EL COLEGIO DE MÉXICO, A.C.
CENTRO DE ESTUDIOS ECONÓMICOS

"ESSAYS ON REGIONAL ECONOMICS: AN EMPIRICAL ANALYSIS FOR MEXICO"

TESIS PRESENTADA POR:

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PARA OPTAR POR EL GRADO DE

DOCTORA EN ECONOMÍA

PROMOCIÓN 2010-2013

DIRECTOR DE TESIS

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MÉXICO D.F. JUNIO DE 2013

EL COLEGIO DE MÉXICO

CENTRO DE ESTUDIOS ECONÓMICOS

CONSTANCIA DE APROBACIÓN

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Tesis:	*Essays on Regional Economics: An Empirical Analysis for Mexico*
Director de Tesis:	Dr. Isidro Soloaga

Aprobada por el Jurado Examinador:

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México, D.F., 27 de junio de 2013

A Ximena, Santiago y Jorge porque dan propósito a mi vida y a mi trabajo

A toda mi familia

Agradecimientos

Agradezco en primer lugar a Isidro Soloaga, mi Director de tesis, por todo el tiempo que dedicó a trabajar conmigo durante estos tres años, por todo lo que me enseñó y porque siempre me impulsa para buscar nuevas preguntas para responder. Ha sido un placer ser tu alumna y espero tener la oportunidad de seguir aprendiendo de ti.

Gracias a Gerardo Esquivel, a Laura Juárez y a Raymundo Campos-Vázquez, quienes formaron parte de mi Comisión Asesora y mi Comisión Lectora, por el tiempo que dedicaron a leer mi trabajo y por todos sus comentarios y consejos.

Muchas gracias a Carolina Palacios por su apoyo con material bibliográfico para este trabajo.

Agradezco los comentarios de Carlos Chiapa y de todos los asistentes a los seminarios en El Colegio de México, así como a los asistentes a las 1st Conference of the Economic Development Network en el Instituto Politécnico Nacional.

A Antonio Yunez, por todo su apoyo.

A mis demás profesores: Edwin van Gameren, Jaime Sempere, Oscar Fernández, Eneas Caldiño y David Cantalá por todo lo que me permitieron aprender durante la maestría y el doctorado.

A Larry Goldsmith por apoyarme con consejos y correcciones de redacción.

A Jorge, Ximena y Santiago por motivarme siempre para dar lo mejor de mí y por los miles de detalles con los que llenan mis días. Gracias por acompañarme y apoyarme en cada paso del camino. ¡Son lo mejor de mi vida! Los amo.

A mis papás y a mi hermana porque me han dado mucho más de lo que una familia puede dar. Gracias por quererme tanto y porque siempre estuvieron ahí cuando los necesité para ayudarme y motivarme.

Agradezco a mis suegros por todo su apoyo, pero sobre todo por todo el cariño que siempre me han dado. Saben que son bien correspondidos.

Agradezco a mi abuela porque siempre ha creído en mí.

A mi tía Irene, a mi abuelo Antonio, a Néstor y al abuelo Emilio. Nunca dejaré de extrañarlos.

Gracias a mis cuñados Bellita y Miguel De León y a Carlos Sierra por su apoyo para lograr esta empresa.

A mi amigo y compañero de clase Juan Pereyra por todo su apoyo y por todo lo que pude aprender de él durante este proceso. ¡Te voy a extrañar!

A mi amigo y también compañero del Doctorado, Jaime Sarmiento. Fue un placer ser tu compañera y aprender tanto de ti.

A mi compañera y amiga Brisna Beltrán, gracias por tu apoyo y amistad.

A todos mis demás compañeros del Doctorado. Fue un placer compartir esta experiencia con ustedes.

Gracias a Marisela, Elena y Olivia por todo su apoyo durante estos cinco años.

A toda la gente de Asuntos Escolares por su apoyo.

Agradezco al Mtro. Luis H. De León por las tan amenas pláticas y por su constante interés en mi desarrollo profesional.

A Ángel Villalobos y a Edwin Rivera por su apoyo para ingresar a la maestría.

A Beatriz Leycegui, por todo su apoyo y amistad.

A Martín Guzmán, de la Secretaría de Economía por toda su ayuda para este trabajo.

A mi familia uruguaya porque a pesar del tiempo y la distancia siento su apoyo incondicional.

A mis amigas de la Asunción porque han estado conmigo la mayor parte de mi vida. Gracias por su apoyo y cariño.

Agradezco a mis ex-compañeros de trabajo en la Secretaría de Economía por todo su apoyo y amistad. Gracias a Lulú Ida, Eduardo Ramos, Juan Carlos Baker, Alfonso Ochoa, Rocío Flores, James Salazar, Leonardo Torre y Norma Mora.

A todos mis demás amigos por su cariño y apoyo.

Gracias a mis tías y a mis primas.

Abstract

Chapter 1 presents an empirical analysis aimed at identifying the determinants of regional growth in Mexico by manufacturing sector in the period 1988-2008. In the framework of agglomeration economies it argues that the main factor behind Mexico's long-term regional industrial growth is Jacobs externalities (urbanization economies), and that wages are the main short-term factor behind this growth. There is heterogeneity in the determinants of regional growth according to technological intensity. Low-technology sectors appear to be more sensitive to initial wages and exhibit Jacobs externalities, while higher technology sectors show Porter economies (competition/specialization). Controlling for market conditions, agglomeration economies, and initial conditions, the south, the center and the Gulf of Mexico have a relative disadvantage for growth in medium-high-technology sectors. Moreover, only one out of the 58 Metropolitan Areas (MAs) studied shows a relative advantage for growth in this kind of industry. Relative advantage for low-technology sectors appears to be related to transportation and service infrastructure, while for high-technology sectors the main determinant is human capital.

Keywords: *agglomeration, regional growth, knowledge spillovers, dynamic externalities, Mexico*
JEL Classification: R1

Chapter 2 estimates the external returns to higher education in Mexico using cross-sectional micro data from the 2000 and 2010 censuses' samples. Because of identification problems, which according to the literature are the main challenge in this kind of model, an instrumental variable approach is used, taking the demographic structure as an instrument for the share of college graduates in a Metropolitan Area (MA). Results indicate that a one percentage point increase in the share of college graduates in Mexico increases the regression-adjusted average wages of an MA in more than six percent over a 10-year period. The constant composition approach is used to assess whether these effects are mainly due to externalities or to supply movements along a downward sloping demand. Part of the external returns to a higher share of college graduates is the result of externalities from direct or indirect interaction with these individuals. There appears to be heterogeneity in the magnitude of the spillovers according to educational level.

JEL classification: J0; R0: O0; O4
Keywords: human capital, knowledge spillovers, education, wages, social returns to education.

Chapter 3 analyzes local multipliers and the relation between tradable job creation and informality in Mexico. Building upon local multipliers analysis, and taking into consideration agglomeration economies as well as general equilibrium effects, if finds that a new job in the tradable sector traduces into three new jobs in the nontradable sector. Half of these jobs occur in the informal sector, which is not a desirable outcome considering the low tax collection and vulnerability to labor market shocks associated to informality. Considering the skill composition of the tradable sector, individuals with some college or more have a much higher multiplier over nontradable jobs compared to other skill levels. There are asymmetric effects in terms of the multiplier as negative shocks (job losses) have higher effects.

Key words: *local multipliers, informal sector, agglomeration, pecuniary externalities, Mexico*
JEL classification: J23, R11, R12, R23

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Chapter 2 External Returns to Higher Education in Mexico 2000-2010

Chapter 3 Local Multipliers and the Informal Sector in Mexico 2000-2010

Introduction

In the same way that some countries have been successful in terms of economic growth, some regions inside a country have experienced high growth rates while others have remained lagged.[1] Behind these outcomes are firms' location decisions; even though big cities represent higher wages and more congestion, there must be some factors that prevent some industries from relocating to other regions with lower wages. That is why recent literature has focused on the benefits of agglomeration: knowledge spillovers, linkages and market access, among others. The analysis of regional industrial growth within a country and the mechanisms behind it, can contribute to the design of more effective public policies to attract investment.

Among the benefits of agglomeration, the factor that has drawn more attention in recent empirical studies is the role of the transference of ideas and knowledge spillovers as forces of attraction for firms to locate in a city and thus, for city growth. This theory suggests that interaction with other individuals, especially those more highly educated, enhances the transference of ideas and increases individual human capital and labor productivity. These externalities are not only important because of their role in attracting new firms, but they represent a crucial factor for growth economics and public policy regarding education, as different strands of economic literature regard human capital as a determinant of development and an equalizing factor.

The whole concept of agglomeration, in which firms tend to locate together, implicitly entails a local labor multiplier effect. When a demand shock, such as the establishment of a new firm in the tradable sector occurs, the increasing demand associated with that shock generates a new set of jobs in the nontradable sector, mainly in services. The analysis of these multipliers is important for regional development policy, as local governments grant incentives for firms to locate in a given city and the knowledge of these figures can help to better target these efforts or gauge its appropriateness.

The case of Mexico has a great deal of distinctive features that makes it an interesting object of study in the context of agglomeration economies, knowledge spillovers and local labor markets. First, it is in a different stage of development against the developed countries

[1] The U.S. has shown a divergent pattern with some areas such as Silicon Valley exhibiting high growth rates while other regions have low growth rates and low wages. In the case of China, the coastal zones are the one that have led China's growth while other zones remain lagged.

that this literature usually analyzes. It is thus important to assess whether the predictions of these models hold for developing countries and if the magnitudes observed for these estimators are different.

Second, Mexico's regional industrial structure has changed over the last two decades. An unequal regional growth pattern has been observed in this period, with a few Metropolitan Areas (MAs) concentrating most of the national employment. This process occurred in coincidence with an aggressive trade opening strategy; thus, it seemed natural to attribute regional differences to this policy in conjunction with transportation costs. However, industrial location patterns have recently changed in a way that indicates that other factors, such as agglomeration economies, may be at work. In the last twenty years, low technology manufacturing sectors have shown movements from the Center of the country to the South, while medium-high technology sectors have moved to the North. This behavior is consistent with a laddering process in which firms' location is moving regionally and being substituted by industries of higher technological intensity. It is therefore important to analyze whether agglomeration economies really have an effect on employment growth in a region and the mechanisms through which they operate.

Third, even though as international measures point out, it still exhibits important lags against developed countries in terms of education, Mexico has increased its educational attainment in the last ten years. During this period, the average years of schooling for individuals aged 25 to 66 in Mexico, have increased from 8.7 in 2000 to 9.9 in 2010, while the share of college graduates rose from 13% to 16.5%. It is thus important to assess whether these improvements are assimilated socially or just privately.

Finally, given the increasing role of the nontradable sector in Mexico, which accounts for 80 percent of total employment in the case of MAs, and the already mentioned regional movements in the manufacturing sector (tradable), it is important to deepen on how job creation in these two sectors is related. As productivity increases usually occur in the tradable sector, particularly in manufacturing, theoretical models within this literature focus on local labor multiplier of tradable employment over nontradable jobs. The analysis of these multipliers for Mexico poses an additional challenge as the nontradable sector is characterized by a high informality rate (60 percent of employment) in this country.

Therefore, it is important not only to assess how many nontradable jobs are created as a result of new tradable firms or jobs in a region, but the quality of these jobs.

All of these features represent different aspects of the same phenomenon and are analyzed in detail in the three chapters of this study:

> In **Chapter 1**, we analyze the determinants of employment growth in Mexico's manufacturing sector between 1988 and 2008. The question addressed in this section is whether market conditions or agglomeration economies are more important for manufacturing employment growth. Furthermore, we analyze if controlling for all of these factors, some regions still have relative disadvantages for growth. Important contributions of this chapter are the emphasis on sectoral differences by technological intensity and the analysis of regional characteristics (e.g. infrastructure, human capital and transportation infrastructure) that may have an effect on relative disadvantages. Among the main results of this chapter are that urbanization economies (diversity) is the main factor behind long-term regional industrial growth, while wages drive short-term growth. There is heterogeneity in these determinants according to technological intensity. Low-technology sectors appear to be more sensitive to initial wages and urbanization while higher-technology sectors favor competition and specialization. Controlling for agglomeration economies, market conditions and initial conditions, the south, the center and the Gulf of Mexico exhibit a relative disadvantage for growth in medium-high technology sectors.
>
> **Chapter 2** goes further on the benefits of agglomeration by analyzing knowledge spillovers, specifically, the external returns to higher education in Mexico in the period 2000-2010. That is, it analyzes whether some individuals really benefit in terms of better wages, from the higher level of education, in this case college, that other individuals have. The main contribution of this chapter is the analysis of these returns for a developing country with educational levels comparable with those of the bottom cities of developed countries and which, unlike those countries, does not have clear links between college, engineering and innovation. Another contribution of this analysis is the use of different empirical

methodologies in order to assess whether these effects come from externalities or just imperfect substitution between skilled and unskilled jobs. Results indicate that a one percentage point increase in the share of college graduates in Mexico increases average wages in an MA, controlling for individual characteristics, in more than six percent over a 10-year period. Part of the external returns to a higher share of college graduates is the result of externalities from direct or indirect interaction with these individuals. There appears to be heterogeneity in the magnitude of the spillovers according to educational level.

In **Chapter 3** we analyze local multipliers of tradable employment over nontradable jobs for the period of 2000-2010. Considering that in the case of Mexico, approximately 60% of employment occurs in the informal sector, which involves less tax collection and a higher vulnerability to labor shocks, the main contribution of the chapter, and a departure from previous studies, is to estimate these multipliers for both formal and informal nontradable sectors, which allows to assess the quality of jobs creation. It also calculates the magnitude of the multipliers for different levels of technological intensity. Results indicate that a new job in the tradable sector traduces into three new jobs in the nontradable sector. Approximately half of these jobs occur in the informal sector. Considering the skill composition of the tradable sector, individuals with some college or more have a much higher multiplier over nontradable jobs compared to other skill levels. There are asymmetric effects in terms of the multiplier as negative shocks (job losses) have higher effects.

Even though the three chapters have a common thread, each one of them can stand alone.

Chapter 1 Determinants of Regional Growth by Manufacturing Sector in Mexico, 1988-2008

1 Introduction

The location choices of firms can help to explain why some countries have been successful in terms of growth while others have lagged. Recent work has therefore focused on the benefits of agglomeration and location: knowledge spillovers, linkages, congestion and market access, among other considerations.[2] As Amiti and Cameron (2007) and Moretti (2011) argue, these factors could explain why, under the assumption that firms minimize costs, some remain in higher wage regions. While market conditions (wages, housing prices, etc.) could give firms an incentive to leave certain locations, externalities and agglomeration benefits may create incentives to remain there.

In the case of Mexico, studies such as Hanson (1998) emphasize transportation costs as the driver of industrial location and agglomeration. If this is the case, firms should tend to concentrate along the northern border of the country. However, following Mexico's trade opening in the late 1980s, industrial location patterns have changed in a way that suggests that other factors may be at work. As shown in Figure 1, during the last twenty years, low technology sectors have moved from the center of the country to the south, while medium-high technology sectors have tended to move north. This behavior is consistent with a laddering process in which firms are moving from one region to another and being replaced by industries of higher technological intensity or with more value added.

The analysis of agglomeration economies is also of great importance due to its implications for economic policy: knowing the factors that firms value in choosing a location would lead to a more effective policy design to attract investment. It is likewise important to analyze the dynamics of these factors: what Henderson et al. (1995) regard as dynamic externalities, because it is possible to identify the effect of historical advantages on the current location of industries. Although there is still much debate regarding the nature of externalities, there is consensus on the existence of long-term agglomeration effects. The literature identifies three different kinds of effects: i) Jacobs economies, which are externalities generated by other industries or urbanization

[2] Studies by Glaeser, Kallal, Scheinkman, and Shleifer (1992) and Henderson, Kuncoro, and Turner (1995) are the most influential.

[3] Even though the *maquiladora* sector was of great importance, representing almost 48% of Mexico's exports in

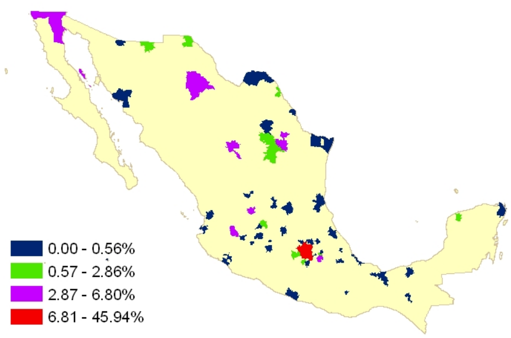
and under which competition is positive for growth; ii) Marshall-Arrow-Romer (MAR) economies, which are intra-industry externalities or specialization benefits which can be internalized by monopolies that are therefore beneficial for growth; and iii) Porter externalities, in which specialized industries incentivize growth and local competition enhances the adoption of technology.

FIGURE 1. MA'S SHARE OF NATIONAL EMPLOYMENT IN THE SECTOR *

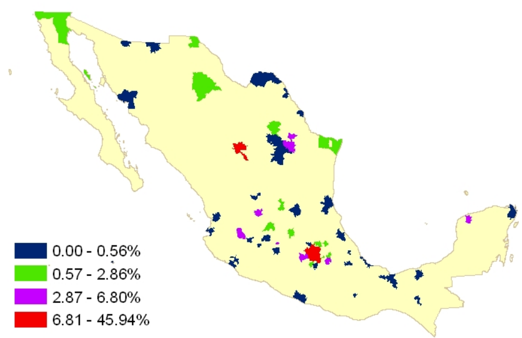
Low technology

a) Apparel

1988



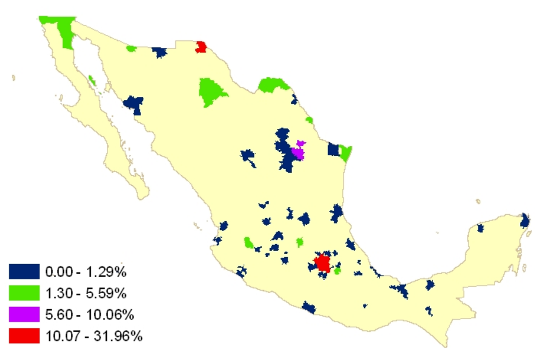
2008



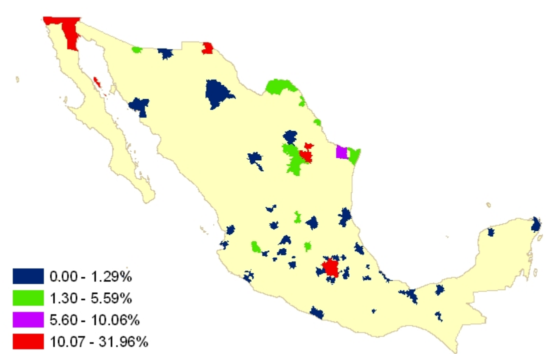
Medium-high technology

e) Electrical appliances

1988



2008



**The sectors shown were selected as an example of each technological group.*
The sum of all areas for each year is 100%.
Source: Author's calculations with data from the 1989 and 2009 Economic Censuses, INEGI.

This article analyzes the factors that affect regional growth across manufacturing sectors in Mexico: market conditions (using wages as an instrument) or knowledge spillovers, and if the latter, which of the three types of agglomeration economies are observed: intra-industry (MAR), inter-industry (Jacobs), or Porter. Additionally, it establishes whether, controlling for market conditions and agglomeration economies, certain regions still exhibit a disadvantage for growth. To address these questions, it starts from the hypothesis that there are sectoral differences in the factors that affect industrial growth in particular regions, which should be associated with technological intensity. Moreover, for low-technology sectors market conditions should prevail, while for higher-technology sectors externalities or agglomeration benefits should have more weight.

This paper's contribution consists, first, in analyzing the determinants of regional growth by manufacturing sector in Mexico, an insufficiently studied topic in which almost always trade opening has been considered the driving force. Second, it emphasizes sectoral differences, principally in technological intensity; unlike other studies, it does not assume that different sectors should exhibit similar behavior. Third, it analyzes relative advantages and disadvantages for regions or MAs (fixed effects), which are generally used only as control variables but which could have policy implications. Finally, it considers the presence of the *maquiladora* industry as a characteristic of an MA that may affect industrial location or labor demand growth and is, therefore, a control variable.[3]

The main conclusions are that in the long term, Jacobs (urbanization) economies are the main factor behind regional growth by manufacturing sector, while wages are more relevant in the short term. There is heterogeneity regarding regional growth determinants, related to technological intensity. Low-technology sectors are relatively more sensitive to initial wages and, in terms of agglomeration economies, exhibit Jacobs externalities, while higher technology sectors show Porter economies (competition/specialization). Controlling for market conditions, agglomeration economies, and initial conditions, the south, the center and the Gulf of Mexico still have a relative disadvantage for medium-high technology sectors that cannot be compensated by changes in agglomeration variables. Moreover, in the analysis of MAs, only one seems to have a relative advantage for medium-high technology sectors. Relative advantage for low-technology sectors appears to be related to transportation and service infrastructure, while for higher-technology sectors the main determinant is human capital.

[3] Even though the *maquiladora* sector was of great importance, representing almost 48% of Mexico's exports in 2000 (Hanson, 2003) the only study for Mexico seeking to control for it is Hanson (1998).

The paper is organized as follows: section 2 includes a literature review of agglomeration economies and studies of Mexico. Section 3 details the model that is used as a basis for empirical estimates. In section 4, the methodology and data are presented. Results are discussed in section 5 and conclusions in section 6.

2 Literature review

2.1 The New Economic Geography and agglomeration economies

As Harris (2011) argues, the New Economic Geography (NEG) emerges as a consequence of the New Trade Theory (NTT) developed by Krugman (1991), Krugman and Venables (1995) and Fujita, Krugman, and Venables (1999) and it is mainly a regional extension of trade between countries aimed at explaining industrial clusters formation and focusing on transportation costs and industrial linkages.

In order to explain agglomerations, the basic models in the framework of the NEG, developed mainly by Krugman and Venables, assume Spence-Dixit-Stiglitz monopolistic competition with increasing returns to scale and product differentiation. As Harris (2011) says, depending on their assumptions, some of these models generate a core-periphery pattern, that is, an equilibrium with agglomeration and in which activity is not uniformly distributed; other models predict differential growth rates and divergent trends; and furthermore, some models suggest initial divergence and later convergence in growth rates.

Centripetal and centrifugal forces play a crucial role in the results of these models. According to Glaeser and Gottlieb (2009) centripetal forces can be classified in three categories: (1) transportation costs, (2) labor market depth, and (3) ideas transference.

In terms of transportation costs, the theory developed mainly by Krugman (1991), indicates that agglomeration reduces costs from moving goods in the space, which has a direct relation to backward and forward linkages.

Regarding labor market depth, in a diversity of analyses following Marshall (1890), emphasis is made on the costs reduction for employers, due to labor pooling in one region. At the same time, uncertainty is reduced for the labor force, allowing workers to make riskier choices due to the decrease in search costs and the better matching between employers and employees. Finally, if very specific abilities are required, workers have more incentives to acquire them in a region in which there is a variety of firms that could demand them. At the same time with a larger pool of specialized workers in a region, the probability of firms using that kind of ability increases. In this sense, this literature is closely related to the one that analyzes the dynamics of the labor market and the wage ratio between skilled and unskilled workers. [4]

Regarding the transference of ideas, this theory arises as a result of Jacobs' (1969) work and it states that agglomerations accelerate the flow of ideas. This is related with the previous group of theories, as the movement of workers between firms, enhances the transference of ideas and innovation and increases individual human capital. According to Glaeser and Gottlieb (2009), the existence of human capital spillovers is suggested by the positive correlation between wages and abilities in a city as well as by the connection between abilities and population growth in a city. Additionally, Rodrik (2004) argues that certain firms could observe the success of other firms in the same sector of activity and, as a result of geographical proximity, decide to copy these best practices. The role of knowledge spillovers is further explored in Chapter 2.

In this sense, the literature distinguishes two types of agglomeration externalities: localization economies and urbanization economies. The first type, also known as Marshall-Arrow-Romer (MAR) economies, are those externalities that arise in the same industry, that is, when firms of the same industry agglomerate in a region or city.[5] The second type, regarded as Jacobs economies, are inter-industry externalities and are based on the assumption that diversity (a great deal of firms of different sectors or industries) generates innovation. As Harris (2011) argues, there is no consensus regarding which of these two types of externalities is more relevant for industrial location and growth.

MAR economies predict that local monopolies enhance growth, as the flow of ideas can be restricted and, at the same time, knowledge spillovers can be internalized (Glaeser et al., 1992). In this sense, these same authors consider a third type of externalities, based on Porter (1990), which as MAR, argues that specialized and geographically concentrated industries enhance growth, but considers that local competition is the force behind growth and technology adoption (see Figure 2 for a summary of agglomeration economies).

[4] See Esquivel, Lustig, and Scott (2010) for an example regarding Mexico in the framework of this literature.

[5] An example of these intra-industry agglomerations, are high-technology firms in the U.S. concentrated in Silicon Valley, as well as automotive firms located in Detroit.

FIGURE 2. CHARACTERISTICS OF AGGLOMERATION ECONOMIES

	Specialization	Non-diversity	Competition
Jacobs		-	+
Marshall-Arrow Romer	+		- , 0
Porter	+		+

Source: Author's elaboration with information from Glaeser et al. (1992)

Recent empirical studies in this field emphasize the centripetal force associated with the transference of ideas or knowledge spillovers, without excluding the possibility of the three forces operating simultaneously.

Just as there are factors that incentivize clusters or agglomerations, there are centrifugal or repelling forces associated to agglomerations that generate costs that must be compensated through higher wages. Among these forces are congestion and pollution. Additionally, due to labor mobility, agglomeration translates into higher prices of immobile factors such as land and housing.

2.2 Empirical studies on agglomeration economies

The two most influential empirical papers in this literature are Glaeser et al. (1992) and Henderson et al. (1995) and both of them analyze industries-cities in the U.S. The first authors find Jacobs (urbanization) economies and that intra-industry externalities, measured by specialization, seem to negatively affect long-term growth, contrary to the predictions of MAR theories. Henderson et al. (1995) analyze mature and new high-technology industries and find that urbanization economies are significant for new industries, which also exhibit intra-industry externalities, but not for the ones already established.

Van Oort (2007) carries out a similar analysis for the Netherlands, taking also into account spatial heterogeneity and finds results consistent with Glaeser et al. (1992) in favor of urbanization economies. Van Stel and Nieuwenhuijsen (2004) have similar results for the same country, but for the manufacturing industry the determinant turns out to be competition. Battisse (2002) studies agglomeration in the case of China, finding results similar to the ones in Glaeser et al. (1992), but this author also finds that growth dynamics differ between coastal zones and mainland China.

For Spain, De Lucio, Herce, and Goicolea (2002) evaluate agglomeration economies by sector of the manufacturing industry and find evidence of MAR externalities. Acs, FitzRoy, and Smith (2002) find results in the same line for high-technology industries in the U.S.

In general, even though there is evidence of agglomeration economies, the results regarding the nature of these externalities are not conclusive. However, there is a bias towards MAR economies when higher-technology industries are considered.

2.3 Empirical studies on industrial location and agglomeration economies for Mexico

There is no much research for Mexico in the framework of the NEG and agglomeration economies, and most of the studies focus on the trade opening strategy. One of the most influential is Krugman and Livas (1996) and these authors conclude that trade barriers before 1986, that is the import substitution model, generated an excessive agglomeration in Mexico City. In this same line, Hanson (1998) finds that trade openness has moved industrial clusters from the center to the north of the country. These articles emphasize transportation costs as the crucial factor that incentivize firms to locate in the north while existent agglomeration reinforces the pre-trade-opening pattern. Results in Mendoza-Cota and Pérez-Cruz (2007), and Diaz-Bautista (2005)[6] are consistent with this approach.

Félix Verduzco (2005) analyzes the effects of agglomeration economy on economic growth for the period of 1988-1998 and concludes that there are externalities from specialization and diversity for the whole country, mainly in the long term, but results change once the analysis is limited to the north, as these factors are no longer significant. Mendoza-Cota (2002) also focuses on the northern border and concludes that there are specialization effects, especially between 1988 and 1993 and that there are little positive effects of diversity on the GDP per capita growth of these cities.

