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Influence of Agglomerations in the Service Sector in Economic Growth: Mexico, 2005-2018

by

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Abstract: This thesis analyses the relationship between the presence of economic agglomerations and regional economic growth in Mexico during the period 2005-2018. The focus is mainly toward understanding the influence of clusters in the service sector due to its increasing potential for driving the economy. The study also examines the effect of agglomerations on regional income inequality. To estimate these relationships, diverse indices of spatial cohesion are used in order to capture the different aspects of agglomeration economies and are later employed in a regression model. Agglomerations in the tertiary sector proved to be promoting economic growth and encouraging conditional convergence in a rate between 1.6 per cent to 3 per cent. Mexico City and the surrounding area showed the highest concentration of service activities and were also among the states that attained greater economic growth.

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Abbreviations

ECLAC	- Economic Commission for Latin America and the Caribbean
EMP	- Employment
ENOE	- National Survey of Occupation and Employment
FDI	- Foreign Direct Investment
GATT	- General Agreement on Tariffs and Trade
GDP	- Gross Domestic Product
GVA	- Gross Value Added
IMF	- International Monetary Fund
INEGI	- National Institute of Statistics and Geography in Mexico
ISI	- Import Substitution Industrialization
NAFTA	- North American Free Trade Agreement
OECD	- Organization for Economic Cooperation and Development
OLS	- Ordinary Least Squares
SEZ	- Special Economic Zone

1 Introduction

The study of territorial cohesion in economic activities and growth has been an ongoing debate in the sphere of economic geographers. The theory suggests that spatial proximity of industries is beneficial for economic growth or, as Fujita and Thisse (2002, p.391) expressed, that "growth and agglomeration go hand-in-hand". Although, agglomeration economies have assumed to be related to the manufacturing sector and there is little evidence of their interaction with the expanding service sector (Faber and Gaubert 2019). From an economic history perspective this analysis is also relevant to explain economic inequality between countries and regions throughout the different stages of development. Agglomeration theories were born by studying scenarios in developed economies, their influence can vary depending on the existing preconditions in which they are formed. This represents an opportunity for analysing the effect of clusters in circumstances where institutions, backgrounds, networks and infrastructures are diverse.

Mexico is an interesting case to study among emerging economies due to its proximity to the largest import market in the world, the U.S., which has greatly influenced the development of the country (ECLAC, 2016). Even though their economies are linked, the growth rates of these two countries have not been equivalent (Padilla-Pérez and Villarreal 2017). The New Economy Geography theory states that at an early stage of development, inequality within regions is expected to grow and as the economy develops those disparities are predicted to decrease. This would then suggest that Mexico is at a convergence trend, yet this has not been the observed behaviour (Aguilar Retureta 2016). Another relevant reason for considering this country is the economic policies and structural change to which the country has been subject to in recent years. A transition towards an open economy and the signing of trade agreements have opened new markets for the country, encouraging the reallocation of industries and foreign investments. This historical context calls for an in-depth review of the factors that have influenced agglomeration and to understand their effect on growth, both nationally and regionally.

This thesis analyses the relationship between the presence of agglomerations in the service sector and regional economic growth in Mexico during the period 2005-2018. The interest of studying the influence of agglomerations is complemented with the importance of the tertiary sector as driver of growth. Mexico is a developing country in process of transitioning from low productivity sectors into services, however, it is relevant to analyse if agglomerations in this sector have positively affecting economic growth. The influence of agglomerations could help explain the level of inequality within the country and offer possible solutions. Lagging regions could be able to attain higher levels of growth by identifying the causes of success in

other parts of the country and by mimicking those conditions. In order to understand the relationship between geographical concentration of economic activities and growth, this study poses the following research question:

How have agglomerations in the service sector influenced economic growth in Mexico?

Did the presence of agglomeration economies in the service sector have a positive effect on regional economic growth? What was the impact for regional inequality during the observed period? Was it different in comparison to other sectors of the economy?

The results of this study will add up to the ongoing research on economic growth, inequality, the dynamics of agglomeration economies and the relevance of the service sector by looking at the behaviour of a country that has failed to attain consistent economic progress across all regions. This will also offer complementary information for policy makers while setting strategies for development, since they need to be aware of the circumstances in which clusters develop and tailor-made solutions that consider the context and background for overcoming structural deficiencies to ensure general wellbeing, as Vincente (2018) emphasise.

The unfolding structure of this thesis is divided in six parts including this introduction. The next section will give an overview of the background and performance of the economy in Mexico accompanied by a discussion of related research in agglomerations, income distribution and economic convergence. The historical context and previous research will be followed by the theoretical and contextual framework that set the pace for the chosen methodology. The data collected for addressing the research question will be discussed next by specifying its sources and considerations for interpretation. After reviewing the data, an analysis of the results will be presented and discussed in the final conclusion section.

2 Theory

2.1 Historical context

Geographically Mexico is located in North America and its political division consist on thirty-two states (Figure 2.1). The U.S.A has been an important factor for the development in Mexico since its economy reflects, to some extent, the performance of the northern neighbour. (Padilla-Pérez and Villarreal 2017).

Figure 2.1 Map of Mexican States
Source: INEGI

The scenario in Mexico is an interesting case to evaluate since the country is still in a developing phase but economic growth has not been equally achieved across all regions. The GINI index, a measurement of wealth distribution that acquires a value between 0 (perfect equality) and 100 (perfect inequality), was 45.9 for Mexico in 2019 compared to 27.1 for Finland, a country recognized for its balanced wealth distribution (The World Bank, 2019). This classifies Mexico as one of the OECD countries with the worst performance regarding income distribution and close to the 41.5 coefficient of the U.S.A. (OECD, 2019). Inequality is also visible in the growth rates of particular localities, the northern region of the country

had an increase of 0.9% in its economic activity during 2019, meanwhile, the southeast region suffered a decrease of 2.6% (INEGI). The importance of analysing economic growth in Mexico relies on understanding why some regions are able to grow while others remain stagnant and if the cause is related to the presence of clustered industries. If economic growth across regions was evened, meeting the rates of top performers, the overall competitiveness of the country would escalate since, as Castells (2011) mentioned, economic gaps and agglomerations could potentially increase economic growth.

Mexico underwent relevant economic transformations by evolving from an agricultural society into a more urbanized region with manufacturing and services as main productive activities. However, this process created a prolonged period of growth at the cost of incrementing inequalities between regions (Trejo-Nieto 2017). Figure 2.2 illustrates the evolution of Gross Domestic Product (GDP) and Gross Value Added (GVA) per sector in Mexico during recent years. The graph shows that the main driver behind economic growth has been the development of activities related to services. In 1993 the share of agriculture accounted for 4% and decreased to 3% in 2019. The manufacturing sector also declined its participation, although it was more perceptible, it went from 38% to 30%. Therefore, the proportion of services to GDP increased from 58% to 67%.

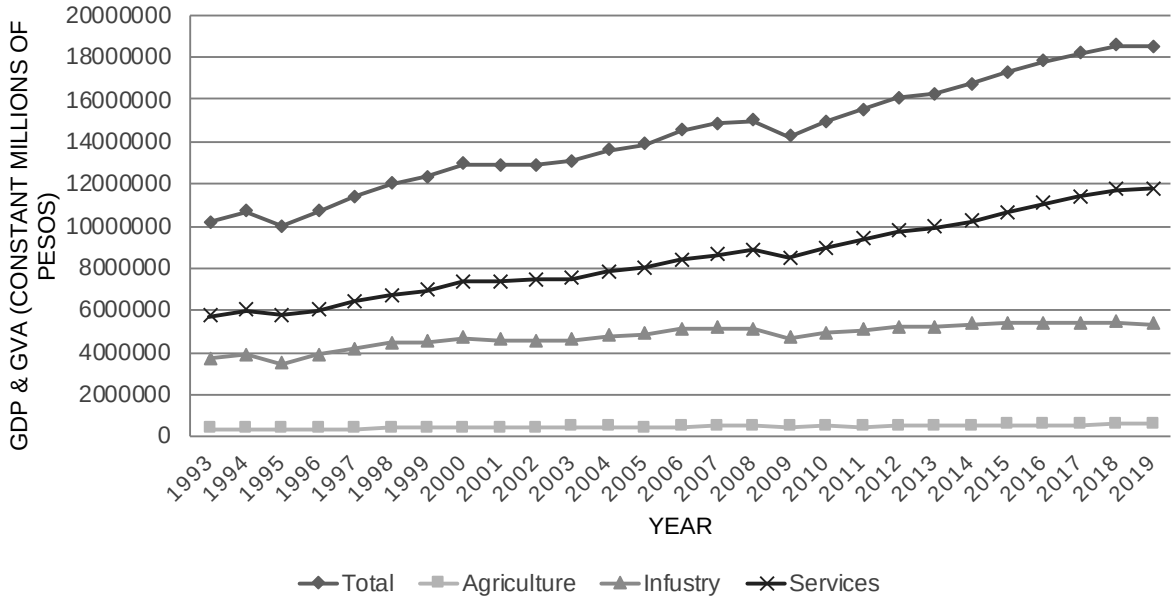

Figure 2.2 *Gross domestic product (GDP) and gross value added (GVA) in Mexico, 1993-2019 (Constant 2013 millions MXN)*
Source: INEGI

Initially, this suggests that the regions where the tertiary sector is expanding would have higher growth rates than the ones whose main activity is related to agriculture or manufacturing. From Figure 2.3, it can be seen that the states with the higher income per capita are located mostly in the north, with the exception of Mexico City and Campeche, and on the south are situated the poorer states. In order to recognize the reasons of this distribution

and the implications on economic growth an understanding of the initial conditions is required.

