The distributional effects of NAFTA in Mexico: evidence from a panel of municipalities

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Abstract

This paper studies the regional distribution of the benefits from trade in Mexico after NAFTA. Specifically, we ask whether or not NAFTA has increased the concentration of economic activity in Mexico. Unlike previous work which uses state-level data, we identify the effect of NAFTA on economic activity at the municipal level allowing us to observe detailed growth patterns across space. Further, to explicitly identify the effect of the trade agreement, we compare results for growth in traded and non-traded sectors. Given the spatial nature of these data, we make explicit use of spatial econometrics methods. We find that NAFTA caused the wealthy regions nearest to the border to grow faster than others, increasing regional disparity. Second, we find that larger municipalities experienced greater per-capita economic benefits from NAFTA. This effect is particularly noticeable in the north. Somewhat surprisingly, we find that regions with a less literate workforce and worse infrastructure grew faster than other areas after the trade agreement, decreasing regional disparity. We notice these redistributive effects occur primarily in the non-traded sectors.

Keywords: Regional Disparities, Trade Liberalization, Agglomeration Economies, Economic Growth, Mexico, Transport Cost, Spatial econometrics

1 Introduction

Economists generally agree that trade will benefit a country's economy. However, trade also affects the location of economic activity (Behrens *et al.* 2007, Krugman 1991, Hanson 1998a). Particularly for a country with great geographic disparity, such as Mexico, the distributional effects of trade are at least as important as the overall effect. Benefits of trade were expected to be concentrated mainly in the northern states of Mexico - due to their proximity to the U.S. market - but empirical evidence is mixed (Aroca *et al.* 2005, Krugman & Lizas-Elizondo 1996, Hanson 2001, Rodríguez-Pose & Sánchez-Reaza

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2005, Smith 1990). On the other hand, standard trade theory might predict that given Mexico's relative abundance of low-skilled labor, poorer regions with large pools of unskilled labor might benefit more from the trade agreement. In this paper, we study the distributional effects of NAFTA throughout Mexico. Specifically, we ask whether NAFTA increased the concentration of economic activity in Mexico.

Mexico has one of the highest rates of income inequality in the world (OECD 2008). Southern regions of Mexico feel that NAFTA hurt them, to primarily benefit northern states.[1] "NAFTA did not reach the South due to obstacles to economic development that afflict the Southern states, such as insufficient infrastructure and access to telecommunications services, and social instability and governance" (Esquivel *et al.* 2002). Despite anecdotal evidence, there is little empirical work looking at whether NAFTA made this disparity worse or better.[2] Since NAFTA was one of the early bilateral trade agreements to link a developing country to a large developed economy, its effects may shed light on the other bilateral trade agreements currently under negotiation. Further, understanding what caused regions to be harmed by trade might facilitate the development of programs to give regions better access to this new, large market, or, at a minimum, might allow for targeted compensation.

Although previous empirical studies have analyzed the geographic effect of NAFTA on economic activity in Mexico, they are limited by using state level data which masks the spatial distribution of economic activity and severely restricts their number of observations. This paper offers the following contributions. First, it uses municipal panel data to identify the relationship between trade and regional patterns of growth. The use of municipal data also provides more observations that could improve the precision of the estimated impact, since as the sample size grows the estimators converge in probability to the quantity being estimated. Second, we include the latest economic census (2004) to observe longer-term effects of NAFTA. Third, by separating economic activity into traded and non-traded goods, we can better identify the specific effect of trade. Last, unlike previous papers, we explicitly control for the spatial nature of our data, and use newly-developed spatial panel data methods (Kapoor *et al.* 2007).[3]

We find that NAFTA has increased the concentration of economic activity in Mexico. Output of regions near the border has grown faster than those regions further from the United States after NAFTA, even when these border regions already had high levels of economic activity before the

[1] Chiquiar (2008) studies wage differentials in Mexico. He finds that Foreign Direct Investment (FDI) and international trade have mostly increased wages in northern states.

[2] A key exception is Robertson (2000). Considering the effect of NAFTA on wages, he shows that border regions are more affected by United States labor market than the Mexican interior.

[3] See also Baltagi *et al.* (2007) for an application to models of complex FDI.

trade agreement. Second, we find that the benefits of NAFTA went disproportionately to densely-populated regions. This effect is particularly notable for cities in the north. Third, as might be predicted by a standard Heckscher-Ohlin model, we find that those regions with high rates of illiteracy benefit more from NAFTA. Regions with low levels of infrastructure also improved economically after NAFTA, implying a redistributive effect of these economic changes. However, mitigating against this redistributional effect, those regions with a large percentage of high-skilled labour also benefit more from the trade agreement.