By emphasizing the role of trade opening, these studies predict well the movements to the north, but they fail to explain the movement of certain industries to the center and south, which could be related to agglomeration effects.

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[6] This author includes migration among the factors that determine growth, which is a questionable assumption due to endogeneity problems between agglomeration and migration.

3 Theoretical framework

Starting from the simple model of Glaeser et al. (1992) in which the production function *Q* for each firm in sector *i,* location *j* and time *t* is given by:

$$Q_{ijt} = A_{ijt} f\left(l_{ijt}, \ldots\right) \quad (3.1)$$

Where:
A_{ijt} = Technology in industry i, location *j* and time *t* in nominal terms (it includes technological changes as well as price changes)
l_{ijt} = Employment in industry *i*, location *j* and time *t*
$f(.)$ =Specific functional form of the production function.

Each firm considers industry technology, prices and wages as given and maximizes benefits when the labor marginal product equals wages. Using the simple functional form included in Glaeser et al. (1992) $f(l) = l^{1-\alpha}$, $0 < \alpha < 1$:

$$w_{ijt} = A_{ijt} f'\left(l_{ijt}, \ldots\right) = A_{ijt}(1-\alpha) l_{ijt}^{-\alpha} \quad (3.2)$$

It is assumed that technology has a national and a local component:

$$A_{ijt} = A_{i,local,t} A_{i,national,t} \quad (3.3)$$

In terms of growth rates between $t - \tau$ and t:

$$ln\left(\frac{A_{ij,t}}{A_{ij,t-\tau}}\right) = ln\left(\frac{A_{i,national,t}}{A_{i,national,t-\tau}}\right) + ln\left(\frac{A_{i,local,t}}{A_{i,local,t-\tau}}\right) \quad (3.4)$$

Following Griliches (1979) and Jaffe (1989), it is assumed that there is a production function of technological change and local innovation (the second term in the right side of equation 3.4). That is:

$$ln\left(\frac{A_{i,local,t}}{A_{i,local,t-\tau}}\right) = f\left(\lambda R\&D_{i,j,t-\tau}, N_{i,j,t-\tau}\right) \quad (3.5)$$

Where:
$\lambda < 1$ as not all investments translate into innovation.
$R\&D$ =Expenditure in Research & Development (R&D)
$N_{i,j,t-\tau}$ =Number of firms in industry i, location j and time $t - \tau$. This term is included following the literature on R&D, in which as the number of researchers increases, more technological innovation is generated.

Under the assumptions that investment in R&D is a proportion ω of employment in the previous period, which is plausible in the context of learn by doing, and that firms maximize their benefits independently of what they spend on R&D, equation 3.5 can be written as:

$$ln\left(\frac{A_{i,local,t}}{A_{i,local,t-\tau}}\right) = f\left(\lambda\omega l_{i,j,t-\tau}, N_{i,j,t-\tau}\right) \tag{3.6}$$

It is assumed that once new knowledge or innovation is generated, it becomes a public good (with no rivalry in consumption and it is difficult to exclude other firms or agents), which is consistent with endogenous growth models. With this assumption, technology generated by other sector and/or locations can be used, but its adoption depends on the ability of the firm or sector to do it. Adding this assumption to equation 3.6 leads to:

$$ln\left(\frac{A_{i,local,t}}{A_{i,local,t-\tau}}\right) = f\left(\underbrace{\lambda\omega l_{i,j,t-\tau}}_{①}, \underbrace{N_{i,j,t-\tau}}_{②}, \underbrace{\sum_{m\neq j}\theta_{1,m}\lambda\omega l_{i,m,t-\tau}}_{③}, \underbrace{\sum_{k\neq i}\theta_{2,k}\lambda\omega l_{k,j,t-\tau}}_{④}, \underbrace{\sum_{k\neq i}\sum_{m\neq j}\theta_{3,k,m}\lambda\omega l_{k,m,t-\tau}}_{⑤}\right) \tag{3.7}$$

Where:
$\theta_{1,m}$ = Part of innovation generated by the same industry *i* in other locations that can be adopted by industry *i* in location *j*. This parameter varies depending on the distance between locations.
$\theta_{2,k}$ =Part of innovation generated by other industries in location *j* that can be adopted by industry *i* in location *j*. This parameter varies depending on industries affinity.
$\theta_{3,k,m}$ =Part of innovation generated by other industries in other locations that can be adopted by industry *i* in location *j*. This parameter varies depending on the distance between locations and industries affinity.

Taking the first and the third terms of equation 3.7, a specialization index can be constructed; this indicator reflects the importance of an industry in a location relative to its importance in other locations. The second term in the equation (number of firms in the sector-location) can be easily related to competition. The fourth and fifth term can be used to generate a diversity indicator, reflecting the importance of other industries in location *j* relative to their importance in all other locations.

Thus, equation (3.7) can be simplified to the form presented in Glaeser et al. (1992)[7], in which they model local technology growth as a function of specialization, competition, diversity and initial conditions, which allowed them to test empirically different types of agglomeration (MAR, Jacobs and Porter):

[7] See De Lucio et al. (2002) for a different model to obtain the equation in Glaeser et al. (1992)

$$ln\left(\frac{A_{i,local,t}}{A_{i,local,t-\tau}}\right) = g(specialization, competition, diversity, initial\ conditions) \quad (3.8)$$

Expressing equation (3.2) in terms of growth rates and substituting the results of (3.4) and (3.8), and solving for employment growth (l_{ij}):

$$ln\left(\frac{l_{i,j,t}}{l_{i,j,t-\tau}}\right) = -\frac{1}{\alpha} ln\left(\frac{w_{i,j,t}}{w_{i,j,t-\tau}}\right) + \frac{1}{\alpha} ln\left(\frac{A_{i,national,t}}{A_{i,national,t-\tau}}\right)$$

$$+\frac{1}{\alpha} g(specialization, competition, diversity, initial\ conditions) \quad (3.9)$$

4 Empirical Strategy

4.1 Data

This paper used information from the last five Economic Censuses (1989, 1994, 1999, 2004 and 2009) at the municipality level. These data was concentrated at the MA level according to the INEGI/ CONAPO/SEDESOL MA classification of 2000.[8] Three additional MA's were included due to their participation in the *maquiladora* industry employment during the 90's. (See Appendix 1 for the MAs structure).

This level of aggregation is used as there is a higher probability that industrial location decisions as well as knowledge spillovers occur at this level. That is, in the boundary between two municipalities, one firm could be indifferent between locating in any of them, as long as they are in the same MA; however, locating in different MAs could have different implications regarding services, infrastructure, amenities, etc.

As Table 1 shows, restricting the sample to 58 MA's, more than 70% of the manufacturing employment reported in economic censuses is covered. Accordingly, 18 sectors of the manufacturing industry were considered. (See Appendix 2 for the sectoral structure).[9]

[8] The 2000 MA classification is used instead of the 2005 classification, since changes in the structure of an MA could be related to its industrial growth. That is, the 2005 could be endogenous with respect to the model.

[9] In other studies for Mexico, such as Mendoza-Cota (2002) and Mendoza-Cota and Perez Cruz (2007), more disaggregated sectors are used due to the change in product classifications (the 1989 and 1995 Economic Censuses use CMAP while the 1999 and 2009 ones use NAICS). In this case, the compatibility between classifications was checked using the 1999 Economic Census as a basis, as the data is available for both classifications. The correlation between the sectoral employment using CMAP and NAICS is 0.93.

TABLE 1. SHARE OF MAS IN MANUFACTURING EMPLOYMENT

	Employment
1988	81.2%
1993	78.1%
1998	76.9%
2003	75.1%
2008	74.3%

Source: Author's calculations using data from the 1989, 1994, 1999 and 2004 Economic Censuses, INEGI.

4.2 Econometric specification

Following Glaeser et al. (1992), under the following assumptions:

1) Workers participate in a national labor market. Therefore, wage growth will be constant across MAs, making initial wages the only relevant variable.
2) Knowledge spillovers are constant through time affecting both new and already established industries in the same magnitude. If this is not the case, the function or the parameters should be different between new and already established sectors and between high-technology and low-technology sectors.

   The validity of these two assumptions will be tested later.

Starting from equation 3.9, the following specification is used:

$$ln\left(\frac{l_{ij,t}}{l_{ij,t-\tau}}\right) = \beta_0 + \beta_1 l_{ij,t-\tau} + \beta_2 ln\left(\frac{\sum_{k\neq j}^{J} l_{ik,t}}{\sum_{k\neq j}^{J} l_{ik,t-\tau}}\right) + \beta_3 w_{ij,t-\tau} + \beta_4 \rho_{ij,t-\tau} + \beta_5 c_{ij,t-\tau} + \beta_6 d_{ij,t-\tau} + \beta_7 maq_{ij,t-\tau} + \alpha_R R_j + e_{ij,t} \quad (4.1)$$

Where:

$l_{ij,t-\tau}$ = Employment of sector *i,* in location *j* in time $t-\tau$

$ln\left(\frac{\sum_{k\neq j}^{J} l_{ik,t}}{\sum_{k\neq j}^{J} l_{ik,t-\tau}}\right)$= Employment growth in sector *i* in the rest of the MAs

$w_{ij,t-\tau}$ =Average wage of sector *i,* in location *j* in time $t-\tau$

$\rho_{ij,t-\tau}$ = Concentration or specialization index of sector *i* in location *j* in time $t-\tau$.

$c_{ij,t-\tau}$ = Competition index of sector *i* in location *j* in time $t-\tau$

$d_{ij,t-\tau}$ =Non-diversity index of sector *i* in location *j* in time $t-\tau$

$maq_{ij,t-\tau}$ =Share of location *j* in the *maquiladora*-industry employment in time $t-\tau$

R_j = Regional dummies

The construction of the agglomeration indicators is as follows:

Concentration or specialization index: This measure is given by the relative share of sector *i* in location *j* versus the same sector's share in the national industry. An MA which is more specialized in sector *i*, exhibits a higher ratio.

$$\rho_{ij,t-\tau} = \frac{\frac{l_{ij,t-\tau}}{\sum_i l_{ij,t-\tau}}}{\frac{\sum_j l_{ij,t-\tau}}{\sum_i \sum_j l_{ij,t-\tau}}} \tag{4.2}$$

A positive and significant parameter could indicate either MAR or Porter economies, depending on the competition index. (See Figure 2 for the summary of these characteristics).

Competition: Number of establishments per worker in industry *i* and location *j* with respect to the number of establishments per worker in that same industry for the whole country. That is, this variable indicates whether more firms per worker exist in that location compared to the national average, which implies more competition. Positive and significant coefficients for this measure could be associated with both Jacobs and Porter economies, while negative or non-significant coefficients could indicate MAR economies.

$$C_{ij,t-\tau} = \frac{\frac{e_{ij,t-\tau}}{l_{ij,t-\tau}}}{\frac{\sum_j e_{ij,t-\tau}}{\sum_j l_{ij,t-\tau}}} \tag{4.3}$$

Diversity: This indicator is used to assess whether having a set of different industries is important in order to enhance growth (Jacobs economies). As a measure of diversity, the indicator suggested by Henderson et al. (1995) is calculated, which is based on a Hirschman-Herfindahl Index (HHI):

$$HHI_{ij,t-\tau} = \sum_{k\neq i}^{I} s_{kj,t-\tau}^2 = \sum_{k\neq i}^{I} \left(\frac{l_{kj,t-\tau}}{\sum_{k\neq i}^{I} l_{kj,t-\tau}}\right)^2 \tag{4.4}$$

This index takes the sum of the squares of the shares of all the other sectors in local employment. An increase in this index means less diversity; in the extreme case where the rest of the economic activity is concentrated in one sector, this indicator will have a value of one.[10]

[10] Glaeser et al. (1992) use the share of the other five main firms in local employment. A higher value of this variable indicates more diversity. In this case, this indicator was not used as it can have a low value either because the first six industries do not concentrate much of the initial local employment (in which case there really is a great deal of diversity) or because the industry concentrates much of the employment in that location (in which case there

Therefore, the first two variables in equation (4.1) are controls: β_1 is the convergence parameter, widely used in growth equations, and β_2 captures the effect of national demand on industry *i.* The parameters of interest are $\beta_3 - \beta_7$. The effect of wages (initial market conditions) on labor demand growth, which is captured by β_3 is expected to be negative. β_4 is the effect of specialization and is expected to be positive in the case of MAR or Porter economies. β_5 is the competition parameter and under Porter or Jacobs economies it should have a positive sign, while under MAR it should be negative or non significant. The effect of diversity, which is related to Jacobs economies should be captured by β_6 and its sign is expected to be negative as an increase of the HHI is related to a reduction in diversity. (See Figure 2 for the expected effects in agglomeration variables)

β_7 is the parameter associated to the share of the MA in the *maquiladora* industry employment. Following Hanson (1998) and due to the importance of this industry during Mexico's trade opening process, it is important to control for it.[11] R_j are regional dummies, which allow to control for region-specific policies or transportation costs.[12]

Under this specification, which uses growth rates in the left side, observations in which employment in one sector-MA was zero are not included. However, only 97 of the 1,044 observations that represent less than one percent of total employment in 2008 have this characteristic.

Equation 4.1 is estimated for two values of τ: 1) $\tau = 20$, in which only information from the 1989 and 2009 censuses is used; and 2) $\tau = 5$, where data from the five last censuses is used (1989, 1994, 1999, 2004 y 2009).[13]

---

is no diversity). Additionally, it would reduce the sample to the main six sectors only. As a robustness test, the equation was estimated using the Theil Index as a non-diversity measure.

[11] Hanson (1998) uses women's employment in the state-sector as proxy for the importance of the *maquiladora* industry, as these industries used to employ a higher proportion of women. This methodology is not followed here as the share of women has increased for all industries.

[12] The regions used are defined by INEGI (see Appendix 1 for the detail). Alternatively, the following specification is estimated where MA effects are included (*Fj)*:

$$ln\left(\frac{l_{ij,t}}{l_{ij,t-\tau}}\right) = \beta_0 + \beta_1 l_{ij,t-\tau} + \beta_2 ln\left(\frac{\sum_{k\neq j}^{J} l_{ik,t}}{\sum_{k\neq j}^{J} l_{ik,t-\tau}}\right) + \beta_3 \ln(w_{ij,t-\tau}) + \beta_4 \rho_{ij,t-\tau} + \beta_5 c_{ij,t-\tau} + \beta_6 d_{ij,t-\tau} + \beta_7 maq_{ij,t-\tau} + \alpha_F F_j + e_{ij,t}$$

[13] In order to assess the robustness of the results, the model is estimated using System Generalized Method of Moments (GMM).

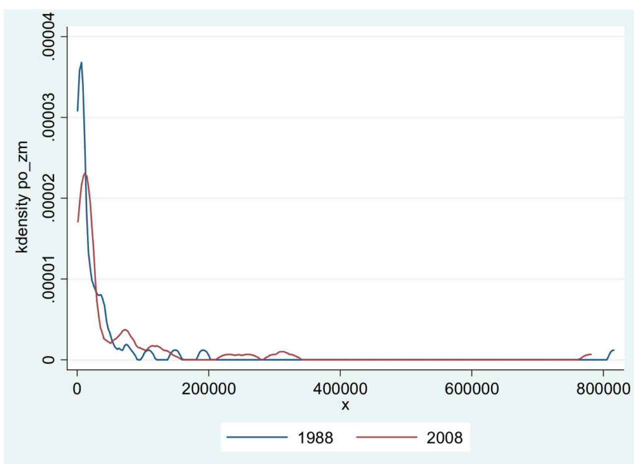
As the focus of this study is on sectoral differences, the equation was estimated by technological intensity[14], using the OECD classification (see Appendix 3 for this classification), which is exogenous to the data. In this case, seemingly unrelated regressions (SUR) are estimated and Chow tests are used in order to test the hypothesis that parameters are different between the different groups.

Results can be divided in two. First, parameters are analyzed in terms of market conditions and agglomeration. Second, fixed effects from these models are discussed.

4.3 Descriptive statistics

As can be seen in Figure 3, the density of employment by MA shows that most of the observations take low values. That is, a few MAs concentrate most of the employment. This is consistent with what in urban economics is regarded as Zipf's Law[15], which states that there is always a higher density of small cities. This is important because estimates will thus include a great deal of observations with low weights in terms of employment. Therefore it is essential to control for the initial value of employment.

FIGURE 3. KERNEL DENSITY OF TOTAL MANUFACTURING EMPLOYMENT BY MA



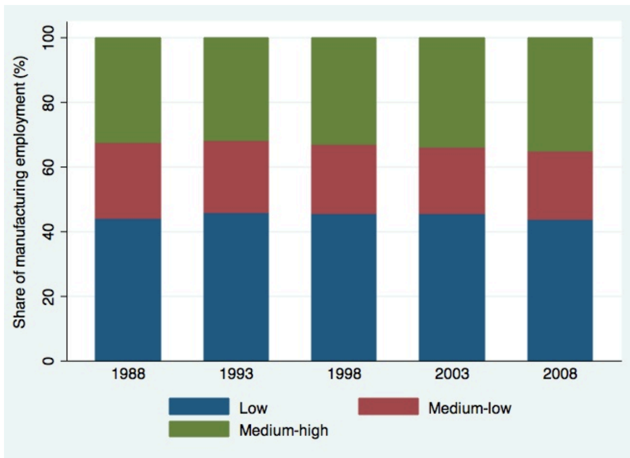
Source: Author's calculations using data from the 1989 and 2009 economic censuses, INEGI.

[14] Results were also obtained at the sectoral level but are not shown because in some MAs there is no presence of some sectors, which reduces the degrees of freedom in the regression analysis. These tables are available upon request.

[15] See Gabaix (1999) for further details on Zipf's Law.

Regarding the distribution of employment by technological intensity, as Figure 4 shows, the shares of each intensity group in total employment have remained relatively stable, indicating that even though low-technology sectors have the largest share, the three groups have shown similar growth patterns.

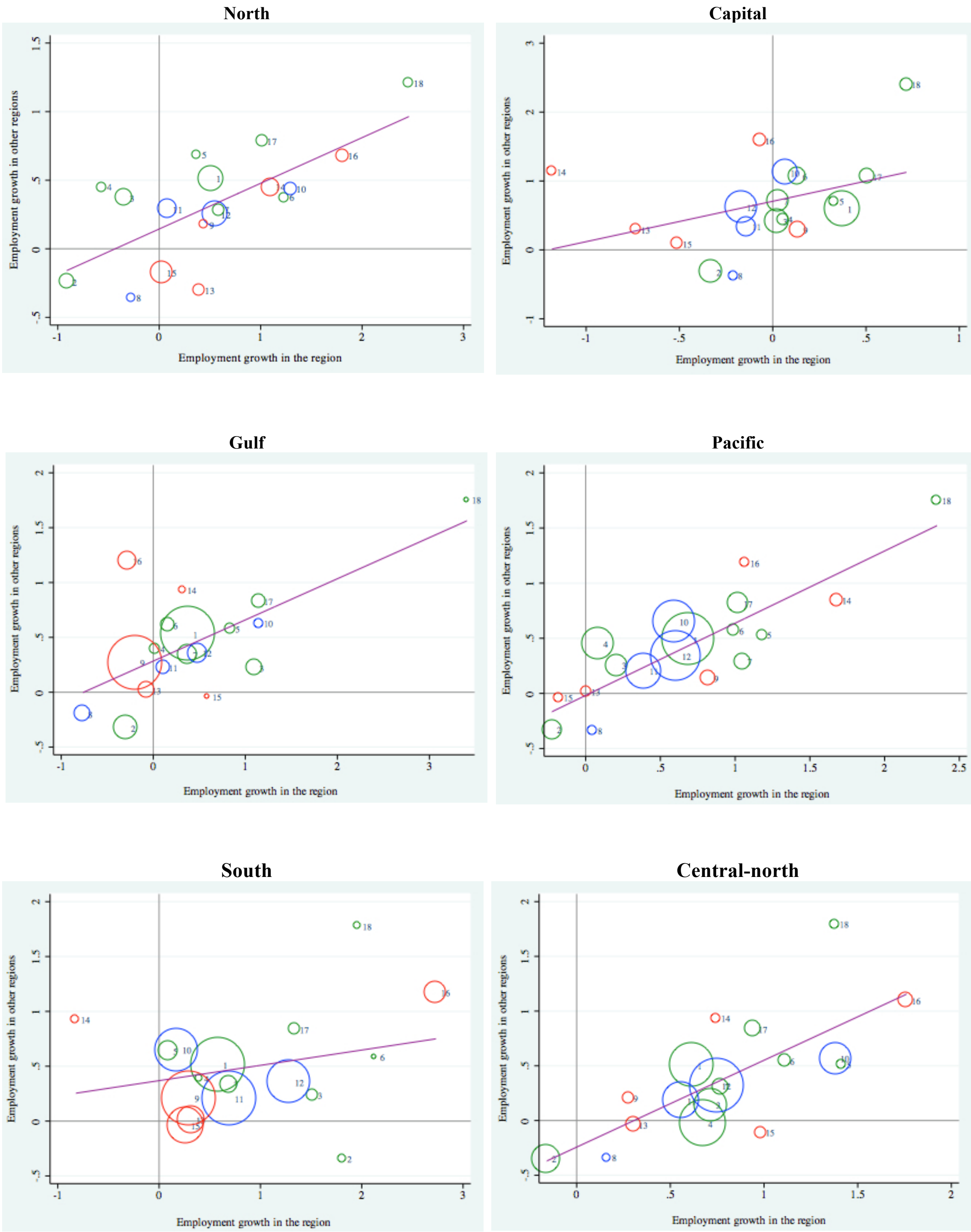
FIGURE 4. SHARE OF MANUFACTURING EMPLOYMENT BY TECHNOLOGICAL INTENSITY



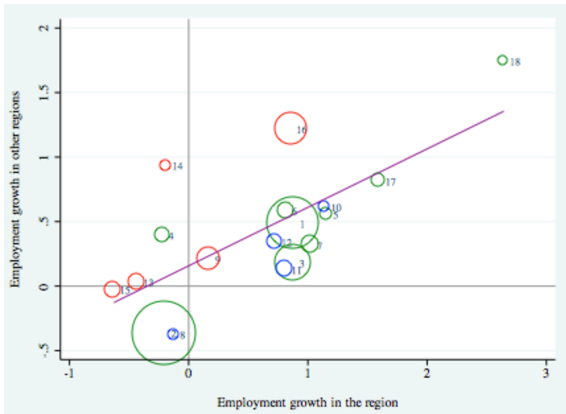
Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

Figure 5 shows whether employment in an MA is growing in the same sectors in which national demand is increasing (using employment growth in the rest of the regions as a proxy). For example, for the north region, employment grows in the same sectors as national demand. However, in the case of medium-high technology sectors, such as electric machinery and equipment, employment in this region is growing, while in other regions there is little change; this could indicate that the north is a leader region. The central-north region shows a similar but less marked trend. In the case of the Capital region, employment decreases are observed in a group of sectors in which other regions exhibit growth, which reflects the decentralization experienced in recent years. Although the Gulf of Mexico is growing in industries in which other regions exhibit growth too, in some high-technology sectors such as the chemical sector it is decreasing while other regions are growing.

FIGURE 5. GROWTH IN EMPLOYMENT AGAINST THE REST OF THE REGIONS *



Center



Low-technology intensity
Medium-low technology intensity
Medium-high technology intensity

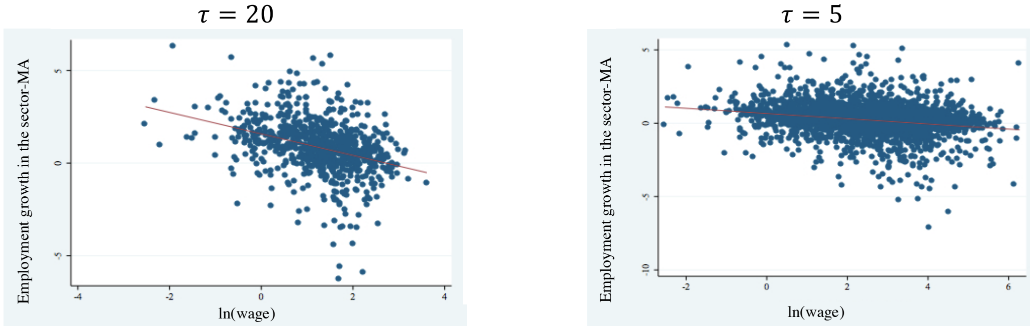
1 Food, beverages and tobacco
2 Textiles
3 Apparel
4 Leather and footwear
5 Wood
6 Paper
7 Printing
8 Petroleum and coal products
9 Chemical industry
10 Plastics and rubber
11 Non-metallic mineral products
12 Primary metal manufacturing and metal products
13 Machinery and equipment
14 Computers and electronics
15 Electric apparatus
16 Transportation equipment
17 Furniture and mattresses
18 Other industries

**Marker sizes are based upon total employment in the region-sector.*
Source: Author's calculations with data from the 1989 and 2009 Economic Censuses, INEGI.

Regarding the variable that summarizes market conditions (initial wage), Figure 6 presents the relationship between this variable and employment growth by sector-MA for the two different periods analyzed ($\tau = 5$ and $\tau = 20$). The data exhibits the expected negative relation (higher wages create negative incentives for the location of industries in an MA). This relation appears to be more negative for $\tau = 20$.

FIGURE 6. CORRELATION BETWEEN INITIAL WAGE AND EMPLOYMENT GROWTH IN THE INDUSTRY-MA

$\tau = 20$ $\tau = 5$



Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

TABLE 2. DESCRIPTIVE STATISTICS OF INDEPENDENT VARIABLES

	1988			1993			1998			2003			2008		
	Mean	Std. Dev.	C.V.	Mean	Std. Dev.	C.V.	Mean	Std. Dev.	C.V.	Mean	Std. Dev.	C.V.	Mean	Std. Dev.	C.V.
Whole sample															
Logarithm of employment	5.65	2.25	0.40	5.90	2.13	0.36	6.17	2.12	0.34	6.12	2.17	0.35	6.20	2.19	0.35
Logarithm of nominal wage	1.28	0.90	0.70	2.36	0.91	0.39	3.17	0.97	0.31	3.61	0.93	0.26	3.64	1.05	0.29
Non-diversity index	0.29	0.17	0.60	0.25	0.13	0.52	0.24	0.13	0.53	0.25	0.12	0.49	0.24	0.11	0.47
Competition index	1.55	2.85	1.84	1.92	4.79	2.49	1.97	4.03	2.05	2.10	4.00	1.90	1.94	3.34	1.72
Specialization index	1.23	2.78	2.26	1.16	2.85	2.45	1.14	2.41	2.11	1.15	2.42	2.11	1.16	2.86	2.47
		N=831			N=904			N=932			N=920			N=938	
Low technology															
Logarithm of employment	5.47	2.18	0.40	5.85	2.03	0.35	6.07	2.09	0.34	6.04	2.00	0.33	6.20	1.91	0.31
Logarithm of nominal wage	1.03	0.85	0.83	2.07	0.93	0.45	2.81	0.90	0.32	3.27	0.83	0.25	3.27	0.98	0.30
Non-diversity index	0.28	0.17	0.59	0.25	0.13	0.53	0.24	0.13	0.53	0.25	0.12	0.49	0.24	0.11	0.47
Competition index	1.72	2.94	1.71	1.85	3.06	1.65	2.20	3.56	1.62	2.73	4.16	1.52	2.50	3.08	1.23
Specialization index	1.25	2.12	1.70	1.15	1.73	1.50	1.14	1.67	1.47	1.17	1.85	1.58	1.15	1.77	1.54
		N=434			N=467			N=489			N=495			N=501	
Medium-low technology															
Logarithm of employment	6.00	1.97	0.33	6.20	1.93	0.31	6.39	1.78	0.28	6.46	1.86	0.29	6.48	2.09	0.32
Logarithm of nominal wage	1.38	0.88	0.64	2.57	0.79	0.31	3.52	0.94	0.27	3.97	0.89	0.22	3.92	0.90	0.23
Non-diversity index	0.30	0.18	0.59	0.27	0.13	0.51	0.25	0.13	0.54	0.26	0.13	0.49	0.25	0.12	0.47
Competition index	1.91	2.81	1.47	1.54	2.02	1.31	1.63	1.75	1.07	1.45	1.60	1.11	1.53	3.18	2.08
Specialization index	1.46	4.71	3.22	1.47	5.32	3.62	1.38	4.11	2.97	1.36	4.00	2.95	1.49	5.30	3.56
		N=177			N=192			N=213			N=200			N=202	
Medium-high technology															
Logarithm of employment	5.73	2.56	0.45	5.76	2.44	0.42	6.18	2.47	0.40	5.97	2.68	0.45	5.99	2.76	0.46
Logarithm of nominal wage	1.71	0.82	0.48	2.76	0.77	0.28	3.60	0.83	0.23	4.04	0.89	0.22	4.19	1.01	0.24
Non-diversity index	0.28	0.17	0.61	0.25	0.13	0.51	0.23	0.12	0.51	0.23	0.12	0.49	0.22	0.10	0.44
Competition index	0.94	2.61	2.78	2.35	7.96	3.39	1.78	6.00	3.37	1.29	4.83	3.74	1.09	3.76	3.43
Specialization index	1.01	1.55	1.54	0.94	1.49	1.58	0.91	1.36	1.51	0.90	1.43	1.58	0.88	1.30	1.48
		N=220			N=245			N=230			N=225			N=235	

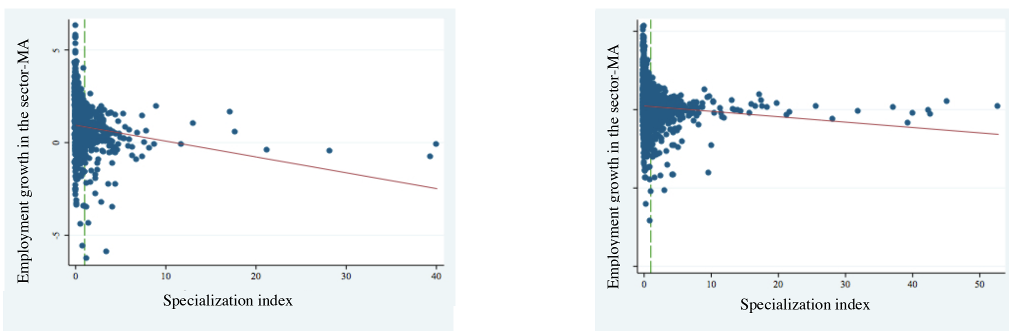
* Descriptive stats shown are for the $\tau = 5$ sample. Means and standard deviations do not differ much (a difference of less than one percent) with respect to the $\tau = 20$ sample.

Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

As Table 2 shows, the specialization index by technological intensity does not show much specialization (mean values close to unity), but standard deviations for each group indicate that there are MAs where industries are overrepresented, especially for medium-low technology industries. Considering this variable's relation to employment growth, as Figure 7 shows, the relation is not clear (probably because there is a great deal of low values) and if it exists, it appears to be negative, which is an unexpected pattern in the framework of MAR economies, although consistent with other studies such as Glaeser et al. (1992). The relation between employment growth and the non-diversity index (both the HHI and the Theil index) is also not clear and appears to have a sign contrary to what is expected in this literature (Figure 8).

FIGURE 7. CORRELATION BETWEEN THE SPECIALIZATION INDEX AND EMPLOYMENT GROWTH IN THE INDUSTRY-MA

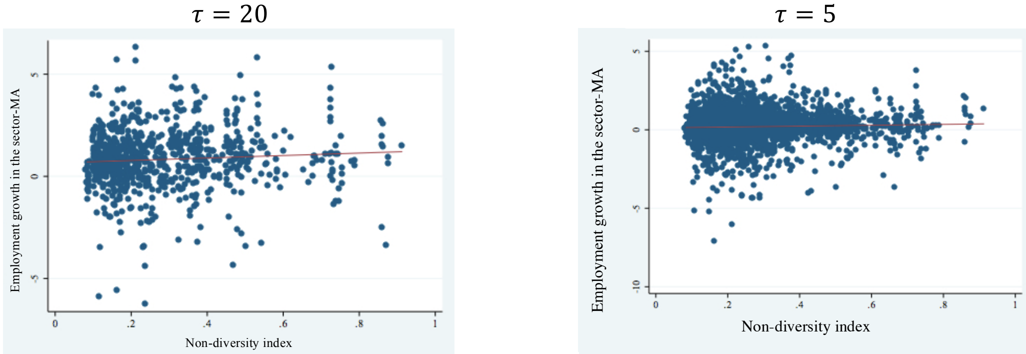
$\tau = 20$ $\tau = 5$



Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

FIGURE 8. CORRELATION BETWEEN INITIAL NON-DIVERSITY AND EMPLOYMENT GROWTH IN THE INDUSTRY-MA

$\tau = 20$ $\tau = 5$

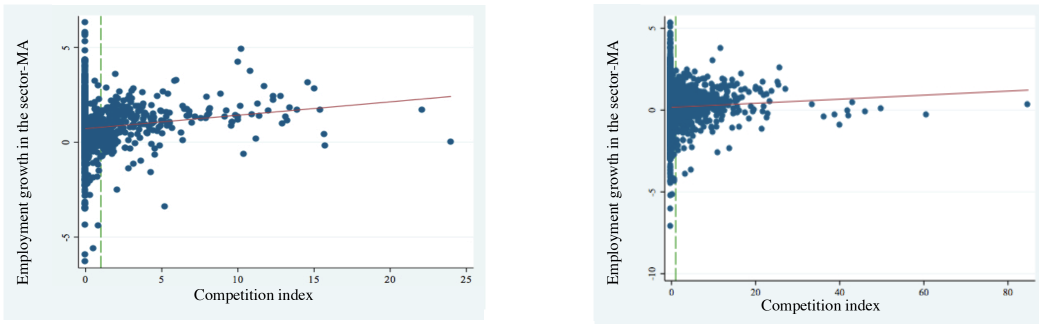


Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

Finally, the competition index appears to have a positive linear relation with employment growth, although the slope is not very steep (mainly in the case of $\tau = 5$). That is, initial competition seems to positively affect employment growth in an MA, which is consistent both with Jacobs and Porter economies, depending on other indicators (Figure 9).

FIGURE 9. CORRELATION BETWEEN INTITIAL COMPETITION AND EMPLOYMENT GROWTH IN THE INDUSTRY-MA

$\tau = 20$ $\tau = 5$



Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

5 Results

5.1 Results for $\tau = 20$

<u>5.1.1 Whole sample</u>

Table 3 shows the results for the whole sample, that is, without sectoral or technological intensity breakdowns. The results for the variables of interest (wages and agglomeration economies variables) are robust to the inclusion of regional effects, share of the MA in the *maquiladora* industry employment and MAs fixed effects. The F-test over fixed effects (E6) shows that they are jointly significant.

As expected, initial wages have a negative, though small, effect in employment growth for an MA-sector. Thus, a 10% higher wage in 1988 reduces growth by 2.2 percentage points during the twenty-year period analyzed.

Regarding the variables associated with knowledge spillovers, the specialization index that indicates MAR or Porter economies is not significant in any specification while the competition variable is positive and significant, but low; if a sector increases its competition level against country average by 10%, it will result in an increase of half a percentage point in employment growth in the period of analysis. Finally, the non-diversity variable is significant in all specifications. Therefore, in average, the externalities observed are consistent with Jacobs or urbanization economies.

TABLE 3. RESULTS FOR $\tau = 20$ (STANDARDIZED COEFFICIENTS)[16]

Dependent variable: MA-industry employment growth	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**
Employment growth of the same industry in the rest of the MAs	0.24***	0.23***	0.23***	0.23***	0.23***	0.24***
	(6.44)	(6.39)	(6.38)	(6.37)	(6.35)	(7.19)
Logarithm of nominal wage 1988	-0.13***	-0.14***	-0.14***	-0.14***	-0.13***	-0.16***
	(-3.07)	(-3.20)	(-3.27)	(-3.26)	(-2.94)	(-3.63)
Logarithm of employment 1988	-0.34***	-0.36***	-0.38***	-0.38***	-0.44***	-0.43***
	(-6.54)	(-7.02)	(-6.96)	(-6.93)	(-7.44)	(-8.22)
Specialization index 1988	-0.02	-0.00	0.00	0.00	0.02	0.03
	(-0.76)	(-0.16)	(0.13)	(0.13)	(0.77)	(1.63)
Competition 1988	0.08**	0.10***	0.10***	0.10***		0.12***
	(2.33)	(2.82)	(2.83)	(2.84)		(3.63)
Non-diversity 1988	-0.11***	-0.08**	-0.08**	-0.08**	-0.08**	-0.17***
	(-3.00)	(-2.31)	(-2.16)	(-2.02)	(-2.22)	(-3.31)
Share of the MA in employment of the *maquiladora* industry			0.09**	0.16	0.09**	-0.52
			(2.56)	(1.03)	(2.32)	(-1.01)
Square of the share of the MA in employment of the *maquiladora* industry				-0.06		
				(-0.46)		
Regional effects						
Capital		0.13	0.31	0.35	0.30	
		(0.52)	(1.22)	(1.25)	(1.18)	
Gulf		-0.40**	-0.25	-0.22	-0.26	
		(-2.10)	(-1.21)	(-0.97)	(-1.27)	
Pacific		-0.11	0.04	0.07	0.00	
		(-0.42)	(0.14)	(0.24)	(0.01)	
South		-0.47**	-0.33	-0.30	-0.33	
		(-2.43)	(-1.54)	(-1.28)	(-1.58)	
Central-North		0.05	0.21	0.24	0.19	
		(0.29)	(1.03)	(1.08)	(0.91)	
Center		-0.16	-0.01	0.03	-0.05	
		(-0.92)	(-0.06)	(0.12)	(-0.24)	
Competition deciles						
5					-0.17	
					(-0.76)	
6					0.28*	
					(1.97)	
7					0.31**	
					(2.17)	
8					0.46***	
					(3.50)	
9					0.30***	
					(2.68)	
10					0.43***	
					(2.73)	
MA fixed effects	No	No	No	No	No	Yes
Constant	2.20 ***	2.36***	2.25***	2.20***	2.35***	2.89***
	(9.29)	(8.62)	(8.32)	(7.58)	(8.69)	(10.01)
Observations	825.00	825.00	825.00	825.00	825.00	825.00
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.25	0.27	0.27	0.27	0.28	0.36

E1: without regional effects; **E2:** including regional effects; **E3:** including regional effects and share of the MA in employment of the *maquiladora* industry; **E4**: same regressors as E3 and a quadratic term for share of the MA in employment of the *maquiladora* industry; **E5:** same regressors as E3 but substituting the competition index by dummy variables indicating the competition decile; **E6:** same regressors as E3 but substituting regional effects by MA effects. Variables in the first panel are standardized on the dependent and all independent variables.
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.
Source: Author's estimates using data from the 1989 and 2009 Economic Censuses, INEGI.

[16] Coefficients are standardized on both the dependent and independent variables.

Analyzing whether market conditions (wages) or agglomeration economies (competition and diversity) have a greater impact on economic growth, the results indicate that urbanization economies are more important, since considered jointly, the standardized coefficients of these two variables are higher than initial wages, and as Table 2 shows, their coefficients of variation are equal or greater than that of the wages variable. This indicates that when growing (in terms of employment) in a region, industries give more value to urbanization than wages. However, results are expected to differ by technological intensity groups.

Regarding the variable to control for *maquiladora* industry, the coefficient is positive and significant except when a quadratic term is included (E4) and when fixed effects for the 58 MA are included (E6). That is, the effect of the share of an MA in total *maquiladora* industry employment is absorbed by the particular characteristics of the MA. Additionally, results are consistent with the regional concentration of this industry (located mainly in the northern region) as once a control for the *maquiladora* industry is included, regional effects are no longer significant.

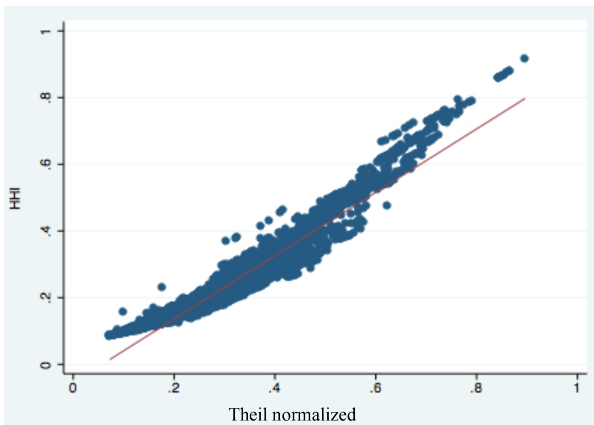
Robustness checks

- Measurement error in the competition variable: Due to confidentiality concerns, when in a municipality the number of firms is as small as to easily identify the firms included, INEGI does not report the number of firms. Therefore, the number of establishments for these cases is considered as cero. Thus, competition is underestimated. This measurement error should not be important since the "cero cases" are indeed of low competition. However, in order to ensure the robustness of the results, equation (4.1) was estimated including dummy variables for each decile of competition (column E5 of Table 3). Results indicate that employment growth rate between 1988 and 2008 increases with each decile of competition, which shows that results are robust.

- Endogeneity due to the use of initial values (1988): Even though econometric specifications in the framework of growth literature use as a control the initial value (see Durlauf, Johnson, & Temple, 2005), in order to ensure exogeneity the dependent variable was changed for employment growth between 1993 and 2008, keeping the initial values for 1988. Results are similar to the ones presented in Table 3.

- Non-diversity indicator: Considering that the inclusion of the non-diversity variable is related to inequality in the distribution of employment in other sectors, following studies such as Paci and Usai (2000) and Van Oort (2007), an inequality index is tested. Other papers use the Gini coefficient to account for non diversity. However, since the normalized Theil index[17] has better properties (is decomposable), this indicator was used in order to assess the robustness of the results obtained using the HHI. As Figure 10 shows, the correlation between both variables is high (0.96). Therefore, results obtained using the Theil index are very similar to the ones obtained using the HHI.

FIGURE 10. CORRELATION BETWEEN THE THEIL INDEX AND THE HHI



Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

- Regional labor markets: In principle, the assumption of a national labor market should not be too restrictive since there were migration flows during this period within the country.[18] In order to assess the validity of this assumption, firstly, regional wages were analyzed using the north as the basis. If the ratios of regional wages against the north did not change much during the period of analysis, the assumption of a national labor market, in which wages growth rates are the same, can be made. However, as Figure 11 shows, this is not the case, since the ratios have changed. In order to evaluate the effect of this assumption on the results, the 2008 wage was included as an independent variable with the purpose of controlling for unequal wage growth. The hypothesis

[17] The normalized Theil index is given by:

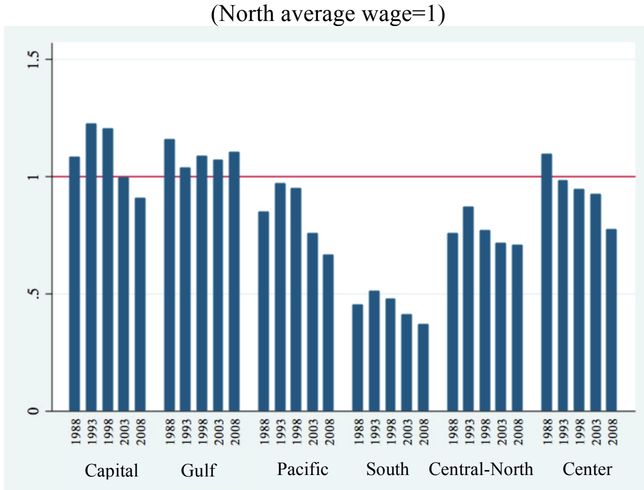
$$T_{ij,T-\tau} = \frac{1}{(I-1)}\frac{1}{\ln(I-1)}\sum_{k\neq i}^{I}\left(\frac{l_{k,j,t-\tau}}{\bar{l}}\right)\ln\left(\frac{l_{k,j,t-\tau}}{\bar{l}}\right)$$

where *(I-1)* is the number of sectors different from the one analyzed. That is, if in an MA 18 sectors are present, *(I-1)=17.*

[18] According to Soloaga, Lara, and Wendelspiess (2010) between 1975 and 2000 approximately 800,000 people migrated on an annual basis between the different states of Mexico. Between 2000 and 2005, this figure was 530,000.

that coefficients were equal to the ones presented in Table 3, could not be rejected in any specification. [19]

FIGURE 11. NOMINAL WAGES BY REGION
(North average wage=1)

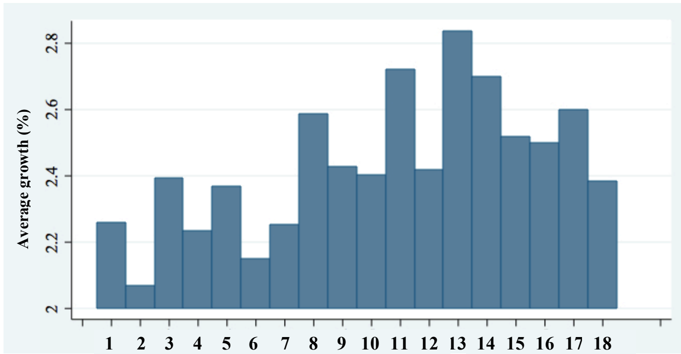


Source: Author's calculations with data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

- Sectoral labor markets: It is important to evaluate the possibility of sectoral labor markets, which is feasible due to the sectoral variability in average wages growth (see Figure 12). Including sectoral interactions with the wages variable in equation 4.1, the results indicate that the effect of initial wages differs by sector and, furthermore, in some medium-high technology sectors these coefficients are positive indicating that some industries tend to grow in locations with higher initial wages. Therefore, it is important to estimate the equation by technological intensity in order to assess whether the effects of market conditions and agglomeration variables, differ across groups.

[19] Furthermore, it is not possible to reject the hypothesis that, in absolute terms, the coefficient of initial wages and final wages is the same, which indicates that the wage variable can be included in the equation in terms of growth rates.

FIGURE 12. SECTORAL AVERAGE WAGE GROWTH 1988-2008



Source: Author's calculations with data from the 1989 and 2009 Economic Censuses, INEGI.

5.1.2 Technological intensity breakdown

As Table 4 shows, results are statistically different for each technological intensity group, at the one percent significance level. It is important to highlight the following results: (1) Wages are only significant in the case of low technology. This group also exhibits Jacobs economies (competition and non-diversity) and, due to the same reasons mentioned in the previous section, the most important factor are these externalities. (2) In the case of medium-low technology, agglomeration externalities are the determinant of employment growth and a combination of Jacobs and Porter economies is present (competition, non-diversity and specialization are significant). (3) For medium-high technology industries, neither market conditions nor agglomeration variables are significant; only controls and MA effects are statistically different from zero. These results indicate that these industries consider other kinds of factors when they decide whether to increase their presence in an MA.

In general, results show that, as expected, low-technology industries are more sensitive to initial wages and agglomeration factors operate differently, depending on technological intensity.

Sectoral regressions[20] were performed, in order to assess the robustness of these results as well as the validity of Glaeser et al. (1992) assumption that agglomeration economies have the same effect regardless of the economic sector. In principle, this assumption is rejected as in a test on the coefficients for 18 sectors, the hypothesis that coefficients are equal across sectors is

[20] Results are not shown here but are available upon request.

rejected. Results are consistent with Table 4, as low-technology sectors, such as food and beverages and textiles, are more sensitive to initial wages, while for higher technology sectors wages effects are negligible.

TABLE 4. SUR ESTIMATES BY TECHNOLOGICAL INTENSITY, $\tau = 20$ (STANDARDIZED COEFFICIENTS)

Dependent variable: MA-industry employment growth	**Low**	**Medium-low**	**Medium-high**
Employment growth of the same industry in the rest of the MAs	0.21***	0.43***	0.23***
	(5.45)	(6.33)	(3.49)
Logarithm of nominal wage 1988	-0.10*	-0.13	-0.03
	(-1.74)	(-1.29)	(-0.27)
Logarithm of employment 1988	-0.73***	-0.77***	-0.52**
	(-9.99)	(-5.39)	(-2.44)
Specialization index of the industry 1988	0.04	0.20***	0.11
	(1.24)	(2.99)	(0.77)
Non-diversity 1988	-0.23***	-0.29**	-0.23
	(-4.36)	(-2.15)	(-0.83)
Share of the MA in employment of the *maquiladora* industry	-1.30*	-0.35	0.46
	(-1.66)	(-0.32)	(1.23)
Competition deciles			
5	-0.52	-0.39	-0.01
	(-1.57)	(-1.27)	(-0.03)
6	0.30	0.91***	-0.23
	(1.58)	(3.46)	(-0.43)
7	0.42**	0.51***	0.13
	(2.24)	(2.66)	(0.30)
8	0.29*	0.88***	0.53
	(1.84)	(4.07)	(1.10)
9	0.01	0.98***	-0.24
	(0.10)	(4.34)	(-0.53)
10	0.21	1.17***	0.68
	(1.36)	(5.15)	(1.46)
MA fixed effects	Yes	Yes	Yes
Constant	4.05***	2.86***	2.98***
	(12.28)	(7.31)	(3.88)
N	433.00	179.00	213.00
p	0.00	0.00	0.08
R^2	0.57	0.64	0.38

Variables in the first panel are standardized on the dependent and all independent variables.
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.
Source: Author's estimates using data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

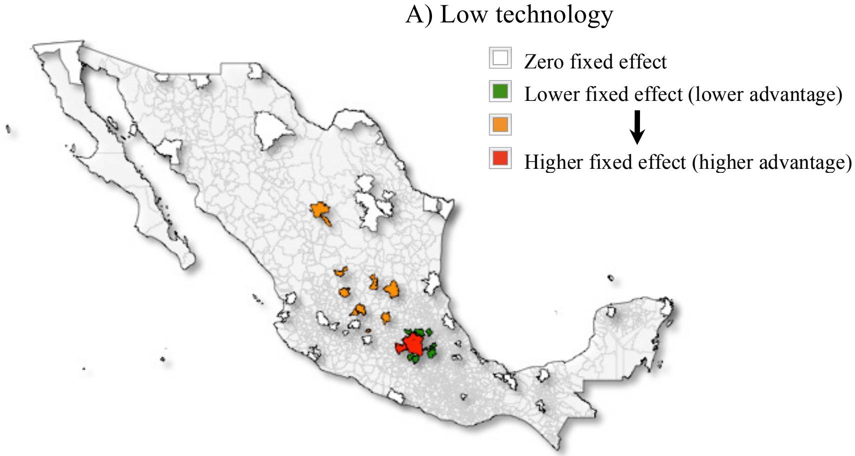
5.1.3 Fixed effects analysis

As Tables 3 and 4 show, even after controlling for market conditions (wages) and agglomeration economies (specialization, non diversity and competition), there still are some regional characteristics (relative advantages or disadvantages), captured by dummies, which affect regional growth. The importance of analyzing these factors stems from their relation with regional infrastructure: a factor that can be corrected or improved (in the case of disadvantages) through public policy.

Figure 13 shows regional fixed effects. In the case of low-technology sectors, as the figure depicts, there are no regions with a relative disadvantage.[21] This makes sense, considering that this kind of industry tend to move easily across regions. In this group of industries a clear regional location pattern is observed, as relative advantages are concentrated in the central region. In the case of the medium-low technology group, regional effects are not significant, indicating that there are neither relative advantages nor relative disadvantages. Finally, medium-high technology industries also show a clear regional pattern with relative disadvantages localized in the southern area of the country. In fact, the south is the region with the highest level of disadvantage.

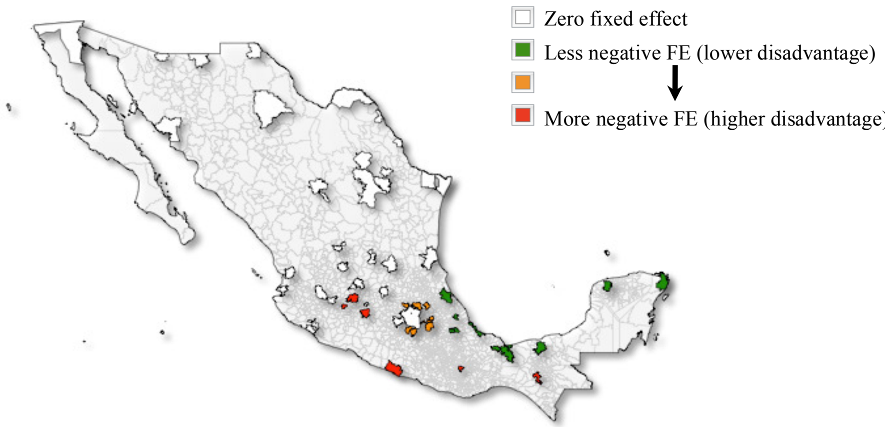
FIGURE 13. REGIONAL FIXED EFFECTS

A) Low technology



[21] The basis is the northern region but the null hypothesis that there are no differences against that region can't be rejected for any other region. Thus, this test can be interpreted as advantage or disadvantage against other regions.

B) Medium-high technology



Source: Author's estimates with data from the 1989 and 2009 Economic Censuses using the results from Table 4.

The only case in which an advantage in low-technology is accompanied by a disadvantage in medium-high technology sectors is the center, a result that reflects the changes experienced by this region in the last twenty years.

Table 5 shows the analysis of how much the non-diversity index should change in regions that exhibit relative disadvantages for employment growth in medium-high technology sectors[22] in order to compensate these negative fixed effects and attract these kinds of industries. For example, the south should reduce its index (become more diverse) in 0.14 to compensate its disadvantage against the Center (the region with the second higher disadvantage); however, that kind of change would imply to achieve a level of diversity comparable with the north, which does not appear to be plausible because that is the leader region, as mentioned before. Thus, there is no agglomeration variable in the equation capable of compensating these relative disadvantages.

The analysis of how the regional disadvantages by technological intensity group correlate at the MA level shows that firstly the correlation between the low-technology and medium-low technology groups is 0.46. However, the correlation between either of these two groups and the medium-high technology group is approximately 0.29. These figures show that relative advantages or disadvantages are more similar in the case of the two lower technological intensity groups.

[22] The non-diversity index was selected because, though it is not significant in the specification shown in Table 4, it is the only significant agglomeration variable in a specification including regional effects.

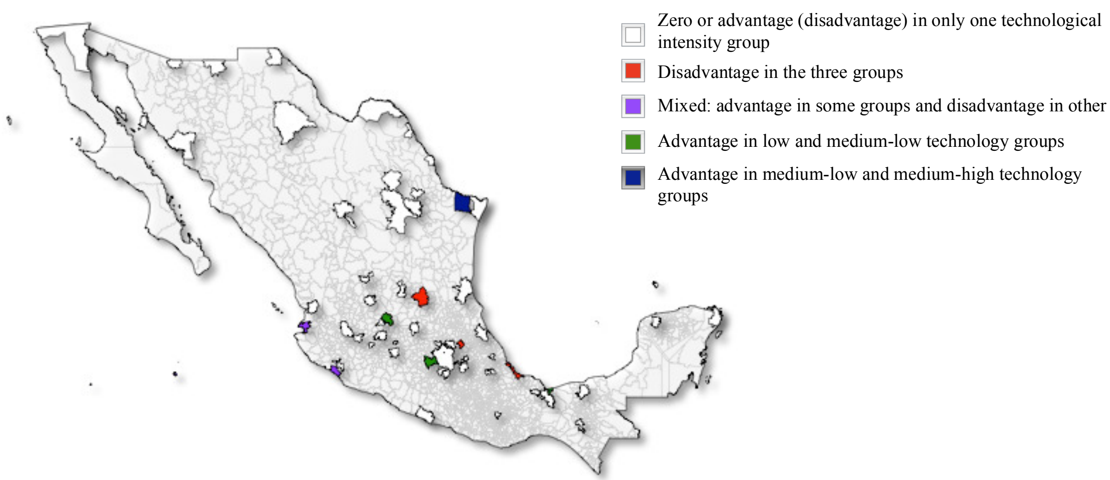
TABLE 5. REQUIRED CHANGE IN THE NON-DIVERSITY INDEX IN ORDER TO COMPENSATE RELATIVE DISADVANTAGES IN MEDIUM-HIGH TECHNOLOGY SECTORS

		Change in the non-diversity index in order to eliminate disadvantages with respect to:		
	Non-diversity index mean	Center	Gulf	Rest
South	0.39	-0.14	-0.17	-0.68
Center	0.24		-0.03	-0.55
Gulf	0.40			-0.52
North	0.25			
Capital	0.11			
Pacific	0.35			
Central-North	0.28			

Source: Author's calculations using estimates similar to the ones presented in Table 4, but including regional effects instead of MA effects. These results are available upon request.