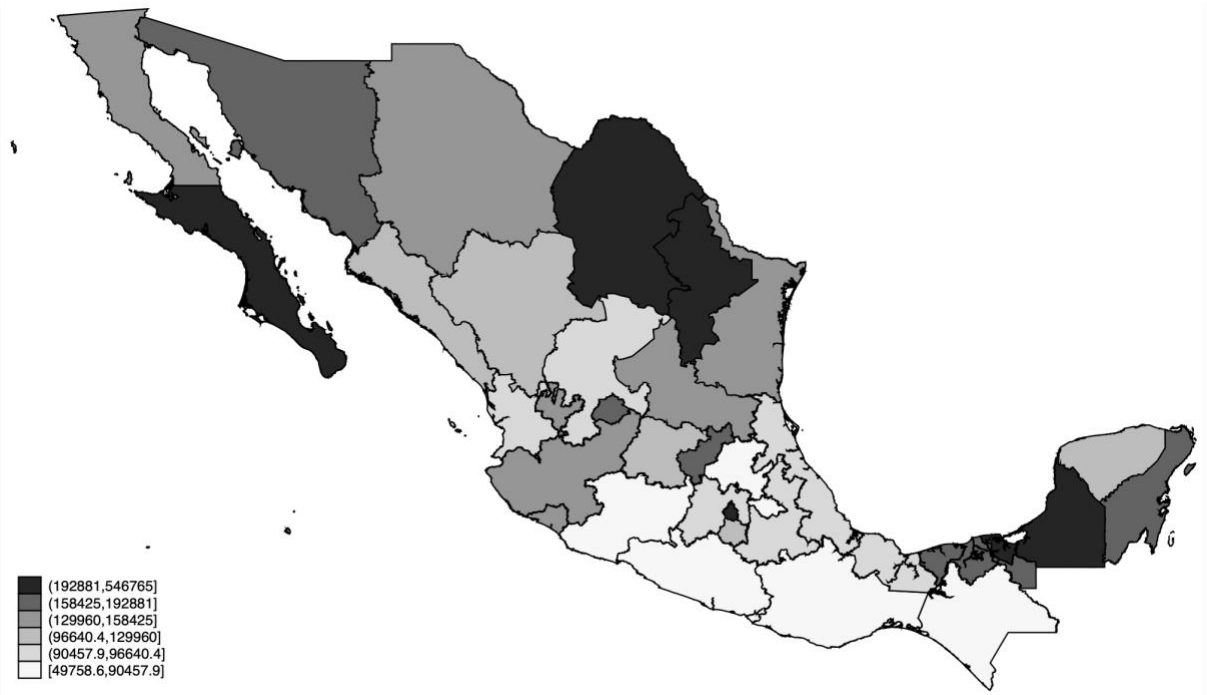

Figure 2.3 *GDP per capita in Mexico, 2018 (Constant 2013 MXN)*
Source: INEGI

From the late nineteenth century up until the Great Depression decade, Mexico experienced an increase on primary goods exports and on regional specialization, both boosted by the expanding railway infrastructure (Kuntz 1999). The country was economically modernized because of the rise of the secondary sector, mining in particular, and the agro-exports (Kuntz 2010). In this period, the share of agriculture in total GDP fell from 23.8 to 13.9 percent and the share of manufacturing increased from 9.1 to 13.2 percent (Pérez López 1960). Industrial activity was concentrated in Mexico City, the northern states and Veracruz but mining experienced a geographic dispersion (Aguilar Retureta 2016).

During the 1940s the government implemented a development strategy that encouraged import substitution (ISI) through protectionists policies aimed at industrializing the country. This model was differentiated by a strong state participation under a closed economy (Bertola & Ocampo 2010). The strategy was successful since the subsequent years were characterized by a steady rate of economic growth and an expanding industrial sector (López-Malo 1960). There were several actors involved in this process, including funding institutions that supported an ever so growing manufacturing industry. Although cumbersome subsidies and the prevalence of a small group of actors allowed for inefficient industries to grow even if the goods produced were expensive for consumers or had low quality (Cardenas 1996). These policies initially encouraged economic activity to cluster around Mexico City, Jalisco and Nuevo León, the states with the highest levels of GDP per capita (López-Malo 1960). Hernández Laos (1985) suggested that the formation of this agglomerations was driven by the

already existent markets in these states, especially in Mexico City. Krugman and Livas-Elizondo (1996) added that this was a characteristic of models with a closed economy since industries tend to emerge in the vicinity of the largest national markets, creating agglomerations around them.

The secondary sector received a second impulse during the sixties with the creation of a programme that supported the industrialization of regions that were located close to the country's borders. This set the bases of development for the manufacturing sector in northern cities, close to the United States, and prompted the creation of jobs in the region (Trejo-Nieto 2017). The benefits generated by this sector were later shared with cities in the other parts of the country. This process encouraged the transformation of rural societies into urban congregations. Lagging states in the south and centre started to increase their productivity, particularly the Yucatan peninsula and the Southeast region which achieved the highest growth rates in the country (Rodríguez-Pose and Sánchez-Reaza 2002). There was a relative catch-up phase driven by the discovery of oil reserves in the Gulf peninsula and the migration from the population in the south to other parts of the country and the U.S.A. (Rodríguez-Pose and Sánchez-Reaza 2000).

During this period the manufacturing sector overshadowed for the first time the participation of the primary sector in GDP of the nation. Through the following years the participatory share of agriculture in the country's economy continued to shrink while the secondary and tertiary sector increased their productivity (Trejo-Nieto 2017). However, by the end of this decade the country started to present relevant structural weaknesses which were handled by increasing the external funding and by taking advantage of a rising oil industry (Loría, 2009).

At the beginning of the 1980s the structural deficiencies and the overleveraging of the country created an uncontainable crisis. The oil market that had previously helped the economy was now decreasing the prices of this commodity and pressuring the economic stability of the country (Cárdenas 1996). This event was known as the Latin American Debt Crisis since the phenomenon was not exclusive of Mexico, other countries in Latin America experienced similar debt difficulties. Several structural measurements were imposed by the Interational Monetary Fund (IMF) in order to be able to renegotiate the external debt conditions. The programme consisted of policies that deregulated, privatized and liberalized the economy. The government in Mexico carried out these policies by implemented the National Development Plan which supported the export of manufactured goods as main mechanism for economic growth. In these years of crisis, the overall growth results were negative but some states managed to keep the upwards trend. Mexico City, Aguascalientes, Quintana Roo and the states bordering the U.S.A achieved the highest growth rates (Rodríguez-Pose and Sánchez-Reaza 2002). The factors encouraging economic growth were different for each of these regions. The increased productivity of northern states and Mexico City was, to some extent, a result of market proximity. Jordaan and Rodriguez-Oreggia (2009) identified that a series of industries in the manufacturing sector were allocating in the north and center of the country and foreign direct investment (FDI) was following this tendency. The influence of regional endowment such as human capital and infrastructure, characteristics of the states in the north

and Mexico City, were also influential for attracting industries and achieving economic growth (Gonzalez Rivas 2007; Chiquiar 2005). At this point, the share of Mexico City and the State of Mexico on the total national GDP reached 36.14 percent, indicating a significant concentration of activity (Germán-Soto 2005). In different circumstances, Quintana Roo's improved performance was linked to its existing natural resources and the development of a tourism industry around them (Faber and Gaubert 2019). At the same time, the southern part of the country and other states underwent a productivity decline which ended the convergent trend of previous decades.

In the 1990s the structural policies were intensified with additional privatizations and the signing of free trade agreements, such as the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT). The former agreement, integrated by Canada, Mexico and the U.S.A., is quite relevant since it represents the largest regional market in the world, although the level of development of each of its members has been unequal as suggested by Rodríguez-Pose and Sánchez-Reaza (2002). The authors identified some of the benefits of NAFTA for the Mexican economy. The first one was a decrease in the level of reliance on oil due to the development of other industrial activities and the service sector. The second one was an increase of international commerce and the relevance of FDI. There were other positive aspects of the liberalization strategy, such as the inflation stability, however the results were not equally beneficial for all sectors and regions in Mexico. The productive capacity, employment opportunities and development in general was only enhanced in some states, leaving others stagnating (Trejo-Nieto 2017). According to Rodrígues-Oreggia (2005) the states that were converging to the average regional income, under the previous economic model, were once again lagging behind and that behaviour is seen up until these days.

During the import substitution period, Mexico City was the preferred location of the manufacturing industry (Krugman and Livas-Elizondo 1996). The proportion of value added from this sector to the total productivity of the city increased from 19% to almost 50% (Hanson 1997). After this period, with the liberalization policies, the trend was reverted and the share decreased giving rise to the service sector (Trejo-Nieto 2017). The location of the secondary sector shifted to northern states, close to the U.S. market, which strengthened the existent clusters. The agglomeration was significant since 60% of the employees in the sector were located in this region (Jordaan and Rodriguez-Oreggia 2009). According to Rodríguez-Pose and Sánchez-Reaza (2002), by 1998 the six states that shared border with the U.S. accounted for more than 85 percent of national employment in the manufacturing sector known as "maquila", being Chihuahua the most relevant. Other states that thrived during those years were Michoacán, Tlaxcala, Puebla and Querétaro and, in contrast, Tabasco and Campeche experienced a decrease in per capita growth rates, as the authors point out. Campeche and Tabasco have as main economic activity the production of petroleum, their decline is linked to the oil crisis of the time and have been unable to recover up to these days. On the other hand, Michoacán was a state that achieved high levels of growth due to the importance of agriculture and the export of its products, such as avocado (INEGI). The rest of the states with positive growth were located in the center, in the vicinity of Mexico City. The

two factor that Rodríguez-Pose and Sánchez-Reaza (2002) identify as causal are the market proximity and agglomeration externalities. These states benefited from the closeness to the expanding dynamic market in Mexico City and the U.S and the already developed clusters. Storper (1997) signaled that agglomeration economies tend to become regional rather than local and that was the behavior seen in this area. Companies benefited from a less congested location with lower labour costs while being near to a large market (Carrillo and Hualde 1998). There was a second wave of manufacturing companies emerging as a result of the NAFTA, only this time the hosting states were the ones in the central region (Rodríguez-Pose and Sánchez-Reaza 2002). The developing industries were related to textiles, automotive production, chemicals and mining and were mainly stablished in the states of Aguascalientes, Querétaro, Puebla and Tlaxcala. Population distribution (Figure 2.4) shows a similar arrangement. The urban concentrations are observed in the central region, specifically in Mexico City and the surrounding states.

