the Southwestern United States offers us the advantages of analyzing consistent, high-quality data from a region that at that time still relied heavily on agriculture. This is important because much of the discussion surrounding the link between resource abundance and gender issues has concentrated on developing, often heavily agrarian economies. Keeping these advantages in mind, we now turn to implementing our empirical strategy.

3.4 Results

Before 1900 the economy of the Southern United States was predominantly agricultural and the overwhelming majority of oil fields had not yet been discovered (see Figures 3.1 and 3.2). We begin our analysis by providing some suggestive evidence that oil-rich counties (virtually all of which would not have yet discovered oil) were not systematically different from counties that lacked any oil deposits when seen from the level of the starting year in our sample, 1900. For the year 1900 we have a restricted sample of only 580 counties, as the future states of Oklahoma and New Mexico were largely unorganized by this point in time. With that caveat in mind in table 3.1 we present, separately for oil-rich and non-oil counties, the sample averages of a battery of key variables[7] for the year 1900.

As can be seen, apart from population density, the two groups of counties do not systematically differ at the level of the baseline year 1900 (the difference for the oil employment share is statistically significant, but economically irrelevant). These findings are reassuring as they imply that the oil wealth “treatment” can be seen as nearly randomly assigned and thus the setting we study constitutes a valid natural experiment and

[7] The variables included in table 3.1, which contrasts the pre-oil discovery characteristics of oil-rich and baseline counties, a measure of population density, female and male labor force participation rates, the urbanization rate, average number of children born for each woman, and the labor force shares of the oil sector, agriculture, manufacturing and services

Variable	Non Oil	Oil	difference	t statistic of difference
Inhabitants over 14 per square mi	17.7635	10.0463	7.7172	3.09***
	(49.9877)	(9.9435)		
Female LFP	.1688	.1524	.0164	1.29
	(.137)	(.1166)		
Male LFP	.9156	.9148	.0008	0.12
	(.0468)	(.0653)		
Ratio Urban Pop	.0517	.039	.0127	1.18
	(.1114)	(.1012)		
(mean) Children ever born	4.2666	4.4056	-.139	-1.64
	(.607)	(.8487)		
Share LF empl. in oil industry	.0001	0	.0001	1.81*
	(.0013)	(.0001)		
Share LF empl. in manufacturing	.0325	.035	-.0025	-0.49
	(.0424)	(.0505)		
Share LF empl. in agriculture	.6824	.6527	.0297	1.31
	(.1944)	(.2218)		
Share LF empl. in services	.0909	.0965	-.0056	-0.84
	(.058)	(.0652)		
Observations	467	113		

t-statistic refers to a t-test for differences in means, allowing for unequal variances.
One non-oil county has missing information for all variables but male labor force participation and urbanization. Data on county surface areas in 1900 are from Haines (2010).
*** p<0.01, ** p<0.05, * p<0.1

Table 3.1: Oil vs Non-Oil Counties in 1900 (Before the Discovery of Oil)

the “common trend” assumption needed for the validity of our difference-in-difference design is likely to hold.[8] Based on these results, we proceed to set the stage for our main analysis relating resource shocks to gender outcomes by first checking whether oil field discoveries indeed represent important developments for the discovering counties. In particular we verify whether the discovery of major oil deposits can be found to have substantial effects on counties’ economies and demographic characteristics.

To do so, we study the evolution of some key demographic variables and the sectoral composition of the economy using our baseline panel model (specification (3.1) in the previous section), the results of which are presented in tables 3.2 and 3.3. Taken together, these tables largely confirm the findings of Michaels (2011): Discoveries of major oil fields are associated with rapid population growth, increased urbanization rates and a younger population. We also check whether oil wealth is associated with gender-biased immigration by assessing whether oil-rich counties exhibit substantial changes in their sex ratios after the discovery of oil, and find no evidence that this is the case. Thus, contrary to popular perception and anecdotal evidence based on short-run analyzes [9], but in line with our working assumption of continuously clearing marriage markets from the previous section, in our sample we observe no tendency for the gender ratio in oil counties to become skewed in favor of men. This might be interpreted as evidence that the impact of resource shocks on the gender composition of the local population, to the extent that it is present, is likely to be short lived and difficult to capture with relatively coarse decadal data.

In addition, the sectoral composition of the economy, measured by the share of the labor force employed in each of the 4 major sectors of agriculture, oil extraction, manufacturing and services, also displays substantial changes, with agriculture experiencing relative declines, whereas oil extraction displays a sharp growth (see table 3.3). Interestingly, the entire relative growth of the oil extractive sector is accommodated by a relative decline of agriculture, with the manufacturing and service sectors growing only slightly.[10] We also detect some spillover effects from oil discoveries in neighboring

[8] Further evidence for this will be presented in section 3.5

[9] See for example Sheerin and Bressanin (2014)

[10] When interpreting the results, it has to be borne in mind that these are sectoral shares of the total labor force. A positive coefficient thus means that a sector’s employment grows faster than the total labor force. As can be seen, our results reveal no evidence of the “Dutch Disease” in our sample. If anything, manufacturing as well as services seem to benefit (even in relative terms) from the discovery of oil.

counties, which largely go in the same direction as own-county discoveries, but are of substantially smaller magnitudes.

The results so far (which mirror those of Michaels 2011) highlight that oil discoveries constitute substantial shocks to a county that affect both its economy, as well as its social structure. What is more, oil extraction and manufacturing, the two broad sectors that seem to benefit the most from oil discoveries, are relatively male-dominated: While women account for more than 15.5% of the overall labor force over our sample, their shares in manufacturing and oil extraction amount to only 8.2% and 1.6%, respectively. Moreover, within manufacturing, the sectors most connected to oil extraction by either supply or demand linkages (and which can be expected to grow in oil-rich counties after the discovery of oil[11]) also tend to employ relatively few women. For example, the oil refining sector, the most closely related activity to oil extraction via forward linkages, draws only 5.5% of its labor force from among women, whereas glass products and fabricated metals, the first and second most closely linked sectors to oil extraction via backward linkages, exhibit shares of females in their overall employment of 5.1% and 8.4% respectively. Thus, our findings on the sectoral composition of the economy coupled with an informal analysis of employment shares provide suggestive evidence that oil discoveries may constitute a male-biased labor demand shock.

In light of these first results, which indicate that some of the conditions required for oil discoveries to represent substantial male-biased shocks to local labor markets are met, we now move to the main question of interest: Do oil field discoveries have an impact on measures of labor market participation by gender? We assess this in table 3.4, using our baseline panel specification with male and female employment and labor force participation rates as outcome variables.

Interestingly, we do not find large effects on either gender: While the male labor force participation seems to increase at least slightly in oil-rich counties, we do not observe any changes in female labor force participation. Similarly, we fail to identify any effect of oil discoveries on either the male or female employment rates. The respective point estimates are close to zero across all specifications and statistically insignificant. Our results thus suggest that there is no effect on the relative demand for female labor

[11]The fact that sectors linked via backward and forward linkages to the resource sectors tend to benefit from resource shocks has already been established elsewhere (Black et al. 2005, Marchand 2012, Fetzer 2014).

that is reflected in the quantities transacted in local labor markets, at least when one focuses on the extensive (i.e. participation) margin. Switching attention to the intensive margin, in table 3.5, we study two measures of labor supply intensity, namely the number of weeks worked per year and the number of hours worked per week. Due to data limitations, we are only able to assess the impact of oil wealth on these measures of labor supply on a cross-section for the year 1940. We proceed to estimate our cross-sectional specification (specification (3.2) in the previous section) and for the purposes of comparison we report regression results for both men and women.[12] Again, we do not find any evidence supporting a differential change in female labor supply due to oil discoveries. For both measures employed, the coefficients are quite small and never statistically significant.

Thus, in contrast to the cross-country results of Ross (2008), we do not find evidence for a negative relationship between oil wealth and female labor market participation. What can explain this absence of an effect? As discussed in section 3.3, a negative relationship between oil wealth and female labor market involvement crucially relies on two conditions. Firstly, labor markets have to be segregated by gender. Secondly, there must not be any sector that is open to women and that is sufficiently large to absorb the excess female labor that may result from the shifting structure of the rest of the local economy. If such a sector exists and is not hurt (or is even helped) by the discovery of oil, the non-response of female labor force participation is to be expected.

To assess this, in tables 3.6 and 3.7, we estimate the effect of oil discoveries on the weight of different sectors in female and male employment, respectively. In particular, we use each sector's employment share by gender as the outcome variable. Not surprisingly, we find that manufacturing and oil extraction grow as a share of male labor, while agriculture becomes a less important employer of men. For women, on the other hand, we find a reallocation from manufacturing and agriculture into services, with a very small and economically negligible increase in oil extraction. These findings are consistent with labor markets being partially segregated across gender lines and with oil discoveries representing a male-biased shock to labor demand within the manufacturing sector (e.g. due to more "male" industries growing particularly). However, while oil

[12]One potential worry might be that going from a panel specification to a cross-section might causes biases. In order to address this, we re-ran the previous panel regressions on the 1940 cross-sectional sample. The results of this exercise are provided in the appendix of this chapter and support the validity of the cross-sectional regressions.

wealth thus seems to play a role in driving women out of manufacturing, it does not seem to drive them out of the labor force altogether. This is largely because oil discoveries are associated with a growing service sector that absorbs "excess" female labor. In this respect, our results provide evidence for the mechanism described qualitatively by Ross (2008): even if labor markets are segregated by gender and even if oil discoveries represent an initial male biased shock to local labor markets, the presence of a sector that is open to women and large enough to absorb "excess" female workers is sufficient for oil wealth not to notably hamper women's labor market involvement.

The absence of sizeable participation and employment effects in the labor market also begets the question of whether oil discoveries can be found to affect the price of labor, i.e. wages. To analyze this, we estimate our baseline cross-sectional regression (see specification (3.2) in the previous section) for the 1940 sample. Our results are presented in table 3.8, which in line with our previous analysis reports separate regression estimates of the effect of oil wealth on male and female wages for the purposes of comparison. Unlike our previous results on labor force participation and employment, we identify substantial effects of oil wealth on local wage rates, with average wages in oil-rich counties being over 32 log points higher relative to baseline counties after the discovery of oil. Interestingly, the benefits of oil field discovery in terms of higher wages seem to accrue mostly to men, whose wages are almost 36 log points higher in oil-rich counties than in comparable counties that do not have oil deposits (or have not yet discovered their oil field). There is also some evidence that women's wages are higher in oil-rich counties, with the point estimate indicating a female wage differential between oil-rich and baseline counties of some 11 log points. However, the coefficient on our variable of interest in the female wage regressions is not statistically significant. Taken together, our results point to a substantial widening of the gender wage gap in oil-rich counties, with the differential between the average male wage and the average female wage being 25 log points higher in counties with discovered oil fields in 1940. One potential concern with this finding is that data limitations force us to perform this regression at the cross-section level only. While we think that oil discoveries are plausibly exogenous even in a cross-sectional model that cannot control for county fixed effects, we try to further address this concern in columns 5 and 6, where we employ our 1900-1940 panel specification with occupational income score variables (by gender) as outcome variable. This variable, which is available from IPUMS, assigns each person

i the median annual income of all persons with i's occupation in 1950, measured in hundreds of 1950 dollars. Being based on national medians, this measure of course will not capture wage increases within the same occupations in different counties. However, it will capture any wage effects due to an increased prevalence of better-paying occupations. As can be seen in columns 5 and 6, oil discoveries lead to a marked increase in relative occupational quality for men compared to women: While the occupational scores of women stay basically unchanged, men tend to work in significantly better-paying occupations. This corroborates and adds further credibility to our wage results. Moreover, it can also give an indication of changes in occupational quality, where the gap between men and women seems to be widening as well after oil discoveries.