Figure 14 shows a summary of the fixed effects for MAs that exhibit advantages or disadvantages in more than one kind of industry. In this case, the basis is Aguascalientes, but since the difference against this MA is not statistically significant for most of the other MAs results can be interpreted as against the rest. Three MAs have disadvantages for all technological intensity groups: Tulancingo, Rioverde-Cd. Fernandez, and Veracruz. Leon, Toluca and Coatzacoalcos show relative advantages for both low-technology and medium-low technology industries. Finally, only Reynosa-Rio Bravo exhibits a relative advantage for growth in medium-low and medium-high technology groups.

FIGURE 14. SUMMARY OF MA FIXED EFFECTS



Source: Author's estimates with data from the 1989 and 2009 Economic Censuses using results from Table 4.

5.2 Results for $\tau = 5$

5.2.1 Whole sample

The same analysis was performed for $\tau = 5$ but due to the panel structure of the data time effects were included and real wages (2003 prices) were used. As Table 6 shows, results for control variables (logarithm of initial employment, growth in the rest of the MAs) don't change much against the results from Table 3. However, there are changes in the variables of interest; for example, the coefficient of initial wages is still significant, although its magnitude reduces mainly because the variable is in real terms now. [23] Considering the F-test over MA fixed effects, the hypothesis that all coefficients are zero is rejected (column E6 in Table 6).

Regarding agglomeration variables, the conclusion from these results is that Porter externalities are observed (specialization and competition are significant).[24]

Considering which factor has greater effects on industrial growth in an MA (market conditions or agglomeration economies), in this case the conclusion would be different from the one presented in section 5.1.1 as it is necessary to consider how the different independent variables have changed over time. In this case, as Figure 15 shows, real wages are the variable that has changed most in terms of its mean and distribution.[25] Therefore, they are the main determinant of short-term industrial growth.

An interesting and robust result across the different specifications is that time effects show a "v" pattern that reaches its minimum in 2003 and then returns to a value similar to the one of 1998. These parameters could be related to the macroeconomic environment. However, results differ across technological intensity groups and sectors (Table 7), which could indicate that macroeconomic factors do not affect all groups in the same manner.

[23] If nominal wages are used, the standardized coefficient changes from -0.05 in column E1 of Table 6 to -0.09.

[24] As a robustness check, and in order to analyze the effect of the initial period once we control for other realizations of these same variables, the equation was estimated using the dynamic panel methodology developed by Blundell and Bond (1998), and a lag structure similar to the one used by Henderson (1997). Results indicate that controlling for other realizations of the same variables, wage remains as the variable that has more dynamic effects, while in terms of agglomeration economies, the data is consistent with Jacobs economies, similar to what was obtained for $\tau = 20$.

[25] The non-diversity variable also exhibits change in its distribution, but as Table 6 shows it is not significant in the specification that includes MA fixed effects, which are jointly significant.

TABLE 6. RESULTS FOR $\tau = 5$ (STANDARDIZED COEFFICIENTS)

	E1	E2	E3	E4	E5	E6
Employment growth of the same industry in the rest of the MAs	0.25***	0.25***	0.25***	0.25***	0.25***	0.25***
	(9.27)	(9.13)	(9.14)	(9.14)	(9.15)	(-11.70)
Logarithm of nominal wage in *t-5*	-0.05**	-0.06**	-0.06**	-0.06**	-0.04	-0.06***
	(-2.32)	(-2.54)	(-2.54)	(-2.53)	(-1.44)	(-2.46)
Logarithm of employment in *t-5*	-0.20***	-0.22***	-0.23***	-0.23***	-0.30***	-0.38***
	(-7.40)	(-7.63)	(-7.52)	(-7.49)	(-9.19)	(-10.96)
Specialization index in *t-5*	-0.02	-0.01	-0.01	-0.01	0.00	0.04**
	(-1.13)	(-0.62)	(-0.38)	(-0.35)	(0.19)	(-3.10)
Competition in *t-5*	0.01	0.02	0.02	0.02		
	(0.84)	(1.04)	(1.09)	(1.13)		
Non-diversity in *t-5*	-0.08***	-0.07***	-0.07***	-0.06***	-0.06***	-0.03
	(-4.37)	(-3.64)	(-3.73)	(-3.61)	(-3.82)	(-0.84)
Share of the MA in employment of the *maquiladora* industry in *t-5*			0.06***	0.14**	0.16**	-0.07
			(3.46)	(2.26)	(2.56)	(-0.61)
Square of the share of the MA in employment of the *maquiladora* industry in *t-5*				-0.07	-0.09*	
				(-1.41)	(-1.74)	
Regional effects						
Capital		0.10	0.17**	0.20**	0.20***	
		(1.58)	(2.52)	(2.63)	(2.70)	
Gulf		-0.13**	-0.07	-0.05	-0.05	
		(-2.23)	(-1.17)	(-0.70)	(-0.80)	
Pacific		-0.07	-0.01	0.01	-0.00	
		(-0.87)	(-0.14)	(0.13)	(-0.02)	
South		-0.12**	-0.06	-0.04	-0.05	
		(-2.22)	(-1.09)	(-0.61)	(-0.78)	
Central-North		0.02	0.08	0.10	0.09	
		(0.24)	(1.11)	(1.38)	(1.20)	
Center		-0.05	0.01	0.04	0.03	
		(-0.96)	(0.15)	(0.56)	(0.47)	
Time effects						
1998	-0.15***	-0.14***	-0.13***	-0.13***	-0.15***	-0.12***
	(-3.09)	(-2.90)	(-2.81)	(-2.82)	(-3.13)	(-2.90)
2003	-0.34***	-0.33***	-0.32***	-0.32***	-0.33***	-0.28***
	(-6.60)	(-6.46)	(-6.24)	(-6.21)	(-6.17)	(-6.31)
2008	-0.15***	-0.14***	-0.13***	-0.13***	-0.15***	-0.11***
	(-3.36)	(-3.10)	(-2.85)	(-2.85)	(-3.04)	(-2.68)
Competition deciles						
4					0.05	0.05
					(0.58)	(0.61)
5					0.18***	0.17***
					(3.33)	(2.65)
6					0.22***	0.20***
					(4.42)	(3.65)
7					0.22***	0.22***
					(6.32)	(4.30)
8					0.22***	0.22***
					(5.19)	(4.85)
9					0.19***	0.19***
					(4.28)	(3.84)
10					0.15***	0.16***
					(3.19)	(2.93)
MA fixed effects	No	No	No	No	No	Yes
Constant	0.86***	0.90***	0.87***	0.84***	0.93***	1.19***
	(9.15)	(9.16)	(8.90)	(8.71)	(9.63)	(9.24)
N	3587	3587	3587	3587	3587	3587
p	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.16	0.16	0.17	0.17	0.18	0.20

E1: without regional effects; **E2:** including regional effects; **E3:** including regional effects and share of the MA in employment of the *maquiladora* industry; **E4**: same regressors as E3 and a quadratic term for share of the MA in employment of the *maquiladora* industry; **E5:** same regressors as E3 but substituting the competition index by dummy variables indicating the competition decile; **E6:** same regressors as E5 but substituting regional effects by MA effects.

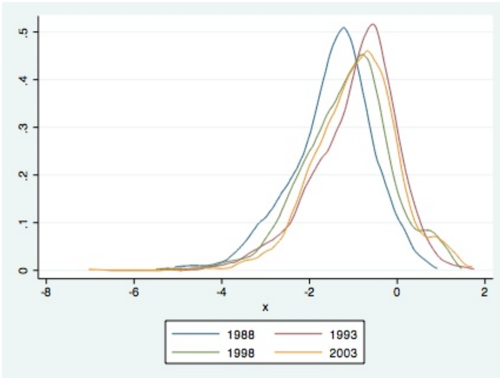
Variables in the first panel are standardized on the dependent and all independent variables.

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

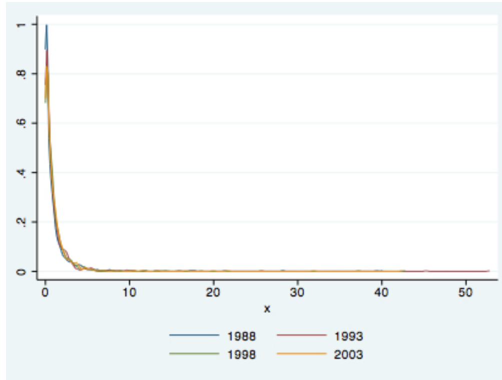
Source: Author's estimates using data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

FIGURE 15. KERNEL DENSITIES OF INDEPENDENT VARIABLES

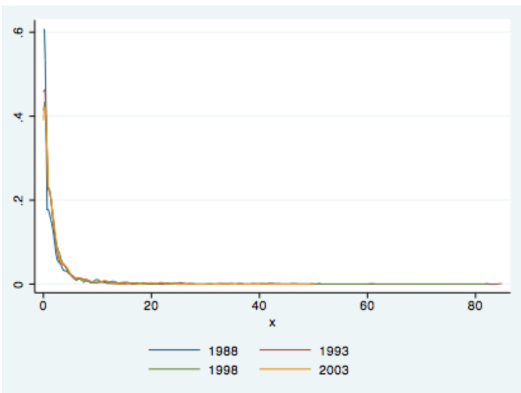
Logarithm of the real wage



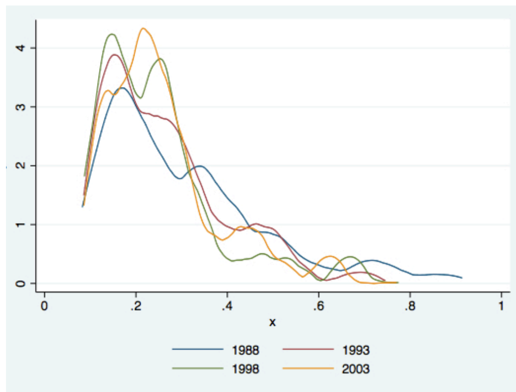
Specialization index



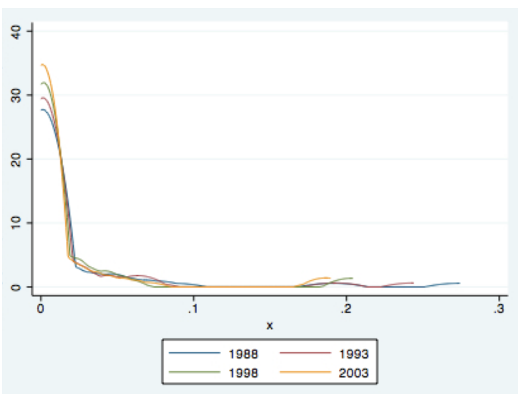
Competition index



Non-diversity index



Share of the MA in the *maquiladora* industry



Source: Author's calculations using data from the 1989, 1994, 1999 and 2004 Economic Censuses, INEGI

Regional and MA fixed effects exhibit a similar pattern to the one analyzed for $\tau = 20$. Although the magnitudes differ due to the inclusion of other dummy variables, the sign and significance of the effects is similar to the results of the larger period. This is an expected result, considering that these fixed effects reflect relative advantages or disadvantages that should not change regardless of the length of the period under analysis.

5.2.2 Technological intensity breakdown

The SUR estimates by technological-intensity group show that once again the null hypothesis that coefficients are equal for the three groups considered is rejected, which indicates that externalities and market conditions operate in a different way depending on technological intensity (see Table 7).

Comparing the results with the ones presented in Table 4, it is important to highlight the following: (1) in the case of low technology, wages remain significant but in terms of agglomeration factors only the non-diversity index is significant, when in the case of $\tau = 20$ Jacobs economies were observed (diversity and competition). (2) For the medium-low technology group, in this case wages are significant and furthermore, their coefficient is higher than the value observed for low technology. For this group, Porter (competition and specialization) externalities appear to be present. (3) For the medium-high technology group, unlike with $\tau = 20$, wages are significant but the coefficient has a positive sign (contrary to what is expected), which could indicate that in the short term (5 years) these industries tend to grow where wages are higher. Regarding agglomeration economies, unlike the case of $\tau = 20$ in which none of the variables were significant, in this case specialization and competition deciles are both significant, and thus consistent with Porter economies.

The equations were estimated by sector and the results show heterogeneity regarding the way market conditions and agglomeration economies operate. In this case, some sectors showed positive coefficients on wages. Considering agglomeration economies, none of the sectors could be classified as MAR, Jacobs or Porter as the variables required for each case were not jointly significant. That is, agglomeration effects are observed, but not in a way consistent with any type of agglomeration economy.

TABLE 7. SUR ESTIMATES BY TECHNOLOGICAL INTENSITY, $\tau = 5$ (STANDARDIZED COEFFICIENTS)

Dependent variable: MA-industry employment growth	**Low**	**Medium-low**	**Medium-high**
Employment growth of the same industry in the rest of the MAs	0.26***	0.39***	0.19***
	(9.40)	(5.63)	(4.50)
Logarithm of real wages in *t-5*	-0.07**	-0.23***	0.15***
	(-2.01)	(-4.27)	(2.70)
Logarithm of employment in *t-5*	-0.39***	-0.58***	-0.76***
	(-6.99)	(-7.70)	(-5.47)
Specialization index of the industry in *t-5*	0.01	0.13**	0.14**
	(0.59)	(2.46)	(1.67)
Non-diversity in *t-5*	-0.08*	0.10	-0.03
	(-1.89)	(1.02)	(-0.32)
Share of the MA in employment of the *maquiladora* industry in *t-5*	0.06	0.17*	-0.36**
	(0.44)	(1.93)	(-2.43)
Time effects			
1998	-0.12**	-0.01	-0.25**
	(-2.38)	(-0.13)	(-2.11)
2003	-0.27***	0.09	-0.49***
	(-4.98)	(1.02)	(-3.43)
2008	-0.10**	0.04	-0.21
	(-2.01)	(0.49)	(-1.59)
Competition deciles			
4	-0.19	0.20*	0.26
	(-1.21)	(1.82)	(1.43)
5	0.08	0.15	0.43**
	(0.88)	(1.35)	(2.11)
6	0.04	0.42***	0.34***
	(0.61)	(4.75)	(2.79)
7	0.08	0.33***	0.20
	(1.26)	(4.17)	(1.39)
8	0.06	0.26***	0.20
	(1.01)	(3.16)	(1.49)
9	0.04	0.31***	-0.01
	(0.59)	(4.26)	(-0.10)
10	-0.05	0.41***	0.13
	(-0.75)	(5.08)	(1.05)
MA fixed effects	Yes	Yes	Yes
Constant	1.33***	1.09**	2.81***
	(8.14)	(5.61)	(6.91)
N	1885.00	782.00	920.00
p	0.00	0.00	0.00
R^2	0.26	0.36	0.21
Chow test of coefficients equality between groups		chi2(48) = 2.1e^{07} Prob > chi2 =	0.0000

Variables in the first panel are standardized on the dependent and all independent variables.
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.
Source: Author's estimates using data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, INEGI.

5.2.3. Determinants of fixed effects

Considering that behind the MA fixed effects, structural conditions particular to each of them should be at work, the effect of these factors was analyzed. Following the growth literature, variables related to human capital, transportation infrastructure (kilometers of highway) that according to Banerjee, Duflo, and Qian (2009) have an important effect on growth, and financial institutions were analyzed. The last variable seeks to control for the services supply in the MA as well as to identify the effect of the financial system depth in the area on its relative advantages for industrial growth. Due to the lack of information regarding the financial system at the municipality level, the number of commercial banks branches was used as a proxy. (See Appendix 4 for the detail of the information used in this analysis as well as the correlations between these variables).

As Table 8 shows, in the case of low-technology industries, only the number of commercial bank branches appears to have an effect on the relative advantage of the MAs, while for the medium-low technology intensity group, human capital (using the number of literate individuals as a proxy) is significant both included separately and along with the other variables. Transportation infrastructure and bank branches, however, are significant considered separately but once we include both variables, bank branches absorb all the effect.

Finally, for medium-high technology industries, even though all variables are significant considered separately, including the three variables (E12) the only one that remains significant is human capital.

These results are consistent with the literature in which industries with a higher technological level should give more weight to human capital as certain abilities are required in order to take advantage of innovation and new technologies.

TABLE 8. DETERMINANTS OF MA FIXED EFFECTS BY TECHNOLOGICAL INTENSITY*

	Low				Medium-low				Medium-high			
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
Share of literate population	0.12			0.09	0.19***			0.12**	0.34***			0.31***
	(1.60)			(1.28)	(3.01)			(2.19)	(4.16)			(3.71)
Km of federal highway		0.04		0.02		0.21**		0.13		0.13**		0.01
		(0.54)		(0.64)		(1.99)		(1.21)		(2.04)		(0.19)
Number of commercial banks			0.18***	0.18***			0.21***	0.14***			0.15*	0.08
			(3.50)	(3.36)			(3.21)	(2.86)			(1.75)	(1.28)
Constant	-0.74	0.09*	0.09**	-0.56	-7.78***	-0.68***	-0.36***	-5.32**	-9.35***	-0.61***	-0.49**	-8.80***
	(-1.41)	(1.67)	(2.11)	(-1.09)	(-3.12)	(-3.15)	(-5.16)	(-2.46)	(-4.53)	(-2.67)	(-2.13)	(-4.09)
N	232	232	232	232	232.	232.	232	232	231	231	231	23100
p	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.15	0.00
R^2	0.13	0.12	0.15	0.15	0.15	0.16	0.16	0.19	0.11	0.02	0.03	0.12

* All estimates include time effects
All variables (except the constant) are standardized on the dependent and all independent variables.
Source: Author's estimates using data from the 1989, 1994, 1999, 2004 and 2009 Economic Censuses, SIMBAD, the 1990 and 2000 Population and Housing Censuses, and the 1995 and 2005 Population Counts, INEGI.

6 Discussion

The analysis of industrial growth from a geographical perspective, which has not received much attention in the economic literature, can contribute to explain country differences in industrialization processes. It also has policy implications, as consideration of the factors influencing firms' decisions about expansion within a region, could lead to the design of more effective policies to attract investment.

In the case of Mexico, the literature on agglomeration economies and the New Economic Geography has focused on transportation costs and trade opening as the crucial factors that explain industrial location patterns and employment growth. However, industrial movement in the last twenty years seems to indicate that additional factors may be at work: Agglomeration economies, market conditions (wages), and even historical or natural relative disadvantages that affect industrial growth at the regional level.

This paper has analyzed the determinants of regional growth by manufacturing sector for the period of 1988-2008. In the long term, the results show that, for the whole sample, urbanization externalities (Jacobs) are the main factor behind industrial growth in a region. That is, industrial diversity in a certain location may create incentives for expanding there. In the short term, however, the main determinant is the initial wage, and the results regarding agglomeration economies indicate that there are Porter externalities. (See Table 9 for a summary of the results)

Applying the same analysis by group of technological intensity and sector, which is the main contribution of this study, there is heterogeneity in the parameters; low-technology sectors are more sensitive to initial wages. Additionally, agglomeration externalities seem to operate in a different way depending on the kind of industry; in general, low-technology sectors exhibit Jacobs dynamic externalities, while high-technology sectors show Porter economies. This means that competition is always beneficial for industrial growth, but low-technology sectors are affected positively by diversity, while high-technology sectors are better off with more specialization. These results are consistent with the idea that high-technology industries require more specific abilities and thus benefit from specialization in the same industry, whereas low-technology industries are directed to more urbanized regions, where their markets are.

TABLE 9. SUMMARY OF EFFECTS

	Wages	Competition	Non diversity	Specialization	Possible kind of agglomeration economies**
Whole sample					
τ=20	-	+	-	0	Jacobs
τ=5	-	+	0	+	Porter
Low technology					
τ=20	-	+	-	0	Jacobs
τ=5	-	0	-	0	-
Medium-low technology					
τ=20	0	+	-	+	Jacobs and Porter
τ=5	-	+	0	+	Porter
Medium-high technology					
τ=20	0	0	0	0	-
τ=5	+	+	0	+	Porter

Source: Author's calculation with data from the Economic Censuses, INEGI

The results for the whole sample are consistent with other studies that favor the existence of urbanization economies, such as Glaeser et al. (1992) for the United States, Van Oort (2007) and Van Stel and Nieuwenhuijsen (2004) for the Netherlands, and Batisse (2002) for China. However, in other studies such as De Lucio et al. (2002) for Spain and Acs et al. (2002) for the United States, the results indicate that there are MAR externalities, even though these last authors focus on high-technology sectors which, as shown in Section 5, analyzed separately, exhibit not urbanization but rather Porter economies (specialization and competition).

The analysis of regional particular characteristics shows that, controlling for market conditions, agglomeration effects, initial conditions and national demand growth, the south, the center, and the Gulf of Mexico have a relative disadvantage for growth in medium-high technology sectors that cannot be compensated by changes in agglomeration variables. This means that there are structural factors that make growth difficult for this kind of industry. Performing this same analysis at the MA level, only one of 58 areas considered shows an advantage for medium-high technology goods. This indicates limitations in the capacity for attracting medium-high technology industries.

Finally, the analysis of fixed effects or relative advantages suggests that additional financial services and transportation infrastructure increase these advantages for low and medium-low technology sectors, with the latter group also affected by the stock of human capital in the MA. However, the only factor capable of reducing disadvantages in medium-high technology sectors is human capital. These results have further policy implications regarding the direction of public investment, depending on the type of industries that a region intends to attract.

This paper is a first approach to the determinants of regional industrial growth, it is important to expand this analysis in different dimensions. First, even though this study incorporates geography through fixed and regional effects, it implicitly assumes that geographical units (MAs) are independent. That is, it does not allow for positive externalities from proximity to other units -what Anselin, Le Gallo, and Jayet (2008) call spatial dependency. It is thus important to extend this work to consider the interaction between different geographical areas. Second, it would be appropriate to replicate this work as a sensitivity analysis for different geographical and sectoral groupings as the effects of knowledge spillovers tend to strengthen as more disaggregated geographical units are used (Van Oort, 2007). Finally, although the OECD establishes different technological intensity groups exogenously, these groups should differ between countries: A high-technology sector for one country could be medium-technology for another, due to the differences in production processes. Taken together, these considerations suggest more complex models in which alternative definitions should be studied.

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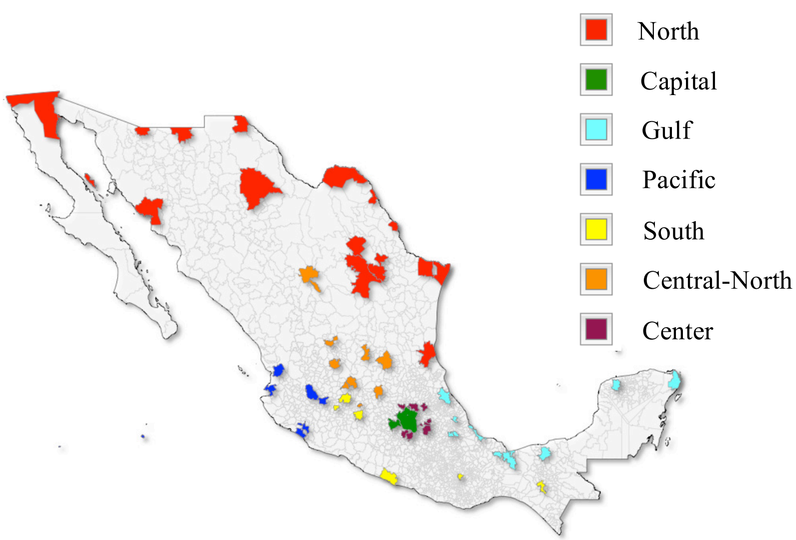
Appendix 1 MAs and regional structure

FIGURE 16. MAS STRUCTURE

Source: INEGI/CONAPO SEDESOL

FIGURE 17. REGIONAL STRUCTURE*



Capital: Distrito Federal and Estado de Mexico; **Center:** Hidalgo, Morelos, Puebla and Tlaxcala; **Central-North**: Aguascalientes, Durango, Guanajuato, Queretaro, San Luis Potosi and Zacatecas; **Gulf**: Campeche, Quintana Roo, Tabasco, Veracruz and Yucatan; **North:** Baja California, Coahuila, Chihuahua, Nuevo Leon, Sonora and Tamaulipas; **Pacific:** Baja California Sur, Colima, Jalisco, Nayarit and Sinaloa; **South:** Chiapas, Guerrero, Michoacán and Oaxaca

*When an MA included two or more municipalities from different states that correspond to different regions, it was classified according to the state that concentrated most of the employment.

Source: Author's calculations using data from INEGI.

Appendix 2 Structure of the 18 manufacturing sectors considered

TABLE 10. STRUCTURE OF THE SECTORS CONSIDERED BY PRODUCT CLASSIFICATION

Sector	1988- CMAP codes	2008-NAICS codes
Food, beverages and tobacco	311, 312, 313 y 314	311, 312
Textile	3211, 3212, 3213	313, 314
Apparel	3214, 3220	315
Leather and footwear	323, 324	316
Wood	331	321
Paper	341	322
Printing	342	323
Oil and coal products	353, 354	324
Transportation equipment	3841, 3842	336
Computer and telecommunication equipment, electronic components and accessories	3823, 3832, 3850	334
Electric apparatus	3831, 3833	335
Machinery and equipment	3821, 3822	333
Chemical industry	351, 352	325 (Except 3254)
Plastic and rubber	355, 356	326
Non-metallic mineral products	361, 362, 369	327
Primary metal manufacturing and metal products	371, 372, 389	331, 332
Furniture and mattresses	332	337
Other industries	3900	339

Source: INEGI

Appendix 3 OECD classification by technological intensity (ISIC rev. 3)

This classification is based on the analysis of Research and Development (R&D) expenses, as well as the production of twelve members of the OECD during 1991-1999. The ISIC REV. 3 and input-output matrices are used.

The classification of manufacturing sectors in high-technology, medium-high technology, medium-low technology and low technology was made after sorting the different industries according to their average for 1991-1999. There were also considered: i) temporal stability, that is, that for adjacent years industries classified under the highest categories had more intensity than the ones classified in the lowest categories. ii) country median stability which means that industries classified to the higher categories have a higher median intensity than those in lower categories.

Even though this classification considers four categories, in the case of high-technology only a handful of sectors appear in this category. Therefore, the two higher technology groups were considered as one:

TABLE 11. PRODUCTS CLASSIFICATION BY TECHNOLOGICAL INTENSITY

Low intensity	Medium-low intensity	Medium-high intensity
Food, beverages and tobacco Textiles Apparel Leather and footwear Wood Paper Printing Furniture and mattresses Other industries	Petroleum and coal products manufacturing Plastic and rubber Non-metallic mineral products Primary metal manufacturing and metal products	Machinery and equipment Transportation equipment Computers and electronics Electric apparatus Chemical products

Source: Author's elaboration with information from the OECD.

Appendix 4 Data used in estimates of the determinants of MA fixed effects

The percentage of people with more than 15 years who is literate was used as a proxy of average human capital in the MA. This variable was obtained from the 1990 and 2000 Housing and Population Censuses, as well as the 1995 and 2005 Population Counts. This information was used to approximate the period required according to the Economic Censuses: The 1990 Population Census was used for the 1988 Economic Census; the 1995 Population Count for the 1993 Economic Census; the 2000 Population Census for the 1998 Economic Census and the 2005 Population Count for the 2003 Economic Census.

Even though from these sources the share of population older than 18 with more than six years of education, this information was not used as this indicator did not appear as such in the Population Counts and the methodology was different. Additionally a correlation between this indicator and the literate population of 78% was found for all the Census and Counts.