The dynamics of agglomerations have been changing ever since. There has been an upraise of the tourism sector, an emergence of new industries, such as aerospace or nanotechnology, and Padilla-Pérez and Villarreal (2017) identify an increasing participation of commerce, telecommunication services, transport equipment and electronics, all of them part of the service sector. The latest policies in Mexico, implemented with the purpose of decreasing income disparities, encourage the creation of industries in regions with low productivity levels. The strategy is to stablish SEZ to attract private investments, increase employment and growth by giving special benefits to the firms that establish in said region. Therefore, an analysis on how industries are transforming agglomeration patterns and shaping the economy is a relevant contribution to understand the past and future development of Mexico and other developing countries.

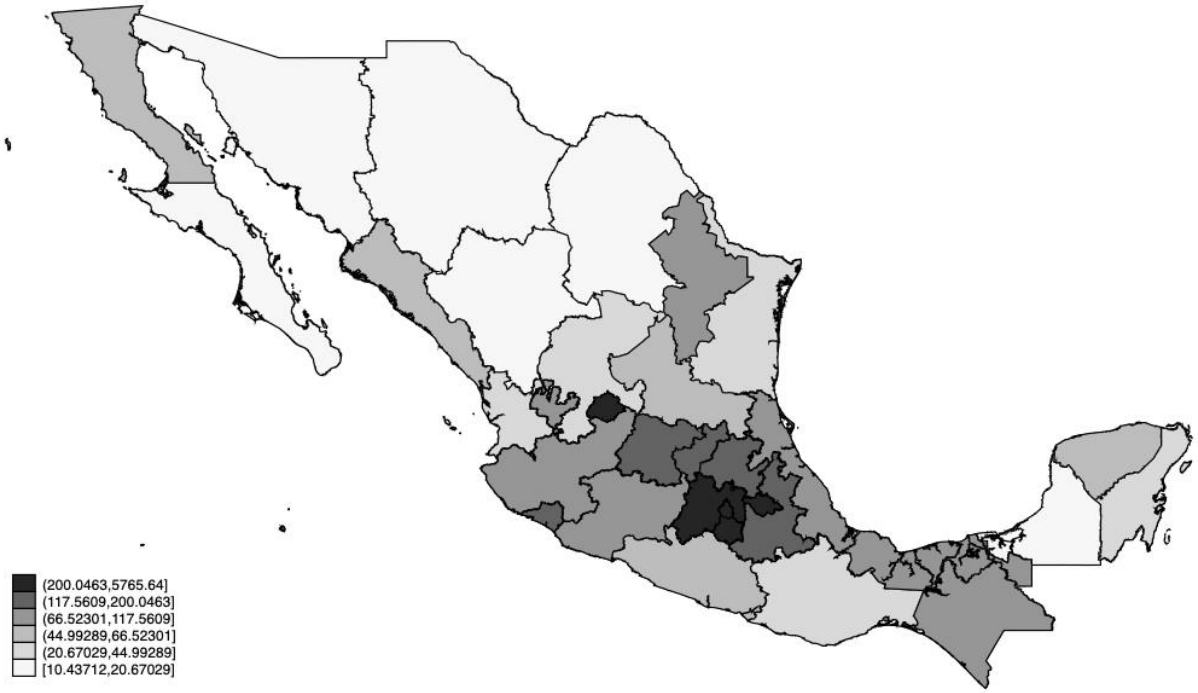

Figure 2.4 Population density in Mexico, 2018 (Inhabitants per square kilometre)
Source: Own calculations based on INEGI data

2.2 Previous research

The concentration of economic activity is the reason of being for the cities. Both economic historians and development economists have noticed a positive relationship between agglomeration economies and economic growth. The spatial proximity of the supply and demand elements favours growth. Central urban economies usually call for more productivity, and at the same time are willing to pay the workers more and allows them to specialize, which again, leads to greater productivity (Hanson, G. 1997). As opposed to low density regions where the consumer has to produce for himself, specialization disappears, and does not allow for higher wages for workers (Ciccone and Hall 1996). This is why agglomeration economies allow the link between spatial proximity of producers and consumers to strengthen, favouring them and the productivity of said space as long as the cost of opportunity is worth it (Fujita, M. & Thisse, JF. 2002).

The studies on the evolution of regional income distribution, focused on Western Europe and the U.S., explain a pattern described as an inverted U-shape in the long term (Geary & Stark 2002; Klein & Crafts 2012; Martinez- Galarraga 2012; Enflo & Rosés 2015). This pattern describes the initial divergence at a first stage of market integration, a middle plateau and then a trend towards convergence. This behavior is described by the New Economic Geography model which suggests that lower transportation costs, market potential and increasing returns at first leads to economic agglomerations and regional income inequality (Krugman 1991). At

a second stage, firms became sensitive to congestion costs if transportation or trade costs continue decreasing, leading to dispersion of economic activity (Puga 1999). This behavior was observed by Rodríguez-Pose and Sánchez-Reaza (2002) in the case of Mexico. In the third phase, market integration may eventually lead to regional income convergence (Williamson 1965). This inverted U model is known as the Kuznets curve and previous studies of regional convergence in developed countries have confirmed the theory behind it. The influence of regional distribution of economic activities in developing countries is still unclear and more analysis on this subject are required. Badia-Miró (2015), as an example, studied the case of Chile and concluded that the country was not following the U-shape pattern but did followed a trend towards for regional income convergence, although agglomerations were not the reason behind it. Another example is the work by Caruana-Galizia (2013) on India, where during the first stage of development regional income diverged, opposed to what the theory predicts. There are a few studies that have aimed at understanding the phenomenon in the Mexican context (Padilla-Pérez and Villarreal 2017; Rodríguez-Pose and Sánchez-Reaza 2002; Mallick and Carayannis, 1994; Jordaan and Rodriguez-Oreggia 2009; Faber and Gaubert 2019; Rodríguez-Benavides et al. 2016).

The work of some authors has identified the clustering patterns of industries in different states of Mexico. Bassols (1979) analysed the economic regions and their industrial activity, from 1945 to 1976, through data collected from surveys. Even though his work is a useful baseline for understanding the distribution of clusters in Mexico, a recent study would shed some light in the evolution of industry agglomerations for linking the analysis with the economic performance of the country. Padilla-Pérez and Villarreal 2017 Aguilar-Retureta (2016) examines the manufacturing industries and their development in the northern region of the country, taking as a starting point the trade liberalization epoch. This has been a crucial factor since the commercial agreements have represented an opportunity for industries located in the north to participate in a wider market such as the U.S. The author also identifies an agriculture agglomeration, present in the southern region, that generates negative impact for the states that host the industry. The work by Mallick and Carayannis (1994) supports these findings. The authors describe that the agricultural industry, present mainly in south-east regions, does not possess much flexibility since it is an activity that relies on unmovable resources and cannot be mimicked in other areas. They state that this activity has low contribution to value added and that the states whose main activity has been agriculture are identified as the poorer ones in the country. These states have not developed infrastructure to change into more productive sectors and one of the limitations has been the abundance of natural resources, according to the authors. Padilla-Pérez and Villarreal (2017) finds similar results in his analysis of structural changes in Mexico and concludes that there is a flow from high productive sectors towards declining or unproductive ones. According to the authors, this pattern prevents the economy from benefiting of superior production factors, such as IT investments or educated workers, because of the low demand of efficiency and competitiveness. Other regions have developed competences in activities with higher productivity, leaving agricultural regions lagging behind and forced to seclude into their area of expertise, avoiding the creation of new industries. The manufacturing industry located in northern regions is more flexible than agriculture, has gained presence in central states of the

country and did contribute to economic development (Mallick and Carayannis, 1994). This is an example of how concentrations of firms or industries are affected by geographical conditions and have a relationship with regional growth (Tappi, 2001). In contrast, Klein and Crafts (2012) offered an analysis on the drivers for manufacturing agglomerations in the case of the U.S. This example is relevant since the U.S. economy is influential on the development path of Mexico. The evidence obtained by the authors suggests that the main precursor of clusters is market proximity and in the case of the U.S this has meant that the allocation on new sectors, such as services, is linked to existent markets and agglomerations. Maddison (1995) had previously identified the substitutionary role of the tertiary sector for manufacturing activities and how this is favorable for economic growth. A direct approach on the study of services in the U.S. is the one carried out by Cermeño (2018) where market potential is also identified as the main driver for service agglomerations. Both of these finding would then suggest that clusters linked to the tertiary sector develop in the same location as the manufacturing agglomerations, therefore increasing regional income inequality by benefiting the regions with already developed economies.

Brülhart and Sbergami (2009) worked on a cross country analysis of agglomerations and growth. They found that clusters boosted economic growth but only for countries under a certain level of income. The limit they established was of USD 10,000 per inhabitant and further past this point agglomeration not only ceases to be beneficial, they became detrimental for productivity. The authors also conducted an analysis that looked at the influence of agglomerations from a sectoral perspective and identified financial services to be positively correlated to growth as opposed to clusters related to the manufacturing industry.

Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016) pick up on the work by Brülhart and Sbergami (2009) and analyse the specific case of Spain from a cross-regional perspective. The early stages of economic development in Spain took place adjacent to a greater spatial inequality both regarding the space where the industry clustered and the lower growth of GDP per capita for these regions. It is important to note that during this early development of Spain, there was an industrial specialization in some Spanish provinces, which translated as agglomeration economies. One could further establish that the reason for the regional income inequality amongst the industrial regions of Spain and the ones with a lower level of income during the early years was also influenced by the still low density where the distance and hence the transportation and product cost raises affect productivity and led to said inequality. The authors remark that the construction of the railroad network naturally contributed to better communication between the provinces and also enhanced the industrialisation, which consequently brought a decrease in transport costs thus bringing about the presence of agglomeration economies that characterise the industrial economic sector.