When we split the data by sector, we observe that the traded sector, manufacturing, is affected most strongly by the pull of the border after NAFTA. For the non-traded sector, services, if anything we see a tendency to redistribute activity further away from the United States. Second, the non-traded sectors are driving the increased growth in municipalities with lower human capital and infrastructure. One possibility is that these sectors are moving out of regions where they compete against an expanding manufacturing sector for labour.

As expected, we find substantial spatial correlation in the municipal growth rates.

In the next section, we look at the regional distribution of growth in labor productivity before and after NAFTA. Next, we review the NEG models that suggest which factors might affect this distribution. Then we present our empirical model, estimation technique and data. Results and conclusions end the paper.

2 Regional distribution of economic activity in Mexico

Regional income inequality can create severe hardship for those families who are not easily mobile, and can cause stress on the social structure of a country. Thus, understanding the origin of this income inequality across and within regions in Mexico is essential for developing policies that can ameliorate the pervasive high levels of poverty in Mexico. Overall, Mexico has grown rich. Its $1.578 trillion economy is the world's eleven-largest, up from fifteenth position 15 years ago. Trade volume has nearly tripled since the NAFTA, from $52 billion to $161 billion in 2003, placing Mexico ahead of Britain, South Korea and Spain as a trading power (Smith & Lindbland 2003, Jordan & Sullivan 2003).

Over the same time, the number of poor in Mexico has increased.[4] Over half, 54% of the Mexican population is poor, which is unchanged from the early 1980, but given increase in population from

[4]According to Jordan & Sullivan (2003) poor are those individuals unable to meet basic needs.

70 to 100 million over the same period, this means that about 19 million more Mexicans are living in poverty than 20 years ago. More worrying, about 24 million, nearly one in every four Mexicans, are classified as extremely poor and unable to afford adequate food (Jordan & Sullivan 2003). Income inequality and poverty levels in Mexico remain the highest across the OECD. These poverty and income inequality levels are one and a half times higher than in a typical OECD country and twice as high as in low-inequality countries, such as Denmark (OECD 2008). Furthermore, most of those who are extremely poor live in rural areas. As a result between 400 to 600 people a day are packing up and migrating to cities or to the United States (Jordan & Sullivan 2003).

Economic output varies sharply by region. Following (Chiquiar 2008), we divide Mexico into 5 regions i) the Border Region, being states that border the United States; ii) the Northern Region, which includes states just south of the Border Region; iii) the Center; iv) the capital (Mexico City and surroundings); and v) the South (see figure 1).

Figure 2 shows the Gross Value Added (GVA) in real pesos by region. Before and after NAFTA, most of the GVA has been generated in or near Mexico City, followed by the Border and Center regions. The Border and Center regions grow more quickly over this period than other regions, while the North and South lag behind.

Growth of GVA before and after NAFTA is illustrated in figure 3. The map showing growth from 1980-85 (panel a) illustrates a higher number regionally-diverse municipalities with a growth of more than 100% than in 98-03. In contrast, in 98-03, growth is more concentrated in clusters along the US-Mexico Border (panel b). Some of the clusters that can be seen in the post-NAFTA map are Chihuahua, Saltillo, and Monterrey. One can clearly identify the areas of low growth in the south and more rapid growth in the north. Note that these maps also indicate that growth is by no means homogenous within a state. Therefore, considering these data by municipality allows us to more accurately discern the patterns of economic activity.

3 The location of economic activity after trade

In this paper, we ask: What is the distributional effect of NAFTA on Mexico? In particular, we are interested in whether NAFTA afforded poor regions economic opportunities, or whether the benefits are concentrated in those regions where economic growth was already robust. In the 1990s, a number of trade economists developed a theory explaining the location of economic activity, called the New Economic Geography (NEG). We briefly review NEG and its prediction for economic activity, particu-

larly after trade. Next, we present some possible implications of standard trade theory for the location of benefits from trade. We then use these theories to develop several hypotheses about how NAFTA may have changed the location of economic activity in Mexico.

3.1 NEG Theory

Agglomeration economies are positive externalities that induce the spatial concentration of economic activity, and these externalities can be affected by trade. Urban economic theory posits that firms obtain productive advantages from locating in close proximity to other firms and these benefits can explain the formation and growth of cities and industrial locations. The main sources of agglomeration externalities arise from improved opportunities for labor market pooling, knowledge interactions, specialization, the sharing of inputs and outputs, and from the existence of public goods (Chua 1993, Vayá *et al.* 2004). Myrdal (1957) talks about "Circular Causation" or "Positive Feedback" (Arthur 1989), where manufactures tend to locate around a large market, while the market also grows where manufactures production is concentrated. As the scale and density of urban and industrial agglomerations grows, an increase in the external benefits available to firms is also expected to be found Graham (2006). However, these benefits are expected to be balanced by the increase in congestion costs, increase land rent and higher wage rates (Krugman 1991).