Reconciling our labor force participation and employment rates results with the results of our wage regressions is not immediate. In particular, it is surprising that the substantial wage gains observed for men in oil-rich counties do not seem to be reflected in either notably increased labor force participation and employment rates for men[13] or in increases in labor supply by employed men.[14] Our findings regarding women's labor market outcomes are somewhat easier to rationalize. From the perspective of the demand-side of labor markets, while we find some evidence that the(3.1) employment structure of manufacturing moves against women, this effect seems to be balanced out by increasing opportunities for women in the service sector. On the supply-side of labor markets, our findings seem to indicate that, for women, the negative effect on labor force involvement that could ensue as a result of higher male wages may be compensated by the positive effect of increasing own wages, though admittedly the evidence in favor of higher female wages in oil-rich counties is only suggestive.

In a final step, we assess whether oil discoveries affect women's marriage market outcomes. As discussed in section 3.2, a substantial literature has linked female labor force participation to marriage rates and fertility. Since we do not find any effects

[13]This apparent inelasticity of the labor supply of men seems particularly surprising given the strong response we observe on the extensive margin represented by the immigration channel.

[14]Interpretation of our wage results has to be undertaken with care. In the main text we discuss the movements we observe in *nominal* wages, which may differ substantially from movements in real wages as a result of oil wealth. Indeed Michaels (2011) finds evidence of increasing prices of non-tradables (particularly rental rates) in oil-rich counties, which indicates that movements in real wages are likely to be of lower magnitude than movements in nominal wages. However, given that in our period of analysis (and even after) we observe substantial immigration into oil counties, the direction of movement of real wages and of the relative gap in real pay by gender are likely to be analogous to the corresponding movements observed for nominal wages.

on male or female labor force participation, this channel is unlikely to be operational in our setting. However, by increasing male wages both absolutely and relatively to women's wages, oil discoveries might increase the local supply of "marriageable" men and thereby increase marriage rates (Wilson 1987, Darity and Myers 1995, Buckley 2003). In order to assess this, we run our baseline panel specification (specification (3.1) in the previous section) with three marriage-market related outcomes: women's likelihood to be married (the marriage rate), women's age at first marriage and fertility (measured as children ever born to a woman). The results are shown in table 3.9. Overall, we find no association between oil wealth and the female marriage market outcomes we study. Women in oil-rich counties are not more likely to be married than women in baseline counties and also are not getting married at younger ages. Finally, we find suggestive evidence for a negative association between oil wealth and average fertility. However, this result is not statistically significant and seems to be largely compositional: declining fertility seems to be driven by the fact that oil wealth shifts the local age composition towards younger cohorts. Once we restrict analysis to the fertility of women aged over 40, any association between local oil abundance and fertility disappears.

All in all, the results of our analysis of the impact of oil wealth on women's marriage market outcomes are largely consistent with our findings related to labor markets. As oil wealth shocks seem to have virtually no effect on measures of female involvement in labor markets in our sample, it is not very surprising, from the perspective of the class of theoretical frameworks that underpins this study, that they also seem to have little impact on women's marriage market outcomes. It is interesting to note, however, that our results concerning marriage markets seem to indicate the absence of notable effects ensuing from the widening of the gender pay gap in oil-rich counties.

3.5 Robustness Checks

In this section, we implement a number of robustness checks that aim to provide further support for the notion that the effects we find are indeed caused by the discovery of major oil fields. Furthermore, some of the specifications that we estimate in this section serve to shed some light on the characteristics and timing of the transmission of oil shocks.

The first robustness check we perform involves exploiting the timing of oil field discoveries to verify more rigorously if our identifying assumption of common trends between oil and baseline counties before the discovery of oil fields holds. This check also has the added benefit of allowing us to study the timing of the transmission of oil shocks. To perform this verification we augment our baseline panel specification by replacing our variable of interest with a full set of leads and lags of the date of oil discovery relevant for each oil-rich county. The specification we estimate is thus of the form:

$$y_{ct} = \alpha_c + \tau_t + \sum_{j \in \{-30,-20,-10,10,20,30\}} \beta_j DiscoveredOilField_{c,t+j} + \eta NeighborOil_{ct} + X_c' \gamma_t + u_{ct} \quad (3.3)$$

where the set of dummies $DiscoveredOilField_{c,t+j}$ code for whether an oil field is to be discovered $20 - 30$ years from period t, $10 - 20$ years from period t, $10 - 0$ years from period t or was discovered $0 - 10$ years prior to period t, $10 - 20$ years prior to period t or more than 20 years prior to period t, with the omitted reference category being represented by discoveries that occur more than 30 years after the reference period t. All the remaining variables and controls retain their meanings from specification (3.1) in section 3.4. The results of estimating this leads and lags specification for a range of dependent variables are presented in tables 3.10 and 3.11. For brevity, we focus on the key variables of our study: Male and female labor force participation, the local sex ratio, marriage rates, occupational income scores and the sectoral composition by gender. Leads and lags analyzes for the remaining outcomes we have discussed can be found in the appendix of this chapter.

Reassuringly, our results indicate that there is no evidence that oil-rich counties display systematically different characteristics before the discovery of oil, with virtually all the leading dummies (that indicate oil discoveries in the future) having no significant impact on any of our outcome variables of interest.

The findings related to the lagging dummies (that indicate time elapsed since discovery) largely confirm the results from our main specifications in the previous section: While there is no effect on either male or female labor force participation rates, sectoral reallocation is active. An interesting, but also intuitive further result is that the reallocation of male labor into the oil industry takes place immediately, while the increase in manufacturing needs a bit longer to materialize. The occupational income scores for men show a similar pattern, growing stronger as time past the oil discovery elapses.

In addition, the effect on the importance of the oil industry for men becomes weaker as time elapses after discoveries. This could reflect a number of factors including the exhausting of oil fields, the oil sector generally becoming more capital and less labor intensive as time elapses, or oil wealth bringing about growth in other sectors of the economy that take more time to materialize. All in all, our results from the lead and lag analysis are consistent with the results emerging from our main specifications and support the view that the systematic differences we observe between oil-rich and baseline counties do indeed appear after oil discoveries and can be attributed to oil abundance in a causal way.

A second robustness check we apply to the results of our baseline panel specification involves performing the estimation on a limited sample in which all counties without oil deposits are dropped from the analysis. This type of empirical exercise is quite demanding, as it involves deriving identification only from the time variation in oil field discoveries, as well as dropping more than three quarters of our observations. Our results are shown in tables 3.12 and 3.13. Again, we focus on our key variables of interest. Overall, the findings of this robustness test provide a convincing validation of the results obtained from our baseline specification in the previous section: having a discovered oil field is found to be associated with a reallocation of men from agriculture into oil and (to a lesser extent) manufacturing, while women increasingly work in service sector jobs. Women tend to work in occupations that pay similarly as before, while men move towards better-paying occupations. The overall labor force participation rates of men and women are left unchanged, as are the local sex ratios and female marriage rates. Moreover, not only do all our findings from our baseline panel specification survive unqualified, but the point estimates of the coefficients obtained by estimating over this limited sample are very similar to those obtained in the previous section.

Finally, we perform two robustness checks on the results obtained from our baseline cross-sectional specification in the previous section. The first involves adding an additional dummy for "having an undiscovered oil field" to our baseline cross-sectional specification. Secondly, we perform a placebo test: we drop all counties that have a discovered oil deposit from the analysis and replace our variable of interest from the baseline cross-sectional specification with the dummy variable that codes for "having an undiscovered oil field". We thus treat counties that have an undiscovered oil field as if they have discovered it- if the effects we have seen are indeed caused by oil discoveries, these placebo discoveries should not lead to any significant effects.

The results from these robustness specifications are presented in tables 3.14 and 3.15. Reassuringly, their results seem to validate our findings and interpretation from the previous section. Our wage results survive and only emerge in oil counties with an already discovered oil field. Most importantly, in the second specification, the "having an undiscovered oil field" dummy (i.e. the placebo treatment) is not found to have an effect on any of our outcomes of interest.

3.6 Conclusion

In this chapter we have sought to provide an extensive analysis of the effect of oil wealth on female labor market participation.

By making use of within country historical data on plausibly exogenous oil discoveries over an extended time period, we have been able to combine the benefits of more credible identification with the relevance and informativeness given by studying a setting that is not too dissimilar from the environment that prevails in some of today's resource rich developing countries.

Contrary to previous studies (e.g. Ross 2008), we do not find a negative relationship between oil wealth and female labor force participation. While oil abundance is found to have substantial economic and demographic implications, which include shifting the sectoral composition of employment at the level of local economies, once we focus on our labor market outcomes of interest (labor force participation by gender, employment rates by gender) we fail to find any association between oil wealth and women's labor market success. Oil abundance is thus not associated with lower rates of female labor force participation at the county level or with depressed employment rates for women. The most likely explanation for this is a process of sectoral reallocation by gender, where women find ample employment opportunities in the service sector. Consistent with these findings concerning labor markets we also fail to identify any association between oil wealth and potentially malign marriage market outcomes for women: women in oil-rich counties were not getting married younger or displaying higher fertility levels than women in baseline counties, and were also not more likely to be married. The only evidence in favor of the notion that oil abundance may bring about a male-biased shock to local labor markets comes from the analysis of wage data, as we indeed find that oil wealth is associated with notably larger pay differentials between men and women at the county level. However, in light of our other findings concerning labor and marriage markets, this widening of the gender gap in oil-rich counties does not appear to be very consequential.

In our view, our findings show that while oil discoveries may, in the first instance, constitute a male-biased demand shock to local labor markets, this does not necessarily lead to worse labor market outcomes for women in the aggregate. As hypothesized by Ross (2008), the predicted link between resource abundance and adverse female outcomes is only likely to materialize in the absence of a sector that finds itself on the employment margin between hiring male or female labor and that is also sufficiently large to absorb any "excess" female labor resulting from a relative decline in the demand for female labor elsewhere in the economy. In our setting, we observe a general boost to the local economy (also documented by Michaels 2011) with a corresponding increased demand for women in the service sector. Our inability to find any impact of oil wealth on most outcomes of interest can thus potentially be explained through the fact that in our sample the service sector expands and absorbs an increasing share of the female labor force in oil-rich counties in the wake of major oil field discoveries. The existence of such sectors and their openness towards women thus are a crucial determinant of whether the initial male-biased shock will actually end up hurting women's prospects. Furthermore, our findings seem to indicate that the circumstances in which such a sector is likely to be present are wider than previously thought. As a result, settings in which the entire set of conditions required for oil in itself to adversely impact women's labor market opportunities are likely to be rare.[15]

A somewhat broader implication of our finding is that an initial gender-biased shock does not necessarily lead to aggregate gender-biased outcomes. If such a shock has indirect effects on other sectors via income effects or backward and forward linkages, the

[15] Ross (2012), for example, named the case of the Southern US that we study as one in which all the conditions required for oil wealth to have a notable impact on female socioeconomic outcomes are likely to be fulfilled. As our results show, even in this potentially "ideal" context, there is no such clear adverse effect of oil on women's labor market participation. It may well be the case that oil wealth only has an adverse impact on women's labor market outcomes in settings in which their access to large sections of the labor market is restricted, perhaps due to institutional, cultural, religious or other factors. However, in such settings, it becomes a matter of interpretation whether resource wealth causes adverse outcomes for women, or is merely a secondary aggravating factor.

initial gender-biased implications can easily be attenuated or even fully netted out.

Finally, our study leaves unanswered a series of important questions that could be productive to explore in further research. Firstly, it would be important to determine the conditions that lead to the transmission of the labor market demand shocks to operate almost exclusively through relative wages, without any discernible effects on the relative numbers of men and women involved in the labor market.