There are other studies that explore the linkages between clustering and economic development in different countries (Frazer, 2006; Geppert & Stephan, 2008; Meihua & Shanyon, 2013; Yu et al. 2014) but none have taken Mexico as subject of their analysis.

In the Mexican context, the work of previous authors has not studied the country as a whole, they present fractions of the regional environment and miss out on other industries that currently play an important role in the economy, such as tourism or the emergent aviation sector. This thesis would therefore be aimed at covering this gap by analysing the agglomerations patterns across the country during recent years when the service sector has expanded. This contribution would help to understand the effects of agglomerations and the service sector on regional income distribution under the context of a developing economy. By following the criteria of analysis performed in other countries the outcome of this study would be comparable to the results of former.

3 Methods

3.1 Theoretical Framework

As stated before, the main purpose of this thesis is to elucidate the effects of agglomerations on economic growth in the context of a developing country so as to have more elements that could explain regional inequality and poor income distribution. Mexico is the chosen country to evaluated in this case since agglomerations have been signalled as important drivers for its economy and causes of inequity. In the previous research section, it has been discussed how related analysis have addressed this topic and this preceding work is also used as guideline for developing the following theoretical framework.

Porter (2000, p. 15) defines cluster as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions … in a particular field that compete but also cooperate". The author also points out that for understanding economic development it is important to examine the interactions from a cluster perspective since it portraits the linkages, technological spillovers, skills, information and market needs that are present across companies and industries. Clusters can also affect the workforce by providing specialized training for the population and promote efficient production costs due to economies of scale (Trullen, 2015). These factors are relevant for constructing suitable strategies that boost the economy. Understanding the influence of clusters on growth is crucial for setting policies that prompt the dynamics of growth and achieve effective results, especially for developing economies. In the specific case of Mexico, the existence of natural resources and the proximity to wider markets have led to the development of agglomeration economies. An example of this clusters is found in the northern region of the country, where the manufacturing sector has benefited from the close access to international markets, and more acutely since the trade liberalization agreements.

Other important aspects to consider while analysing economic growth are the structural shifts and the levels of productivity between sectors. As Kuznets (1973) defined, some of the characteristics of modern economic growth are the rise in productivity and the high rate of structural transformation, which consist of economic shifts from the least productive sector of agriculture into manufacturing and then into services. The limited productivity of the primary sector is explained by the Engel's Law, it states that when the purchase power of individuals rises, the amount of income spend in food may increase but up to a limit of satisfaction. This behaviour is not seen in the demand of other goods such as manufactured products or services from the tertiary sector of the economy. The broader demand gives room for more competitors in search of efficiency and innovation, making these sectors more flexible and

productive (Perez, 2009). However, in some countries, structural changes and increased competitiveness under a globalized environment have hampered regional productivity instead of increasing it. McMillan and Rodrik (2011) explain that for countries where the local industries are smaller or inefficient the arrival of external competitors cause the close down of companies, reduction of job opportunities and, hence, a decrease in regional productivity.

The theory suggests that agglomerations and spatial proximity of economic activities are beneficial for productivity and growth, especially in economies at an early stage of development. The formation of clusters, highly populated areas and development centres have been a characteristic of economic growth. Ciccone and Hall (1996) conclude that the ratio of output to input, also known as productivity, rises with density. Brülhart and Sbergami (2009) results suggest that there is a positive relationship between agglomerations and growth for countries that have not reached a high level of income per capita. Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016) confirmed these findings by analysing the performance of Spain and provide evidence of a trade-off between income distribution and economic growth. Mexico is in the segment of countries with low or middle level of income per capita, clusters should be a driver in the economy. However, the results of Aguilar-Retureta (2016) and Mallick and Carayannis (1994) suggest that agglomerations in some sectors have negatively affected productivity in the Mexican context. The subsequent evaluation follows the framework proposed by previous authors while studying the phenomena in the context of developed countries. The results from this work would, therefore, serve to standardize the criteria for comparing results.

Based on the theory, the posed hypotheses in the case of Mexico are:

1. Agglomerations in the service sector have a positive association with GDP.
2. The higher productivity of the tertiary sector will be reflected on its impact on growth, and in comparison to agglomerations in other sectors.
3. Since service clusters are present in only some regions of the country, the consequences are uneven growth and regional divergence.

3.2 Methodology

This research uses a quantitative method to assess the relationship between agglomerations economies in the service sector and economic growth. The availability of observations over time, for each state, allows to work with a panel regression that controls for short-term cyclical effects.

With the purpose of analysing the influence of clustering, the independent variable, on economic growth, the dependent variable, the employed regression model is the one proposed by Barro and Sala-i-Martin (1991):

$$g_{i,p} = \alpha y_{i,t-T} + \beta A_{i,t-T} + \gamma Z_{i,t-T} + \mu_i + \nu_t + \varepsilon_{i,p} \quad [1]$$

The dependant variable is the average annual growth rate of GDP per capita for the state *i* during the period *p*, which is (*t*,*t*-*T*), where *t* and *T* stand for the year and the length of the period (*T* = 5). The dependent variable is calculated as

$$g_{i,p} = (y_{i,t} - y_{i,t-T}) / T \quad [2]$$

Where $y_{i,t}$ is the log of GDP per capita for the state *i* in the year *t*; $y_{i,t-T}$ is the log of the initial value of GDP per capita; $A_{i,t-T}$ is the variable of interest and it reflects the presence of agglomerations in state *i* at the start of each period; Z is the vector of control variables measured at the start of each period; μ_i, ν_t and $\varepsilon_{i,p}$ represent a state-specific effect, a time-specific effect and an error term, respectively. This model includes lagged variables since economic growth is autocorrelated with observations at different points in time and it depends on the initial level of income. The control variables included in this model are the ones recommended by Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016) since their work also focuses on within country comparisons and go in line with the growth accounting theory presented by Solow (1956). This set of variables include the rate of enrolment to high school education as a proxy for human capital stock and the log of stock of infrastructure as proxy for regional stock of public capital. The last variable to consider is share of mining as percentage of GDP to control for regional differences in natural resources, such as the presence of precious metals and oil, which are important elements of the Mexican economy.

For constructing the variables that capture the agglomeration effects in production, the indices proposed by Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016) are used. Both models are calculated first by using gross value added (GVA) and later using employment (EMP). The employment indices are analogous to the formulas displayed and the results are normalized in a range between 0 and 1.

The first index, Φ^i, is a proxy for the presence of agglomeration economies at the aggregate level for each state *i*, and is constructed as follows:

$$\Phi^i = \sum_{r=3} \left[log \left(\frac{\frac{GVA_r^i}{area^i}}{\frac{GVA_S^I}{area^I}} \right) \cdot \left(\frac{GVA_r^i}{GVA_S^i} \right) \right] \quad [3]$$

Where *i* corresponds to the 32 states in which the country is divided; S represents the total GVA for each of the states; *I* is the total of Mexico; *r* represents each economic sector (agriculture, manufacturing and services); and each state's area is expressed in square kilometres.

The second index that identifies the presence of agglomerations at a sectoral level for each state *i* and economic sector *r*, denoted as Ω_r^i, is the next one:

$$\Omega_r^i = log\left(\frac{\frac{GVA_r^i}{area^i}}{\frac{GVA_r^I}{area^I}}\right) \quad [4]$$

Since these indices calculate relative state agglomeration per square meter, they can be interpreted as a measure of relative economic density as in Ciccone and Hall (1996) study. The results obtained by using the topographic with-in country Theil indices express the difference between the expected and observed participation in the economy, hence an indicator of inequality. The absolute value of the index will be higher with stronger deviations from the expected outcome.

The method for estimating the model proposed above is a pooled ordinary least squares (OLS) regression. The model is tested with and without consideration of the control variables for the purpose of understanding their influence and to check for robustness. The use of different agglomeration indices, calculated with GVA and employment, has also the purpose of testing the initial results since they capture different aspects of agglomerations in production. It must be considered that, by employing an OLS regression in the modeling of a dynamic panel data, state-specific effects are ignored and potential endogeneity problems related to the explanatory variables. The results from a pooled OLS tend to be positively correlated to the error term, therefore, biasing the coefficients upwards.

4 Data

This section defines the variables that are required to execute the methodology previously illustrated, followed by the statistical analysis of the collected data and, lastly, a description of the database and its source.

4.1 Variables

The data used in this study covers the period from 2005 till 2018. In previous research, authors have used longer time spans by working with their own estimates on economic performance but the aim of this study is to focus on recent trends and differences between regions rather than presenting a historical analysis. The length of the chosen period allows to construct a reliable panel data that controls for unmeasured regional characteristics while relying on observed data instead of working with estimations.

To carry out the methodology proposed above, the required variables are the following:

Dependent variable

- GDP per capita in constant 2013 MXN: Gross Domestic Product is chosen in most analysis as a measurement of economic growth. In this case the indicator would be handled for reporting annual growth rate when used as regressand and in the form of base–year when used as regressor. The data is available on the national accounts section of the INEGI.

Agglomeration index variables

- GVA in constant 2013 MXN: Gross Value Added measures the contribution of each economic sector to the country's productivity. The data is acquired from the national account section of the INEGI and the information is classified into primary, secondary and tertiary activities by state.

- Sectoral employment: the data is collected from the National Survey of Occupation and Employment (ENOE) performed by the INEGI and it reports the number of individuals employed in each economic sector, specified by state.

- Area in square meters: data collected from the geostatistical information by state of the INEGI.

Control variables

- High school education rate: percentage of high school education enrolment in each state. The information is gathered from the intercensal survey by the INEGI at the beginning of the academic year.

- Stock of public capital: infrastructure, machinery and other economic assets owned by the state. The variable was calculated through the modified perpetual inventory method proposed by Almon (1999) and the considerations from Gutiérrez (2017), with information from the economic data bank of the INEGI (Appendix A).