New Economic Geography (NEG) theory posits that cities arise because the location of economic activity is influenced by market size, transportation cost, and economies of scale (Krugman & Lizas-Elizondo 1996). Krugman (1991) develops a two-region economy where there is tension between agglomeration (or the "centripetal" force) arising from economies of scale plus transport costs, while pressures for dispersion (or the "centrifugal" force) arises from the transport costs to dispersed immobile farmers. He argues that manufacturing firms will try to locate themselves in or near a region with large demand for their products, but that city size will be limited by congestion costs.

In a later paper, Krugman & Lizas-Elizondo (1996) replace the market demand from immobile, dispersed farmers by land rent as the source of centrifugal force. They show that in this case, increased trade can lead to dispersion of economic activity. The intuition is that as a new market arises from trade, the pull of the existent domestic market diminishes. The domestic center loses the consumers who can now consume from abroad. They apply this model to Mexico, and show that Mexico City has lost relevance as a determinant of regional economic growth over time. Further, Krugman & Lizas-Elizondo predict that the removal of trade barriers will primarily benefit for those regions close to the new market, in our case, those regions closer to the U.S. border.

In contrast, Paluzie (2001) and Monfort & Nicolini (2000) extend the original Krugman model by assuming that labor is not internally mobile, and show that trade agreements can increase agglomeration within the country, since as trade in manufacturing increases, regions already with these manufacturing facilities (i.e. maquiladora hubs in the north of Mexico) will tend to benefit more than other regions. The core differences between the Paluzie and Krugman models are, first, Paluzie (2001) assumes that high land costs and rents are the centrifugal force encouraging dispersion instead of the demand of dispersed agricultural population. Second, she assumes labor is immobile in the short run. The result is that once trade is opened up, imports and exports to and from the major cities increase more than the demand from rural areas (Rodríguez-Pose & Gill 2006).

NEG has a specific focus on the dynamics of growth. Krugman & Venables (1995) mention that as transport costs fall, or similarly, as trade barriers fall, one should observe convergence in real incomes, in which poorer peripheral nations definitely gain and core nations may well lose. This theory has been heavily tested using data from the EU. Barro & Sala-i Martin (1992) find that within the European Union (EU), as internal trade barriers fell, regions experienced convergent growth in GDP per capita in the period 1950-1985. Brakman *et al.* (2006), find similar results for the period between 1992 to 2000. Armstrong (1995) confirms the convergence in the EU for the periods of 1950-1960 and 1960-1970 but finds less convergence for the periods of 1970-1980 and 1980-1990. When comparing countries within the EU, Quah (1997) finds that Spain and Portugal, being the two countries with the highest rates of economic growth in the EU, are also those with the highest increase in regional imbalance. Sala-i Martin (1996) analyses Spain's regional convergence during the period 1950-1990, and although he finds convergence during the first decades, he determines that it fades after 1980. Outside the EU, Rodríguez-Pose & Gill (2006) find that among a variety of countries that increased trade from 1980 to 2000 (Brazil, China, Germany, Italy, Mexico, Spain and the U.S.), they observe a general trend towards economic divergence.

In the two papers that explicitly test for economic convergence in Mexico, empirical findings are mixed. Sánchez-Reaza & Rodríguez-Pose (2002) find that those states closer to the U.S. border grew faster than others before NAFTA, and there was no significant change in this pattern after the trade agreement. In this study, Mexico appears to follow a "Core and Periphery" pattern of economic development during the Import Substitution Industrialization (ISI) period (1930s to 1985). Regional growth was mainly characterized by convergence and linked (1) to the presence of oil and raw materials and (2) to proximity to Mexico City. However, during the GATT period (1985-1993), proximity to Mexico City lost its relevance as a determinant of regional economic growth. Thus, they

find evidence that the draw of Mexico City lessened after increased international trade, giving support to the hypothesis of Krugman & Lizas-Elizondo that trade has decreased agglomeration in Mexico. In contrast, Aroca et al. (2005) do not find that NAFTA substantially changed growth patterns in Mexico, and instead argue that agglomeration has emerged in the form of several income clusters. In particular, they find that regional disparities result from southern states lagged behind in economic growth since before the trade agreement was signed. Hanson (1998a,b) argues there has been a cluster creation along the U.S. border, especially in the manufacturing sector, which has led to the decline of Mexico City's manufacturing belt since mid-1980s. In a recent paper, Nicita (2009) finds similar results to Aroca *et al.* (2005) and Hanson (1998a,b). He estimates how NAFTA has affected living standards in Mexico through its effect on wages and prices. He finds that richer households have gained more than poor ones. While poor households also benefit from NAFTA, their gains are considerable lower. He also finds that households in urban areas close to US border are the larger beneficiaries while households in southern state are largely bypassed by the effects of trade liberalization.