Another important question related to the line of enquiry explored in the present chapter is whether oil wealth can be found to have any impact on women's political involvement, particularly their propensity to vote and (later on) to stand for elected office. While previous studies from the political science literature (e.g. Ross 2008) have touched upon this issue, it would be interesting to further investigate this question in a sub-national setting that mitigates some of the potential threats to identification that affect previous studies. Finally, given that we find a substantial widening of the gender gap and an increase in the occupational income scores of men, it would be interesting to study whether these can also bring about some of the detrimental socioeconomic developments that have been linked with low rates of female labor force participation.

VARIABLES	(1) Ln(Pop)	(2) Ratio Urban Pop	(3) Mean Age Fem	(4) Mean Age Male	(5) Sex Ratio
DiscoveredOilField	0.324***	0.0388***	-0.878***	-0.638**	-0.00769
	(0.0755)	(0.0103)	(0.251)	(0.248)	(0.0152)
NeighborOil	-0.0132	0.0118	-0.176	-0.339*	0.0154
	(0.0307)	(0.00771)	(0.176)	(0.193)	(0.0121)
Observations	3,568	3,570	3,569	3,569	3,568
R-squared	0.932	0.966	0.692	0.640	0.500

Controls described in text.All regressions control for county and year FE
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.2: Impact of Oil Discoveries on Some Demographic Variables

	(1)	(2)	(3)	(4)
VARIABLES	Share of the Labor Force employed in			
	Oil industry	Manufacturing	Services	Agriculture
DiscoveredOilField	0.0479***	0.00625	0.0101	-0.0734***
	(0.00725)	(0.00519)	(0.00806)	(0.0217)
NeighborOil	0.00864***	0.00239	0.00176	-0.0152
	(0.00294)	(0.00444)	(0.00467)	(0.0141)
Observations	3,567	3,567	3,567	3,567
R-squared	0.744	0.807	0.824	0.930

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.3: Impact of Oil Discoveries on Sectoral Composition of Employment

VARIABLES	(1) Fem LF Part	(2) Fem Emp Rate	(3) Male Lf Part	(4) Male Emp Rate
DiscoveredOilField	-0.00577	-0.0187	0.00323	-0.00746
	(0.0113)	(0.0198)	(0.00578)	(0.00984)
NeighborOil	-0.000165	0.0159	0.00755*	-0.00327
	(0.00852)	(0.0112)	(0.00397)	(0.00665)
Observations	3,569	2,132	3,569	2,237
R-squared	0.770	0.454	0.727	0.611

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.4: The Impact of Having a Discovered Oil Field on the Labor Force Participation Rate and Employment Rate, by Gender

VARIABLES	(1) Hours/week Fem	(2) Hours/week Male	(3) Weeks Fem	(4) Weeks Male
DiscoveredOilField	0.210	-0.230	0.490	0.234
	(0.532)	(0.402)	(0.598)	(0.353)
NeighborOil	0.160	-0.0852	0.745	0.180
	(0.520)	(0.320)	(0.633)	(0.263)
Observations	730	761	740	761
R-squared	0.096	0.253	0.081	0.119

Controls described in text. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.5: The Impact of Having a Discovered Oil Field on Measures of Labor Supply, by Gender

	(1)	(2)	(3)	(4)
VARIABLES	Share of the Labor Force employed in			
	Oil industry	Manufacturing	Services	Agriculture
DiscoveredOilField	0.00152**	-0.0113	0.0548*	-0.0525
	(0.000720)	(0.00891)	(0.0324)	(0.0333)
NeighborOil	0.000126	-0.00604	-0.00122	0.00796
	(0.000440)	(0.00593)	(0.0224)	(0.0246)
Observations	3,368	3,368	3,368	3,368
R-squared	0.563	0.525	0.572	0.801

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.6: Impact of Oil Discoveries on the Sectoral Composition of Employment, Women

	(1)	(2)	(3)	(4)
VARIABLES	Share of the Labor Force employed in			
	Oil industry	Manufacturing	Services	Agriculture
DiscoveredOilField	0.0574***	0.00940	-0.000155	-0.0741***
	(0.00840)	(0.00610)	(0.00563)	(0.0203)
NeighborOil	0.00991***	0.00360	0.00438	-0.0194
	(0.00329)	(0.00530)	(0.00350)	(0.0132)
Observations	3,568	3,568	3,568	3,568
R-squared	0.754	0.810	0.770	0.929

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.7: Impact of Oil Discoveries on the Sectoral Composition of Employment, Men

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ln(avg wage)	ln(M-F wage ratio)	ln(avg male wage)	ln(avg fem wage)	Occupational income score	
					Male	Female
DiscoveredOilField	0.324***	0.252***	0.356***	0.105	1.205***	-0.0715
	(0.0923)	(0.0584)	(0.103)	(0.0872)	(0.303)	(0.440)
NeighborOil	0.0307	0.0212	0.0346	0.0105	0.319	-0.218
	(0.0997)	(0.0612)	(0.112)	(0.0884)	(0.198)	(0.297)
Observations	762	722	760	724	3,568	3,372
R-squared	0.306	0.105	0.278	0.215	0.912	0.681

Controls described in text. Robust standard errors in parentheses.
Columns 5 and 6 control for county and year FE and use standard errors clustered at the county level
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.8: The Impact of Having a Discovered Oil Field on Wages, by Gender

VARIABLES	(1) Marriage rate	(2) Fem age at 1st marriage	(3) Children ever born women over 40	(4) Children ever born
DiscoveredOilField	0.00162	-0.0836	-0.130	0.0249
	(0.00752)	(0.336)	(0.117)	(0.209)
NeighborOill	0.00116	0.343	-0.0793	0.0817
	(0.00529)	(0.240)	(0.0901)	(0.149)
Observations	3,567	1,524	2,034	1,976
R-squared	0.604	0.703	0.860	0.851

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.9: Impact of Having a Discovered Oil Field on Women's Marriage Market Outcomes

VARIABLES	(1) Male LF Part	(2) Fem LF Part	(3) Sex Ratio	(4) Marriagerate	(5) Share of Male LF employed in Oil	(6) Manufacturing	(7) Services
20-30 years prior to discovery	-0.00975	-0.0161	-0.0125	0.0143	0.00292	-0.00103	0.00937
	(0.00694)	(0.0194)	(0.0246)	(0.0103)	(0.00369)	(0.00701)	(0.00809)
10-20 years prior to discovery	0.00284	0.00330	-0.0238	0.000882	-0.00263	-0.00842	0.00528
	(0.00842)	(0.0278)	(0.0279)	(0.0117)	(0.00472)	(0.0111)	(0.00747)
0-10 years prior to discovery	0.0132	0.00744	-0.0487*	-0.00902	-0.00721	-0.00301	-0.00521
	(0.00888)	(0.0274)	(0.0291)	(0.0123)	(0.00651)	(0.0124)	(0.00874)
0-10 years post discovery	0.0102	-0.00445	-0.0175	-0.000555	0.0558***	-0.00304	-0.00479
	(0.00898)	(0.0285)	(0.0288)	(0.0128)	(0.0107)	(0.0120)	(0.00910)
10-20 years post discovery	0.00790	-0.00372	-0.0824**	0.000661	0.0511***	0.0159	0.00913
	(0.0107)	(0.0308)	(0.0368)	(0.0148)	(0.0105)	(0.0136)	(0.0111)
20+ years post discovery	0.00299	0.0103	-0.0668	-0.00107	0.0353***	0.0285*	0.00992
	(0.0129)	(0.0348)	(0.0507)	(0.0192)	(0.0128)	(0.0161)	(0.0129)
NeighborOil	0.00698*	7.45e-06	0.0168	0.00141	0.00965***	0.00421	0.00470
	(0.00397)	(0.00881)	(0.0120)	(0.00533)	(0.00339)	(0.00538)	(0.00360)
Observations	3,569	3,569	3,568	3,567	3,568	3,568	3,568
R-squared	0.728	0.771	0.503	0.605	0.756	0.811	0.772

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.10: Leads and Lags Analysis, First Part

VARIABLES	(1) Share of Male LF employed in Agriculture	(2) Oil	(3) Share of Fem LF employed in Manufacturing	(4) Services	(5) Agriculture	(6) Ocupational income score Male	(7) Female
20-30 years prior to discovery	0.0136	0.000278	-0.0114	-0.0294	0.0294	-0.111	0.205
	(0.0187)	(0.000406)	(0.00877)	(0.0486)	(0.0424)	(0.296)	(0.505)
10-20 years prior to discovery	0.0241	-0.000547	-0.0108	-0.0177	-0.00574	-0.129	0.545
	(0.0213)	(0.000398)	(0.0120)	(0.0689)	(0.0629)	(0.311)	(0.566)
0-10 years prior to discovery	0.0312	0.000157	-0.00291	-0.0412	0.0282	-0.528	-0.342
	(0.0236)	(0.00127)	(0.0161)	(0.0639)	(0.0585)	(0.367)	(0.729)
0-10 years post discovery	-0.0377	0.00112	-0.0128	0.0129	-0.0330	0.683	0.147
	(0.0288)	(0.000963)	(0.0137)	(0.0711)	(0.0654)	(0.434)	(0.715)
10-20 years post discovery	-0.0631*	0.00153	-0.0274	0.0471	-0.0434	1.148**	-0.355
	(0.0328)	(0.00130)	(0.0167)	(0.0747)	(0.0704)	(0.487)	(0.762)
20+ years post discovery	-0.0727**	0.00604*	-0.0250	-0.0289	-0.00273	1.548***	0.354
	(0.0366)	(0.00351)	(0.0183)	(0.0902)	(0.0823)	(0.568)	(0.934)
NeighborOil	-0.0209	0.000256	-0.00602	-0.00186	0.00814	0.351*	-0.190
	(0.0136)	(0.000420)	(0.00606)	(0.0236)	(0.0254)	(0.202)	(0.299)
Observations	3,568	3,368	3,368	3,368	3,368	3,568	3,372
R-squared	0.930	0.568	0.526	0.574	0.801	0.913	0.682

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.11: Leads and Lags Analysis, Second Part

VARIABLES	(1) Male LF Part	(2) Fem LF Part	(3) Sex Ratio	(4) Marriagerate	(5) Share of Male LF employed in Oil	(6) Manufacturing	(7) Services
DiscoveredOilField	-0.00324	-0.0120	0.0197	0.00210	0.0553***	0.00302	-0.00315
	(0.00771)	(0.0142)	(0.0226)	(0.00975)	(0.0103)	(0.00838)	(0.00636)
NeighborOil	0.00310	0.00542	0.0265	0.00635	0.0153*	0.00201	0.00168
	(0.00721)	(0.0137)	(0.0301)	(0.0110)	(0.00916)	(0.00857)	(0.00761)
Observations	757	757	757	756	756	756	756
R-squared	0.681	0.716	0.493	0.584	0.745	0.855	0.749

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.12: Results When Dropping All Counties Without an Oil Deposit, part 1

VARIABLES	(1) Share of Male LF employed in Agriculture	(2) Oil	(3) Share of Fem LF employed in Manufacturing	(4) Services	(5) Agriculture	(6) Occupational income score Male	(7) Female
DiscoveredOilField	-0.0530**	0.000143	-0.00346	0.0521	-0.0474	0.825**	0.262
	(0.0223)	(0.00138)	(0.0111)	(0.0392)	(0.0357)	(0.340)	(0.508)
NeighborOill	-0.0164	-0.000126	-0.0151	-0.0175	0.0291	0.259	-0.777
	(0.0253)	(0.00106)	(0.0101)	(0.0358)	(0.0305)	(0.393)	(0.498)
Observations	756	691	691	691	691	756	691
R-squared	0.906	0.707	0.518	0.559	0.779	0.901	0.686

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.13: Results When Dropping All Counties Without an Oil Deposit, part 2