- Share of mining: proportion of gross value added originated from the mining industry (oil included) to GDP. The GVA data, on the national accounts section of the INEGI, includes a subdivision of the detailed economic activities that conform each sector. From this subdivision the share of mining production in regional productivity is obtained.

4.2 Data Statistics

The following table (Table 4.1) with the descriptive statistics gives a brief description of the employed data. When handling the data for the modelling process, the figures on GDP and stock of infrastructure were transformed from pesos into a logarithmic scale. The agglomeration variables are shown in the normalized range [0-1]. Except for the growth rate of GDP per capita, the variables have 128 observations since the information covers the years of 2005, 2010, 2015 and 2018 for each of the 32 states in Mexico. There were no missing values and the data represents the figures from the original database.

Table 4.1 Descriptive Statistics

Variables	Mean	SD	Maximum	Minimum	Observations
GDP per capita					
Annual growth rate	0.01	0.02	0.071	-0.087	96
Level (MXN)	152345.60	153642.10	1376034	49758.64	128
Agglomeration [0-1]					
Aggregated, GVA	0.259	0.186	1	0	128
Agriculture, GVA	0.564	0.267	1	0	128
Industry, GVA	0.334	0.211	1	0	128
Services, GVA	0.247	0.189	1	0	128
Aggregated, EMP	0.297	0.194	1	0	128
Agriculture, EMP	0.566	0.285	1	0	128
Industry, EMP	0.359	0.196	1	0	128
Services, EMP	0.287	0.198	1	0	128
Controls					
High school education rate (0-1)	0.552	0.098	0.922	0.332	128
Stock of infrastructure (millions MXN)	20.180	17.984	135.734	1.004	128
Share of minning (GDP)	0.063	0.165	0.878	0.000	128

Notes: GDP: Gross Domestic Product GVA: Gross Value Added, EMP: Employment, MXN: Mexican peso

At first glance, the level of inequality is manifested on the statistical description of GDP per capita. The maximum level corresponds to the state of Campeche during the year of 2005 and the minimum to Chiapas for the year of 2018. These two states are located close to each other in the south eastern part of the country, nevertheless, the difference in availability of natural resources plays in favour of Campeche where the oil industry generates important revenues. On the other hand, the growth rates show a contrasting picture, the minimal observation correspond to the previously ranked top state of Campeche but this time during the period between 2015 and 2018. The maximum growth rate was registered in the same period and corresponds to Baja California Sur. This state is located in the north western part of Mexico and its main economic activity is tourism. In the case of Campeche, the figures reflect the performance of the oil industry where, since 2015, international market prices have dropped and the national production has decreased. In overall, GDP per capita has increased in Mexico, even though between the period of 2005 to 2010 the growth rate was negative.

The rate of enrolment to high school education has in general increased over the observed periods. The percentage of the total population that enrolled was 44% in 2005 and 64% in 2018. The minimum observed value conveys the level of education in Guanajuato during 2005 and the maximum corresponds to Mexico City in 2018. There is a marked difference between the southern states, where the rates of high school participation and GDP per capita are lower, and the rest of the country. It is also worth mentioning that the south has the smallest proportion of alphabetized population while the highest is recorded in northern states and Mexico City.

In the case of the share of mining, the minimal observation corresponds to Mexico City in 2015 and the maximum to Campeche in 2005. This reflects the importance of the oil industry

for the Mexican economy and its decreasing value added. The states with the highest participation in mining are the ones who produce oil, located in the Gulf of Mexico (Campeche, Tabasco, Veracruz and Tamaulipas), the ones who produce precious metals (Zacatecas, Sonora, Durango and Chihuahua), Baja California Sur with the extraction of salt and Chiapas by the production of amber. At a country level, the share of mining in GDP has decreased from 9.8% in 2005 to 5% in 2018.

4.3 Database

The data used for carrying out this analysis is obtained from the National Institute of Statistics and Geography in Mexico (INEGI). The INEGI is the institution in charge of obtaining and spreading the information related to territory, resources, population and economy in Mexico. It exists since 1983 and follows international regulations that assure transparency, objectivity and independence for reliable data collection. In addition to the external normative to which the institution complies, its structure includes an internal auditing organism and an ethics committee that promotes and reinforce integrity within the organization.

The INEGI is a member of several international organizations, such as the Statistics Committee of the OECD, the executive committee for International Comparison Programme and the Statistical Commission of the United Nations. It also has a cooperation agreement with the statistical office of the European Union EUROSTAT. This makes the databases from which the information is collected a trustworthy source. The INEGI display transparent methods on how the data, gathered from periodical census, surveys and statistical information from other public institutions, is managed.

5 Empirical Analysis

In this section, the results from the econometrics models are presented and analysed. The first segment shows the pattern of agglomerations, the second explains the outcomes of the proposed model for aggregate production and the third one presents the results for sectoral indicators.

5.1 Agglomerations

The aggregated agglomeration variable, when GVA is considered, indicates that the maximum concentration was reached in 2018 by Mexico City and the minimum was on the same year by the state of Durango (Figure 5.1). This suggests that agglomeration have increased in some regions while in others spatial cohesion has diminished through time, since the minimal value is found in recent years and not at the beginning of the studied time interval. When EMP is considered for the calculation, the maximal value corresponds to Mexico City as well but in the year of 2005 and the minimum to Baja California Sur in the same time period. The data indicates that the concentration of value added produced by Mexico City has increased although with less employees compared to the national trend, which also implies higher productivity in this city. Agglomeration economies under the GVA approach seem to follow a divergent pattern, meanwhile for employment the data is converging. In other words, the gap of value added generated is tending to increase between regions while inequality of job opportunities is shrinking.

At the sectoral level, the maximum value observed in agricultural agglomerations, considering GVA (Figure 5.2), is Aguascalientes during 2018 and the minimum is Quintana Roo during 2015. By looking at employment agglomerations in this sector, the state that ranks highest is Morelos in 2010 and the lowest is Coahuila in 2018.

Moving on with the secondary sector, the maximum value corresponds to Mexico City in 2005 and the minimum to Baja California Sur, also during 2005. For the industrial sector, the employment data reports the same behaviour as the GVA agglomerations and describe a consistent pattern of convergence. This means that the presence of industries across regions has been more homogeneous since the observations tend to be closer to the mean through time. The contribution to GDP (Figure 5.3) and the employed individuals in the industrial sector have become more uniform across regions.

Figure 5.1 Agglomeration Economies in Aggregate Production Φ^i in Mexico, 2018 (Gross Value Added)
Source: Own calculations based on INEGI data

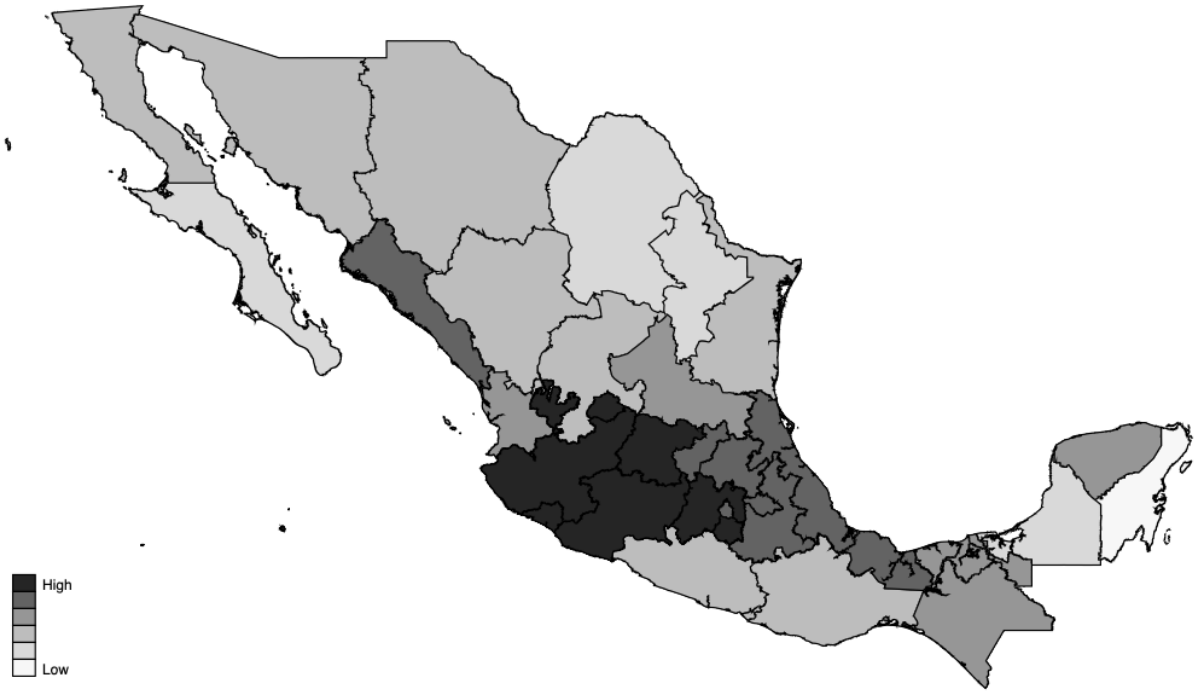

Figure 5.2 Agglomeration Economies in the Agriculture Sector Ω_r^i in Mexico, 2018 (Gross Value Added)

Source: Own calculations based on INEGI data

Figure 5.3 Agglomeration Economies in the Manufacturing Sector Ω_r^i in Mexico, 2018 (Gross Value Added)

Source: Own calculations based on INEGI data

Figure 5.4 Agglomeration Economies in the Service Sector Ω_r^i in Mexico, 2018 (Gross Value Added)

Source: Own calculations based on INEGI data

In the service sector, the same trend towards equality is visible when agglomerations are calculated with data on employment. The minimum observation corresponds to Baja California Sur in 2015 and the maximum to Mexico City in 2005. Nonetheless, the data for agglomerations by GVA is not conclusive on the pattern in which clusters are evolving. The maximal value is, as before, Mexico City in 2005 but the minimal is observed in 2018 for the state of Durango.