3.2 Standard Trade Theory

Along with affecting the strength of centripetal and centrifugal forces, trade likely has a direct effect on the location of economic activity. As long as inputs are not completely mobile, those regions with a greater amount of inputs used in export production will presumably gain more from trade than those regions who are endowed with inputs that most efficiently produce import-substituting products. Assume that we have three inputs: land, skilled and unskilled labor, and three sectors, skilled-intensive, unskilled-intensive, and non-traded.[5] Further, assume that land is immobile, and labor is not perfectly mobile.[6] The standard Hecksher-Ohlin (H-O) model predicts that if Mexico has an abundant supply of unskilled labor relative to its trading partners, the United States and Canada, then it will export goods that are "unskilled-labor intensive". Therefore the "unskilled-labor intensive" goods industry will grow in Mexico and (mobile) unskilled labor in Mexico will benefit from higher wages resulting from this increase in demand for their services. Further, one might anticipate that regions with abundant unskilled labor will benefit more than other areas from trade with the United States. Last, if the sector using the abundant input has increasing returns to scale, one might anticipate trade to cause increasing agglomeration, despite the increasing conjestion costs and the decreased pull of the domestic market.

[5] We think of capital as completely mobile, and ignore it in this simple notional model.

[6] Evidence that labour is not completely mobile comes from Chiquiar (2008) who finds little mobility of individuals across Mexican regions in five-year intervals surrounding the Mexican trade reforms in the late 1980s and 1990s.

Combining the NEG and standard trade theory, we get the following hypotheses:

H1: Following Krugman & Lizas-Elizondo, trade will decrease agglomeration

H1a: Alternatively, following Paluzie, Monfort & Nicolini, trade will increase agglomeration

H2: Due to transportation costs, the benefits of trade will be greater in those regions closer to the border

H3: Those regions with an abundance of low-skilled labor will benefit

H4: Traded sectors will be more influenced by NAFTA and distance to the U.S. market than non-traded sectors

4 Empirical Model

Based on the previous subsections and the information available, we set out a panel data model with error components that are both spatially and time-wise correlated to explain the change in economic output over the period 1980-2003.

The general formulation assumes that in each time period $t = 1, \dots T$ the data are generated according to the following model:

$$y_N(t) = X_N(t)\beta + u_N(t) \tag{1}$$

where $y_N(t)$ denotes an $N \times 1$ vector of observations on the dependent variable in time period t, $X_N(t)$ denotes the $N \times K$ matrix of observations on exogenous regressors in the same time period, β is a corresponding $K \times 1$ vector of regression parameters, and $u_N(t)$ is a vector of disturbance terms. The disturbance process in each period follows a classical first order spatial autoregressive process:

$$u_N(t) = \rho W_N u_N(t) + \varepsilon_N(t) \tag{2}$$

where W_N is an $N \times N$ weights matrix of known constants,[7] ρ is a scalar generally referred to as the spatial autoregressive parameters, and $\varepsilon_N(t)$ is a vector of innovations in time period t. To further allow for the innovations to be correlated over time, (Kapoor *et al.* 2007) postulate an error component structure for the innovation vector, that is:

$$\varepsilon_N = (e_T \otimes I_N)\mu_N + \nu_N \tag{3}$$

[7] In our empirical application we will define a distance matrix with cut-off at the first quantile. We also experimented with different spatial weights matrices obtaining similar evidence. Results obtained with different W matrices are available from the authors upon request.

where μ_N represents the vector of unit specific error components and $\nu_N = [\nu'_N(1), \ldots \nu'_N(T)]'$ contains the error components that vary both over cross-sectional units and time periods. Finally, e_N is a $T \times 1$ unit vector and I_N an $N \times N$ identity matrix. Note that the specification of the error term in (3) corresponds to that of a classical one-way error component model as in Baltagi (2008), the only difference being the way in which the data are grouped.