VARIABLES	(1) ln(avg wage)	(2) ln(avg male wage)	(3) ln(avg fem wage)	(4) Fem Hours/week	(5) Male Hours/Week	(6) Fem weeks	(7) Male weeks
DiscoveredOilField	0.303***	0.333***	0.0944	0.221	-0.135	0.599	0.278
	(0.0958)	(0.107)	(0.0905)	(0.544)	(0.407)	(0.622)	(0.357)
NotYetDiscovered	-0.157	-0.171	-0.0785	0.0844	0.687	0.791	0.318
	(0.132)	(0.146)	(0.123)	(0.790)	(0.537)	(0.688)	(0.410)
NeighborOil	0.0330	0.0370	0.0114	0.159	-0.0950	0.735	0.176
	(0.0980)	(0.110)	(0.0877)	(0.520)	(0.318)	(0.636)	(0.264)
Observations	762	760	724	730	761	740	761
R-squared	0.310	0.282	0.216	0.096	0.255	0.082	0.120

Controls described in text. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.14: First Cross-Sectional Robustness Check, Adding a Dummy for Not Yet Discovered Oil Field

VARIABLES	(1) ln(avg wage)	(2) ln(avg male wage)	(3) ln(avg fem wage)	(4) Fem Hours/week	(5) Male Hours/Week	(6) Fem weeks	(7) Male weeks
NotYetDiscovered	-0.164	-0.180	-0.0856	0.109	0.606	0.896	0.283
	(0.134)	(0.149)	(0.126)	(0.773)	(0.561)	(0.708)	(0.423)
NeighborOil	0.0148	0.0128	0.0196	0.168	-0.210	0.728	0.0811
	(0.101)	(0.113)	(0.0903)	(0.546)	(0.333)	(0.678)	(0.276)
Observations	648	646	617	620	647	629	647
R-squared	0.270	0.243	0.221	0.098	0.284	0.094	0.157

Controls described in text. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.15: Cross-Sectional Placebo Test

3.7 Appendix

3.7.1 Further Tables and Robustness Checks

In this appendix, we present several additional specifications and robustness checks that were omitted from the main text for the sake of brevity.

Given that data limitations compel us to perform our wage and intensive margin labor supply regressions on a cross-sectional sample for 1940 only, one worry is that this might cause bias, as in this specification we cannot employ a difference-in-difference design and have to fully rely on the exogeneity of major oil fields. To partially address this concern, table 3.A.1 repeats the panel analyses of tables 3.3 and 3.4 on the 1940 cross-section. The results of this exercise support the validity of using the 1940 cross section for wages and intensive labor supply: In spite of the inevitable loss in precision, the results in table 3.A.1 are usually both qualitatively and quantitatively similar to the panel specifications, the one exception being male labor force participation, where we find a larger and statistically significant effect.

Secondly, when presenting our robustness checks, we have focussed on eight key variables in the main text. The results of both robustness checks for the remaining variables are presented in tables 3.A.2-3.A.3 and 3.A.4-3.A.5, respectively. As for the main variables, the leads and lags analysis for our remaining variables confirm our earlier results: oil-rich counties become more populous, more urbanized and younger than baseline counties after the discovery of oil, and their economies display growth in the oil industry, manufacturing and services at the expense of agriculture. For the case of population and the urbanization rate, the effect of oil abundance seems to take some time to materialize fully, as differences between oil-rich and baseline counties with respect to these two variables seem to augment as more time elapses since the discovery of an oil field. In the case of the average age at the county level, the entire effect of oil abundance in tilting the age profile of the local population is realized fully in the first decade after oil discovery. In addition, there is little evidence for differential trends prior to the discovery of oil fields. The one potential exception to this is population, which seems to display a slight upward trend in oil-rich counties that pre-dates the discovery of oil. However, this trend is only of a small magnitude (notably smaller than the systematic differences in these variables that we observe between oil-rich and baseline counties after the discovery of oil) and thus unlikely to be responsible for our findings.

A final specification exploits size differences between counties' oil endowments: If oil wealth has substantive effects on local economies and local labor markets, we may expect larger oil fields to be associated with larger such effects. To test this hypothesis we estimate the following empirical specification:

$$\begin{aligned} y_{ct} = \alpha_c + \tau_t + \beta_1 DiscoveredOilField_{ct} + \beta_2 DiscoveredOilField_{ct} * SizeOilField_c \\ + \eta NeighborOilField_{ct} + X_c' \gamma_t + u_{ct} \end{aligned} \quad (3.4)$$

where we add to our baseline panel specification a term that interacts the oil field discovery dummy with a variable containing the size of each oil field (measured per 100 million barrels). Our results are set out in tables 3.A.6-3.A.9. When interpreting them, care has to be taken in recognizing the nonstandard nature of our intercept in this specification, as the inclusion of the $DiscoveredOilField_{ct}$ dummy in the regression already means that a county sits above a discovered oil field of at least 100 million barrels[16].

Our findings from this exercise are somewhat inconclusive, as the coefficients corresponding to terms that reflects the size of counties oil fields always have the expected signs but are most often not statistically significant. However, we do find evidence that larger oil fields are associated with smaller involvement of the local labor force in agriculture and with increased earnings for men, as well as suggestive evidence that counties with larger oil fields tend to have a higher population growth, a somewhat larger share of their female labor force involved in manufacturing and a slightly higher marriage rate. We attribute our limited findings related to the remaining outcomes to the nonstandard specification of the intercept in our regression model and interpret our results as implying that once a county sits on top of a large oil field (interpreted in our specification as an oil field larger than 100 million barrels of oil) the impact of any incremental oil reserves is likely to be second order: Local economies are only likely to be affected by the flow of resources actually extracted and transacted, and this flow is unlikely to vary much above a certain (high) threshold of oil field size. Thus above a certain threshold of oil field size we may expect larger oil fields to be associated with longer resource booms, rather than larger magnitudes of the static impact of oil abundance.

[16]This does not necessarily mean that the whole oil field accrues to the county, of course, since one oil field can lie below the surfaces of several counties

VARIABLES	(1) Oil	(2) LF share employed in Manufacturing	(3) Services	(4) Agriculture	(5) Fem LF Part	(6) Fem Emp Rate	(7) Male LF Part	(8) Male Emp Part
DiscoveredOilField	0.0430***	0.0189*	0.0155	-0.0862**	0.0111	-0.000267	0.0193***	-0.00312
	(0.00634)	(0.0111)	(0.0155)	(0.0426)	(0.0151)	(0.0102)	(0.00610)	(0.00567)
NeighborOil	0.0108***	-0.00323	0.00340	-0.0191	-0.00376	0.00518	-0.000735	0.000103
	(0.00281)	(0.0100)	(0.0157)	(0.0440)	(0.0151)	(0.00892)	(0.00608)	(0.00545)
Observations	761	761	761	761	762	737	761	761
R-squared	0.337	0.246	0.127	0.232	0.164	0.041	0.176	0.192

Controls described in text. Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.A.1: Impact of Discovered Oil Fields on Labor Force Participation and Sectoral Composition, 1940 Cross-Section Only

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Employment Rate		Ln(Pop)	Ratio Urban Pop	Fem Mean Age
	Female	Male			
20-30 years prior to discovery	0.0199	0.0205	0.0412	-0.0156	0.112
	(0.0202)	(0.0138)	(0.0778)	(0.0107)	(0.294)
10-20 years prior to discoveryr	0.00127	0.0287*	0.0759	-0.0165	-0.344
	(0.0280)	(0.0170)	(0.0986)	(0.0121)	(0.293)
0-10 years prior to discovery	0.00196	0.0369**	0.141	-0.0113	-0.00706
	(0.0316)	(0.0172)	(0.107)	(0.0158)	(0.361)
0-10 years post discovery	-0.0145	0.0265	0.349***	0.0179	-1.072***
	(0.0316)	(0.0175)	(0.119)	(0.0176)	(0.387)
10-20 years post discovery	-0.0114	0.0199	0.535***	0.0333*	-0.841*
	(0.0326)	(0.0202)	(0.133)	(0.0197)	(0.457)
20+ years post discovery	-0.0343	0.0152	0.668***	0.0578**	-0.839*
	(0.0373)	(0.0217)	(0.156)	(0.0254)	(0.492)
NeighborOil	0.0154	-0.00485	-0.0125	0.0129*	-0.174
	(0.0115)	(0.00686)	(0.0306)	(0.00781)	(0.177)
Observations	2,132	2,237	3,568	3,570	3,569
R-squared	0.456	0.614	0.933	0.966	0.693

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.A.2: Further Leads and Lags Regressions, Part 1

VARIABLES	(1) Male Mean Age	(2)	(3) Share of LF employed in	(4)	(5)
		Oil Industry	Manufacturing	Services	Agriculture
20-30 years prior to discovery	0.481	0.00277	-0.00212	0.00101	0.0151
	(0.315)	(0.00319)	(0.00586)	(0.00994)	(0.0200)
10-20 years prior to discovery	0.104	-0.00221	-0.00810	-0.00188	0.0212
	(0.370)	(0.00404)	(0.0100)	(0.0110)	(0.0250)
0-10 years prior to discovery	0.157	-0.00617	-0.00149	-0.0155	0.0301
	(0.388)	(0.00558)	(0.0109)	(0.0115)	(0.0262)
0-10 years post discovery	-0.520	0.0475***	-0.00296	-0.00679	-0.0392
	(0.400)	(0.00925)	(0.0101)	(0.0126)	(0.0320)
10-20 years post discovery	-0.282	0.0411***	0.00969	0.0161	-0.0628*
	(0.487)	(0.00879)	(0.0116)	(0.0140)	(0.0360)
20+ years post discovery	-0.687	0.0283***	0.0198	0.00941	-0.0671
	(0.544)	(0.0109)	(0.0138)	(0.0192)	(0.0412)
NeighborOilI	-0.354*	0.00841***	0.00283	0.00228	-0.0165
	(0.193)	(0.00303)	(0.00452)	(0.00499)	(0.0146)
Observations	3,569	3,567	3,567	3,567	3,567
R-squared	0.641	0.747	0.808	0.825	0.930

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.A.3: Further Leads and Lags Regressions, Part 2

VARIABLES	(1) Fem Emp Rate	(2) Male Emp Rate	(3) Ln(Pop)	(4) Ratio Urban Pop	(5) Fem Mean Age
discovered_oil_field	-0.0195	-0.0134	0.0918	0.0255**	-0.902***
	(0.0212)	(0.0152)	(0.0677)	(0.0122)	(0.299)
neighbour_oil	0.0299	-0.00896	-0.0184	0.0133	0.0494
	(0.0212)	(0.0145)	(0.0609)	(0.0157)	(0.272)
Observations	449	484	757	757	757
R-squared	0.485	0.613	0.921	0.951	0.587

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.A.4: Further Regressions When Dropping All Counties Without an Oil Deposit, Part 1

VARIABLES	(1) Male Mean Age	(2) Oil Industry	(3) Share of LF employed in Manufacturing	(4) Services	(5) Agriculture
DiscoveredOilField	-0.579*	0.0469***	0.00229	0.00587	-0.0533**
	(0.349)	(0.00895)	(0.00734)	(0.00814)	(0.0227)
NeighborOil	-0.275	0.0133	-0.00112	-0.00422	-0.00872
	(0.293)	(0.00835)	(0.00760)	(0.00847)	(0.0242)
Observations	757	756	756	756	756
R-squared	0.505	0.735	0.846	0.808	0.909