In the case of highway infrastructure, the length of federal highways (in kilometers) from the State and Municipal System of Databases (SIMBAD for its initials in Spanish), INEGI. The indicator for the highway network length was also obtained and its correlation with the length of federal highway was of 77%.

Finally, for the indicator of financial services supply, the number of commercial banks branches was used, using also SIMBAD, INEGI as source.

TABLE 12. CORRELATION MATRIX OF VARIABLES RELATED WITH FIXED EFFECTS

	FE low technology	FE medium-low technology	FE medium-high technology	Share of literate population	Km of federal highway	Number of commercial banks
FE low-technology	1					
FE medium-low technology	-0.0285	1				
FE medium-high technology	0.0984	0.1462	1			
Share of literate population	0.0780	0.1685	0.3110	1		
Km of federal highway	0.0494	0.2001	0.1293	0.2857	1	
Number of commercial banks	0.1750	0.1840	0.1471	0.2444	0.3469	1

Source: Author's calculation with data from the 1989. 1994, 1999, 2004 and 2009 Economic Censuses, SIMBAD, the 1990 and 2000 Population and Housing Censuses and the 1995 and 2005 Population Counts, INEGI.

Chapter 2 External Returns to Higher Education in Mexico 2000-2010

1 Introduction

Even though there is consensus regarding the magnitude of private returns to education (approximately 7% to 11% per extra year of schooling for the United States)[26], there is still no agreement on the existence, let alone the magnitude of social returns to higher education and the channels through which they operate (Moretti, 2004a). This paper analyzes the social returns for a developing country such as Mexico,[27] to the best of our knowledge for the first time, and finds that they are significant.

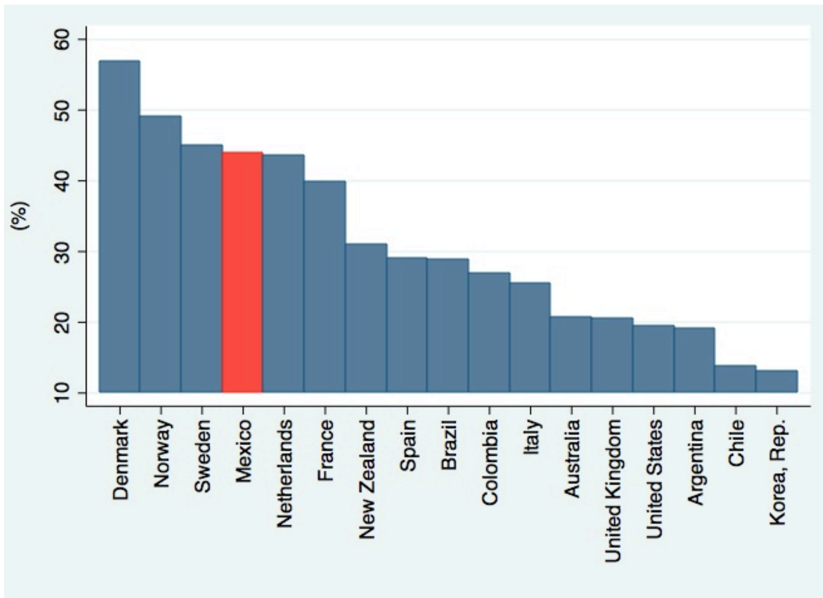
The assumption of social returns to higher education and the externalities generated from direct or indirect interaction with more highly educated individuals is crucial for growth economics and public policy regarding education. Growth theorists like Lucas (1988) argue that, depending on their magnitude, human capital externalities can be considered a determinant of development. Furthermore, many economists such as Mankiw, Romer, and Weil (1992) and Benabou (1996) consider that cross-country income and productivity disparities are the result of differences in the distribution of human capital. According to Goldin and Katz (2008) and Acemoglu and Autor (2012), investments in human capital can play an equalizing role in the context of skill-biased technological change.[28] As Figure 1 shows, public investment per pupil in tertiary education in Mexico represents more than 40% of GDP per capita, a figure comparable with that of developed countries such as Sweden and the Netherlands. Although these public investments in education are significant, there is no quantitative measure of their total return.

[26] Especially during the 90's a great deal of studies for the United States focused on the identification problems (unobserved ability) in the classical Mincerian regressions. One of the most influential papers on this topic is Angrist and Krueger (1991) who use the quarter of birth as an instrumental variable (IV) for education; they argue that the effect of the IV on education is related to compulsory schooling laws. In general, the IV approach for private returns leads to higher returns than the OLS approach. See Card (1999) for a survey of the studies that use institutional factors as instruments to solve the endogeneity problem of education.

[27] In the case of Mexico, previous studies have found private returns to schooling in the range of 8-15%. See Morales-Ramos (2011) for a summary of the different results for Mexico.

[28] If technology is skilled biased, when technological change occurs (demand shifts), it benefits skilled workers increasing inequality between skilled and unskilled individuals. However, if the change is accompanied by steady increases in human capital (supply shifts), inequality can be reduced. Goldin and Katz (2008) regard these competing forces as a "race between education and technology."

FIGURE 1. PUBLIC INVESTMENT IN TERTIARY EDUCATION PER PUPIL AS A PERCENTAGE OF GDP PER CAPITA 2009



Source: World Bank

According to Moretti (2012), if such externalities really exist, they are not reflected in the wages of college graduates, who generate a social benefit for which they are not fully compensated, indicating a market failure. Accordingly, more people would probably earn a college degree if they were paid for the positive externalities they generate.

Recent studies, assessing the existence and magnitude of external returns to higher education, have focused on both the theoretical implications and the empirical problems that arise in estimating such returns. The empirical analyses conducted have found mixed results. Much of the lack of consensus emerges from the econometric difficulties of estimating social returns as well as human capital externalities. As Ciccone and Peri (2006) note, wages can change because of externalities, but could simply be responding to movement along a downward sloping demand curve for human capital: if the change is just a market response, there is no space for policy implications.

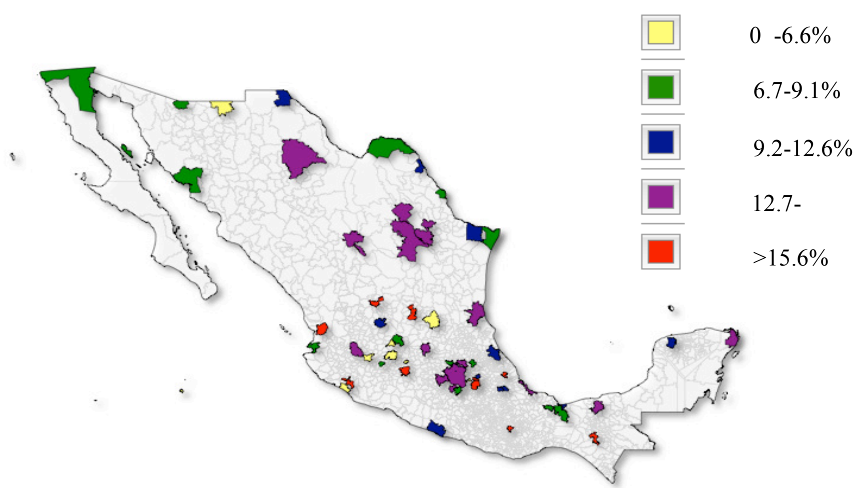
The question has thus inspired research on the identification of human capital externalities. Among the most influential papers are Rauch (1993), Acemoglu and Angrist (2001), Conley, Flyer, and Tsiang (2003), Moretti (2004b, 2004c), Ciccone and Peri (2006) and Rosenthal and

Strange (2008). Most of these papers have focused on developed countries, which have different educational characteristics and labor markets than developing countries. It is therefore important to analyze whether there are differences in human capital spillovers in developing countries.

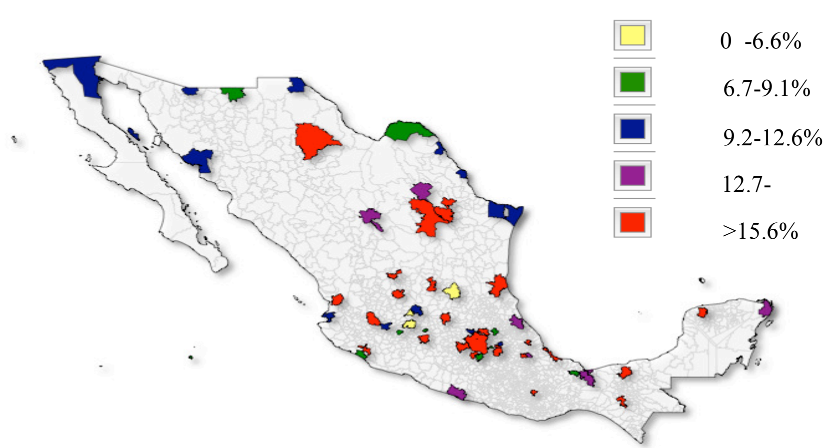
According to census data, in the last decade average years of schooling for Metropolitan Areas (MA) and individuals aged 25 to 66 in Mexico, have increased from 8.7 in 2000 to 9.9 in 2010. In this same period the share of college graduates rose from 13% to 16.5%. Indeed, as Figure 2 shows, most of the MAs have increased their share of college graduates, especially in the central and central-north region, where the proportion of college graduates is now greater than 15% in nearly all MAs. It is therefore of the utmost importance to assess the magnitude of these benefits and determine whether they are assimilated socially or merely privately.

FIGURE 2. PERCENTAGE OF COLLEGE GRADUATES 2000-2010

A) 2000



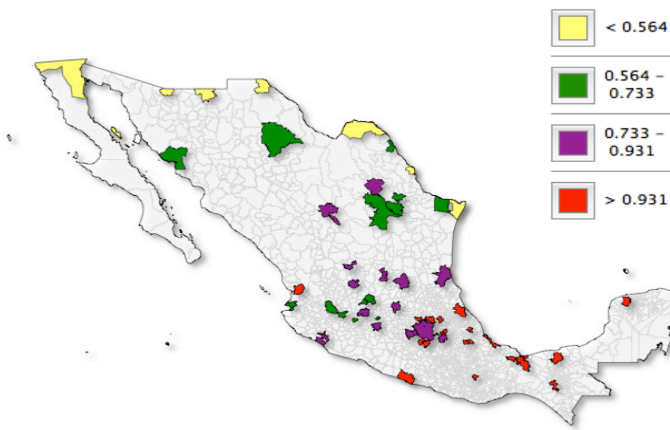
B) 2010



Source: Authors' calculations using data from Mexico's 2000 and 2010 Population and Housing Censuses, INEGI

In the north, it is mainly the border that exhibits less improvement in the share of college graduates. As can be seen in Figure 3, the same applies to the percentage change in average MA wages, controlling for individual characteristics, from 2000 to 2010. That is, there appears to be a direct relation between the change in the share of college graduates and the change in average regression-adjusted wages[29], which is consistent with external returns to higher education.

FIGURE 3. CHANGE IN REGRESSION-ADJUSTED AVERAGE LOG(WAGE) 2000-2010



Source: Authors' calculations using data from Mexico's 2000 and 2010 Population and Housing Censuses, INEGI

Even though these data suggest a clear improvement in terms of education, a static analysis of the figures shows that they are similar to those of the bottom MAs in the U.S, in which the percentage of college graduates ranges from 11% to 17% while in the top MAs it reaches more than 35% (Moretti, 2012). With such a different educational structure, as Table 1 shows for the whole population, Mexico is likely to have a different dynamic than the U.S.

TABLE 1. MEXICO'S EDUCATIONAL STRUCTURE VS. THE UNITED STATES'

	None	1st-6th grade	7th-8th grade	9th grade	Occupational degree	10th-12th grade	Some college or more
Mexico	6.9%	32.9%	3.0%	21.3%	0.7%	15.8%	18.7%
U.S.	0.3%	2.26%	1.53%	1.61%	10.1%	34.9%	49.27%

Source: Mexico's 2010 Housing and Population Census, INEGI.
U.S. Census Bureau, Current Population Survey, 2011 Annual Social and Economic Supplement

29 Average regression adjusted wages are obtained as the MA effect from a Mincerian regression including education, age, age squared, gender and marital status. Although the classical Mincerian equation includes potential experience, which is constructed as E*=age-6-years of schooling, age is used in this case in order to avoid problems with the calculation of this variable especially in the case of people with little education, for whom it is necessary to arbitrarily define an age of entry into the labor market.

This paper analyzes whether, in the case of Mexico, some individuals benefit from the higher level of education (in this case university education) that other individuals receive; in other words, whether there are external returns to human capital. Furthermore, it examines whether these benefits arise or not from externalities.

In order to correctly identify these effects, the ideal experiment would compare the wages of individuals with similar educational level, gender, family background, and other relevant characteristics, in two cities that differ only in average level of education (in this case the proportion of college graduates).

The main contribution of this paper is to analyze the external returns to higher education in a developing country with a college educated population comparable to those of cities of lower educational level in developed countries. The case of Mexico is particularly relevant because it is still in a manufacturing stage with no clear link between college, engineering and innovation; therefore, different magnitudes of social returns and externalities are expected. The empirical strategy is to analyze both the external returns to higher education and the externalities generated by college graduates, using Moretti's (2004b) IV and Ciccone and Peri's (2006) constant composition approaches and comparing the results. This method clarifies the importance of externalities as opposed to market responses.

The paper is organized as follows: section 2 provides a literature review of the empirical studies on social returns to education. Section 3 presents the theoretical model that is used as a basis for empirical estimates. In section 4, the methodology and data are presented. Results are discussed in section 5 and conclusions in section 6.

2 Literature review

As the concepts are essential to understanding the policy implications of the findings presented here, we should start by examining what is meant by social and external returns to higher education. Social returns are the change in average wages due to an increase in the average level of education (in this case, the share of college graduates); external returns are social returns minus the private return. As will be explained later in more detail, external returns are observed if there are human capital externalities, but also in the case of imperfect substitution between skilled and unskilled workers.

According to human capital theory,[30] education generates positive externalities either through technology or prices (pecuniary externalities). In the first case, human capital is included in the neoclassical aggregate production function as a determinant of technology;[31] that is, human capital increases productivity both directly and indirectly. Lucas (1988) argues that external effects are the result of interaction with others as "most of what we know we learn from other people." Following Jacobs (1969), this approach emphasizes the role of cities in the exchange of ideas and thus in economic growth.

In the second case, externalities arise from complementarities between physical and human capital; increased supply of human capital in a city creates incentives for firms to invest in additional physical capital, as there are more people capable of using it. However, since there are costs associated with job matching, unskilled workers end up using more physical capital and enjoying higher wages than similar workers in other cities (Acemoglu, 1996). The difference between these two kinds of externalities is that the first one builds upon the production function in a frictionless context, while the second is the result of microeconomic market interactions. Empirically, both theories lead to similar relationships.

Other positive social benefits of human capital considered in this literature and not directly related to productivity are the reduction of crime rates and improvements in voting behavior. According to Lochner (2004) and Lochner and Moretti (2004) street crimes are reduced as a result of an increase in human capital in a city, while white collar crimes decline less as they can't be committed by uneducated individuals.

As Moretti (2004a) argues, there is still a great deal of research to do in this area, as empirical studies have found mixed results regarding the existence of external returns to higher education. In his view, there are three different empirical approaches in the analysis of human capital spillovers and social returns to education. The first and most commonly used is the Mincerian approach, which basically includes an aggregate measure of human capital in the widely used relationship between individual wages and education. The second approach consists of analyzing plant production functions and directly obtaining the effect of the plant-level stock

[30] It is assumed that human capital affects productivity (Becker 1980) as opposed to being merely a signaling device. In the latter case, an increase in the average human capital in a city would yield negative externalities instead of the positive ones that are tested in the empirical models throughout this paper.

[31] Lucas (1988) includes a specific term for the external effect of human capital in the neoclassical production function and assumes that the technology level is constant.

of human capital on productivity. Finally, since land prices should fully reflect spillovers in a general equilibrium framework, a measure of the spillover could be obtained by comparing housing prices of cities with different levels of human capital, for housing with similar characteristics.

Rauch (1993) represents the first attempt to find quantitative measures of the social return to education under the Mincerian approach. Starting from the Roback (1982) model, he treats the city educational level as a public good, finding social returns for the U.S. of 3-5% in terms of average years of schooling. Acemoglu and Angrist (2001) extend this analysis by using panel data and compulsory schooling laws as an instrumental variable (IV) for average MA schooling and the quarter of birth as an IV for individual schooling in order to solve the problems resulting from unobserved heterogeneity and endogeneity of individual education.[32] They find evidence of modest returns for the U.S. in the range of 1-3%.

Following the previous results, Conley et al. (2003) and Rosenthal and Strange (2008) focus on the geographical scope of these spillovers. The first authors analyze human capital spillovers considering the economic distance between agents measured as travel times between locations and find results consistent with external returns for Malaysia. The other two authors analyze the attenuation of these effects considering concentric rings of influence based on distances and find that a 100,000 increase in the number of individuals with a college degree, generates an upward change in wages in the range of 5-7%.

One of the problems that arise in the estimation of human capital externalities or social returns to education is the difficulty of establishing whether the relation between wages and any measure of average human capital is causal. As Ciccone and Peri (2006) as well as Moretti (2004a, 2004b) explain, it is difficult to assess whether these externalities really exist or if the effects on wages are merely a movement along a downward sloping demand for skilled workers. This is important because policy implications are different depending on the case. If the effect is associated just to demand, everything is working through the market; however, if there are externalities, there is some space for public policy. Paraphrasing Moretti (2012), if people with a college degree could incorporate the social benefits they generate (externalities) into their wages, probably more would earn a college degree.

[32] The use of quarter of birth is based on Angrist and Krueger (1991).

The downward slope of the demand curve is related to imperfect substitution (or complementarity) between skilled and unskilled workers (in a framework of two skill types). In this sense, Moretti (2004a, 2004b) argues that wages of unskilled workers will always benefit from an increase in the percentage of college graduates in a city as two reinforcing effects are at work: imperfect substitution that allows less skilled workers to use more capital in their work, as well as the positive externalities from direct or indirect interaction with more educated individuals. However, the effect for college graduates is ambiguous as there are two opposing forces: the increase in the supply of skilled people pushes their wages downward while the positive externalities of interacting with other college graduates exerts an upward influence on their wages.

Considering these differentiated effects, Moretti (2004b) extends the previous literature by controlling for possible demand shocks and using the MA demographic structure as an IV for the percentage of college graduates. He finds that a one-percentage point increase in the supply of college graduates has an average effect of 1.13% on regression-adjusted average wages for the U.S. By estimating the social return for different educational groups he concludes that part of the effect should be the result of externalities.

Ciccone and Peri (2006) argue that the Mincerian approach fails to identify the externalities generated by a higher supply of more educated people as it cannot separate the effects of externalities and the effects of a downward sloping demand curve for human capital. They propose the constant composition approach, in which the skill composition in an MA is held constant, to identify the effects of these spillovers and find no externalities for the U.S.

Another empirical problem in the estimation of these returns is that it is difficult to establish whether there are unobservable characteristics in the cities that attract highly educated individuals, in which case, there would be inverse causality.

3 Theoretical framework

Following the model presented in Moretti (2004a, 2004b), it is assumed that cities are competitive economies that produce one output good *y* that is traded nationally. The production function is Cobb-Douglas, and uses skilled (S) and unskilled (U) workers, as well as physical capital (K), and includes productivity shifters:

$$y = (\theta_U N_U)^{\alpha_U} (\theta_S N_S)^{\alpha_S} K^{1-\alpha_U-\alpha_S} , \quad (3.1)$$

Where:
N_U = Number of unskilled workers
N_S = Number of skilled workers
θ_j = Productivity shifters, *j=U,S*

Human capital spillovers are included by letting workers' productivity depend on the share of skilled people in the city, $s \equiv N_S/(N_S + N_U)$:

$$\ln(\theta_j) = \phi_j + \gamma \left(\frac{N_S}{N_S+N_U}\right) \qquad j = U,S \quad (3.2)$$

ϕ_j is group-specific and captures the direct effect of own human capital on productivity. Therefore, $\phi_S > \phi_U$.

If spillovers are observed, γ must be different from zero. At equilibrium, considering productivity shifters as given, the effects of an increase in the share of skilled people (*s*) on wages for the two skill groups are:

$$\frac{\mathrm{dln(w}_S)}{\mathrm{ds}} = \left(\frac{\alpha_S - 1}{s}\right) - \left(\frac{\alpha_U}{1-s}\right) + (\alpha_U + \alpha_S)\gamma$$
$$\frac{\mathrm{dln(w}_u)}{\mathrm{ds}} = \left(\frac{1-\alpha_U}{1-s}\right) + \left(\frac{\alpha_U}{s}\right) + (\alpha_U + \alpha_S)\gamma \quad (3.3)$$

where the last term in both equations is the effect of the spillover. As can be seen, in the case of skilled people *(S),* the first two terms are negative, consistent with a downward sloping demand curve. However, due to imperfect substitution between skilled and unskilled workers, the first two terms in the equation for unskilled people *(U)* are positive. That is, unskilled people always benefit regardless of the channel, while the effect on wages of skilled people is ambiguous. Therefore, if positive effects are found for skilled people they indicate the presence of externalities.

In this sense, the external return is defined as the derivative of average wages with respect to the share of college graduates less the private return β (the difference in wages between skilled and unskilled):

$$\frac{\mathrm{dln}(\bar{w})}{\mathrm{ds}} - \beta = s\frac{d\beta}{ds} + \frac{dln(w_U)}{ds} + (\alpha_U + \alpha_S)\gamma \quad (3.4)$$

This equation clearly shows that, on average, external returns can be observed even in the absence of externalities ($\boldsymbol{\gamma} = \mathbf{0}$), as the second term, which represents imperfect substitution, is positive.

4 Empirical Strategy

Two kinds of estimates are used in order to establish the existence of external returns to higher education and determine whether they are due to externalities or are merely supply movements along a downward sloping demand. In this sense, both the Mincerian and constant composition approaches are used.

First, following Moretti (2004b), and due to the cross-section characteristics of the census data, social returns to education are estimated in two stages. In the first, Mincerian equations with city effects are estimated separately for each census:

$$lnw_{ict} = \alpha_{ct} + \boldsymbol{x_{ict}\beta_t} + u_{ict} \qquad t = 2000, 2010 \qquad (4.1)$$

Where:
lnw_{ict} = logarithm of nominal hourly wage of individual i in city c and time t
α_{ct} = Regression-adjusted average city ln(wages)
x_{ict} =Vector of individual characteristics such as education, gender, marital status, age and a quadratic term for age.

Nominal wages are used as a dependent variable because, in a general equilibrium framework such as Roback (1982), prices in general should be reflected in land prices. That is, in a city with greater amenities, wages will be higher, but these amenities will also increase the cost of living. The regression-adjusted city wages are then the estimated average city wages obtained after controlling for individual characteristics.[33]

In the second stage, the estimated city effects $\hat{\alpha}_{ct}$ are used as a dependent variable in a regression analysis against the percentage of college graduates in the city (P_{ct}), a vector of city-time characteristics such as unemployment or demand shocks ($\boldsymbol{Z_{ct}}$), as well as city (d_c) and year effects (d_t).

$$\hat{\alpha}_{ct} = \pi P_{ct} + \boldsymbol{Z_{ct}\gamma} + d_c + d_t + \varepsilon_{ct} \qquad (4.2)$$

[33] In this sense, the regression-adjusted average city wages indicate average wages in a city for single males between 25 and 66 years old.

The parameter of interest in this equation is π, as it represents the return (in terms of wages) of having more educated people in a city.

As mentioned before, social returns to education share most of the econometric problems of private returns, including inverse causality, meaning that high wages attract college graduates instead of wages increasing due to a raise in the percentage of more highly educated individuals. In order to correct for this, following Moretti (2004b) and Ciccone and Peri (2006), the demographic structure is used as an instrumental variable. Additionally, an index of demand shifts proposed by Katz and Murphy (1992) is used in an effort to control for changes in the industrial mix of the cities that could confound the relation between the share of college graduates and nominal wages.[34]

The second-stage equation is estimated in first differences, so the time-constant city specific effects are taken into account implicitly.

4.1 Instrumental Variables

Endogeneity of the percentage of college graduates poses a challenge in the identification of externalities generated by the share of college graduates in a city. Thus, following Acemoglu and Angrist (2001), Moretti (2004b) and Ciccone and Peri (2006), an IV approach is used.

Three variables, based on the demographic structure of the MAs, were tested as instruments. The first one is based on Moretti (2004b) and consists of the 1990 demographic structure, which should be exogenous. This IV builds upon the fact that younger cohorts are more educated, so MAs with a higher proportion of young people in 1990 should have experienced a greater increase in their share of college graduates.[35] It is important to note that this variable is based on

[34] This index is defined as $shock_{jc} = \sum_{s=1}^{S} \eta_{sc} \Delta E_{js}$

Where

$shock_{jc}$ = Predicted employment change of workers from educational group j in city c

η_{sc} = Share of hours worked in sector s in city c in 2000

ΔE_{js} = Change in the ln(hours) worked by group j in industry s nationally

[35] The IV is constructed as follows:

$$IV_c = \sum_{m=1}^{M} \omega_{mc} \Delta P_m$$

Where:

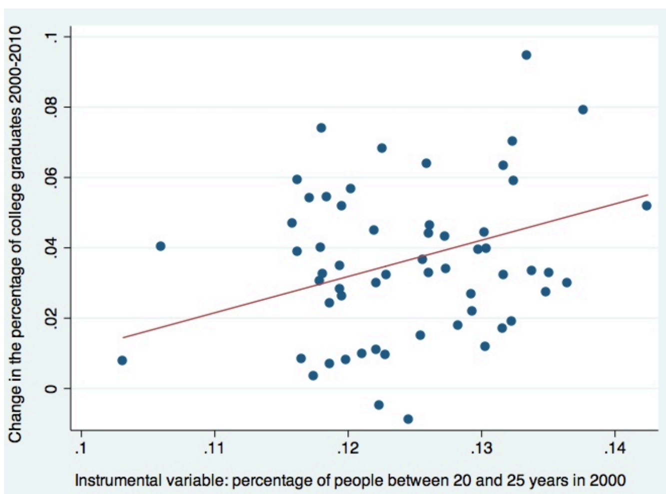
ω_{mc} = Weights in 1990 of the age-gender group m

ΔP_m = National change in the college share for group m 2000 - 2010 the assumption that there is variability in the demographic structure among MAs. However, for Mexico this is not the case. Therefore, it is not possible to use the IV approach introduced by Moretti (2004), as the age structures of the 58 MAs used in this paper are very similar.

The second IV is OLD, and it is calculated as the percentage of people aged 60-65 in an MA, who leave the sample in 2010. Considering that older cohorts received less education, it was expected that this variable would show correlation with the share of college graduates. However, the hypothesis that it was a weak instrument could not be rejected.

Finally, the IV YOUNG is calculated as the percentage of people aged 20-25 in an MA in 2000. This is the cohort entering the sample in 2010 and, as depicted in Figure 4, there is a direct relation between this variable and the share of college graduates in an MA. Accordingly, all tests indicate that this is not a weak instrument.

FIGURE 4. RELATION BETWEEN THE CHANGE IN THE PERCENTAGE OF COLLEGE GRADUATES AND THE INSTRUMENTAL VARIABLE



Source: Authors' calculations using data from Mexico's 2000 and 2010 Population and Housing Censuses, INEGI

In this case, 40 age-gender groups were created from the sample using the 1990 demographic structure as weights. Data from the whole labor force were used.