(Kapoor *et al.* 2007) maintain the assumption that the error components ν_{it} are identically and independently distributed with mean zero, variance σ^2_ν and finite fourth moments. The error components μ_{it} are also identically and independently distributed with mean zero, variance σ^2_μ and finite fourth moments. Finally, the two processes are independent. Kapoor *et al.* (2007) suggest a generalization of the generalized moment estimator suggested in Kelejian & Prucha (1999) for estimating the spatial autoregressive parameter and the two variance components of the disturbance process. These estimators are then used to define a feasible generalized least square procedure (FGLS) for the regression parameters. Following the classical error component literature, a convenient way of calculating the FGLS estimator is to further transform the (spatially transformed) model by premultiplying it by $I_{NT} - \theta Q_1$, where $\theta = 1 - \sigma_\nu/\sigma_1$, I_{NT} an $NT \times NT$ identity matrix and Q_1 the standard transformation matrix well known in the error component literature (properly adjusted to account for the different ordering of the data, Baltagi 2008). The FGLS estimator is then identical to an OLS calculated on the "doubly" transformed model.

We assume economic growth will be a function of various measures of productivity, such as education and local infrastructure, transportation costs to the United States, and local market size. We then test whether the influence of these variables changed after NAFTA to determine which municipalities gained and lost from the trade agreement. We first consider growth (and levels) in overall GVA, and then split our data into traded and non-traded sectors, to see how the location of economic activity in traded sectors changed in response to NAFTA in comparison with the location of non-traded sectors.

4.1 Data

We use data from the *Sistema Municipal de Base de Datos* (SIMBAD) generated by the Mexican National Institute of Statistics, Geography and Information (INEGI, TABLES, 2005). Specifically, within SIMBAD, we use information from the 1981, 1986, 1989, 1994, 1999 and 2004 economic census and the 1980, 1985, 1990, 1995, 2000 and 2005 population census. The information on each census corresponds to data from the previous year.[8]

[8]Between the 1980 and 2004 censuses, 65 new municipalities were created. To analyze the same municipalities through the years, we merged the new municipalities back to their 1980 boundaries. We obtained the list of new municipalities

To observe how spatial patterns of economic activity have evolved in the different regions, we use the log of the municipal Gross Value Added (GVA).[9] We also consider the growth rate, defined as the difference in the log GVA. Because GVA nets out the value of inputs from outside the municipality, it is negative in about 0.68% of the observations. Thus, we took the minimum GVA over all years and all municipalities and added it as a constant to all productivity levels to ensure we did not lose any observations.[10]

Total GVA is calculated as the sum of output of various industrial sectors. When examining the data, we noticed a sharp change in the GVA of mining from 1980 to 1985, causing a very low correlation between GVA by municipality from 1980 to 1985 and then again from 1985 to 1988. In conversation with researchers at INEGI, we learned that the methodology for calculating mining GVA changed in this period. Therefore, to ensure that this anomaly did not affect our results, we use total GVA net of mining for the entire period.

For the sectoral analysis, INEGI reports the GVA for manufacturing, commerce and services consistently over our time period. The manufacturing sector is comprised of establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The Commerce sector is defined as firms engaged in wholesaling and retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The service sector is defined as establishments engaged in construction; transportation and warehousing; producing and distributing information; finance and insurance services; professional, scientific, and technical services; management of companies and enterprises; educational services; health care and social assistance; arts, entertainment, and recreation; and accommodation and food services (US 2002). We argue that manufacturing is clearly a traded sector, producing both exports and import-competing products. Commerce is less easily defined, since it will act as distributors for both imported and exported products, but the services it provides are not easily traded. We categorize services as the non-traded sector.

Figure 4 shows the GVA for each of the sectors. Both manufacturing and commerce increased their growth rate notably with NAFTA, while services, although increasing, grew at approximately the same rate before and after the trade agreement

and from where they were created (INEGI 2006). For those created from more than one municipality, we allocate the new municipality data by the percentage of how many people (or how much land), in the new municipality, were taken from the former municipalities (information provided by SEGOB 2005).

[9] GVA are presented in real thousand pesos from 2003.

[10] GVA is linked to the Gross Domestic Product (GDP) since both measure output. However, unlike GDP, GVA does not include taxes and subsidies on products. This approach is similar to Martin (2001), Fingleton & McCombie (1998), Fingleton & López-Bazo (2006), Esquivel & Messmacher (2002).

Summary statistics are in the appendix (Table 1).

NEG posits that distance to market influences the location of economic activity. To capture the effect of the local market, we include the population density in the municipality, measured in thousands of people per sq. kilometer. Following Krugman & Lizas-Elizondo (1996), we might expect the centripetal force may weaken after NAFTA, giving way to the centrifugal force that will make for a less concentrated urban system.