Figures 5.2, 5.3 and 5.4 present the agglomeration distribution, calculated through GVA, for each economic activity in the year of 2018. The map displaying the spatial density of the service production (Figure 5.4) does not show much variation compared to the one reflecting aggregate production (Figure 5.1). Therefore, it would indicate that clusters in the service sector are more relevant than agglomerations in other sectors. The spatial allocation of industries, when estimated with employment data, show similar patterns (Appendix B).

The relationship between agglomeration economies and GDP per capita can be examined in Figure 5.5. It presents GVA per capita in each state for the four time intervals and its relationship with the agglomeration index, calculated through GVA. The trend suggests that with stronger presence of clusters, GVA per capita is also higher. However, the pattern is somehow erratic. The observation that appears as an outlier on top of each graph, corresponds to the state of Campeche and the share of mining variable aims at controlling this deviation.

To have a visual representation of the distribution of growth, clustering and their relationship, Figures 5.1 and 5.6 show the presence of agglomerations at state level and the rate of growth of GDP per capita during the period analysed.

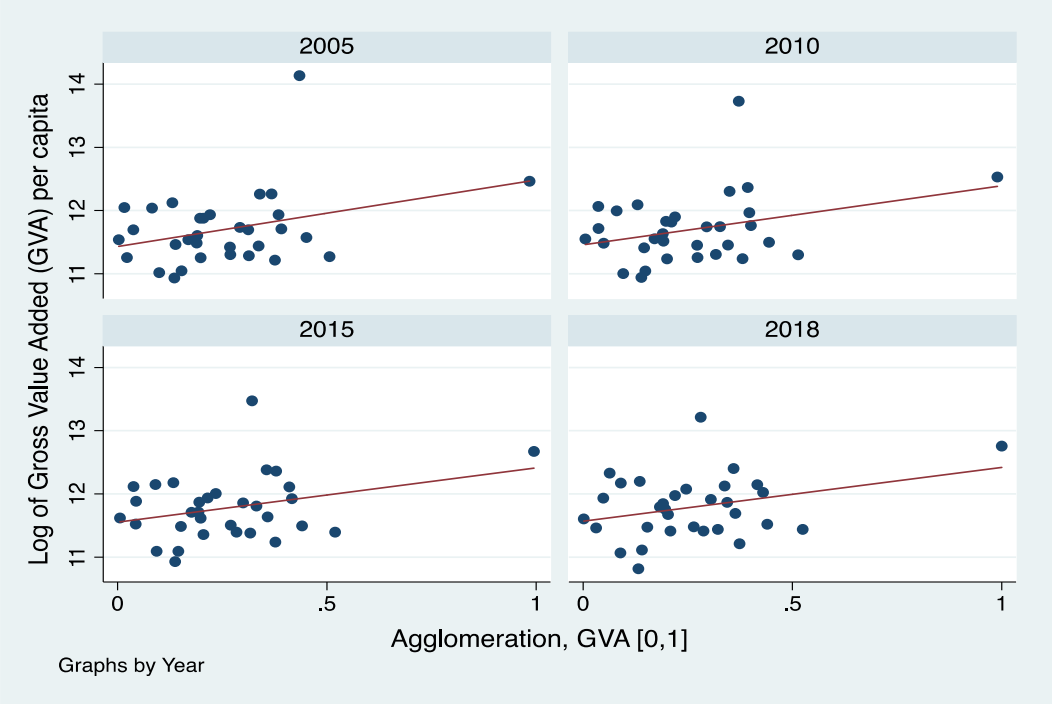

Figure 5.5 GDP per Capita and Agglomeration Economies in Aggregate Production (Φ^i) in Mexico by Year, 2005-2018

Source: Own calculations based on INEGI data

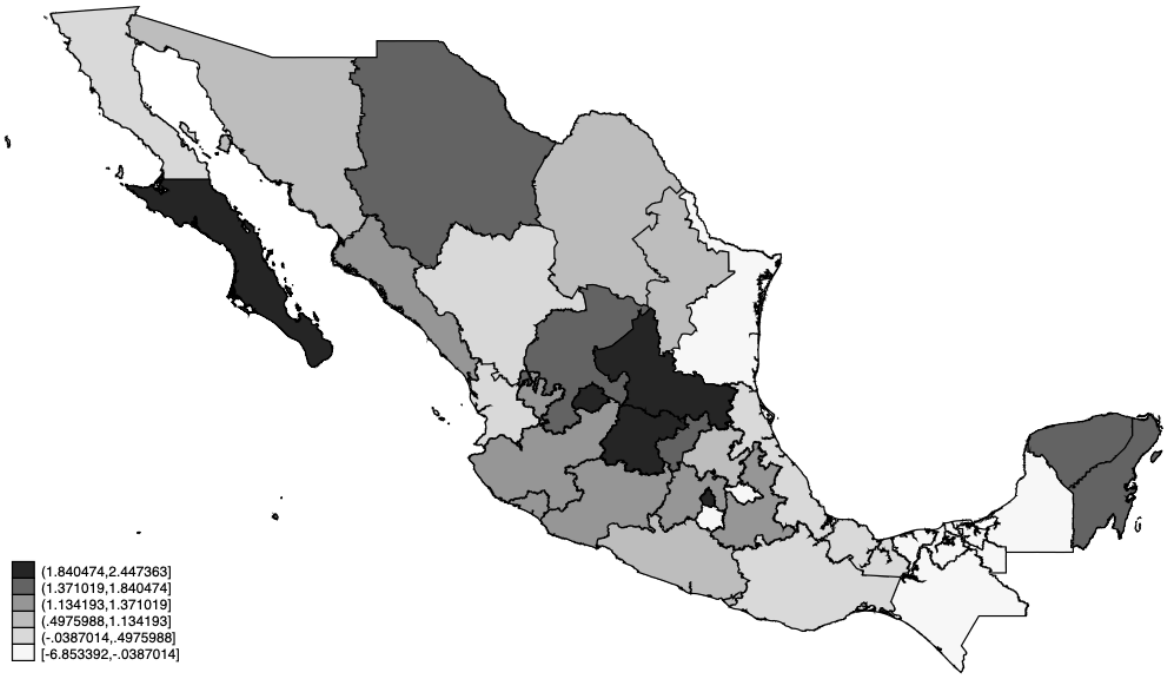

Figure 5.6 Annual Growth Rate (Per Cent) of GDP per Capita in Mexico, 2005-2018
Source: Own calculations based on INEGI data

According to the index Φ^i in 2018, the state with the greatest economic density was Mexico City. The agglomeration indicator seems to describe a ripple effect on the states surrounding Mexico City and the second region in the ranking is the State of Mexico, which is nearest to the capital. In the north, Nuevo Leon also shows a significant concentration of production. In here is located Monterey, one of the most important cities of Mexico. The rest of the states in the north and in the southern extreme of the country show poor production density.

The annual growth rates, displayed in Figure 5.6, identify Mexico City, Aguascalientes, San Luis Potosi, Baja California Sur and Guanajuato as the states with the best performance. There are some similarities between this distribution and the one presented in Figure 5.1. although a conclusive relationship cannot be reached.

The description of the variables indicates the apparent relationship between agglomeration economies and growth. However, the analysis continues on the next segment by estimating the parameters of the model proposed in the theoretical framework.

5.2 Aggregate Production Model

The first step of the modelling is to evaluate the association between spatial production density and economic growth through the agglomeration index of aggregate production (Φ^i).

The results from the pooled OLS regression are displayed in Table 5.1 and the standard deviation is indicated under the estimated coefficients. The sample contains 96 observations that correspond to the thirty two states in Mexico over three periods. Columns (1) and (4) show the estimates for the GVA and EMP indices without considering other interacting factors. The value of R-squared is between 0.14 and 0.16 and in both cases the variables are statistically significant. These two approaches reach matching results and suggest that the effect of agglomerations on GDP per capita growth is positive. The negative coefficient of the lagged variable on GDP per capita indicates conditional convergence. This means that poorer states grow faster than richer states because they are further away from a steady stage.

Table 5.1 Agglomeration and GDP per Capita Growth in Mexico, 2005-2018 (Ordinary Least Squares (OLS))

Variables	(1) **OLS**	(2) **OLS**	(3) **OLS**	(4) **OLS**	(5) **OLS**	(6) **OLS**
GDP per capita	-0.017 (0.002)	-0.018 (0.003)	0.006 (0.013)	-0.015 (0.002)	-0.016 (0.003)	0.006 (0.013)
Agglomeration, GVA	0.015 (0.002)	0.011 (0.004)	-0.002 (0.004)			
Agglomeration, EMP				0.020 (0.004)	0.016 (0.006)	-0.002 (0.004)
High school education rate		0.000 (0.000)	0.000 (0.000)		0.000 (0.000)	0.000 (0.000)
Stock of infrastructure		0.001 (0.002)	0.000 (0.003)		0.001 (0.002)	0.000 (0.003)
Share of mining			-0.105 (0.053)			-0.106 (0.054)
Observations	96	96	96	96	96	96
R-squared	0.144	0.165	0.464	0.159	0.175	0.464

Notes: GDP: Gross Domestic Product, GVA: Gross Value Added, EMP: Employment
Dependent variable: annual growth rate of GDP per capita; independent variables are lagged once; all variables are in logarithmic scale except for rates/shares (0-1).
Results tested at a 95% statistical significance level, standard errors are reported in parenthesis below the coefficients.

Columns (2) and (5) show the regression results when controls for education and stock of infrastructure are added. With GVA and EMP indices, agglomerations remained to be relevant in the model but the coefficients of the control variables appeared not to have significance. The r-squared measure improved in both cases although the model is stronger when data on employment is used, as well as the coefficient for agglomerations.