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.A.5: Further Regressions When Dropping All Counties Without an Oil Deposit, Part 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Ln(Pop)	Ratio Pop Urban	Sex Ratio	Marriage rate	Share of LF employed in			
					Oil industry	Manufacturing	Services	Agriculture
DiscoveredOilField	0.266**	0.0293**	-0.0113	-0.00865	0.0394***	0.000512	0.00782	-0.0430*
	(0.103)	(0.0138)	(0.0203)	(0.0103)	(0.00801)	(0.00659)	(0.00984)	(0.0225)
DiscoveredXsize	0.0148	0.00247	0.000936	0.00268*	0.00223	0.00150	0.000585	-0.00795**
	(0.0161)	(0.00219)	(0.00278)	(0.00158)	(0.00197)	(0.00105)	(0.00161)	(0.00359)
NeighborOil	-0.0153	0.0112	0.0152	0.000588	0.00816***	0.00207	0.00164	-0.0135
	(0.0307)	(0.00774)	(0.0122)	(0.00534)	(0.00286)	(0.00446)	(0.00467)	(0.0140)
Observations	3,568	3,570	3,568	3,567	3,567	3,567	3,567	3,567
R-squared	0.932	0.966	0.500	0.604	0.746	0.808	0.824	0.931

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.A.6: Exploiting Oil Field Size, Part 1

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Share of Male LF employed in				Share of Female LF employed in			
	Oil industries	Manufacturing	Services	Agriculture	Oil industries	Manufacturing	Services	Agriculture
DiscoveredOilField	0.0476***	0.00700	-0.00392	-0.0423**	-0.000328	-0.0351***	0.0520	-0.0293
	(0.00944)	(0.00785)	(0.00693)	(0.0213)	(0.000800)	(0.0105)	(0.0371)	(0.0362)
DiscoveredXsize	0.00255	0.000626	0.000984	-0.00831**	0.000489*	0.00631***	0.000742	-0.00616
	(0.00232)	(0.00119)	(0.00104)	(0.00351)	(0.000280)	(0.00235)	(0.00632)	(0.00547)
NeighborOil	0.00936***	0.00346	0.00417	-0.0177	2.39e-05	-0.00736	-0.00138	0.00925
	(0.00319)	(0.00532)	(0.00351)	(0.0131)	(0.000453)	(0.00589)	(0.0224)	(0.0246)
Observations	3,568	3,568	3,568	3,568	3,368	3,368	3,368	3,368
R-squared	0.755	0.810	0.770	0.930	0.565	0.527	0.572	0.801

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.A.7: Exploiting Oil Field Size, Part 2

VARIABLES	(1) Fem LF Part	(2) Fem Emp Rate	(3) Male LF Part	(4) Male Emp Rate	(5) Fem Mean Age	(6) Male Mean Age	(7) Occupational income score Male	(8) Female
DiscoveredOilField	-0.0134	-0.0255	0.00753	-0.00513	-0.901***	-0.559*	0.746**	-0.236
	(0.0140)	(0.0232)	(0.00802)	(0.0131)	(0.335)	(0.302)	(0.355)	(0.547)
DiscoveredXsize	0.00199	0.00195	-0.00112	-0.000645	0.00591	-0.0207	0.120*	0.0438
	(0.00180)	(0.00473)	(0.00139)	(0.00172)	(0.0482)	(0.0502)	(0.0671)	(0.0960)
NeighborOil	-0.000590	0.0155	0.00779*	-0.00313	-0.177	-0.335*	0.293	-0.227
	(0.00858)	(0.0111)	(0.00399)	(0.00660)	(0.177)	(0.194)	(0.197)	(0.299)
Observations	3,569	2,132	3,569	2,237	3,569	3,569	3,568	3,372
R-squared	0.771	0.455	0.727	0.611	0.692	0.640	0.912	0.681

Controls described in text.All regressions control for county and year FE.
Standard errors, clustered at the county level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.A.8: Exploiting Oil Field Size, Part 3

VARIABLES	(1) Ln(avg wage)	(2) Ln(avg male wage)	(3) Ln(avg wage fem)	(4) Hours/week Female	(5) Male	(6) Weeks Female	(7) Male
DiscoveredOilField	0.240**	0.255**	0.141	-0.203	-0.182	0.846	0.199
	(0.103)	(0.116)	(0.0964)	(0.763)	(0.448)	(0.817)	(0.397)
DiscoveredXsize	0.0147	0.0183	-0.0109	0.101	0.0111	-0.0585	0.0188
	(0.0121)	(0.0138)	(0.0124)	(0.148)	(0.0677)	(0.138)	(0.0627)
NotYetDiscovered	-0.156	-0.169	-0.0794	0.0938	0.688	0.786	0.320
	(0.132)	(0.146)	(0.123)	(0.791)	(0.537)	(0.689)	(0.410)
NeighborOil	0.0298	0.0331	0.0138	0.138	-0.0975	0.748	0.172
	(0.0983)	(0.110)	(0.0878)	(0.521)	(0.318)	(0.637)	(0.265)
Observations	762	760	724	730	761	740	761
R-squared	0.311	0.284	0.216	0.097	0.255	0.083	0.120

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.A.9: Exploiting Oil Field Size, Cross-Section

3.7.2 Figures

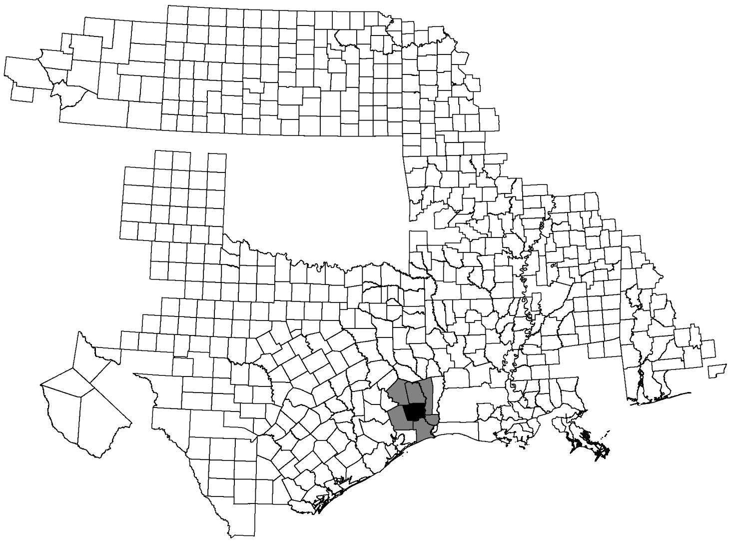

Figure 3.2: Map of Oil Discoveries 1900

Note: Oil abundant counties (black), Neighbors of oil abundant counties (grey), Other counties (white)

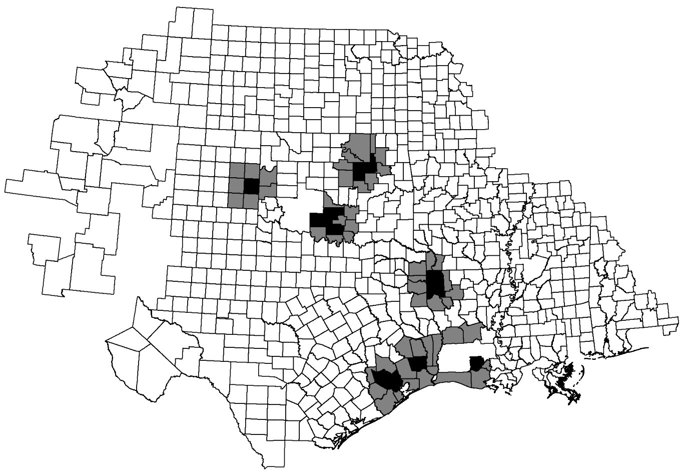

Figure 3.3: Map of Oil Discoveries 1910

Note: Oil abundant counties (black), Neighbors of oil abundant counties (grey), Other counties (white)

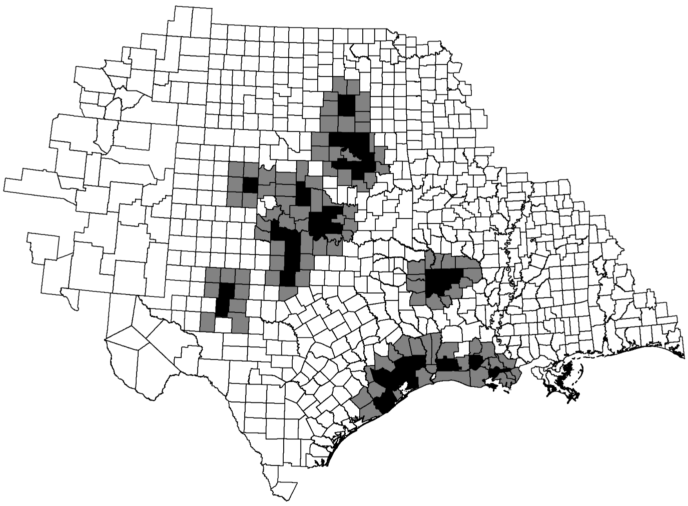

Figure 3.4: Map of Oil Discoveries 1920

Note: Oil abundant counties (black), Neighbors of oil abundant counties (grey), Other counties (white)

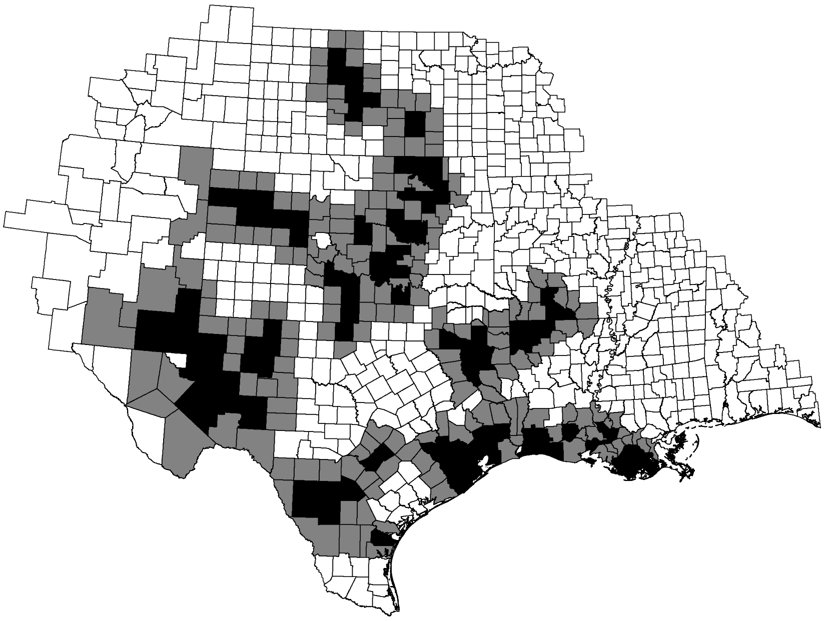

Figure 3.5: Map of Oil Discoveries 1930

Note: Oil abundant counties (black), Neighbors of oil abundant counties (grey), Other counties (white)

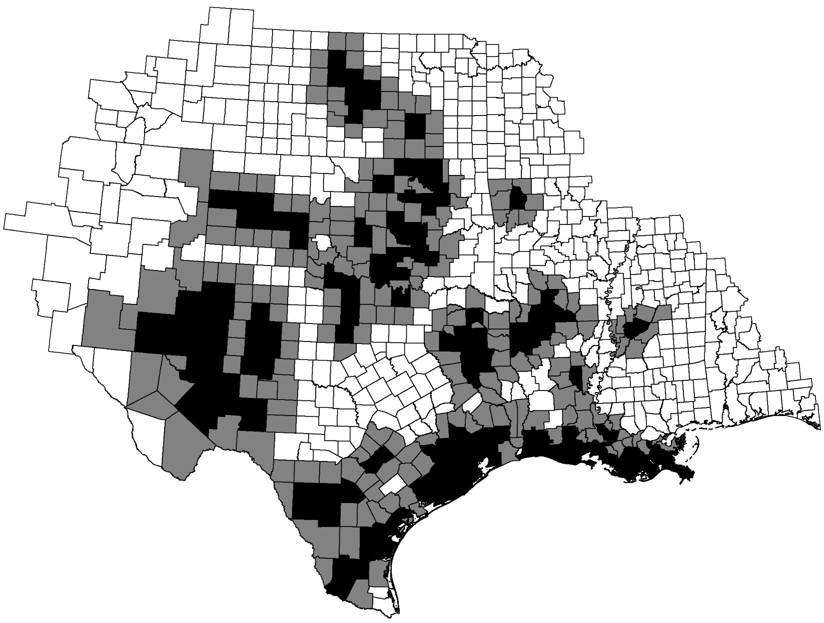

Figure 3.6: Map of Oil Discoveries 1940

Note: Oil abundant counties (black), Neighbors of oil abundant counties (grey), Other counties (white)

Bibliography

Ades, A. F. and Glaeser, E. L. (1995). Trade and circuses: Explaining urban giants. *Quarterly Journal of Economics*, 110(1):195–227.