Also, to observe if Mexico City has lost relevance as a determinant of regional economic growth over time, we included the variable mexcap, which is 1 if the municipalities are in the Federal District or in the State of Mexico, which is where most of the concentration of growth has been focus before the NAFTA (Rodríguez-Pose & Sánchez-Reaza 2005).

Given the influence of the United States market even before NAFTA, we assume growth may be correlated with transportation costs to the U.S. border, which we proxy by road distance. We generate by calculating the distance from the capital of each municipality[11] (INEGI 2008 April 18) to the closest border-crossing point (using webpage "Traza tu Ruta" provided by the Secretária 2008).[12]

To control for existing infrastructure by using the % of households in the municipality with drainage (drain). This measure of infrastructure is highly correlated with other variables, such as electricity and plumbing, and results do not change substantially when we use these other indicators. To capture productive capacity, we include the literacy rate of the population between 6 to 14 years of age, lit614, and the percentage of the population with high school, hs, to capture high-skilled labor living in the municipality. To control for the effect of migration, we include the % of population that reside in a different entity 5 years ago, inmigration.

We would be remiss if we did not include the free-trade zone established by the Mexican government to produce manufactured goods for the U.S. market before NAFTA.[13] This zone was restricted to the border towns/cities in the northern states of Mexico. These towns/cities are Ensenada, Mexicali, Tecate, and Tijuana, in the state of Baja California; La Paz in Baja California Sur; Ciudad Acuña and Piedras Negras in Coahuila; Ciudad Juarez in Chihuahua; Agua Prieta and Nogales in Sonora; and Matamoros, Nuevo Laredo and Reynosa in Tamaulipas (Smith 1990, INEGI 2007,12 13). We include the annual average number of maquiladora establishments by municipality, ,Estadística de la Industria

[11] When one municipality includes more than one city or town, one of them is selected as *cabecera municipal* (head city or seat of the municipal government).

[12] For Municipality heads that do not appear as origin point, we calculate the distance of the nearest available city or town and add the road distance from that point to the municipality head of interest, which we calculate manually by using a map of Mexico.

[13] The maquiladora program is a governmental initiative, created by Mexico and the US in 1965, aimed at attracting foreign investment in the production of exportable goods, mainly in electronics and garment assembly (Fernández-Kelly 2007)

Maquiladora de Exportación, (INEGI 2007,12 13).[14]

We include a dummy variable that equals 0 for periods before NAFTA (1988 & 1993) and 1 for periods after NAFTA (1999 & 2004). We also interact the various market, distance and productivity variables with NAFTA to determine which characteristics determined whether a municipality benefited or lost from the trade agreement.

One issue we had with the data is that the change in GVA per municipality had a few notable outliers, lying over 10 standard deviations from the mean, resulting in a very peaked distribution. To ensure that our results were not driven by these outliers, we censored our sample at the first and 99th percentile of the distribution each year. This censoring changed 186 observations, and does create a small mass at each end of the distribution each year. However, while our coefficient estimates were mostly unchanged, our explanatory power improved, and the regression results became more robust to changes in model specification.

Hypotheses

We use the above data to test the following hypotheses:

H1: Trade will decrease agglomeration.

(a) Specifically, we test whether the draw of the domestic market weakens after NAFTA, and growth is faster in those regions with less dense population.

(b) Second, we test whether transportation cost to the U.S. market is more important after NAFTA. Specifically we test whether those regions closer to the U.S. border grew more rapidly after the trade agreement.

Since cities and those regions closer to the border were already growing more quickly before NAFTA, further growth specifically in these regions would imply that NAFTA worsened regional inequalities.

H3: Those regions with an abundance of low-skilled labor, measured by a low portion of the population with high school education, will benefit from trade. If Mexico is endowed with low-skilled workers relative to the United States, we might expect these regions to benefit more from trade. Since these regions tend to be more slow-growing generally, this effect would help mitigate against regional inequality.

[14]We use annual average of maquiladoras in 1990 for the period of 1988 since there is no data for 1988.

H4: Traded sectors will be more influenced by NAFTA and distance to the U.S. market than non-traded sectors. Specifically, manufacturing, and to a lesser degree, commerce, will see locational changes as described in H1, while services will either remain in the same location, or perhaps will move in the opposite direction due to the increased wages and conjestion costs caused by the growth other industries.

5 Results and Discussion

Table 2 reports the regression results using panel data from 2,377 municipalities over six years (1980, 1985, 1988, 1993, 1998, and 2003). We regress both the level and growth rate of GVA per municipality against various characteristics and see whether the influence of these characteristics changed after NAFTA. We find substantial spatial correlation in the error terms, particularly for the growth rate regression, with a ρ of 0.65. Thus, we believe we are justified in using a spatial panel model.