4.2 Constant-composition Approach

As mentioned before, one of the problems regarding human capital externalities is that they can easily be confounded with neoclassical supply-demand movements that need no government intervention. The approach used by Moretti (2004b) merely allows the identification of such externalities but can say nothing about their magnitude. In order to address this problem, Ciccone and Peri (2006) introduced the constant-composition approach, which also has the advantage of avoiding the need to find instruments for individual schooling.[36]

Under their approach, the effects of externalities are estimated in two steps. In the first, regression-adjusted average wages are estimated for each age-education group in an MA:[37]

$$\boldsymbol{lnw_{ict}} = \boldsymbol{lnw_{ct}(s,a)} + \boldsymbol{x_{ict}\beta} + \boldsymbol{v_{ict}} \tag{4.3}$$

Where:
w_{ict} = hourly wage of individual i in city c at time t
$lnw_{ct}(s,a)$ = log average hourly wage of individuals with schooling s and age a in city c at time t
x_{ict} = vector of controls for marital status and gender

In the second stage, the constant composition logarithms of wages are calculated using the same age-education weights for both 2000 and 2010 ($\boldsymbol{l}_{c,2000}(s,a)$). By doing this, the skill composition of the MAs is held constant and the effects related to a downward sloping demand are eliminated:

$$l\widehat{w}_{c,2010}^{2000} = \sum_{s,a} \widehat{lw}_{c,2010}\,(s,a)\boldsymbol{l}_{c,2000}(s,a)$$

$$l\widehat{w}_{c,2000}^{2000} = \sum_{s,a} \widehat{lw}_{c,2000}\,(s,a)\boldsymbol{l}_{c,2000}(s,a) \tag{4.4}$$

Finally, a regression analysis is performed of the difference of wage logarithms against the percentage of college graduates (for which YOUNG is used as an IV), as well as other city characteristics, an analysis similar to equation 4.2:

$$l\widehat{w}_{c,2010}^{2000} - l\widehat{w}_{c,2000}^{2000} = \pi \Delta P_{c,2010} + \Delta Z_{c,2010}\gamma + \Delta\varepsilon_{c,2010} \tag{4.5}$$

[36] Following Angrist and Krueger (2001) an IV approach is necessary in order to estimate private returns to education in the classic Mincerian equation.

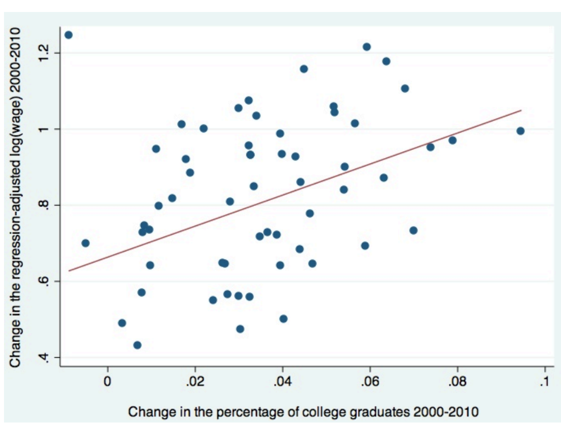
[37] Ciccone and Peri (2006) use potential experience (E*) instead of age. Potential experience is constructed as E*=age-6-years of schooling. However, due to the problems in calculating potential experience (especially in the case of people with little education, for whom it is necessary to arbitrarily define an age of entry into the labor market), education-age groups are used.

4.3 Data and descriptive statistics

The data used in this paper come from microdata of Mexico's 2000 and 2010 Housing and Population Censuses' samples, INEGI. The sample includes employed individuals aged 25-66 who live in any of 58 MAs considered.[38] MAs are chosen as units of analysis, as they are the areas in which an individual lives and works, so knowledge spillovers are more likely to be observed in these geographical units. As Conley et al. (2003) argue, the definition of the geographical area is important, due to the difficulty of characterizing the human capital of the set of agents that interact with each individual.

As can be seen in Figure 5, there is a direct relation between the change in the percentage of college graduates in an MA and the regression-adjusted average wages growth.[39] The same pattern is observed for the different educational groups, although the effects appear to be stronger for college graduates, which is an unexpected result. In the theoretical model the effects of human capital externalities and the supply effects of an increase in college graduates have different signs. A possible explanation for this result could be that human capital externalities are stronger for this group.

FIGURE 5. CHANGE IN THE REGRESSION ADJUSTED AVERAGE LN(WAGE) VS. CHANGE IN THE PERCENTAGE OF COLLEGE GRADUATES 2000-2010.



Source: Authors' calculations using data from Mexico's 2000 and 2010 Population and Housing Censuses, INEGI
The regression-adjusted wage is obtained through two separate regressions for 2000 and 2010 including as regressors years of schooling, age and age squared, controlling for marital status and gender. The sample selected includes individuals with ages ranging from 25 to 65.

[38] The 58 MA are constructed using CONAPO and INEGI's definition. Three additional MAs are included because of the importance of the *maquila* industry and the industrial growth of these areas. See Appendix I for the construction of the MAs.
[39] As can be seen in Figure 5, there is an outlier. This point exhibits little change in the share of college graduates, while its average wage shows a substantial increase.

Table 2 shows the descriptive statistics for the data used in the first-stage estimates.[40] There is a significant increase in the average hourly nominal wage as well as the average years of schooling.

TABLE 2. SAMPLE DESCRIPTIVE STATISTICS

	Mean	Std.	Min	Max
2000				
Hourly wage	21.81	23.33	2.40	176.74
ln(hourly wage)	2.71	0.82	0.88	5.17
Years of schooling	9.47	4.68	0	22
Marital status1	0.74	0.44	0	1
Age	38.13	9.83	25	66
Gender (1=women)	0.33	0.47	0	1
N		974,303		
2010				
Hourly wage	37.91	36.39	3.86	263.94
ln(hourly wage)	3.32	0.76	1.35	5.58
Years of schooling	10.42	4.52	0	24
Marital status1	0.70	0.46	0	1
Age	40.12	10.23	25	66
Gender (1=women)	0.38	0.49	0	1
N		803,508		

Source: Authors' calculations using data from Mexico's 2000 and 2010 Population and Housing Censuses, INEGI.

5 Results

Table 3 presents the results under the Mincerian approach using YOUNG as an instrument for the share of college graduates in an MA. In column (1) no other controls are included, column (2) controls for the change in unemployment in the city and column (3) uses the index of Katz and Murphy (1992) to control for demand shifts. Finally, column (4) includes both unemployment and the Katz and Murphy index.

As can be seen in the first panel, the parameters indicate that a one percentage point increase in the share of college graduates in an MA results in more than a six percent increase in wages over a period of ten years. That is, whatever the cause (externalities or a downward sloping demand), there is an effect from an increase in the supply of college graduates. The magnitude of these results is almost six times that found by Moretti (2004b) for the U.S.

[40] These figures differ from the ones discussed in the introduction because in Table 2, only people who receive a wage are included, rather than the whole population.

TABLE 3. ESTIMATES OF THE EFFECT OF THE PERCENTAGE OF COLLEGE GRADUATES ON THE REGRESSION-ADJUSTED MA WAGES USING THE DEMOGRAPHIC STRUCTURE AS IV

Dependent variable: log difference of the regression-adjusted MA wages				
Whole sample	1	2	3	4
Change in the percentage of college graduates	7.74*	6.44	7.52**	7.35*
	(4.08)	(5.02)	(3.01)	(4.42)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.04	0.16	0.21	0.22
Prob>F	0.000	0.001	0.000	0.000
Less than high school				
Change in the percentage of college graduates	4.18*	1.46	4.47***	2.66
	(2.34)	(2.14)	(1.70)	(2.07)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.26	0.47	0.46	0.57
Prob>F	0.070	0.000	0.000	0.000
High school and occupational				
Change in the percentage of college graduates	4.40**	2.70	4.36***	3.34*
	(2.16)	(2.22)	(1.53)	(1.90)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.10	0.39	0.34	0.47
Prob>F	0.040	0.000	0.000	0.000
Some college				
Change in the percentage of college graduates	4.16*	4.58	4.09*	4.84
	(2.43)	(3.35)	(2.32)	(3.49)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.14	0.15	0.15	0.16
Prob>F	0.000	0.010	0.010	0.020
College graduates				
Change in the percentage of college graduates	7.33***	7.65**	6.90***	7.57**
	(2.50)	(3.49)	(2.10)	(3.15)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	-	-	0.07	-
Prob>F	0.000	0.010	0.010	0.210

Source: Authors' calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

However, transforming the results in order to compare them with that of Rosenthal and Strange (2008) it is found that an increase of 100,000 individuals with a college degree generates changes in average wages of 3%.[41]

According to the theoretical model, less educated individuals should benefit both from externalities and from supply movements along a downward sloping demand. On the other hand, the effect is ambiguous for more educated people, as the increase in the supply of college graduates puts a downard pressure on their wages while externalities generate an upward pressure. Therefore, if most of the effect is due to externalities, the coefficient for more educated people should be positive and significant.

In this case, analyzing the coefficients by educational groups, the results show that there are effects for all the different groups and that the parameters for college graduates are higher than the others, an unexpected result that could indicate that externalities work differently depending on the educational group. Another possibility is that movements along a downward sloping demand, which under this approach are still considered, are heterogeneous between these groups. In this sense, externalities appear to be present, at least qualitatively.

Using the constant composition approach and the variable YOUNG as an instrument for the share of college graduates in order to isolate the effect of knowledge spillovers or externalities, and under the four different specifications of the equation, the change in the percentage of college graduates is positive and significant. However, against the result of Table 3, the parameters reduce to approximately 5% for the whole sample, as can be seen in Table 4. This means that externalities are observed in Mexico and their effects are not the modest ones found in other studies, such as Angrist and Acemoglu (2001) for the U.S.

[41] The sample of individuals aged 25-66 who live in MAs consists of 22,616,641 people and has a weighted mean share of people with college of 16% for 2000. Thus, the number of individuals with college in the sample for that year is of 3.7 million. Hence, a change of one percentage point is equivalent to 227,562 individuals. Considering the parameters from Table 3, a change of 100,000 individuals with a college degree generates an average increase in regression-adjusted wages of approximately 3%.

TABLE 4. ESTIMATES OF THE EFFECT OF THE PERCENTAGE OF COLLEGE GRADUATES ON THE CONSTANT COMPOSITION REGRESSION-ADJUSTED MA WAGES USING THE DEMOGRAPHIC STRUCTURE AS IV

Dependent variable: constant composition log difference of the regression-adjusted MA wages- Whole sample	1	2	3	4
Change in the percentage of college graduates	5.64***	4.34*	5.44***	4.59**
	(2.1)	(2.29)	(1.65)	(2.13)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.11	0.36	0.3	0.43
Prob>F	0.010	0.000	0.000	0.000

Source: Authors' calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

In order to compare the results presented in Table 3 using educational groups with the ones using the constant-composition approach, results are presented in Table 5 for five educational groups, holding the age composition constant for each in all the MAs. Results are consistent with the Mincerian approach and, once again, the coefficients are higher for individuals with college education.

5.1 Robustness checks

As a robustness test, the same equations were estimated for women and the results (not shown here) were very similar to the ones presented in Tables 3 and 4. Additionally, estimations were made excluding Acayucan which, as can be seen in Figure 3, is an outlier that exhibits a low change in the percentage of college graduates while its regression-adjusted average wage shows a high growth rate; the results did not change significantly. Finally, a similar IV to YOUNG, was constructed using data from the 1990 census for people with ages between 10-15 (the same people that would be 20-25 in 2000) and the results did not change much.

TABLE 5. ESTIMATES OF THE EFFECT OF THE PERCENTAGE OF COLLEGE GRADUATES ON THE CONSTANT COMPOSITION REGRESSION-ADJUSTED MA WAGES USING THE DEMOGRAPHIC STRUCTURE AS IV BY EDUCATIONAL LEVELS

Dependent variable: log difference of the regression-adjusted MA wages	1	2	3	4
No education				
Change in the percentage of college graduates	5.48**	3.27	5.66***	3.94
	(2.55)	(2.73)	(2.18)	(2.89)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.21	0.43	0.28	0.43
Prob>F	0.030	0.000	0.020	0.000
Primary school				
Change in the percentage of college graduates	4.93**	2.54	5.04***	3.45
	(2.25)	(2.13)	(1.73)	(2.12)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.25	0.48	0.44	0.56
Prob>F	0.030	0.000	0.000	0.000
7th-9th grade				
Change in the percentage of college graduates	4.83*	2.75	4.85***	3.76
	(2.76)	(2.91)	(1.85)	(2.40)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	.	0.32	0.28	0.41
Prob>F	0.080	0.000	0.000	0.000
10th-12th grade				
Change in the percentage of college graduates	4.90***	4.18*	4.62***	4.24**
	(1.83)	(2.20)	(1.42)	(1.83)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.10	0.25	0.30	0.36
Prob>F	0.010	0.000	0.000	0.000
College or more				
Change in the percentage of college graduates	6.31***	6.61**	6.05***	6.75**
	-2.11	-3	-1.81	-2.79
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.0	.	0.2	.
Prob>F	0.000	0.000	0.000	0.000

Source: Authors' calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

In order to test the robustness of the results regarding demand shifts, the constant composition approach was extended in order to account for the possible demand shifts directly in the dependent variable.[42] Therefore, the change in wages was calculated holding the age-education-sectoral composition constant. As Table 6 shows, results are similar to the conventional constant composition approach (Table 4). Thus, the original model is controlling well for demand shifts.

TABLE 6. ESTIMATES OF THE EFFECT OF THE PERCENTAGE OF COLLEGE GRADUATES ON THE CONSTANT COMPOSITION REGRESSION-ADJUSTED MA WAGES USING THE DEMOGRAPHIC STRUCTURE AS IV

(SECTORAL CONSTANT COMPOSITION)

Dependent variable: constant composition log difference of the regression-adjusted MA wages- Whole sample	1	2
Change in the percentage of college graduates	5.78***	4.08*
	(2.12)	(2.28)
Change in unemployment	No	Yes
N	58	58
R^2	0.07	0.39
Prob>F	0.010	0.000

Source: Authors' calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

5.2 Sectoral results

Table 7 shows the sectoral breakdown of external returns. In this case the methodology proposed by Moretti is used, as holding the skill composition constant for each sector is too restrictive.

In the case of agriculture and mining the change in the share of college graduates in an MA is only significant in one out of the four specifications. That is, wages of workers in this sector are not affected by their interaction with more educated individuals. A possible explanation for

[42] Instead of equation III.3 we estimate:

$$lnw_{ict} = lnw_{ct}(s,a,k) + x_{ict}\beta + v_{ict}$$, where

$lnw_{ct}(s,a,k)$ = log average hourly wage of individuals with schooling s and age a working in sector k in city c at time t .

In the second stage, the logarithms of wages are calculated as a weighted mean, using as weights the share of each schooling-age-sector group for each city: $l\widehat{w}_{c,2010}^{2000} = \sum_{s,a,k} \widehat{lw}_{c,2010}(s,a,k)\boldsymbol{l}_{c,2000}(s,a,k)$

this result is that tasks performed in this kind of activity may not be subject to productivity improvements as a result of an increase in the share of college graduates in a city.

Other sectors, mainly manufacturing and services have coefficients close to the ones presented for the whole sample (between 4.5 and 6%).

TABLE 7. ESTIMATES OF THE EFFECT OF THE PERCENTAGE OF COLLEGE GRADUATES ON THE REGRESSION-ADJUSTED MA WAGES USING THE DEMOGRAPHIC STRUCTURE AS IV
SECTORAL BREAKDOWN

Dependent variable: log difference of the regression-adjusted MA wages				
Agriculture and mining	1	2	3	4
Change in the percentage of college graduates	3.16	1.62	3.34*	2.36
	(2.36)	(3.09)	(1.93)	(2.90)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.26	0.27	0.34	0.33
Prob>F	0.180	0.040	0.020	0.000
Manufacturing				
Change in the percentage of college graduates	5.77**	3.78	5.94***	5.08**
	(2.55)	(2.60)	(1.61)	(2.03)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.12	0.4	0.36	0.46
Prob>F	0.020	0.000	0.000	0.000
Trade (wholesale & retail)				
Change in the percentage of college graduates	4.65**	2.36	4.62***	2.85
	(2.30)	(2.33)	(1.78)	(2.17)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.24	0.49	0.42	0.55
Prob>F	0.040	0.000	0.000	0.000
Finance & insurance				
Change in the percentage of college graduates	6.14*	5.69	5.86**	6.23
	(3.40)	(4.71)	(2.60)	(3.84)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	.	.	.	.
Prob>F	0.070	0.010	0.010	0.010
Other services				
Change in the percentage of college graduates	5.32**	4.08*	5.43***	4.91**
	(2.17)	(2.28)	(1.72)	(2.15)
Change in unemployment	No	Yes	No	Yes
Katz & Murphy demand shocks variables	No	No	Yes	Yes
N	58	58	58	58
R^2	0.16	0.39	0.31	0.39
Prob>F	0.010	0.000	0.000	0.000

Source: Authors' calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
* Significant at the 10 percent level. ** Significant at the 5 percent level. *** Significant at the 1 percent level.

5.3 Externalities and regional inequality

In order to assess the regional equalizing role of external returns (i.e. important changes in the skill mix of individuals in a city), the change in the share of college (keeping control variables at their real levels) that cities with regression-adjusted average wages below the median would have required in order to reach the median in 2010 was calculated.

Results indicate that the MA with the lowest wage level (controlling for individual charactersitics) needed an increase of 17 percentage points in its share of college graduates in order to reach the median MA wage level (see Table 8). Comparing this figure with the highest change in the percentage of college graduates registered by an MA (9.2 percentage points), such a change does not appear to be plausible. As the table shows, the MAs did not even reach 50% of the change required, holding other variables constant, in order to achieve the median regression adjusted wage for MAs.

TABLE 8. CHANGE IN THE SHARE OF COLLEGE GRADUATES 2000-2010 REQUIRED TO REACH THE MEDIAN REGRESSION-ADJUSTED AVERAGE WAGE VS. REAL CHANGE

Metropolitan Area	Required change	Real change
Orizaba	17.23	6.38
Poza Rica	17.05	5.94
Cordoba	16.30	4.49
Apizaco	16.08	2.99
Tlaxcala	15.81	3.40
Tulancingo	14.92	1.70
San Martin Texmelucan	14.90	2.20
Minatitlan	14.61	5.66
Xalapa	14.60	6.82
Acayucan	14.36	-0.88
Merida	14.18	5.17
Tuxtla	14.02	5.19
Acapulco	13.97	3.24
Tula	13.84	3.23
Cuautla	13.66	1.11
Puebla-Tlaxcala	13.30	4.30
Pachuca	13.21	3.96
Oaxaca	12.63	7.90
Tampico	12.31	5.42
Veracruz	12.19	4.00

Source: Authors' calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.

6 Discussion

Even though external returns to higher education are crucial for growth theory and public investment on education, there is still little agreement regarding their existence and even less on their precise nature. That is, it is not clear whether they are due to market conditions or to externalities generated by direct or indirect interaction with more educated individuals.

Most of the literature has focused on developed countries, which have an entirely different educational structure from developing economies, with mixed results.[43] Thus, it is important to analyze whether similar results are obtained for developing countries, as well as to determine the nature of these returns, in order to consider the different policy implications.

This paper addressed these issues by using the Mincerian and constant composition approaches, instrumenting in both cases for the share of college graduates in an MA with its demographic structure. The results indicate that external returns to education are found in all the different specifications used in the analysis. A one percentage point increase in the share of college graduates in an MA results in more than a six percent increase in regression-adjusted average wages. This magnitude is much higher than that of Moretti's (2004) finding for the U.S. (1.13%) but highly consistent with the results of Rosenthal and Strange (2008).

An unexpected outcome of this analysis is that the parameters are higher for college graduates, while according to the theoretical model, the effects should be ambiguous for this kind of worker. A possible explanation is that externalities have different effects depending on the educational level. Another alternative that could lead to these results, and that should be further analyzed, is the case of a segregated distribution of skills in which individuals with very different educational background do not interact much. Theoretically, we could consider a continuum of agents located along an interval of the real line where skilled and unskilled individuals could either locate uniformly along the inverval or divide into segments of skilled and unskilled people.[44] In this kind of framework the relevant variable for each individual in the productivity shifter (equation 3.2) would no longer be the share of college graduates in the city but a function $\rho(c)$, that indicates the proportion of skilled people that individual c works with. Thus, for

[43] Conley et al. (2003) calculate social returns for Malaysia, which is a developing country, but as can be seen in their descriptive statistics, the average share of college graduates in that country is much higher that the one observed in Mexico.

[44] See Mookherjee, Napel, and Ray (2010) for an example of segregated settings.

unskilled individuals, the proportion of college graduates in a city would be much higher than the one he really observes.[45] In this context, the equalizing role of human capital is not clear.

Contrary to what Ciccone and Peri (2006) find for the U.S., in the case of Mexico, human capital externalities are significant. In this sense, there appears to be space for public policies aimed at enhancing these positive externalities (incentives for college studies), which are consistent with the standard public finance analysis.

Further analysis is required in order to identify the sources of these externalities. For example, Mexico, unlike the U.S., is not involved in a process in which clusters of college graduates are drivers of the whole country's productivity. Therefore, it is important to assess the effects of different kinds of occupations, which pose the challenge of finding appropriate instruments.

From the geographical perspective, this paper assumes that MAs are the best units for the analysis of knowledge spillovers, that is, that individuals live and work in an MA, and all the interactions that could generate positive human capital externalities take place in this area. Thus, it is important to test whether these results hold under alternative geographical definitions, as well as to allow for the possibility of commuting between locations.

Finally, it is important to consider that these results are based on a one generation model: more highly educated individuals only affect people of the same generation. However, in a more comprehensive analysis based on development theory, the interaction with more educated individuals could have intergenerational effects through changes in aspirations regarding future generations. The exchange of ideas could broaden what Ray (2006) regards as the aspiration window, allowing parents to expect more from their children, which in turn will generate wage benefits for the next generation.

[45] Additionally, in this case the conclusion that pecuniary externalities and technology externalities lead to similar empirical results does not longer hold. As pecuniary externalities work mainly through prices, they would still have the same effects even though less skilled individuals do not interact much with skilled people.

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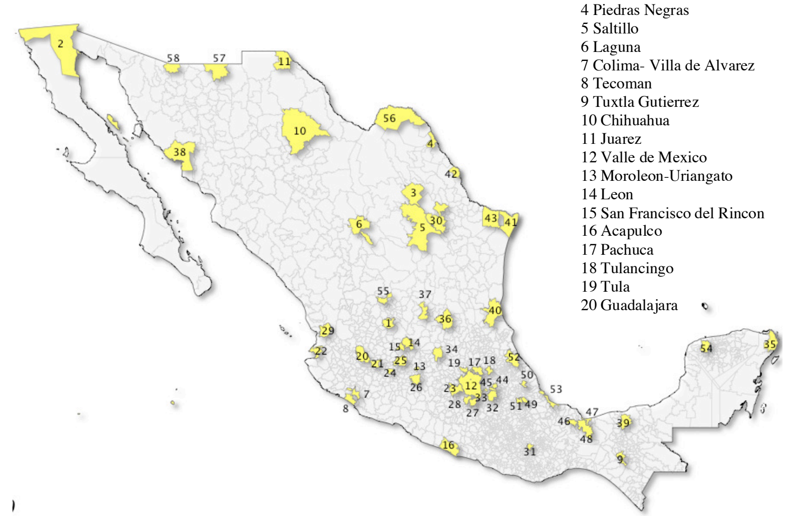
Appendix 1. MAs considered in the analysis

FIGURE 6. MAS STRUCTURE



1 Aguascalientes
2 Tijuana
3 Monclova-Frontera
4 Piedras Negras
5 Saltillo
6 Laguna
7 Colima- Villa de Alvarez
8 Tecoman
9 Tuxtla Gutierrez
10 Chihuahua
11 Juarez
12 Valle de Mexico
13 Moroleon-Uriangato
14 Leon
15 San Francisco del Rincon
16 Acapulco
17 Pachuca
18 Tulancingo
19 Tula
20 Guadalajara
21 Ocotlan
22 Puerto Vallarta
23 Toluca
24 Zamora-Jacona
25 La Piedad
26 Morelia
27 Cuautla
28 Cuernavaca
29 Tepic
30 Monterrey
31 Oaxaca
32 Puebla-Tlaxcala
33 San Martin Texmelucan
34 Queretaro
35 Cancun
36 Rioverde-Ciudad Fernandez
37 San Luis Potosi-Soledad Graciano Sanchez
38 Guaymas
39 Villahermosa
40 Tampico
41 Matamoros
42 Nuevo Laredo
43 Reynosa-Rio Bravo
44 Apizaco
45 Tlaxcala
46 Acayucan
47 Coatzacoalcos
48 Minatitlan
49 Cordoba
50 Xalapa
51 Orizaba
52 Poza Rica
53 Veracruz
54 Merida
55 Zacatecas-Guadalupe
56 Acuña
57 Agua Prieta
58 Nogales

Source: Authors' elaboration with information from INEGI/CONAPO SEDESOL

Chapter 3 Local Multipliers and the Informal Sector in Mexico 2000-2010

1 Introduction

Every time new jobs are created, they have further effects in the economy due to the fact that newly employed individuals increase their expenditure and thus, stimulate other industries. That is why these so called multiplier effects are taken into account in the evaluation of economic crises recovery plans (See Romer & Bernstein 2009).

As Moretti (2010) argues, this same process occurs at the local level when new businesses are attracted, increasing local demand for goods and services; even though this indirect job generation is partially offset by general equilibrium effects induced by local wages and nontradable prices increases.[46] The value of this multiplier is important for regional development and for public policy, as local governments grant incentives for firms to locate in a given city and the knowledge of these figures can help to better target these efforts or gauge its appropriateness. Additionally, as this same author notes, local multipliers provide bounds for national multipliers.

Considering the negative case, as Black, McKinnish and Sanders (2005) mention, when a firm closes there is concern regarding expected jobs losses. Therefore it is important to have a measure of indirect jobs created (or lost), which according to Moretti and Thulin (2013) has a great variation across industries and types of jobs. In the case of the U.S., the results obtained by Moretti (2010) indicate that whenever a job is created in the tradable sector 1.6 nontradable jobs arise, but a much higher multiplier is observed when only skilled jobs are considered.

In the case of a developing country, such as Mexico, it is not only important to assess the magnitude of the multipliers, but the quality of this indirect job creation, as informality is a widely observed phenomenon in this kind of countries and, as Maloney (2004) argues, most of it occurs in the nontradable sector. According to Mexico's National Institute of Statistics and Geography (INEGI), more than 60% of national employment belongs to the informal sector. Informal jobs represent a lower tax collection and more expenses (e.g. the Seguro Popular in the case of Mexico, which grants medical insurance for informal and unemployed individuals) on the government's side, while on the workers' side it represents concerns regarding job security, as

[46] In most theoretical models based on Rosen (1979) and Roback (1982) these nontradable prices are mainly housing prices as this sector is included along with firms and consumers (workers).

well as a higher vulnerability to labor market shocks. As Loayza and Sugawara (2005) point out, informality is not only a sign of underdevelopment but may be the source of further retardation.[47]

This paper estimates the local multiplier for Metropolitan Areas (MAs) in Mexico between 2000 and 2010; that is, nontradable jobs created as a result of new tradable jobs. It also analyzes the role of skilled and unskilled tradable jobs in this process as well as the effects by technological intensity. Furthermore, it assesses whether indirect creation of employment is focused on the formal or the informal sector. In this sense, its main contribution and departure from previous literature is to analyze informality in the framework of the local labor markets literature, which allows assessing the quality of local job creation.

In order to correctly identify these effects, the ideal experiment would be to have two otherwise similar cities and compare jobs creation after the establishment of a new tradable firm in one of them. However, as commonly observed in non-experimental empirical analysis, the problem with these multipliers' estimation is that there is no counterfactual to whether the firms decided to locate elsewhere. Hence, it is difficult to assess whether nontradable employment grew in a region as a consequence of this new firm or if nontradable employment would have grown anyway. Therefore, as Delgado, Porter and Stern (2005) argue it is important to account for convergence (or divergence) in these empirical exercises. Additionally, in order to address the problems generated by unobserved shocks to nontradable employment that also affect tradable employment, an instrumental variables (IV) approach is used.

The paper is organized as follows: section 2 presents the conceptual framework that supports the predictions of local multipliers. Section 3 provides a literature review of both theoretical and empirical studies on local multipliers as well as on articles regarding informality. In section 4, the methodology is presented. Section 5 explains the data used in the analysis as well as some descriptive statistics. Results are discussed in section 6 and conclusions in section 7.

[47] In their empirical analysis these authors find negative effects of informality on economic growth.