Akbulut, R. (2011). Sectoral changes and the increase in women's labor force participation. *Macroeconomic Dynamics*, 15:240–264.

Albanesi, S. and Olivetti, C. (2009). Gender roles and technological progress. NBER Working Paper no. 14873.

Alder, S., Shao, L., and Zilibotti, F. (2016). Economic Reforms and Industrial Policy in a Panel of Chinese Cities. *Journal of Economic Growth*. forthcoming.

Alesina, A. F., Giuliano, P., and Nunn, N. (2013). On the origins of gender roles: Women and the plough. *Quarterly Journal of Economics*, 128(2):469–530.

Alonso-Villar, O., Chamorro-Rivas, J. M., and Gonzalez-Cerdeira, X. (2004). Agglomeration economies in manufacturing industries: the case of Spain. *Applied Economics*, 36(18):2013–2116.

Amiti, M. and Konings, J. (2007). Trade Liberalization, Intermediate Inputs and Productivity: Evidence from Indonesia. *American Economic Review*, 97(5):1611–1638.

Anderson, G. and Ge, Y. (2005). The Distribution of Chinese City Sizes. *Regional Science and Urban Economics*, 35(6):756–776.

Anderson, K. (2015). Contributions of the GATT/WTO to Global Economic Welfare: Empirical Evidence. *Journal of Economic Surveys*. forthcoming.

Antras, P. (2003). Firms, Contracts, and Trade Structure. *Quarterly Journal of Economics*, 118(4):1375–1418.

Antras, P., Garicano, L., and Rossi-Hansberg, E. (2006). Offshoring in a Knowledge Economy. *Quarterly Journal of Economics*, 121(1):31–77.

Antras, P. and Helpman, E. (2004). Global Sourcing. *Journal of Political Economy*, 112(3):552–580.

Aragon, F. M. and Rud, J. P. (2013). Natural resources and local communities: Evidence from a peruvian gold mine. *American Economic Journal: Economic Policy*, 5(2):1–25.

Attanasio, O., Low, H., and Sanchez-Marcos, V. (2008). Explaining changes in female labor supply in a life-cycle model. *American Economic Review*, 98(4):1517–1542.

Au, C.-C. and Henderson, J. V. (2006). Are Chinese Cities Too Small? *Review of Economic Studies*, 73(3):549–576.

Autor, D., Dorn, D., and Hanson, G. (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *American Economic Review*, 103(5):2121–2168.

Auty, R. M. (1993). *Sustaining development in mineral economies: The resource curse thesis*. Routledge, London.

Baker, S. R., Bloom, N., and Davis, S. J. (2015). Measuring Economic Policy Uncertainty. NBER Working Paper No. 21633.

Baldwin, R. and Robert-Nicoud, F. (2014). Trade-in-goods and Trade-in-tasks: An Integrating Framework. *Journal of International Economics*, 92(1):51–62.

Banister, J. (2005). Manufacturing Employment in China. *Monthly Labor Review*, 128(3):11–29.

Bartik, T. J. (1991). Who Benefits from State and Local Economic Policies? Upjohn Press.

Baum-Snow, N., Brandt, L., Henderson, J. V., Turner, M. A., and Zhang, Q. (2015). Roads, Railroads and Decentralization of Chinese Cities. mimeo.

Baumol, W. J. (1967). Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crises. *American Economic Review*, 57(3):415–426.

Behrens, K., Gaigne, C., Ottaviano, G. I., and Thisse, J.-F. (2006a). How density economies in international transportation link the internal geography of trading partners. *Journal of Urban Economics*, 60:248–263.

Behrens, K., Gaigne, C., Ottaviano, G. I., and Thisse, J.-F. (2006b). Is remoteness a locational disadvantage? *Journal of Economic Geography*, 6(3):347–368.

Behrens, K., Gaigne, C., Ottaviano, G. I., and Thisse, J.-F. (2007). Countries, regions and trade: On the welfare impacts of economic integration. *European Economic Review*, 51(5):1277–1301.

Behrens, K., Gaigne, C., and Thisse, J.-F. (2009). Industry location and welfare when transport costs are endogenous. *Journal of Urban Economics*, 65(2):195–208.

Bernanke, B. S. (1983). Irreversibility, Uncertainty, and Cyclical Investment. *Quarterly Journal of Economics*, 98(1):85–106.

Berry, C. R. and Glaeser, E. L. (2005). The divergence of human capital levels across cities. *Papers in Regional Science*, 84(3):407–444.

Black, D. and Henderson, J. V. (1999). A Theory of Urban Growth. *Journal of Political Economy*, 107(2):252–284.

Black, D., McKinnish, T., and Sanders, S. (2005). The economic impact of the coal boom and bust. *Economic Journal*, 115(503):449–476.

Bloom, N., Reenen, J. V., and Bond, S. (2007). Uncertainty and Investment Dynamics. *Review of Economic Studies*, 74(2):391–415.

Borjas, G. J. and Ramey, V. A. (1995). Foreign Competition, Market Power and Wage Inequality. *Quarterly Journal of Economics*, 110(4):1075–1110.

Brambilla, I., Khandelwal, A., and Schott, P. K. (2010). China's Experience under the Multi-Fiber Agreement (MFA) and the Agreement on Textiles and Clothing (ATC). In Feenstra, R. C. and Wei, S.-J., editors, *China's Growing Role in World Trade*, pages 345–387, Chicago. NBER and University of Chicago Press.

Brandt, L., Biesebroeck, J. V., and Zhang, Y. (2012). Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing. *Journal of Development Economics*, 97(2):339–351.

Bremmer, D. and Kesselring, R. (2004). Divorce and female labor force participation: Evidence from times-series data and cointegration. *Atlantic Economic Journal*, 32:174–189.

Brewster, K. L. and Rindfuss, R. R. (2000). Fertility and women's employment in industrialized nations. *Annual Review of Sociology*, 26:271–296.

Brunnschweiler, C. N. and Bulte, E. H. (2008). The resource curse revisited and revised: A tale of paradoxes and red herrings. *Journal of Environmental Economics and Management*, 55(3):248–264.

Buchmann, C., DiPrete, T. A., and McDaniel, A. (2008). Gender inequalities in education. *Annual Review of Sociology*, 34:319–337.

Buckley, P. D. (2003). *Essays in applied microeconomics: Signaling, marriage hazard rates, and ability sorting*. PhD thesis, Massachusetts Institute of Technology.

Bustos, P. (2011). The Impact of Trade Liberalization on Skill Upgrading. Evidence from Argentina. mimeo.

Campos-Vazquez, R. M. (2010). Why did wage inequality decrease in Mexico after NAFTA? mimeo.

Caselli, F. and Coleman, J. W. (2001). The U.S. structural transformation and regional convergence: A reinterpretation. *Journal of Political Economy*, 109(3):584–616.

Caselli, F. and Michaels, G. (2013). Do oil windfalls improve living standards? Evidence from Brazil. *American Economic Journal: Applied Economics*, 5(1):208–238.

Chan, K. W. (2007). Misconceptions and Complexities in the Study of China. *Eurasian Geography and Economics*, 48(4):383–412.

Chan, K. W. (2012). Internal labor migration in China: Trends, geography and policies. In *United Nations Population Division, Population distribution, urbanization, internal migration and development: An international perspective*, pages 81–102, New York, NY: United Nations.

Chaney, T. (2014). The Network Structure of International Trade. *American Economic Review*, 104(11):3600–3634.

Chen, Y., Henderson, J. V., and Cai, W. (2015). The bias towards politically connected cities in China's capital markets. mimeo.

Chen, Y., Jin, G. Z., and Yue, Y. (2010). Peer Migration in China. NBER Working Paper no. 15671.

Chiquiar, D. (2008). Globalization, Regional Wage Differentials and the Stolper-Samuelson Theorem: Evidence from Mexico. *Journal of International Economics*, 74(1):70–93.

Chowdorow-Reich, G., Feiveson, L., Liscow, Z., and Woolston, W. G. (2012). Does State Fiscal Relief during Recessions Increase Employment? Evidence from the American Recovery and Reinvestment Act. *American Economic Journal: Economic Policy*, 4(3):118–145.

Corden, M. W. and Neary, P. J. (1982). Booming sector and de-industrialisation in a small open economy. *Economic Journal*, 92(368):825–848.

Costa, F. J. M., Garred, J., and Pessoa, J. P. (2014). Winner and Losers from a Commodities-for-Manufactures Trade Boom. mimeo.

Csillag, M. and Koren, M. (2011). Machines and machinists: Capital-skill complementarity from an international trade perspective. mimeo.

Cushman and Wakefield (2002). Office space across the world 2002. a Cushman and Wakefield publication.

Da Mata, D., Deichmann, U., Henderson, J. V., Lall, S. V., and Wang, H. G. (2007). Determinants of City Growth in Brazil. *Journal of Urban Economics*, 62(2):252–272.

Darity, W. A. J. and Myers, S. L. (1995). Family structure and the marginalization of black men: Policy implications. In Tucker, B. M. and Mitchell-Kernan, C., editors, *The Decline in Marriage Among African Americans*, New York. Rusell Sage Foundation.

Davis, D. and Dingel, J. (2014). The Comparative Advantage of Cities. NBER Working Paper No. 20602.

Davis, J. C. and Henderson, J. V. (2003). Evidence on the political economy of the urbanization process. *Journal of Urban Economics*, 53(1):98–125.

de la Garza, A. G. (2008). Do smart cities grow faster? MPRA Paper 10881, University Library of Munich.

Dean, J. M. and Lovely, M. E. (2010). Trade Growth, Production Fragmentation and China's Environment. In Feenstra, R. C. and Wei, S.-J., editors, *China's Growing Role in World Trade*, Chicago. NBER and University of Chicago Press.

Deardoff, A. V. (2001a). Fragmentation across Cones. In Arndt, S. W. and Kierzkowski, H., editors, *Fragmentation: New Production Patterns in the World Economy*, pages 35–51, Oxford. Oxford University Press.

Deardoff, A. V. (2001b). Fragmentation in Simple Trade Models. *North American Journal of Economics and Finance*, 12(2):121–137.

Dix-Carneiro, R. (2014). Trade Liberalization and Labor Market Dynamics. *Econometrica*, 82(3):825–885.

Dix-Carneiro, R. and Kovak, B. K. (2015). Trade Reform and Regional Dynamics: Evidence from 25 Years of Brazilian Matched Employer- Employee Data. mimeo.

Dixit, A. K. (1989). Entry and exit decisions under uncertainty. *Journal of Political Economy*, 97(3):620–638.

Do, Q.-T., Levchenko, A. A., and Raddatz, C. (2012). Comparative advantage, international trade, and fertility. Working Paper no. 624, Research Seminar in International Economics, University of Michigan.

Domenech, J. (2008). Mineral resource abundance and regional growth in Spain, 1860-2000. *Journal of International Development*, 20:1122–1135.

Dumais, G., Ellison, G., and Glaeser, E. L. (2002). Geographic Concentration as a Dynamic Process. *Review of Economics and Statistics*, 84(2):193–204.

Duranton, G. and Puga, D. (2005). From sectoral to functional urban specialization. *Journal of Urban Economics*, 57(2):343–370.