First, we find evidence that, as NEG would predict, the effect of the log distance to the border is significant and negatively associated with output. Although economic activity is already more concentrated near the border before NAFTA, the trade agreement reinforced this trend. Specifically, a municipality located a thousand kilometers from the border, like Tonala,[15] in the pacific coastal state of Jalisco had a 7% lower GVA on average than those municipalities along the border (such as Tijuana and Mexicali; Baja California). After NAFTA, that disparity in output grew to 9%.

We also see this effect reflected in the economic growth rates of municipalities. Although municipalities closer to the border were not growing significantly more quickly than others before NAFTA, they did grow more quickly after the trade agreement. The same municipality 1000 km from the border grew one tenth of a percent more slowly per year than their counterparts near the border. Thus, the economic disparity continues to grow since NAFTA was implemented.

Population density also affects GVA. Perhaps unsurprisingly, the higher the population density, the larger the municipal GVA. However, we do observe a further concentration of economic activity after NAFTA. Specifically, we find that a thousand more residents per km^2 leads to a 7% higher GVA. For cities at the border, this differential increases substantially after NAFTA, where a thousand more people per km^2 generates 17% higher GVA.

As with distance, we observe this effect both in levels and in the growth rate of GVA. For a municipality at the border, an extra thousand people per km^2 results in a small .04 percent increase

[15] Tonala is 1,000.26 km from the nearest border crossing point by road.

in growth rate overall, but a 0.8 percent annual higher growth rate after NAFTA. By contrast, for the average municipality, density did not lead to higher growth after NAFTA.

As hinted by the summary statistics in figure 2, we also observe some evidence that the economic influence of Mexico City appears to be declining over time. This finding conforms with the Krugman & Lizas-Elizondo finding that while the US market appears to be increasing in importance, the domestic market represented by Mexico City is perhaps less important after NAFTA.

Moving to our third hypothesis, NAFTA appeared to benefit those municipalities with a larger fraction of skilled workers, here defined as workers with high school education or more. Although these municipalities already had higher GVA before NAFTA, they benefited more economically from the trade agreement than their counterparts with fewer skilled workers. The evidence on low-skilled workers is more mixed. It appears as if those municipalities with higher rates of illiteracy in their young population also benefited disproportionately from NAFTA.

Perhaps most striking are the results on infrastructure. We find that although those municipalities with better infrastructure, here defined as drainage, had higher GVA overall, after NAFTA, this effect was almost completely mitigated, with infrastructure having no effect on GVA. Part of this result might be explained by noting that there was a marked increase in the number of communities with drainage over this time, going from about 30% of municipalities to 60% after NAFTA. That said, it is notable that the 40% of municipalities without drainage after NAFTA were no longer lagging their counterparts in terms of economic performance. These results hold for both GVA level and growth. Combined with the findings on literacy, this result seems to indicate that NAFTA was not as discriminatory as many have thought. We find evidence that NAFTA appeared to help those regions that struggle with human and physical infrastructure deficits.

We also control for the number of maquiladoras in a municipality, noting that since these regions already had tariff-free access to the United States for some of their production, we would expect them to be less affected by NAFTA. We do observe a higher level of GVA as well as a higher growth rate in those municipalities with a larger number of maquiladoras. After NAFTA, however, we see a slight further increase in the level of GVA associated with maquiadoras, but a significant decrease in the rate of growth for those same municipalities. Thus, having a maquiladora in ones municipality is a boon to growth, but the trade agreement, by reducing tariffs overall, diffused these benefits.

Overall, NAFTA appears to have led to both a slightly higher level of municipal GVA but a slightly slower rate economic growth. Although on its own, the NAFTA dummy indicates that GVA increased 8 percent after the trade agreement, when the other interaction terms are included, we find that the

average GVA was only one tenth of a percent higher after the trade agreement. More striking, the average growth rate is actually one tenth of a percent smaller after NAFTA. Given the peso crisis which caused a real contraction in Mexican GDP right after NAFTA was implemented, these results are perhaps not so surprising.

Sectoral Results

We next divide our data into sectors, to compare results for those products more and less likely to be directly affected by trade. Table 3 presents the sectoral regressions results for output per worker in the manufacturing, commerce, and service sectors, respectively.

We begin with the sector we expect to be most affected by NAFTA: manufacturing. We see a similar pattern for manufacturing as we observe in the total GVA regression. Specifically, the closer the municipality to the border, the higher the GVA, and NAFTA substantially increased this distance premium. In particular, NAFTA had a larger effect on the location of manufacturing than for GVA in total, increasing the distance-based premium by 50% as opposed to a 10% increase for GVA overall.