2 Conceptual framework

2.1 Local multipliers

Following Moretti (2010), Moretti (2011) and Moretti and Thulin (2013) and starting from the Rosen-Roback spatial equilibrium model, which is regarded by Glaeser (2009) as the workhorse of spatial economics, it is assumed that each locality is a competitive economy that produces nationally traded goods, which prices (considered as a numeraire) can't be affected locally; as well as nontradable products, which prices are determined locally. Labor is perfectly mobile across sectors within a city. Therefore, marginal product equals wages within the locality.

In general, these models use the Cobb-Douglas specific functional form for the production function. It is also common to assume that workers are heterogeneous, considering skilled and unskilled workers.[48] The first group of workers is expected to receive higher wages ($w_s \geq w_u$).

On the workers' side, their utility function depends on their wages less their housing and consumption expenses. Moretti (2011) includes idiosyncratic preferences for location in order to have an upward sloping labor supply against the standard model in which labor mobility is perfect and supply is infinitely elastic.[49]

The sector that closes the model is housing, or the nontradable sector in models such as Glaeser and Gottlieb (2009), which is assumed to have an upward sloping supply.

All of these models predict that when an exogenous variable impacts traded goods productivity, such as the establishment of a new firm, the number of workers in the city increases, as well as wages and housing prices.

In the case of the tradable sector, which price is not determined locally, it is not clear whether it generates other jobs besides the ones directly associated with the shock, because it depends on general equilibrium effects, as well as on the linkages between the different industries that compose this sector. First, as predicted by the model, wages rise, generating a cost increase for other tradable firms that cannot be compensated through prices increases. Therefore, employment in other parts of the tradable sector may experience reductions, due to the loss of

[48] In this kind of models, as mentioned in Chapter 2, imperfect substitution between skilled and unskilled workers can be included as an assumption.

[49] This assumption is related to the spatial equilibrium assumption, which requires utility to be equalized across locations. As Moretti and Thulin (2013) mention, including idiosyncratic preferences about location generates more realistic equilibrium conditions, as utility needs not to be the same for all individuals in all locations, it is just equalized for marginal workers and not for inframarginal.

competitiveness. Second, if traded industries have strong backward and forward linkages or agglomeration economies are important, it is possible that the demand shock generates an increasing demand for intermediate goods and thus a positive multiplier of tradable goods over other tradable goods. In the case of agglomeration economies, as Greenstone, Hornbeck and Moretti (2010) show, the demand shock could enhance agglomerations.

For the nontradable sector, which is the most interesting analysis because, as Glaeser (2008) points out, cities are increasingly oriented around this sector, particularly in the case of business services, requiring a higher level of interaction with other people, as the city has more workers with higher wages, the demand for nontradable goods (mainly services such as restaurants, medical services, dry-cleaning, haircuts, etc.) increases.

As Moretti (2010) explains, the magnitude of these effects depends on several factors. First, consumer preferences regarding nontradable products; if consumers (workers) have strong preferences for nontradable goods the multiplier will take a higher value. Second, tradable goods production technology; if the demand shock occurs in a sector that is labor intensive, the direct effect on the number of workers will be higher and, thus, their demand for nontradables will be higher, resulting in a larger multiplier. Third, the type of new jobs; as mentioned before, skilled workers receive higher wages, so if the share of skilled workers is higher in the industry in which the demand shock occurs, a larger multiplier is expected. Finally, general equilibrium effects on wages and local housing prices could partially offset the positive effect on nontradable products; as wages increase, local services costs are also higher, generating a decline in the supply of services (a partial crowding out on the nontradable sector) that also depends on labor supply elasticity.

Regarding the relation of these local multipliers with the national multipliers that as Moretti (2010) argues are crucial elements in countercyclical stimulus policies, this author mentions that tradable multipliers are a lower bound for national multipliers while nontradable multipliers can be interpreted as the upper bound.

2.2 Informal sector models

Even though informality models vary in their assumptions, their predictions regarding the effects of demand shocks in the tradable (mostly formal) sector on informality are similar. As will be explained in more detail later, there are two opposing lines of research regarding the causes of informality, one that considers that it arises from a segmented market, and a second that assumes that it consists of a voluntary decision in the context of integrated markets.[50]

Under the theoretical strand that considers a segmented market, Rauch (1991) constructs a model based on the concepts of labor market dualism and size dualism in which there is a minimum wage that is only enforced for firms with a certain size (formal). The size of the firms is based on the distribution of entrepreneurs' talent or managerial skills. The model's assumptions result in an endogenous choice between the formal and the informal sector. In this framework, increases in the formal sector wage, such as the ones induced by tradable demand shocks or efficiency wages, result in increases in the differential between formal and informal wages.[51] This higher differential causes a higher supply of workers seeking the higher formal wages, as well as a lower labor demand in the formal sector and thus, increases the size of the informal sector. Considering the higher demand for nontradable products, depending on entrepreneurs' skills (determinant of firms' size), some of the firms responding to this demand will be informal. Therefore, a higher proportion of untalented managers will increase the size of the informal sector. Fortin, Marceu and Savard (1997) generalize this model by including taxes besides minimum wages and assuming a cost function for informal firms, which is directly related to the risk of being caught in tax evasion and not complying with minimum wages. Under these assumptions a demand shock in the tradable sector that increases wages, may force small formal firms (either tradable or nontradable) to go into the informal sector due to the higher labor costs.

Models such as Straub (2005) go further on the firms' perspective. In particular, this model analyzes the decision of being formal or informal in an investment framework with credit constraints, moral hazard and entry costs into formality. The model assumes that it is possible to verify the results of an investment project in the case of formal firms, ensuring repayment, while it is not possible to do so for informal firms, so lenders end up using coercion mechanisms to avoid default. Under this kind of model, the response of informality to demand shocks depends on the efficiency of credit markets as small firms seeking to take advantage of the higher

[50] See Esquivel and Ordaz-Díaz (2008) for a discussion regarding these two theoretical approaches.
[51] Under this approach, for similar individuals, wages in the formal sector are higher than the ones of the informal sector.

nontradable demand may prefer becoming informal to avoid entry costs and because they face credit rationing.

Finally, considering the line of research that starts from an integrated labor market, where individuals optimally decide whether to work in the informal sector or in the formal sector, under a life-cycle framework just as the one mentioned in Maloney (2004), the increase in wages generated by the demand shock in the tradable sector, provides incentives (capital) for employees to become entrepreneurs and move to the informal sector. Also, as Levy (2008) argues, under this strand of the literature, social programs focused on the informal sector, such as Seguro Popular in the case of Mexico, may create perverse incentives for formal workers to become informal.[52]

As will be explained in the following section, empirical studies have found mixed results. However, recent studies for Mexico tend to support the view of a segmented market.

3 Literature Review

3.1 Local multipliers

The analysis of local multipliers builds upon spatial labor markets equilibrium analysis. As Glaeser (2008) mentions, the most important concept in regional economics is the spatial equilibrium condition that indicates that if two identical individuals choose different locations it must be because they are receiving the same level of utility. That is, if an individual chooses a location with low wages it must be because he is being compensated with something else (amenities or another advantage).

Starting from this crucial assumption, standard spatial equilibrium models, such as the ones presented by Glaeser and Gottlieb (2009) and Moretti (2010), predict that following a local demand shock in the tradable sector (e.g. the attraction of a new firm), the number of workers and wages in a city will increase. Thus, apart from the tradable jobs directly created, a set of nontradable jobs will arise as a result of the increasing demand for these products, mainly

[52] It is important to note that under this framework, the same individual will receive a higher wage in the informal sector.

services. The magnitude of this multiplier effect, as already explained in section 2, depends on different factors such as consumer preferences, technologies, and skill levels.

As Black et al. (2005) argue, there are two different strands of literature in the empirical analysis of local multipliers or the effects of demand shocks on employment. The first one estimates local effects using aggregated labor data, and the second one takes advantage of specific and localized labor shocks to identify their effects. An example of this first approach is Moretti (2010) who uses U.S. Census data from 1980 to 2000 and estimates a long-term local labor multiplier of 1.6 for the whole sample, finding significantly higher effects (2.5) for tradable skilled jobs. A similar analysis is performed by Moretti and Thulin (2013) with a matched employer-employed database for Sweden finding a multiplier of tradable jobs over nontradable ranging between 0.4 and 0.8.[53]

Along the second line of research are papers such as Carrington (1996), who uses the specific shock generated by the construction of the Trans-Alaskan Pipeline System between 1974 and 1977 to analyze the employment dynamics in that state. As Black et al. (2005) notes, this was a very large temporary shock into a very small economy (Alaska). Additionally, due to its climate, Alaska experiences swings in its employment and population, which could have generated a smoother pattern in terms of employment, against what might be observed in other states. That is, though significant effects were found, the results for Alaska may have a lot of particularities that make it difficult to draw general conclusions from it.

Following this same strand, Black et al. (2005) take advantage of the coal boom in the 1970s during the OPEC oil embargo, and the later coal bust during the 1980s. These authors find that the effects of new employment in the mining sectors on local jobs was of 0.17, while the negative effect (job losses) due to the coal bust was of 0.35. These results indicate asymmetry in the effects as negative demand shocks have an effect of almost double than positive shocks. Effects on the tradable sector were not significant.

Moretti and Greenstone (2004) take a totally different approach by using information of "Million Dollar Plants" articles of the corporate real estate journal Site Selection, which describes the location process of new plants in U.S. counties. The main advantage of this dataset is that it allows them to construct a counterfactual by comparing the winner counties with

[53] In the case of Moretti and Thulin (2013) Stockholm proves to be an influential observation as once it is included in the sample, this multiplier increases, taking a value of approximately four nontradable jobs for each tradable job created.

runner-up counties. Even though they conclude that their estimates are imprecise, they find employment effects for industries in different sectors from the incumbent, as well as for neighbor counties.

3.2 Informal economy

The informal economy is a phenomenon observed mainly in developing countries.[54] A great deal of research has been conducted in order to assess the causes of informality, but there is still no consensus on its causes, let alone its definition and measurement. In the case of Mexico, for example, the measurement of informality was adjusted recently according to the International Labor Organization (ILO) statistical manual, changing the informality rate from 34% to 60%.[55]

Regarding the definition of informality, as Fortin et al. (1997) mention, in general, three approaches have been used to distinguish the informal sector from the formal under the segmented market or dualism line of research. The first one is the scale of the firm, measured by its number of workers. Under this approach, which these authors call scale dualism, an arbitrary threshold is defined and firms smaller than it are considered informal. The second, regarded as wage dualism, considers the wage differential between identical individuals. Such a segmentation can arise from market rigidities and regulations. The third view, referred to as evasion dualism, consists on those firms that avoid paying taxes and other contributions, mainly social security.

Considering its causes, as Rauch (1991) argues, initially this sector was not even seen as a topic worth of separate study. In the Harris-Todaro framework[56] it was seen as consequence of segmented or dualistic labor markets, as a temporary stage in the process of migration, where unskilled rural workers that migrated to urban environments were waiting to be absorbed by a modern formal sector, obtaining thus a more permanent job.

Other recent studies under this framework focus on the firms' side more than the employment side. For example, Straub (2005) emphasizes credit market rigidities. These models

[54] According to Bonner and Spooner (2011), the informal sector represents between 50 percent and 75 percent of non-agricultural employment in developing countries. Although there are not comparable statistics for developed countries, these authors argue that approximately 25% of employment in the U.S is non-standard or atypical (self-employment, part-time work or temporary work) which, though not all of them are informal, most of them receive little if any employment benefits.

[55] See INEGI (2012) and ILO (2012)

[56] See Ray (1998) for a summary and predictions of this model.

are closely related with occupational choice models following Banerjee and Newman (1993), where the lack of access to credit markets that stems from moral hazard, prevents some agents from becoming entrepreneurs.

A related literature, as mentioned in Loayza and Sugawara (2005), considers that the presence of a burdensome regulatory framework, with bad quality in public services and weak law enforcement, generates incentives for firms, specially the small ones, to operate in the informal sector.

However, contrary to the theoretical predictions of segmented market models, as both Rauch (1991) and Maloney (2004) argue, reverse mobility has been observed with formal sector workers changing into the informal sector, challenging this view. Therefore, other lines of research have been developed seeking to explain these movements.

A recent variant of the dualistic view, according to Maloney (2004), is the one that considers that informality is caused by firms facing international competition (price takers) who due to high labor costs induced by wage rigidities, decide to subcontract informal workers at a lower wage. However, in the case of Mexico, this same author reports that only 20% of informal self-employed firms report being affiliated to larger firms.

As Esquivel and Ordaz-Díaz (2008) argue, there is mixed empirical evidence for Mexico regarding whether there are integrated markets (with a wage premium in favor of the informal sector) or segmented markets (with a wage premium in the formal sector).

In favor of integrated markets, Maloney (2004) argues that in the case of Mexico, wage rigidities that would lead to a segmented labor market are not observed and more than 60% of self-employed individuals in the informal sector left their previous formal jobs and entered informality voluntarily. Therefore, this author considers the alternative theory of a life-cycle model where workers enter into the formal sector, acquire certain abilities and knowledge, as well as capital and contacts, and then leave in order to open informal own businesses. He also argues that the later entry into informality is also consistent with a safety net where older people who become unemployed are unable, due to the obsolescence of their abilities, to re-enter the formal sector and thus, end up entering informality. Additionally, informal jobs offer less demanding work for this group. Something similar happens in the case of married women, who can more easily balance work and homecare working for themselves than in formal employment. Considering this attractiveness of the informal sector, formal employers must generate incentives (wage premium) for their employees not to leave their jobs to enter informality. That is, under this hypothesis, informality generates dualistic markets and not the other way around. Perry et al. (2007) also obtain results consistent with integrated labor markets for Mexico.

Recent studies for Mexico, such as Arias, Azuara, Bernal, Heckman, and Villareal (2010) find evidence that support the hypothesis of segmented markets. According to these authors, informality in Mexico is primarily caused by regulation and levels of taxation. By analyzing the trends of informality rates, they conclude that the beginning of Seguro Popular did not change the previous trend, contrary to what the integrated markets hypothesis would predict. Esquivel and Ordaz-Díaz (2008) analyze whether social programs really generate incentives for informality in Mexico, as Levy (2008) argues. Their results show that there is a wage premium in Mexico's formal labor market, which is consistent with the hypothesis of a segmented market. Alcaraz, Chiquiar and Ramos-Francia (2008) obtain similar results in favor of the dualistic hypothesis.

As the empirical evidence shows, there is no agreement regarding the causes of informality. Perry et al. (2007) even allow for the possibility of the two hypothesis coexisting in the same labor market.

Even though consensus hasn't been reached on the causes of informality, according to Galiani and Weinschelbaum (2012), three stylized facts characterize the informal sector. First, small firms tend to be informal while larger firms are usually formal (scale dualism). Second, as Loayza and Sugawara (2005) also argue, the wage gap between the formal and the informal sector is larger for skilled people, making the informal sector a last resort for this kind of people, while for unskilled people it appears to be a first choice. Finally, family members different from the household head have a higher probability of entering the informal sector; this last statement is based on the idea that having one member of the family (usually the head) working in the formal sector provides medical insurance and other benefits for all the other members; this allows them to make riskier choices such as entering the informal sector.

4 Empirical strategy

Following Moretti and Thulin (2013) the following equation is estimated:

$$N_{c,t}^{NT} - N_{c,t-s}^{NT} = \alpha + \beta N_{c,t-s}^{NT} + \gamma(N_{c,t}^{T} - N_{c,t-s}^{T}) + \varepsilon_{c,t} \quad (4.1)$$

Where

$N_{c,t}^{NT}$ = Employment in the nontradable sector in city c at time t

$N_{c,t-s}^{NT}$ = Employment in the nontradable sector in city c at time $t-s$

$N_{c,t}^{T}$ = Employment in the tradable sector in city c at time t

$N_{c,t-s}^{T}$ = Employment in the tradable sector in city c at time $t-s$

Even though this expression in logarithms, as used in Moretti (2010) yields similar results, the main advantage of this formulation is that the parameter γ gives directly the value of the multiplier, without the need of multiplying the ratio of nontradable employment over tradable to calculate it from the elasticity.

It is important to note that following Delgado, Porter, and Stern (2005), as well as the growth literature, unlike previous analysis of local multipliers, the initial level of nontradable employment is included in order to control for convergence. Thus, β stands for the convergence parameter of standard growth equations.

Variants of equation 4.1 are estimated, in order to assess the effects of skilled-unskilled tradable employment, of formal-informal tradable employment and different technological intensity groups. In a departure from previous literature and considering the particularities of a developing country such as Mexico, on the left-hand side of the equation, the effects are analyzed for the formal and informal sectors.

In order to assess the effect of tradable employment shocks on other tradable sectors, as Moretti (2010) and Moretti and Thulin (2013) do, we estimate the following equation:

$$N_{c,t}^{T1} - N_{c,t-s}^{T1} = \alpha' + \beta' N_{c,t-s}^{T1} + \gamma'(N_{c,t}^{T2} - N_{c,t-s}^{T2}) + \varepsilon_{c,t} \quad (4.2)$$

Where:

ΔN_{ct}^{T1} = Randomly selected part of the tradable sector.
ΔN_{ct}^{T2} = Rest of the tradable sector.

In the simple model of Moretti (2010) it is expected that $\gamma > \gamma'$ due to the increase in labor costs as a result of the demand shock. As Black et al. (2005) argue, firms that trade their goods nationally (price takers) do not necessarily face a higher demand for their products, but wage increases affect them as well. Thus, this increase in costs may even reduce their employment, causing an employment crowding out in the tradable sector. In this case, the local multiplier on tradable goods could even be negative (depending on local supply elasticity), reflecting this crowding out effect. On the other hand, this multiplier could be positive in the case of significant agglomeration economies or vertical integration in the framework of local supply chains.[57] Then, the value of the tradable multiplier that we observe is the combination of these two opposite forces.

4.1 Instrumental variables

As Moretti (2010) and Moretti and Thulin (2013) mention, if there are unobserved shocks to nontradable employment that also affect tradable employment, OLS estimators become inconsistent. An example of this kind of shocks could be local labor supply shocks. In order to address these problems, in both articles, IVs are used. The idea is to construct a shift-share instrument that considers demand shifts in a sector out of the city and weights them by city employment in that sector in the initial period (in this case 2000). This instrument was calculated using 22 three-digits NAICS industries:

$$IV = \sum_{j}^{J=22} N_{c,j,t-s}^{T} \left(ln\left(N_{j,t}^{T} - N_{c,j,t}^{T}\right) - ln\left(N_{j,t-s}^{T} - N_{c,j,t-s}^{T}\right)\right) \qquad (4.2)$$

Where

$N_{cj,t}^{T}$ = Employment in the tradable sector in city c, sector j, at time t

$N_{j,t}^{T}$ = National employment in the tradable sector in sector j, at time t

Group specific instruments were calculated for the different variants of equation 4.1. For some of these specific instruments, the hypothesis of weak instruments couldn't be rejected; we indicate whenever this is the case so results are interpreted with caution.[58] Therefore, the possibility that the relation between the instrument and the exogenous variable is non-linear was

[57] This could be the case of perishable tradable products that tend to have local suppliers.
[58] As Moretti (2010) notes an empirical problem experienced in this kinds of analysis is that IV estimates are not identified for all groups.

also considered in all cases and another instrumental variable (IV2), which includes a quadratic term, was also used.

5 Data and descriptive statistics

5.1 Data sources and sample characteristics

The data used in this paper come from microdata of the 2000 and 2010 Population and Housing Censuses' samples. These data were used instead of Economic Census data as it includes information regarding whether an individual works in the informal sector.[59] However, as the primary objective of this census is not employment but demographic characteristics of the population, the quality of the data was assessed by comparing it with the information obtained for the closest Economic Census. For both periods of analysis the correlation between employment in the Population and Housing Census and the same variable of the Economic Census was 0.96.[60]

As the analysis is focused on employment, the sample includes individuals aged 18-66 who live in any of the 58 MAs considered.[61] MAs are used as the unit of analysis because in theory, they are the administrative regions closest to local labor markets. Considering municipalities instead of MAs, although it would have provided us with more degrees of freedom, commuting between municipalities, which is likely to occur, can bias the analysis.

Skilled people in the sample are defined as those individuals with nine or more years of schooling.[62]

5.2 Tradable and nontradable sectors

As Moretti and Thulin (2013) mention, there are different approaches to determine the tradability of each sector. In this case, two-digit NAICS sectors were classified according to the

[59] The 1990 Population and Housing Census was also taken into consideration but we weren't able to use it in the analysis as it does not include the variables necessary to classify employment as formal or informal.
[60] The 2010 Housing and Population Census was compared with the 2009 Economic Census while the 2000 Housing and Population Census was compared with the 1999 Economic Census.
[61] The 58 MA are constructed using CONAPO and INEGI's definition. Three additional MAs are included because of the importance of the *maquiladora* industry and the industrial growth of these areas. See Appendix I for the construction of the MAs.
[62] This is a conventional definition of skilled in the case of Mexico. For example, it is one of the definitions used by Cortez (2001) in his analysis of wage inequality for Mexico.

tradability analysis performed by Spence and Hlatshwayo (2011) for the U.S. Those sectors that exhibited more than 80% of tradability for that country are considered tradable. That is, we are using a classification that is exogenous to our data. The methodology used by these two authors is based on Jensen, Kletzer, Bernstein, and Feenstra (2005) and they use concentration indexes, considering that tradable sectors tend to be more regionally concentrated as they don't require much interaction with the final consumers. In this sense, these authors use the Ellison and Glaeser (1997) concentration index and the Gini coefficient.[63] Spence and Hlatshwayo (2011) add robustness to this methodology by including the analysis of imports and exports as determinants of tradability.

Following Delgado et al. (2005) we exclude natural resource-dependent sectors, as these authors consider them as a different group besides tradable and nontradable and, due to their particular characteristics, they shouldn't respond in the same way than nontradable products to tradable demand shocks.

This methodology basically led to the same results as the traditional or, as called by Moretti and Thulin (2013) assumption methodology, which regards mainly the manufacturing sector as tradable and the services sector as nontradable. In order to test whether this classification really applies for Mexico, an analysis of two-digits and three-digits NAICS sectors was performed using the Census dataset. In this case, the threshold commonly used for the U.S. (0.3 in Porter, 2003) does not apply as the different sectors show a much higher concentration (inequality) in employment. The median-average Gini coefficient for these sectors is of 0.71 in an analysis excluding Valle de Mexico. All of the manufacturing sectors have Gini indexes above the median and seven out of the ten highest indexes in the three-digits analysis correspond to this sector. These results indicate that the classification between tradable and nontradable sectors is correct.

Another approach for the classification of products between tradable and nontradable (not used here) is the use of location quotients (LQ), which basically compare the employment share of certain sector in a city with its share in national employment.[64] In general, the Gini coefficient and LQs are used together (See Delgado et al., 2005) in order to obtain more robust classifications.

[63] As Spence and Hlatshwayo (2011) point out, the classification in Jensen et al. (2005) works better for domestic markets than for international markets.

[64] The LQ has the same specification as the specialization index used in Chapter 1.

5.3 The informal sector

The informal sector definition is based on the ILO's statistical manual and INEGI's technical note regarding the new methodology for measuring informality. The informal sector includes workers with no access to social security (medical services), household paid domestic services, independent workers and non-paid family work.[65]

5.4 Descriptive statistics

Table 1 shows the sample's composition of employment between tradable and nontradable sectors for 2000 and 2010. During this period, the share of the tradable sector reduced from 25% to 20% for the whole sample. The pattern is similar when only MAs are considered.

TABLE 1. TRADABLE VS. NONTRADABLE SHARES IN TOTAL EMPLOYMENT
2000-2010

	2000		2010	
	Number	(%)	Number	(%)
National sample				
Tradable employment	5,982,509	25%	6,108,240	20%
Nontradable employment	17,521,152	75%	24,351,842	80%
Total	23,503,661	100%	30,460,082	100%
Only MAs	Number	(%)	Number	(%)
Tradable employment	4,298,245	27%	4,248,513	21%
Nontradable employment	11,744,621	73%	15,983,348	79%
Total	16,042,866	100%	20,231,861	100%

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010. The sample includes employed individuals aged 25-66.

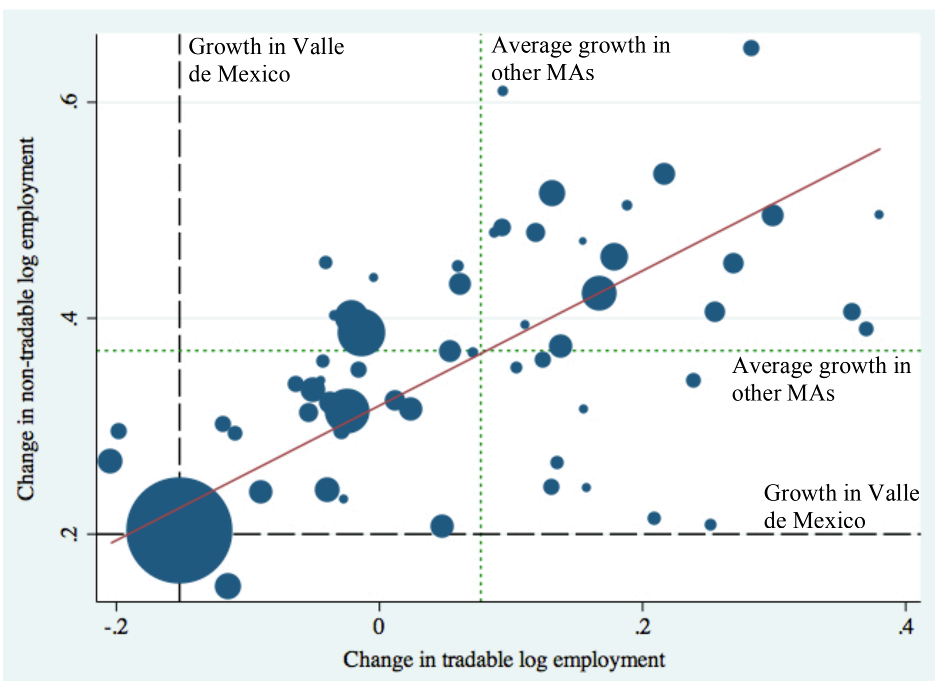
Figure 1 shows the correlation between tradable employment growth and nontradable employment growth in the period of analysis. As can be seen in the figure, there appears to be a direct relation between these two variables, consistent with the theoretical model. An interesting feature observed in this graph is the relative importance of Valle de Mexico in terms of

[65] See INEGI (2012) and ILO (2012). Results using alternative definitions of informality, which analyzed different labor benefits such as pension funds, Christmas bonuses and paid vacations, were also considered, obtaining similar results.

nontradable employment, which concentrated more than 30% of tradable MAs employment and more than 35% of nontradable MAs employment in 2000. Not only is this area important in terms of its weight in total employment, but it also shows different dynamics than most of the other MAs, as its growth rates for tradable and nontradable employment are much lower (even negative for tradable employment). These figures are consistent with the process of decentralization that especially the industrial sector has experienced since the mid-1990s, as shown in Chapter 1. These data also indicate that this MA could be an influential observation, so results including it must be analyzed with caution. That is why, estimates of equation 4.1 are calculated both including and excluding this MA and results are compared.

Growth rates for other MAs with high levels of nontradable employment in 2000 show that most of them experienced rates above the mean for nontradable employment, but below the mean for the tradable sectors. These growth patterns are an indicator of the increasing role of the services sector in these large MAs.