Eaton, J. and Kortum, S. (2001). Trade in Capital Goods. *European Economic Review*, 45(7):1195–1235.

Eligon, J. (2013). An oil town where men are many, and women are hounded. New York Times, January 15.

Ellison, G., Glaeser, E. L., and Kerr, W. R. (2010). What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns. *American Economic Review*, 100(3):1195–1213.

Engerman, S. L. and Sokoloff, K. L. (1997). Factor endowments, institutions, and differential paths of growth among New World economies. In Haber, S., editor, *How Latin America Fell Behind*, California. Stanford University Press.

Fajgelbaum, P. and Redding, S. J. (2014). External Integration, Structural Transformation and Economic Development: Evidence from Argentina 1870-1914. NBER Working Paper No. 20217.

Feenstra, R. and Hanson, G. (1996). Foreign Investment, Outsourcing and Relative Wages. In Feenstra, R. and Grossman, G., editors, *Political Economy of Trade Policy: Essays in Honor of Jagdish Bhagwati*, Cambridge MA. MIT Press.

Feenstra, R. and Hanson, G. (1997). Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras. *Journal of International Economics*, 42:371–393.

Feenstra, R. and Hanson, G. (1999). The Impact of Outsourcing and High-Technology Capital on Wages: Estimates For the United States , 1979-1990. *Quarterly Journal of Economics*, 114(3):907–940.

Feenstra, R. C., Romalis, J., and Schott, P. K. (2002). US Imports, Exports and Tariff Data, 1989-2001. NBER Working Paper 9387.

Feng, L., Li, Z., and Swenson, D. L. (2012). The Connection Between Imported Intermediate Inputs and Exports: Evidence from Chinese Firms. NBER working paper 18260.

Feng, L., Li, Z., and Swenson, D. L. (2014). Trade Policy Uncertainty and Exports: Evidence from China's WTO Accession. CESifo Working Paper No. 4780.

Fernandez, R. (2011). Does culture matter? In Benhabib, J., Jackson, M. O., and Bisin, A., editors, *Handbook of Social Economics*, volume 1A, Amsterdam. North Holland.

Fernandez, R. (2013). Cultural change as learning: The evolution of female labor force participation over a century. *American Economic Review*, 103(1):472–500.

Fetzer, T. R. (2014). Fracking Growth. CEP Discussion Paper No. 1278, London School of Economics.

Fujita, M. and Thisse, J.-F. (2006). Globalization and the Evolution of the Supply Chain: Who Gains and Who Loses? *International Economic Review*, 47(3):811–836.

Fukase, E. (2013). Export Liberalization, Job Creation, and the Skill Premium: Evidence from the US-Vietnam Bilateral Trade Agreement. *World Development*, 41:317–337.

Furchtgott-Roth, D. and Gray, A. (2013). The economic effects of hydrofracturing on local economies: A comparison of New York and Pennsylvania. Growth and Prosperity Report no.1, Manhattan Institute for Policy Research, New York.

Gaddis, I. and Pieters, J. (2014). The Gendered Labor Market Impacts of Trade Liberalization: Evidence from Brazil. World Bank Policy Research WP No.7095.

Glaeser, E. L. (1994). Cities, Information and Economic Growth. *Cityscape: A Journal of Policy Development and Research*, 1:9–47.

Glaeser, E. L. (2013). A World of Cities: The Causes and Consequences of Urbanization in Poorer Countries. NBER Working Paper No. 19745.

Glaeser, E. L. and Gyourko, J. (2005). Urban Decline and Durable Housing. *Journal of Political Economy*, 113(2):345–375.

Glaeser, E. L. and Kohlhase, J. E. (2004). Cities, regions and the decline of transport costs. *Papers in Regional Science*, 83(1):197–228.

Glaeser, E. L. and Ponzetto, G. A. (2010). Did the Death of Distance Hurt Detroit and Help New York? In Glaeser, E. L., editor, *Agglomeration Economics*, pages 303–337, Chicago, IL. University of Chicago Press.

Glaeser, E. L., Ponzetto, G. A. M., and Tobio, K. (2014). Cities, Skills and Regional Change. *Regional Studies*, 48(1):7–43.

Glaeser, E. L. and Saiz, A. (2004). The Rise of the Skilled City. *Brookings-Wharton Papers on Urban Affairs*, pages 47–94.

Glaeser, E. L., Scheinkman, J. A., and Shleifer, A. (1995). Economic growth in a cross-section of cities. *Journal of Monetary Economics*, 36(1):117–143.

Goldberg, P., Khandelwal, A., Pavcnik, N., and Topalova, P. (2009). Trade Liberalization and Imported Inputs. *American Economic Review*, 99(2):494–500.

Goldberg, P., Khandelwal, A., Pavcnik, N., and Topalova, P. (2010). Imported Intermediate Inputs and Domestic Product Growth: Evidence from India. *Quarterly Journal of Economics*, 125(4):1727–1767.

Goldin, C. (1990). *Understanding the gender wage gap: An economic history of American women*. Oxford University Press, New York.

Goldin, C. (2006). The quiet revolution that transformed women's employment, education, and family. *American Economic Review Papers and Proceedings*, 96:1–21.

Goldin, C. and Katz, L. F. (2002). The power of the pill: Oral contraceptives and women's career and marriage decisions. *Journal of Political Economy*, 110(4):730–770.

Gollin, D., Jedwab, R., and Vollrath, D. (2015). Urbanization with and without Industrialization. *Journal of Economic Growth*. forthcoming.

Gollin, D., Parente, S., and Rogerson, R. (2002). The Role of Agriculture in Development. *American Economic Review*, 92(2):160–164.

Greenwood, J., Seshadri, A., and Yorukoglu, M. (2005). Engines of liberation. *Review of Economic Studies*.

Grossman, G. M. and Helpman, E. (2002). Integration versus Outsourcing in Industry Equilibrium. *Quarterly Journal of Economics*, 117(1):85–120.

Grossman, G. M. and Helpman, E. (2004). Managerial Incentives and the International Organization of Production. *Journal of International Economics*, 63(2):237–262.

Grossman, G. M. and Helpman, E. (2005). Outsourcing in a Global Economy. *Review of Economic Studies*, 72(1):135–159.

Grossman, G. M. and Rossi-Hansberg, E. (2008). Trading Tasks: A Simple Theory of Offshoring. *American Economic Review*, 98(5):1978–1997.

Haines, M. R. and Inter-university Consortium for Political and Social Research (2010). Historical, demographic, economic, and social data: The United States, 1790-2002. ICPSR02896-v3. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor]. http://doi.org/10.3886/ICPSR02896.v3.

Handley, K. and Limao, N. (2012). Trade and Investment under Policy Uncertainty: Theory and Firm Evidence. NBER Working Paper no. 17790.

Handley, K. and Limao, N. (2014a). Exporting under Trade Policy Uncertainty: Theory and Evidence. *Journal of International Economics*, 94(1):50–66.

Handley, K. and Limao, N. (2014b). Policy Uncertainty, Trade and Welfare: Theory and Evidence for China and the US. mimeo.

Hausman, R., Hwang, J., and Rodrik, D. (2007). What You Export Matters. *Journal of Economic Growth*, 12:1–25.

Head, K., Ries, J., and Swenson, D. L. (1995). Agglomeration benefits and location choice: Evidence from Japanese manufacturing investments in the United States. *Journal of International Economics*, 38(3-4):223–247.

Henderson, J. V. (1983). Industrial Bases and City Sizes. *American Economic Review*, 73(2):164–168.

Henderson, J. V. (1986). Efficiency of Resource Usage and City Size. *Journal of Urban Economics*, 19:47–70.

Henderson, J. V. (2003). Marshall's Scale Economies. *Journal of Urban Economics*, 53(1):1–28.

Henderson, J. V., Kuncoro, A., and Turner, M. A. (1995). Industrial Development in Cities. *Journal of Political Economy*, 103(5):1067–1090.

Henderson, J. V. and Ono, Y. (2008). Where do manufacturing firms locate their headquarters? *Journal of Urban Economics*, 63(2):431–450.

Humphreys, M., Sachs, J. D., and Stiglitz., J. E., editors (2007). *Escaping the resource curse*, New York, NY. Columbia University Press.

IMF (1997). World Economic Outlook. Washington, DC. International Monetary Fund.

Impullitti, G., Irarrazabal, A. A., and Opromolla, L. D. (2013). A theory of entry into and exit from export markets. *Journal of International Economics*, 90(1):75–90.

Jarreau, J. and Poncet, S. (2012). Export sophistication and economic growth: Evidence from China. *Journal of Development Economics*, 97(2):281–292.

Jedwab, R. (2014). Urbanization without Industrialization: Evidence from Consumption Cities in Africa. mimeo.

Jedwab, R. and Vollrath, D. (2015). Urbanization without Growth in Historical Perspective. *Explorations in Economic History*. forthcoming.

Jensen, J. B. (2008). Trade in High-Tech Services. *Journal of Industry, Competition and Trade*, 8(3-4):181–197.

Jensen, R. (2012). Do labor market opportunities affect young women's work and family decisions? Experimental evidence from India. *Quarterly Journal of Economics*, 127(2):753–792.

Jones, L. E., Manuelli, R. E., and McGrattan, E. R. (2003). Why are married women working so much? Staff Report 317, Federal Reserve Bank of Minneapolis.

Jones, R. W. and Kierzkowski, H. (1990). The Role of Services in Production and International Trade: A Theoretical Framework. In Jones, R. W. and Krueger, A. O., editors, *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*, pages 31–48, Cambridge, MA. Blackwell.

Jones, R. W. and Kierzkowski, H. (2001). Globalization and the Consequences of International Fragmentation. In Calvo, G. A., Dornbusch, R., and Obstfeld, M., editors, *Money, Capital Mobility, and Trade: Essays in Honor of Robert A. Mundell*, pages 365–383, Cambridge, MA. MIT Press.

Kang, A. (2009). Studying oil, Islam, and women as if political institutions mattered. *Politics and Gender*, 5:560–568.

Kim, S. (1999). The Rise of Multiunit Firms in U.S. Manufacturing. *Explorations in Economic History*, 36(4):360–386.

Kim, S. (2000). Urban Development in the United States, 1690-1990. *Southern Economic Journal*, 66(4):855–880.

Kim, S. and Margo, R. A. (2004). Historical Perspectives on U.S. Economic Geography. In Henderson, J. V. and Thisse, J.-F., editors, *Handbook of Regional and Urban Economics*, volume 4. Elsevier.

Klasen, S. and Pieters, J. (2015). What explains the stagnation of female labor force participation in urban India? *World Bank Economic Review*. forthcoming.

Kohler, W. (2004). International Outsourcing and Factor Prices with Multistage Production. *Economic Journal*, 114(494):C166–C185.

Kotsadam, A. and Tolonen, A. (2014). African mining, gender, and local employment. OxCarre Research Paper 114, Oxford Centre for the Analysis of Resource Rich Economies, Oxford.

Kovak, B. K. (2013). Regional Efects of Trade Reform: What is the Correct Measure of Liberalization? *American Economic Review*, 103(5):1960–1976.

Krugman, P. (1998). What's New about the New Economic Geography? *Oxford Review of Economic Policy*, 14(2):7–17.

Krugman, P. and Elizondo, R. L. (1996). Trade Policy and the Third World Metropolis. *Journal of Development Economics*, 49:137–150.

Laudon, K. and Laudon, J. P. (2013). *Managing Information Systems*. Pearson, 13th edition.

Lederman, D. and Maloney, W. F., editors (2007). *Natural resources: Neither curse nor destiny*, Palo Alto, CA. Stanford University Press.

Lei, Y.-H. and Michaels, G. (2013). Do giant oilfield discoveries fuel internal armed conflicts? *Journal of Development Economics*, 110:139–157.

Lewis, W. A. (1954). Economic Development with Unlimited Supplies of Labour. *The Manchester School*, 22(2):139–191.