The last estimations, showed in columns (3) and (6), include share of mining as control variable. This factor is considered because there are some states that are well endowed with mineral or oil reserves and whose economic activity is reliant on these natural resources. The values of R-squared increased considerably for this regression. However, the coefficients and the model were not statistically significant.

5.3 Sectoral Production Model

The second empirical model considers the relationship between sectoral agglomerations and growth of GDP per capita, calculated with the index Ω_r^i. The results of the pooled OLS regressions are shown in Tables 5.2 and 5.3 and the number of observations is the same as in the previous section. In this case, the control variable for share of mining is omitted since it did not contribute in explaining the relationship between the dependant and independent variables. The model is evaluated through the disaggregation of the economic production by sector, first individually and then collectively.

Table 5.2 Sectoral Agglomeration (GVA) and GDP per Capita Growth in Mexico, 20015-2018 (Ordinary Least Squares (OLS))

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS
GDP per capita	-0.016	-0.017	-0.017	0.002
	(0.003)	(0.003)	(0.003)	(0.014)
GVA, Agriculture	0.003			0.014
	(0.003)			(0.020)
GVA, Industry		0.000		-0.119
		(0.004)		(0.067)
GVA, Services			0.024	0.120
			(0.008)	(0.049)
High school education rate	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Stock of infrastructure	0.002	0.002	0.001	0.003
	(0.002)	(0.002)	(0.002)	(0.001)
Observations	96	96	96	96
R-squared	0.159	0.158	0.194	0.340

Notes: GDP: Gross Domestic Product, GVA: Gross Value Added
Dependent variable: annual growth rate of GDP per capita; independent variables are lagged once; all variables are in logarithmic scale except for rates/shares (0-1).
Results tested at a 95% statistical significance level, standard errors are reported in parenthesis below the coefficients.

The first table (Table 5.2) reflects the estimates obtained when data on GVA is used for calculating agglomerations. Column (1) shows the results of the agriculture sector, Column (2) corresponds to the secondary sector and Column (3) to services. In these three cases, the coefficient of GDP per capita is significant and suggests a conditional convergence trend although only the coefficient of agglomeration in the tertiary sector was statistically significant. The value of R-squared oscillates between 0.15 and 0.20, being stronger for the estimate on services. These results would imply that only agglomerations in the service sector positively influenced economic growth. Nonetheless, when regressing the sectoral

agglomerations collectively the model reports an insignificant coefficient which could denote excessive correlation effects.

Table 5.3 shows the results from the regression when the agglomeration index is calculated through employment. In this case, all the coefficients of GDP per capita are statistically significant and negative, which indicate a tendency towards conditional convergence. The measure of R-squared is once again stronger than for GVA, being highest when the model is integrated by the three sectors. The estimates from the agriculture sector, shown in Column (1), report a negative effect of clustering on economic growth and a statistical significance of education, although the coefficient is irrelevant. Columns (2) and (3) show statistical significance for the coefficients of clusters in the industrial and service sectors. The influence of agglomerations in these two sectors seem to positively affect economic growth. Then again, when fitting the three sectors to the model, the results demonstrate that only the agricultural and the service sectors have an influence on growth.

Table 5.3 Sectoral Agglomeration (EMP) and GDP per Capita Growth in Mexico, 2005-2018 (Ordinary Least Squares (OLS))

Variables	(1) **OLS**	(2) **OLS**	(3) **OLS**	(4) **OLS**
GDP per capita	-0.021	-0.016	-0.016	-0.030
	(0.002)	(0.003)	(0.003)	(0.004)
EMP, Agriculture	-0.017			-0.062
	(0.004)			(0.021)
EMP, Industry		0.015		-0.007
		(0.006)		(0.023)
EMP, Services			0.015	0.084
			(0.006)	(0.042)
High school education rate	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Stock of infrastructure	0.002	0.001	0.001	0.000
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	96	96	96	96
R-squared	0.190	0.173	0.175	0.363

Notes: GDP: Gross Domestic Product, EMP: Employment
Dependent variable: annual growth rate of GDP per capita; independent variables are lagged once; all variables are in logarithmic scale except for rates/shares (0-1).
Results tested at a 95% statistical significance level, standard errors are reported in parenthesis below the coefficients.

In overall, the results support conditional convergence in the growth rates of GDP per capita from 1.6 per cent to 3 per cent. This is in line with the existing literature on regional convergence (Barro, R. and Sala-I-Martin 1991; Mathur 2005). The rate of high school enrolment and the stock of infrastructure have positive impact on growth, although

statistically irrelevant. This is similar to Padilla-Pérez and Villarreal (2017) given that they presented highly qualified production factors as non-significant for value added growth.

Conversely, production agglomerations show mixed effects. When analysed on an aggregate level, the relationship between clustering and growth is consistently positive. From a sectoral level perspective, the influence of service agglomerations is positive and agglomerations in agriculture proved to be detrimental for economic growth. This supports the initial hypothesis, the service sector has favourable effects on productivity and the results contrast with the negative influence of the primary sector. Even though the data suggests a pattern of conditional convergence, an absolute trend towards equality between regions was not reached and the hypothesis on divergence holds, which is also the conclusion reached by Aguilar Retureta (2016) during his analysis of the most recent decades.

These results support the findings from Mallick and Carayannis (1994) in their review of the Mexican economy. Their study only represented the service industry through tourism, nevertheless the conclusions are alike, the economic effects of this sector are convergent whilst the manufacturing industry does not show a relevant influence. Brülhart and Sbergami (2009) and Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016) identified conditional convergent patters in their analysis of developed countries. Although the latter signalled the manufacturing sector as significant for economic growth given the industrialization period in which the study was conducted for Spain. The negative effect of agglomerations in agriculture is a behaviour also acknowledged by Mallick and Carayannis (1994) and that goes in line with the theory extracted from Kuznets (1973) on structural transformation. The surplus resources, in this case of labour, do not represent an increase for economic growth due to the low productivity levels of the primary sector.

6 Conclusion

This thesis explores the relationship between economic agglomerations in the service sector and regional economic growth in Mexico between the years 2005-2018. Under the studied period, the country continued the path towards economic openness and encouraged the entry of foreign investment for the development of specialized sectors, such as mining, automotive and aerospace manufacturing industries, tourism and the energy sector. To address the dynamics of interaction between the two variables, this work followed the methodology suggested by Brülhart and Sbergami (2009) and Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016). It also examined the conditional convergence patterns in the states of Mexico. The empirical model considered variables that controlled for human capital and public infrastructure, following the framework of previous literature, and assessed the results through different indices for identifying spatial production density. To achieve this, the information acquired from the INEGI included productivity data on national and regional levels, subclassified by economic sector. The aim of this thesis was to test the theory that describes agglomerations as positive drivers for economic growth in the scenario of a developing country, and to understand the implications on regional inequality. The findings of previous research on the benefits of structural shifts were also considered. The higher productivity of the tertiary sector was expected to be reflect on the rates of growth and have stronger positive effects, compared to the impact of agglomerations in other sectors.

The main hypothesis in this study was that agglomerations in the service sector had a positive association with GDP and the basis for making this assumption followed two lines of thought. On one hand, the previous research by Brülhart and Sbergami (2009) and by Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016) which contributed to the theoretical understanding of agglomeration economies as beneficial agents for economic growth and on the other hand the work of Maddison (1995), where he observed that structural shifts tended to be from agriculture into the tertiary sector because of the higher yield possibilities in services. This hypothesis was first approached from a general perspective, by looking at aggregate agglomerations, to assess whether spatial proximity encouraged economic growth. The second step was to examine the influence of service agglomerations individually. At an aggregate level, the results suggest that production agglomeration in Mexico have indeed favourable effects on productivity. At the sectoral level, the estimates supported the positive impact of the service sector with the GVA and employment indices. This contrast with the conclusions reached by Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016), they observe that the evolution of agglomerations in the industrial sector was determinant in describing the relationship with economic growth. Nevertheless, their study reflects the situation of Spain in a period of early development and industrialization. The work by Brülhart and Sbergami (2009) is a better suited comparison in this respect since their time

span correspond to recent years for 16 European countries. Their main findings do not reflect the influence of each sector as a whole but they conclude that financial service agglomerations have a positive influence on income while estimates for clusters in manufacturing were not significant. These results exhibit similar findings to this thesis since the presented outcomes indicate significance for the service sector and non-relevance for industrial agglomerations.

Which leads to the second hypothesis, agglomerations in the service sector have a stronger contribution for economic growth than other sectors. The estimations for GVA only appointed service agglomerations as influential for growth but with employment data the asseveration extended to agricultural clusters. However, the relationship between agricultural employment agglomerations and economic growth was negative. Mallick and Carayannis (1994) pointed out that agricultural clusters have not represent a positive impact on local economies. This goes in line with what Kuznets (1973) derives from his studies. He identifies a decreasing trend in the contribution of agricultural activities to economic development and a shift towards economic sectors with higher productivity rates. The results suggest that the transition has been inefficient and there are more resources spent on this sector than what is needed. Another possible explanation is the inference made by McMillan and Rodrik (2011), they conclude that countries that lack the infrastructure and flexibility to adapt during structural transformations would suffer a decrease in productivity as a result of misallocation of resources. With globalization and economic openness, weak or small industries in Mexico might have ceased to exist, therefore, decreasing job opportunities and pushing the labour force to return to agricultural activities. Mexico fits the profile of the country described by McMillan and Rodrik (2011). They argued that when a country has an important share of natural resources, the traditional specialization activity would be in the agriculture sector and competition would encourage to exploit this industry. This would explain a stronger spatial density in agriculture hindering regional growth, in accordance with the point made by Aguilar-Retureta (2016) on the negative effects of particular industries in productivity.