FIGURE 1. EMPLOYMENT GROWTH IN THE TRADABLE SECTOR VS. EMPLOYMENT GROWTH IN THE NONTRADABLE SECTOR 2000-2010

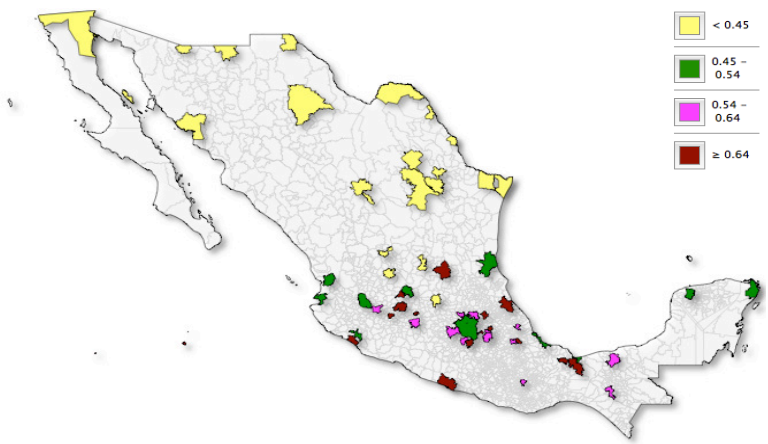


Source: Author's calculations with microdata from the 2000 and 2010 Housing and Population Censuses' samples. The markers' size reflects nontradable employment in 2000.

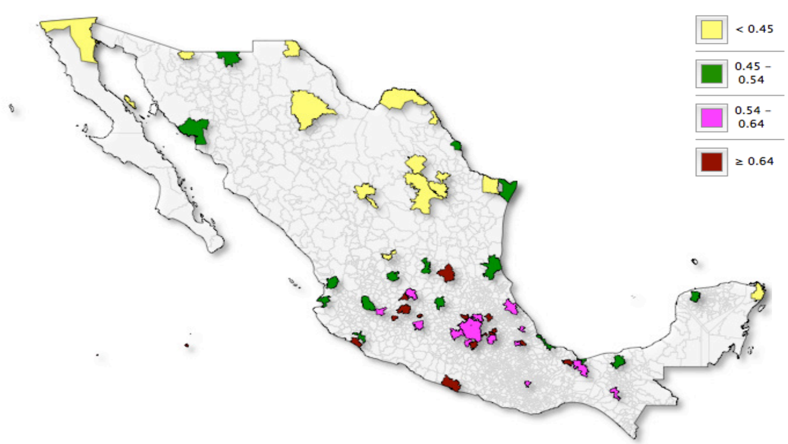
Analyzing informality by MA, as Figure 2 shows, this issue has clear regional patterns. As can be seen in the first panel, the northern region of the country was the one that exhibited the lowest rates of informality in 2000, while the central-south region is where informality was stronger. As the second panel shows, this pattern didn't change much by 2010, even though some MAs in the northern region increased their informality rates. Only five MAs out of the 58 analyzed showed reductions in their informality rates during this period and all of them are concentrated in the Gulf of Mexico and the Yucatan Peninsula.

FIGURE 2. INFORMALITY RATES BY MA 2000-2010

2000



2010



Source: Author's calculations with microdata from the 2000 and 2010 Housing and Population Censuses' samples.

As can be seen in Table 2, in 2000 the nontradable sector had a much higher average informality rate (59%) than the tradable sector (32%). Both rates are very stable as in the last ten years the first one did not change and the second one increased in just three percentage points, reaching 35% in 2010.

TABLE 2. MAS EMPLOYMENT INFORMALITY STRUCTURE AND SKILLS STRUCTURE IN THE TRADABLE AND NONTRADABLE SECTORS
2000-2010

	2000		**2010**	
	Nontradable	**Tradable**	**Nontradable**	**Tradable**
Formal	4,567,118	2,784,012	6,131,753	2,638,589
Informal	6,475,287	1,306,305	8,941,574	1,412,252
Informality rate	59%	32%	59%	35%
Unskilled	4,401,159	1,619,448	4,407,639	1,124,271
Skilled	7,343,462	2,678,797	11,575,709	3,124,242
Skill rate *	62.5%	62.3%	72.4%	73.5%

The totals are not the same for the different breakdowns because the sample includes individuals that did not answer properly the questions that are used to construct the informality variable.

*If the alternative definition of skilled (some college or more) is used, the skill rate reduces to 19% in 2010 for the nontradable sector and almost 14% for tradable products.

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010. The sample includes employed individuals aged 25-66.

Considering the skill composition of the tradable and nontradable sectors, it is important to note that both sectors exhibit a similar composition. Approximately 62% of the individuals in the sample were skilled in 2000, and this share increased to 72% in 2010. These figures reflect the educational improvements that Mexico has experienced, as already mentioned in Chapter 2.[66] As Table 3 shows, the skill composition of the formal and informal sectors is consistent with the stylized facts of the informal sector as the formal sector has a higher proportion of skilled individuals (86% in 2010) than the informal sector (63%).

[66] When an alternative definition of skilled individuals (some college or more) is used, the structure differs between the tradable and nontradable sectors, being the nontradable sector the one with the highest share of skilled people (19% in 2010), while the tradable sector showed a rate of 14% for this same year.

TABLE 3. SKILL VS. INFORMALITY STRUCTURE IN MAS
2000-2010

	2000		2010	
	Formal	**Informal**	**Formal**	**Informal**
Unskilled	2,186,739	4,272,047	1,575,570	4,292,257
Skilled	6,783,000	4,763,972	9,421,980	7,431,319
Skill rate	**75.6%**	**52.7%**	**85.7%**	**63.4%**

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010. The sample includes employed individuals aged 25-66.

When the technological intensity of the tradable sector is taken into account, as can be seen in Table 4, it is important to note that in 2000, more than half of tradable employment was in the low-technology sector. Between that year and 2010, this proportion exhibited a slight reduction in favor of the medium-high technology group, which increased its share from 24% to 27%.

Analyzing the skill composition of each technological intensity group (Table 4), as expected, the medium-high technology group is the one that exhibits the highest proportion of skilled people (85% in 2010), while the other two groups show similar shares (around 70%).

TABLE 4. SKILL VS. TECHNOLOGICAL INTENSITY OF THE TRADABLE SECTOR IN MAS
2000-2010

	2000				2010			
	Unskilled	**Skilled**	**Total**	**Skill rate**	**Unskilled**	**Skilled**	**Total**	**Skill rate**
Low technology	955,259	1,352,504	2,307,763	58.6%	668,775	1,473,056	2,141,831	68.8%
Medium-low technology	325,884	484,297	810,181	59.8%	237,696	592,519	830,215	71.4%
Medium-high technology	272,263	730,748	1,003,011	72.9%	166,065	907,406	1,073,471	84.5%
Total	**1,553,406**	**2,567,549**	**4,120,955**		**1,072,536**	**2,972,981**	**4,045,517**	

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010. The sample includes employed individuals aged 25-66.

6 Results

6.1 The local multiplier

The results for the local multiplier in Mexico between 2000 and 2010, as Table 5 shows, range from 2.56 to 3.91. That is, when one job in the tradable sector is created, between 2 and 4 employments are created in the nontradable sector stemming from the increasing demand of such products, mainly services.

Considering that the MA of Valle de Mexico concentrates more than 30% of tradable employment and more than 35% of nontradable employment in 2000, the same regressions were performed excluding this MA. Results indicate a much lower multiplier of between 0.81 and 1.44. This figure is consistent with what Moretti and Thulin (2013) obtain for Sweden when they exclude Stockholm from their sample.

TABLE 5. ESTIMATES OF THE LOCAL MULTIPLIER OF TRADABLE EMPLOYMENT OVER NONTRADABLE EMPLOYMENT

	Whole sample			**Excluding Valle de Mexico**		
Dependent variable: Change in nontradable employment	**OLS**	**IV1**	**IV2**	**OLS**	**IV1**	**IV2**
Change in tradable employment	2.56***	3.52***	3.91***	1.44***	0.61	0.81**
	(0.47)	(1.14)	(1.22)	(0.30)	(0.74)	(0.33)
Nontradable employment in 2000	0.34***	0.38***	0.39***	0.44***	0.44***	0.44***
	(0.02)	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)
Constant	6992.81**	-166.84	-3069.82	-2344.85	-511.37	-958.88
	(2869.88)	(7023.36)	(7338.9)	(2833.87)	-3308.08	(2623.49)
N	58	58	58	57	57	57
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.97	0.96	0.96	0.95	0.94	0.94

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
The Stock & Yogo test for weak instrument was performed for both IVs and the hypothesis that they are weak instruments is rejected. The IV that exhibits a lower minimum eigenvalue is IV2.

Another important factor to consider is the convergence coefficient, which is robust across regressions and indicates divergence between the MAs in terms of nontradable employment growth. That is, the cities with the higher level of nontradable employment tend to grow more in this same sector. This result contrasts with what is found for the tradable sector in Chapter 1, as there is convergence in terms of industrial growth. Considering the increasing role of the services sectors, these results contribute to the explanation of why there are still important differences in terms of employment level and wealth between the different MAs of the country.

In order to test the predictions of the model regarding the effects of demand shocks in the tradable sectors over other subgroups of the tradable sector, equation 4.2 was estimated. The results, shown in Table 6, indicate that the multiplier is much lower in the OLS specification and furthermore, not significant in the IV estimates. These results are consistent with the idea that tradable firms experience higher labor costs due to the demand shock in other tradable sectors. Hence, the labor multiplier should be lower than the one for the nontradable sector and could even be non-significant or negative, depending on the importance of agglomeration economies. Additionally, the convergence term in this case is negative (the same result observed in Chapter 1), indicating that tradable employment growth is higher in MAs that had lower levels of tradable employment.

TABLE 6. ESTIMATES OF THE LOCAL MULTIPLIER OF TRADABLE EMPLOYMENT OVER TRADABLE EMPLOYMENT

Dependent variable: Change in a subsample of tradable employment (subsample 1)	**OLS**	**IV1**	**IV2**
Change in tradable employment (subsample 2)	0.74***	-0.58	-0.57
	(0.21)	(0.66)	(0.63)
Tradable employment in 2000	-0.03	-0.17*	-0.17*
	(0.03)	(0.09)	(0.09)
Constant	3173.12***	6932.86***	6906.71***
	(823.73)	(2533.43)	(2494.53)
N	58	58	58
Prob>0	0	0.06	0.06
R^2	0.76	0.15	0.16

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
The Stock & Yogo test for weak instruments was performed for both IVs and the hypothesis that they are weak instruments is rejected in the case of IV1 but not in the case of IV2.

6.2 Local multipliers and informality

Analyzing whether formal or informal tradable employment generate more non-tradable jobs, Table 7 shows that in specifications that include Valle de Mexico, only the multiplier for tradable formal jobs is significant and even of a much larger magnitude than the average multiplier (Table 5) in all specifications while the informal sector appears not to affect nontradable jobs. However, once Valle de Mexico is excluded, the informal multiplier is significant and even higher than the one for the formal sector. That is, informal tradable employment has a multiplier effect in MAs different from Valle de Mexico.

TABLE 7. ESTIMATES OF THE LOCAL MULTIPLIERS
OF TRADABLE FORMAL AND INFORMAL EMPLOYMENT OVER NONTRADABLE EMPLOYMENT

	Whole sample			**Excluding Valle de Mexico**		
Dependent variable: Change in nontradable employment	**OLS**	**IV1**	**IV2**	**OLS**	**IV1**	**IV2**
Change in tradable formal employment	2.66***	3.98***	4.20***	1.21***	0.17	1.66***
	(0.7)	(1.4)	(1.1)	(0.3)	(2.2)	(0.6)
Change in tradable informal employment	2.44	5.55	4.90*	2.98***	6.20**	3.06***
	(2.1)	(4.7)	(2.8)	(0.8)	(3.0)	(1.1)
Nontradable employment in 2000	0.34***	0.39***	0.40***	0.43***	0.43***	0.43***
	(0.0)	(0.1)	(0.1)	(0.0)	(0.0)	(0.0)
Constant	6476.68**	-6511.71	-6756.9	-4641.33*	-9262.6	-5016.11*
	(2688.1)	(12030.7)	(6206.8)	(2624.4)	(6707.7)	(3036.1)
N	58	58	58	57	57	57
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.97	-	-	0.94	-	-

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
The Stock & Yogo test for weak instruments was performed for both IVs and the hypothesis that they are weak instruments is rejected in the case of IV1 but not in the case of IV2 for the whole sample. In the case of the sample that excludes Valle de Mexico, the opposite is observed.

Addressing the important question regarding the quality of indirect jobs created by tradable employment, which is the main contribution of this study, the multipliers for both nontradable formal and informal employment were calculated. Results are shown in Table 8 and the parameters obtained for the whole sample are similar (around 2). In a seemingly unrelated regression (SUR), the Chow test indicated that it is not possible to reject the hypothesis that the parameters for these two sectors are equal. These results are also highly consistent with the multiplier for the whole sample (approximately 3).

TABLE 8. ESTIMATES OF THE LOCAL MULTIPLIER
FOR NONTRADABLE FORMAL AND INFORMAL EMPLOYMENT

	Dependent variable: Change in nontradable employment					
	Formal			Informal		
	OLS-SUR	**IV1**	**IV2**	**OLS-SUR**	**IV1**	**IV2**
Whole sample						
Change in tradable employment	1.36***	1.78**	2.11***	1.25***	1.98**	2.84***
	(0.21)	(0.45)	(0.38)	(0.26)	(0.78)	(0.90)
Excluding Valle de Mexico						
Change in tradable employment	0.78***	0.51	0.39	0.61***	0.55	0.53
	(0.11)	(0.49)	(0.59)	(0.16)	(0.34)	(0.37)
N	58	58	58	57	57	57
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
Chow test parameters	Prob > chi2 = 0.5035					

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
The Stock & Yogo test for weak instrument was performed for both IVs and the hypothesis that they are weak instruments is rejected in the case of the whole sample; the IV that exhibits a lower minimum eigenvalue is IV2. In the case of the sample that excludes Valle de Mexico the hypothesis of weak instruments can't be rejected for any of the IVs.

6.3 Local multipliers and skills

Considering the skill composition of the tradable sector, local multipliers for both skilled and unskilled workers were calculated (Table 9). Although the magnitude is a little higher for skilled jobs, it is not possible to reject the hypothesis that both multipliers are equal. This indicates that under our definition of skilled (9 years or schooling or more), these two groups don't differ in terms of indirect jobs creation. Similar results, but with lower magnitudes are observed when we exclude Valle de Mexico from the sample.

As mentioned before, an alternative definition of skilled was used in order to test the robustness of these results, considering skilled people as those who have some college or more (See Appendix 3 for these results). In this case, the effects for the skilled group increase significantly, while the effects for the unskilled group reduce and the hypothesis of equal multipliers is rejected. These results are in line with the conceptual framework as people with college have better wages and can generate higher increases in nontradable demand and thus have a greater capability to indirectly create jobs in this sector.

TABLE 9. ESTIMATES OF THE LOCAL MULTIPLIER
FOR NONTRADABLE EMPLOYMENT BY SKILL LEVEL

Dependent variable: Change in nontradable employment			
Whole sample			
	OLS	**IV1**	**IV2**
Skilled	2.89***	4.42***	4.56***
	(0.61)	(0.59)	(0.91)
Unskilled	1.75**	4.15***	4.48***
	(0.71)	(1.57)	(1.43)
N	58	58	58
Excluding Valle de Mexico			
Skilled	1.25***	10.43	2.76*
	(0.40)	(42.8)	(1.52)
Unskilled	1.68***	10.06	3.04**
	(0.44)	(36.4)	(1.54)
N	57	57	57

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
The Stock & Yogo test for weak instrument was performed for both IVs and the hypothesis that they are weak instruments is rejected in the case of the whole sample. In the case of the sample that excludes Valle de Mexico, for IV1 the hypothesis of weak instruments can't be rejected.

6.4 Technological intensity

In order to analyze what kind of industries of the tradable sector had greater effects over non-tradable job indirect creation, three technological intensity groups were considered: low technology, medium-low technology and medium-high technology (see Appendix 2 for the structure of these groups). Estimates by technological intensity are presented in Table 10. Results show that the medium-low technology group is the one that exhibits the highest multiplier over nontradable employment (between 6 and 7), while the low-technology group is the one that generates less nontradable jobs. When the analysis is extended to consider formal and informal nontradable jobs, results indicate that the medium-low technology sector has a higher effect over informal employment with non-significant multipliers for other technological intensity groups. Formal jobs show a similar pattern than total nontradable jobs, with significant multipliers for medium-high technology industries.

TABLE 10. ESTIMATES OF THE LOCAL MULTIPLIER
BY TECHNOLOGICAL INTENSITY OF TRADABLE PRODUCTS

	Total nontradable			Nontradable formal			Nontradable informal		
Whole sample	**OLS**	**IV1**	**IV2**	**OLS**	**IV1**	**IV2**	**OLS**	**IV1**	**IV2**
Low-technology	1.58***	1.81	1.73	0.91***	0.99	0.96*	0.41	0.55	0.33
	(0.5)	(4.1)	(1.1)	(0.2)	(2.1)	(0.5)	(0.3)	(2.6)	(0.6)
Medium-low	6.01***	-13.47	7.16*	2.33***	-6.43	2.56	4.28***	-9.33	5.33**
	(1.8)	(18.4)	(4.3)	(0.8)	(7.1)	(1.8)	(1.1)	(15.7)	(2.3)
Medium-high	2.06***	10.45	2.67*	1.36***	5.20**	1.76**	0.66	6.39	0.87
	(0.7)	(7.3)	(1.5)	(0.4)	(2.6)	(0.7)	(0.4)	(6.5)	(0.8)
Excluding Valle de Mexico									
Low-technology	2.20***	2.07**	2.33***	1.19***	1.24***	1.15***	0.67***	-0.2	0.73
	(0.4)	(0.8)	(0.9)	(0.2)	(0.2)	(0.2)	(0.3)	(1.7)	(0.6)
Medium-low	1.93	1.75	-4.44	0.53	0.72	-0.51	1.91**	9.99	-1.6
	(1.2)	(15.3)	(3.9)	(0.4)	(1.7)	(0.8)	(0.9)	(17.7)	(1.9)
Medium-high	0.90*	1.01	3.43**	0.68***	0.9	1.19***	0.17	-3.12	1.49**
	(0.5)	(5.9)	(1.5)	(0.2)	(0.6)	(0.3)	(0.4)	(6.1)	(0.7)

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
The Stock & Yogo test for weak instrument was performed for both IVs and the hypothesis that they are weak instruments is rejected for IV2, but not for IV1 in both the cases of the whole sample and excluding Valle de Mexico.

Excluding Valle de Mexico both low-technology and medium-high technology sectors have significant multipliers while there is no effect of the medium-low group. This is consistent with the pattern observed in Chapter 1, as the northern region has grown in medium-high technology sectors while low-technology sectors have moved to the southern region.

In order to further analyze these results and test their robustness, a regression including technological-skill groups was estimated.[67] Results show that skilled workers from the three technological intensity groups have significant multipliers, being low-technology and medium-low technology the ones that exhibit the highest values (almost 5). However, in the case of unskilled individuals, only the ones who work in the medium-high technology group have an effect over nontradable job creation.

[67] Results are not shown here but are available upon request. In this case the hypothesis of weak instrument couldn't be rejected for any IV specification so the results analyzed come from the OLS regression.

6.5 *Asymmetries*

As mentioned before, the multipliers are important not just in terms of employment creation when a positive shock occurs, but also when a firm closes and job losses are expected. Therefore, the following formulation was tested in order to assess whether negative shocks have larger multipliers.

$$N_{c,t}^{NT} - N_{c,t-s}^{NT} = \alpha + \beta N_{c,t-s}^{NT} + \gamma\left(N_{c,t}^{T} - N_{c,t-s}^{T}\right) + d\left(N_{c,t}^{T} - N_{c,t-s}^{T}\right) + \varepsilon_{c,t}$$

Where:

$d =$ dummy variable equal to 1 when $\left(N_{c,t}^{T} - N_{c,t-s}^{T}\right) < 0$

The result from this specification, shown in Table 11, indicate that when Valle de Mexico is considered there are asymmetries in the effects, with job losses having a much higher multiplier (triple) than tradable jobs creation. However, in the sample that excludes this MA, negative shocks do not exhibit a different multiplier than positive ones.

TABLE 11. ESTIMATES OF ASSYMETRIES IN THE MULTIPLIERS

Dependent variable: Change in nontradable employment	**Whole sample**	**Excluding Valle de Mexico**
	OLS	**OLS**
Change in tradable employment (baseline-positive)	1.03**	1.16***
	(0.4)	(0.4)
Change in tradable employment (dummy negative)	3.63***	1.06
	(1.3)	(0.8)
Nontradable employment in 2000	0.42***	0.45***
	(0.0)	(0.0)
Constant	5448.49	-1397.74
	-3711.47	-2530.64
N	58	57
P	0	0
R^2	0.98	0.95

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

7 Discussion

Every time a city attracts new firms in the tradable sector, there is an indirect jobs creation stemming from the higher demand for nontradable goods. These multipliers are important for regional development policy as local governments grant incentives for investments and having a measure of the expected job multiplier can contribute to assess the appropriateness of these efforts and to better target them.

In the case of Mexico, considering that approximately 60% of employment occurs in the informal sector, it is also important to assess the quality of jobs created as a result of demand shocks in the tradable sector.

This paper analyzed local multipliers in the case of Mexico between 2000 and 2010, emphasizing the role of the informal sector in both the tradable and nontradable sectors. It also studied this process considering different skill levels and technological intensities with the purpose of identifying which tradable jobs have a higher capability for creating nontradable employment. In order to address the problems generated by unobserved shocks to nontradable employment that also affect tradable employment, group-specific IVs were used.

The multipliers observed indicate that for every new tradable job, approximately three nontradable jobs are created. This result is high compared to what Moretti (2010) finds for the U.S., but is highly consistent with what Moretti and Thulin (2013) observe for Sweden.[68] Another finding was that the effects are asymmetric, as negative shocks have a much larger effect than positive shocks.

Considering the quality of these jobs, the employment structure appears to reproduce itself as new jobs created in the tradable sector (which has a lower informality rate than the nontradable sector) generate formal and informal jobs in the same proportion. This is not a desirable outcome considering the low tax collection and vulnerability to labor market shocks associated to informality.

Regarding the skill structure of tradable jobs, defining skilled individuals as those with nine or more years of education, results indicate that there is no difference in terms of jobs creation between skilled and unskilled. However, using an alternative definition of skilled (some college

[68] The multiplier reduces significantly when Valle de Mexico is excluded from the sample, similar to what Moretti and Thulin (2013) find for Sweden when Stcokholm is excluded.

or more), the multiplier is at least three times higher for skilled workers than for the unskilled ones.

Additionally, taking into consideration the technological intensity of tradable employment, it was found that medium-high technology jobs have higher effects on nontradable formal employment while medium-low technology sectors have a greater capability for informal nontradable jobs creation.

This paper is a first approach for Mexico's local multipliers and the analysis should be extended in different dimensions. First of all, it is important to include cluster analysis as in Delgado et al. (2005) in order to have a more precise definition of the tradable, nontradable and resource-based sectors, which can lead to more detailed conclusions. Second, even though the administrative definition of MAs has the advantage of being exogenous to the data used in this analysis, different geographic arrangements should be tested in order to assess the sensitiveness of these results. For example, different local labor markets can be constructed using observable variables. Third, the use of firm level data, can provide further information as the effect of the establishment of new firms in an MA can be directly analyzed. Finally, considering that the conceptual framework establishes higher demand for non-tradable products as the channel through which the multiplier operates, it is important to analyze consumption patterns in order to better characterize the effects found in this paper.

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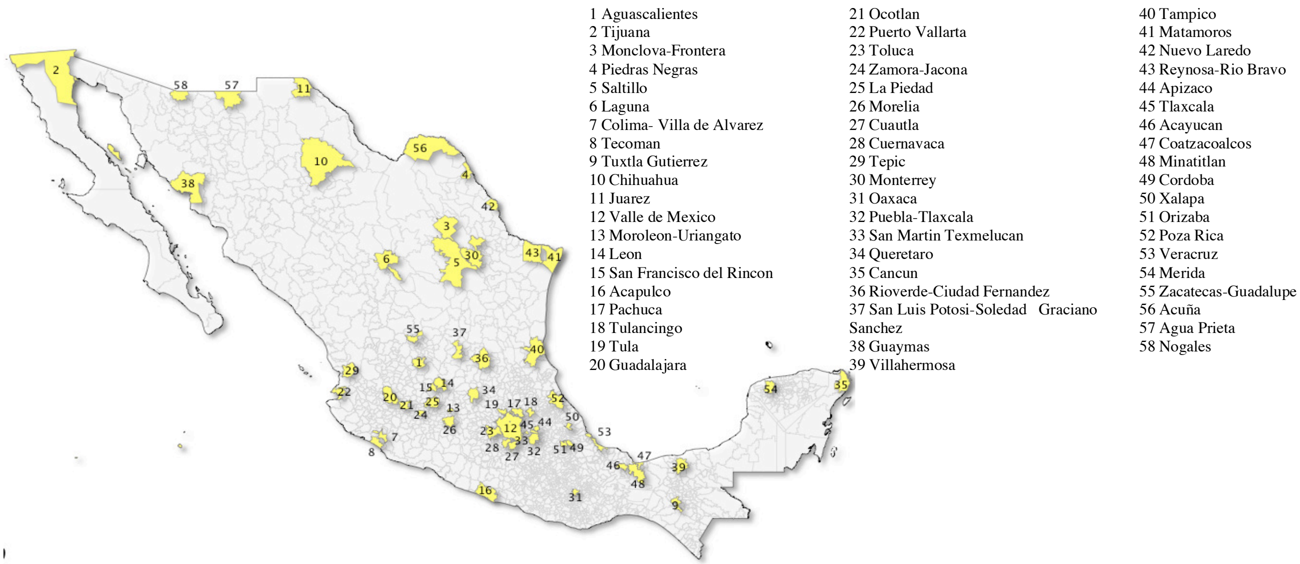
Appendix 1 MAs considered in the analysis

FIGURE 3. MAS STRUCTURE



Source: Author's elaboration with information from INEGI/CONAPO SEDESOL

Appendix 2 OECD classification by technological intensity (ISIC rev. 3)

This classification is based on the analysis of Research and Development (R&D) expenses, as well as the production of twelve members of the OECD during 1991-1999. The ISIC REV. 3 and input-output matrices are used.

The classification of manufacturing sectors in high-technology, medium-high technology, medium-low technology and low technology was made after sorting the different industries according to their average for 1991-1999. There were also considered: i) temporal stability, that is, that for adjacent years industries classified under the highest categories had more intensity than the ones classified in the lowest categories. ii) country median stability which means that industries classified to the higher categories have a higher median intensity than those in lower categories.

Even though this classification considers four categories, in the case of high-technology only a handful of sectors appear in this category. Therefore, the two higher technology groups were considered as one:

TABLE 12. PRODUCTS CLASSIFICATION BY TECHNOLOGICAL INTENSITY

Low intensity	Medium-low intensity	Medium-high intensity
Food, beverages and tobacco	Petroleum and coal products manufacturing	Machinery and equipment
Textiles	Plastic and rubber	Transportation equipment
Apparel	Non-metallic mineral products	Computers and electronics
Leather and footwear	Primary metal manufacturing and metal products	Electric apparatus
Wood		Chemical products
Paper		
Printing		
Furniture and mattresses		
Other industries		

Source: Author's elaboration with information from the OECD.

Appendix 3 Alternative definition of skilled

TABLE 13. ESTIMATES USING THE ALTERNATIVE DEFINITION OF SKILLED (SOME COLLEGE OR MORE)

Dependent variable: Change in nontradable employment			
Whole sample			
	OLS	**IV1**	**IV2**
Skilled	9.15***	6.44***	10.90***
	(2.5)	(2.2)	(2.0)
Unskilled	1.02**	2.24**	1.04
	(0.5)	(1.0)	(0.7)
Prob>F	0.000	0.000	0.000
N	58	58	58
Excluding Valle de Mexico			
Skilled	4.15**	-13.46	3.43
	(1.6)	(28.7)	(2.9)
Unskilled	1.06**	0.44	1.09**
	(0.4)	(1.9)	(0.5)
N	57	57	57

Source: Author's calculations using data from the Mexican Population and Household Censuses for 2000 and 2010.
Standard errors are in parenthesis.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
The Stock & Yogo test for weak instrument was performed for both IVs and the hypothesis that they are weak instruments is rejected for both IV1 and IV2 in the case of the whole sample.
In the case of the sample excluding Valle de Mexico, the hypothesis of weak instruments couldn't be rejected in the case of IV1 but it was rejected in the case of IV2.

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