Liao, W.-C. (2010). Outsourcing and computers: Impact on urban skill levels and rent. *Regional Science and Urban Economics*, 40:136–154.

Limao, N. and Maggi, G. (2015). Uncertainty and Trade Agreements. *American Economic Journal: Microeconomics*, 7(4):1–42.

Marchand, J. (2012). Local labor market impacts of energy boom-bust-boom in Western Canada. *Journal of Urban Economics*, 71(1):165–174.

Markusen, J. R. (1995). The Boundaries of the International Enterprise and the Theory of International Trade. *Journal of Economic Perspectives*, 9(2):169–189.

Matsuyama, K. (1992). Agricultural Productivity, Comparative Advantage and Economic Growth. *Journal of Economic Theory*, 58:317–334.

Mazumdar, J. and Quispe-Agnoli, M. (2002). Trade and the Skill Premium in Developing Countries: The Role of Intermediate Goods and Some Evidence from Peru. Federal Reserve Bank of Atlanta Working Paper No. 2002-11.

McCaig, B. (2011). Exporting out of poverty: Provincial poverty in Vietnam and US market access. *Journal of International Economics*, 85(1):102–113.

McLaren, J. (2000). Globalization And Vertical Structure. *American Economic Review*, 90(5):1239–1254.

Michael, R. T. (1985). Consequences of the rise in female labor force participation rates: Questions and probes. *Journal of Labor Economics*, 3(1):117–146.

Michaels, G. (2011). The long term consequences of resource-based specialisation. *Economic Journal*, 121(551):31–57.

Michaels, G., Rauch, F., and Redding, S. J. (2011). Technical Note: An Eaton and Kortum (2002) Model of Urbanization and Structural Transformation. mimeo.

Michaels, G., Rauch, F., and Redding, S. J. (2012). Urbanization and Structural Transformation. *Quarterly Journal of Economics*, 127(2):535–586.

Michaels, G., Rauch, F., and Redding, S. J. (2013). Task Specialization in US Cities from 1880-2000. NBER working paper 18715.

Minnesota Population Center (2011). National historical geographic information system: Version 2.0. Minneapolis, MN: University of Minnesota.

Monfort, P. and Nicolini, R. (2000). Regional Convergence and International Integration. *Journal of Urban Economics*, 48(2):286–306.

Monte, F. (2015). The Local Incidence of Trade Shocks. mimeo.

Moretti, E. (2004). Human Capital Externalities in Cities. In *Handbook of Urban and Regional Economics*, volume 4, pages 2243–2291.

Moretti, E. (2010a). Local labor markets. In Card, D. and Ashenfelter, O., editors, *Handbook of Labor Economics*, volume 4b, Amsterdam. North Holland.

Moretti, E. (2010b). Local Multipliers. *American Economic Review Papers and Proceedings*, 100(2):373–377.

Moretti, E. (2013). *The New Geography of Jobs*. Mariner Books.

Nakamura, R. (1985). Agglomeration economies in urban manufacturing industries: a case of Japanese cities. *Journal of Urban Economics*, 17(1):108–124.

Naughton, B. (2007). *The Chinese Economy: Transitions and Growth*. MIT Press.

Ngai, R. and Pissarides, C. (2007). Structural Change in a Multisector Model of Growth. *American Economic Review*, 97(1):429–443.

Ngai, R. L. and Petrongolo, B. (2014). Gender gaps and the rise of the service economy. Discussion Paper no. 8134, IZA, Bonn.

Norris, P. (2010). Perhaps petroleum perpetuates patriarchy? A response and critique to Ross. mimeo.

Nunnenkamp, P. (2002). Determinants of FDI in Developing Countries: Has Globalization Changed the Rules of the Game? Kiel Working Paper No.1122.

Odlyzko, A. M. (2000). The history of communications and its implications for the Internet. mimeo.

O'Huallachain, B. and Reid, N. (1997). Acquisition versus Greenfield Investment: The Location and Growth of Japanese Manufacturers in the United States. *Regional Studies*, 31(4):403–416.

Olivetti, C. (2013). The Female Labor Force and Long-run Development: The American Experience in Comparative Perspective. NBER Working Paper 19131.

Ottaviano, G. I. P., Peri, G., and Wright, G. C. (2013). Immigration, Offshoring and American Jobs. *American Economic Review*. forthcoming.

Overman, H. G. and Winters, L. A. (2011). Trade and Economic Geography: The Impact of EEC Accession on the UK. *The Manchester School*, 79(5):994–1017.

Owens, T. and Wood, A. (1995). Export-Oriented Industrialisation Through Primary Processing? IDS Working Paper 19, Institute of Development Studies, University of Sussex.

Paluzie, E. (2001). Trade Policies and Regional Inequalities. *Papers in Regional Science*, 80:67–85.

Papyrakis, E. and Gerlagh, R. (2004). The resource curse hypothesis and its transmission channels. *Journal of Comparative Economics*, 32:181–193.

Papyrakis, E. and Gerlagh, R. (2007). Resource abundance and economic growth in the United States. *European Economic Review*, 51:1011–1039.

Penn Energy Research (2000). Oil and Gas Journal Data Book. Tulsa, OK: Pennwell Publishing Co.

Penn Energy Research (2006). Oil and Gas Journal Data Book. Tulsa, OK: Pennwell Publishing Co.

Pierce, J. R. and Schott, P. K. (2015). The Surprisingly Swift Decline of U.S. Manufacturing Employment. mimeo.

Poelhekke, S. (2013). Human capital and employment growth in German metropolitan areas: new evidence. *Regional Studies*, 47(2):245–263.

Pratt, J. A. (1980). *The growth of a refining region*. Jai Press, Greenwich, Connecticut.

Queiroz, B. L. and Golgher, A. B. (2008). Human capital differentials across municipalities and states in Brazil. discussion paper, UFMG/Cedeplar.

Rajan, R. G. and Zingales, L. (1998). Financial Dependence and Growth. *American Economic Review*, 88(3):559–586.

Rice, T. W. and Coates, D. L. (1995). Gender role attitudes in the southern United States. *Gender and Society*, 9:738–750.

Roberts, M. J. and Tybout, J. R. (1997). The Decision To Export In Colombia: An Empirical Model Of Entry With Sunk Costs. *American Economic Review*, 87(4):545–564.

Robertson, R. (2007). Trade and Wages: Two Puzzles from Mexico. *The World Economy*, 30(9):1378–1398.

Rodrik, D. (1991). Policy Uncertainty And Private Investment In Developing Countries. *Journal of Development Economics*, 36(2):229–242.

Rodrik, D. (2006). What's so Special About China's Exports? *China and World Economy*, 14(5):1–19.

Rogerson, R. (2008). Structural Transformation and the Deterioration of European Labor Market Outcomes. *Journal of Political Economy*, 116(2):235–259.

Rose, A. K. (2004a). Do We Really Know That the WTO Increases Trade? *American Economic Review*, 94(1):98–114.

Rose, A. K. (2004b). Do WTO Members Have a More Liberal Trade Policy? *Journal of International Economics*, 63(2):209–235.

Rosenthal, S. S. and Strange, W. C. (2004). Evidence on the Nature and Source of Agglomeration Economies. In Henderson, J. V. and Thisse, J.-F., editors, *Handbook of Regional and Urban Economics*, volume 4, pages 2119–2172, Amsterdam. Elsevier.

Ross, M. L. (2008). Oil, Islam and women. *American Political Science Review*, 102(1):107–123.

Ross, M. L. (2012). *The oil curse: How petroleum wealth shapes the development of nations*. Princeton University Press, Princeton, NJ.

Ruggles, S., Alexander, J. T., Genadek, K., Goeken, R., Schroeder, M. B., and Sobek, M. (2010). Integrated Public Use Microdata Series: Version 5.0. Minneapolis: University of Minnesota.

Sachs, J. D. and Warner, A. M. (1999). The Big Rush, Natural Resource Booms And Growth. *Journal of Development Economics*, 59:43–76.

Sachs, J. D. and Warner, A. M. (2001). The curse of natural resources. *European Economic Review*, 45:827–838.

Sala-i-Martin, X. (2006). The World Distribution of Income: Falling Poverty and... Convergence, Period. *Quarterly Journal of Economics*, 121(2):351–397.

Sattinger, M. (1975). Comparative Advantage and the Distribution of Earnings and Abilities. *Econometrica*, 43(3):455–468.

Schott, P. K. (2007). The Relative Sophistication of Chinese Exports. *Economic Policy*, 23(53):5–49.

Serrato, J. C. S. and Wingender, P. (2014). Estimating Local Fiscal Multipliers. mimeo.

Shapiro, J. (2006). Smart cities: Quality of life, productivity, and the growth effects of human capital. *Review of Economics and Statistics*, 88(2):324–335.

Sharabi, H. (1988). *Neopatriarchy: A theory of distorted change in Arab society*. Oxford University Press, New York.

Sheerin, J. and Bressanin, A. (2014). North Dakota oil boom: American dream on ice. BBC Magazine, March 12.

Shoag, D. (2012). The Impact of Government Spending Shocks: Evidence on the Multiplier from State Pension Plan Returns. mimeo.

Simon, C. J. and Nardinelli, C. (1996). The Talk of the Town: Human Capital, Information, and the Growth of English Cities, 1861 to 1961. *Explorations in Economic History*, 33(3):384–413.

Simon, C. J. and Nardinelli, C. (2002). Human Capital and the Rise of American Cities, 1900-1990. *Regional Science and Urban Economics*, 32:59–96.

Smith, D. F. J. and Florida, R. (1994). Agglomeration and Industrial Location: An Econometric Analysis of Japanese-Affiliated Manufacturing Establishments in Automotive-Related Industries. *Journal of Urban Economics*, 36(1):23–41.

Subramanian, A. and Wei, S.-J. (2007). The WTO Promotes Trade, Strongly but Unevenly. *Journal of International Economics*, 72(1):151–175.

Tang, L. (2006). Communication Costs and Trade of Differentiated Goods. *Review of International Economics*, 14(1):54–68.

Topalova, P. (2005). Trade Liberalization, Poverty, and Inequality: Evidence from Indian Districts. NBER Working Papers 11614.

Topalova, P. (2010). Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India. *American Economic Journal: Applied Economics*, 2:1–41.

Toulemonde, E. (2006). Acquisition of Skills, Education Subsidies, and Agglomeration of Firms. *Journal of Urban Economics*, 59(3):420–439.

Twenge, J. M. (1997). Attitudes toward women, 1970-1995: A meta analysis. *Psychology of Women Quarterly*, 21:35–51.

Voigtlaender, N. and Voth, J. (2013). How the West ”invented” fertility restriction. *American Economic Review*, 103(6):2227–2264.

Wang, J. (2013). The Economic Impact of Special Economic Zones: Evidence from Chinese Municipalities. *Journal of Development Economics*, 101:133–147.

Wei, S.-J. (1999). Open Door Policy and China's Rapid Growth: Evidence from City Level Data. NBER Working Paper No. 4602.

Wilson, D. J. (2012). Fiscal Spending Jobs Multipliers: Evidence from the 2009 American Recovery and Reinvestment Act. *American Economic Journal: Economic Policy*, 4(3):251–282.

Wilson, W. J. (1987). *The truly disadvantaged*. University of Chicago Press, Chicago and London.

Wood, A. and Berge, K. (1994). Exporting Manufactures: Trade Policy or Human Resources? IDS Working Paper 4, Institute of Development Studies, University of Sussex.

World Bank (2004). Gender and development in the Middle East and North Africa. Washington DC: World Bank.

Wright, G. (1986). *Old South, new South*. Basic Books, New York.

Yao, Y. (2010). The Lewisian turning point has not yet arrived. The Economist.

Zou, B. (2015). The Local Economic Impact of Military Personnel Contractions. mimeo.