The final hypothesis was that agglomerations, as a consequence, create inequality and uneven economic growth across the states of Mexico. The results obtained through productivity and employment data, indicated that regional growth in Mexico followed a trend of conditional convergence. This means that the states sharing similar characteristics will achieve a certain parity on level of income, but the breach between the poorest and the richest would not decrease. The conclusions reached by Brülhart and Sbergami (2009) and Díez-Minguela, Martínez-Galarraga and Tirado-Fabregat (2016) also discard a tendency for absolute convergence and suggest a trade-off between homogeneity in the pattern of agglomerations of economic activity and economic growth. The outcomes of the studies performed for the case of Mexico also ruled out a consistent trend towards convergence. Mallick and Carayannis (1994) found conditional convergence for the states whose primary economic activity is related to hotels and transportation and none for agriculture or mining sectors, where natural resources are fixed determinant characteristics. Aguilar-Retureta (2016) analysis indicates that production agglomerations have attracted more industries to concentrate in already clustered area, leading to a pronounced divergence. The author also mentions that the observed patterns

of convergence were motivated by a decrease in growth from the best performing states rather than from an improvement of the poorest. His estimates on state ranking mobility also confirm the prevalence of inequality across the country.

Policy strategies aiming at decreasing regional inequalities should consider the effects that agglomerations have on income distribution and growth. The criteria for developing policies that stimulate economic growth ought to allocate resources in the sectors with increasing productivity which, based on this study and related research, corresponds to the tertiary sector. In Mexico, there have been some strategies for promoting economic growth in the states that have lagged behind, located mainly in the south. One of these strategies is the implementation of Special Economic Zones (SEZ) which aims at increasing employment, investments, and facilitate economic growth in specific states, by establishing special regulations that could seem appealing for firms, in comparison to the rest of the country. This type of policies could incentivise the creation of agglomeration economies in regions that have failed to converge to average national growth rates. However, an understanding of how clusters interact with the economy is needed in order to create successful strategies and ultimately decrease inequality. The contribution of this thesis has been to expand on the knowledge on agglomerations and their interaction with economic growth as a way to explain regional inequalities. The emphasis has been on service agglomerations given that the tertiary sector is gaining importance in the global economy and Mexico is no exception. The findings thus discussed add up to the ongoing analysis of regional inequality in developing countries and expand on the evidence for future policy strategies.

The results of this thesis were obtained from an OLS regression and the use of alternative spatial concentration indices, based on GVA and employment data. The purpose of using different indicators for clusters was to capture the different aspects of agglomeration economies and generate accurate outputs. However, a regression model run by ordinary least squares in a dynamic panel has the risk of leading to biased estimations because of serial correlation, or autocorrelation errors. In further analysis this could be solved by using a different method to check for robustness, such as system GMM, to minimize simultaneity bias and control for unobserved heterogeneity.

Another improvement would be to work with data on a smaller spatial scale. The theory suggests that some of the effects of agglomerations, such as spillovers and tacit knowledge, are visible at small scale, within states and cities. Local patterns of clustering would be more useful for acknowledging the power of agglomerations. Rosenthal and Strange (2001) realized that, while observations at the level of states reflect the effects of transportation costs and resource availability, only agglomerations examined at close scale can reveal knowledge spillover effects. Nonetheless, data in such detail level could be challenging to gather.

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A. Appendix A

Stock of Public Capital

The method used to build the stock of public capital is the perpetual inventories model recommended by the OECD. The calculations consider the adjustment factor proposed by Almon (1999) and employed by Loria and de Jesús (2007) and Gutierrez (2017) on analogous estimations for Mexico.
The model is expressed as follows:

$$SC_t = (1 - \delta) * SC_{t-1} + I_t$$

Where SC is the stock of public capital; δ is the rate of depreciation; I_t is the investment.
The formula to calculate the adjustment factor is the following:

$$Faj_t = (1-\delta) * Faj_{t-1} + 1$$

Where *Faj* is the adjustment factor and δ is the rate of depreciation rate.

With both calculations the final step is to obtain the adjusted stock of public capital.

$$SCA_t = \left(\frac{SC_t}{Faj_t}\right)/\delta$$

The data required to carry out the estimations was gathered from the INEGI, for each of the 32 states in Mexico, and the depreciation rate was considered to be of 9.07% and constant, as Gutierrez (2017) suggested.

B. Appendix B

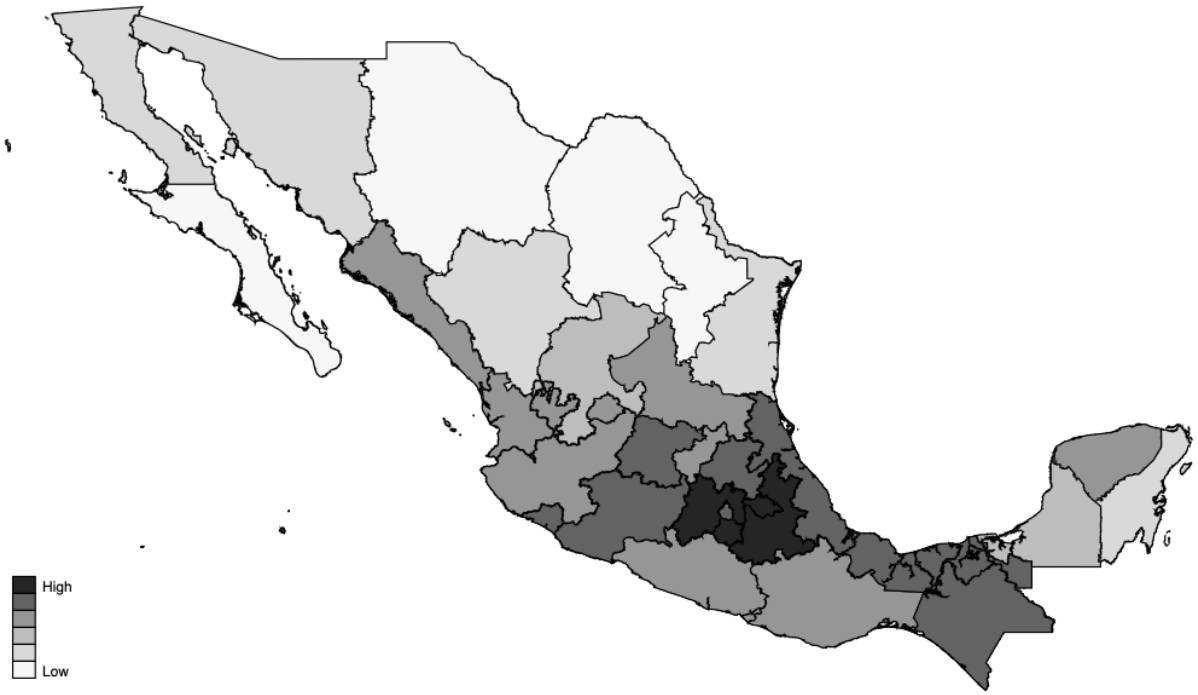

Figure B.1 Agglomeration Economies in the Agriculture Sector Ω_r^i in Mexico, 2018 (Employment)

Source: Own calculations based on INEGI data

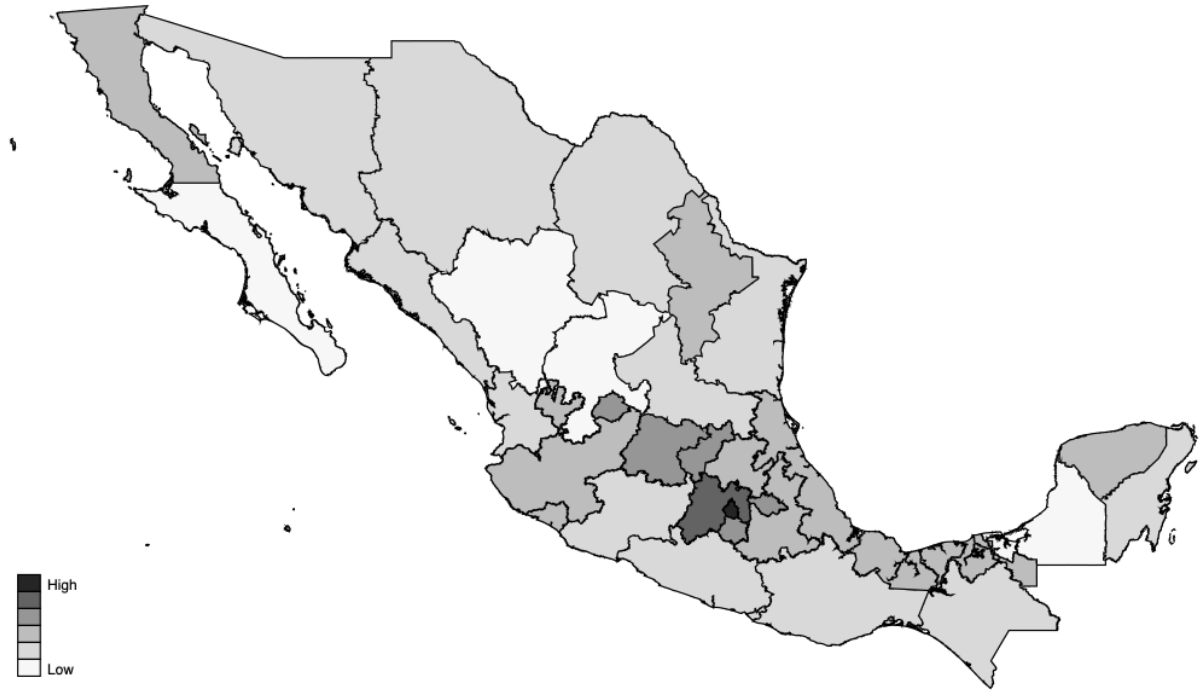

Figure B.2 Agglomeration Economies in the Manufacturing Sector Ω_r^i in Mexico, 2018 (Employment)
Source: Own calculations based on INEGI data

Figure B.3 Agglomeration Economies in the Service Sector Ω_r^i in Mexico, 2018 (Employment)
Source: Own calculations based on INEGI data

Figure B.4 Agglomeration Economies in Aggregate Production Φ^i in Mexico, 2018 (Employment)

Source: Own calculations based on INEGI data