Like the total GVA, manufacturing output is larger in more densely-populated urban areas, and these areas benefit more from NAFTA than their rural counterparts. Specifically, for municipalities along the border, the marginal effect of density doubles for manufacturing after NAFTA. Further, the interaction between density and distance from the border is highly significant, implying that NAFTA specifically benefited manufacturing in cities close to the border.

Although distance to the border implied increased wholesale and retail activity, this relationship does not appear to have been significantly affected by NAFTA, except for more densely-populated centers. This result is understandable given that we might expect wholesale/retail to be less affected by trade in general. However, the regression on economic growth rate shows that those municipalities closer to the border did increase their economic output from the wholesale/retail sector more quickly after NAFTA. Perhaps these wholesale/retail centers are focused on reselling imports, or facilitating exports. In contrast, proximity to the US market does not appear to strengthen the services sector after NAFTA. Although being closer to the border implies a municipality has a larger services sector overall, this relationship does not demonstrably change after NAFTA. As most services are not traded internationally, this result is appealingly intuitive. In the regression on growth rates, distance to the border actually appears to decrease the size of the services sector after NAFTA, although this result is only significant at an 11% confidence level. The relationship between growth in the services sector and population density also remained unchanged with NAFTA, unlike the other two sectors. Thus,

we see notable differences in the effect of NAFTA among traded and non-traded sectors.

Other notable differences among the sectors is that while in all three sectors having better human and physical infrastructure led to a higher level of output overall, NAFTA had very different effects on these relationships. In manufacturing, having a higher portion of the municipality with access to drainage led to a further increase in output after NAFTA. In other words, municipalities with better physical infrastructure were better able to benefit from increases in manufacturing output generated by NAFTA than their poorer counterparts. However, the reverse is true for the wholesale/retail and services sectors. Here municipalities with high levels of drainage saw the benefits of that infrastructure fall significantly after NAFTA. While municipalities with drainage had an average 10.5 higher retail/wholesale GVA than their counterparts before NAFTA, that difference shrank to 3.5 sectoral GVA after NAFTA. The results for services are more dramatic, with the spread in GVA from drainage dropping from 20% before NAFTA to only 5% after the trade agreement. Thus, it appears as if NAFTA disproportionately benefited the non-traded sectors in poorer municipalities.

The differences for education appear in the regression on growth rates. Having a higher-skilled workforce is associated with an increased rate of growth in manufacturing and wholesale/retail after NAFTA. However, it is associated with a lower rate of growth in services after the trade agreement. One possible explanation is that the service sector was crowded out of these markets by increased labor demand from the manufacturing and wholesale/retail sectors, which generally have higher wages.

The last notable differences among the sectors comes from the role of maquiladoras. A maquiladora leads to higher levels and growth rates of GVA in all three sectors. However, after NAFTA, the extra GVA from maquiladoras shrinks for wholesale/retail and services. That said, for all three sectors, the extra growth rate associated with maquiladoras diminishes after the trade agreement. Thus, it appears as if manufacturing facilities are being set up in municipalities with pre-existing maquiadoras after NAFTA, but not at the same rate as manufacturing is growing elsewhere. Wholesale/retail and services appear to be concentrating their expansion elsewhere after NAFTA.

6 Conclusions

The paper studies the regional distribution of the benefits from trade in Mexico after NAFTA. This analysis demonstrates that Mexicos trade liberalization, via NAFTA, has caused important changes in the location of economic activity. Although regional disparities have existed in Mexico since industrialization began in the 1930s (López Malo 1960), NAFTA appears to have exacerbated these regional

trends, concentrating growth in regions that already had larger GVA: specifically in the north and in urban centers.

Thus, we find that trade liberalization has not reduced territorial disparities, but rather led to a greater polarization. While Mexican municipalities close to the U.S. market have profited from integration by increasing their production and incomes, regions further away from the US have become more disconnected from Mexicos integration into world markets. Specifically, we find that while NAFTA increased GVA by 7% for municipalities at the border, it actually decreased GVA by 1% for a municipality in the southern end of the country.

However, north-south disparities are only one part of the story. Counter to popular belief, we find that NAFTA appeared to benefit those regions with poorer infrastructure, decreasing the gap between regions without drainage and those with drainage. Similarly, we see some evidence that NAFTA also lowered the gap between regions with higher rates of illiteracy and those with more literate populations. Thus, it appears as if NAFTA did have some redistributive effect. That said, regions with a larger population of highly-skilled workers benefited more from the trade agreement.

Splitting the data by sector gives us some insight into these patterns of economic growth. As one might expect, we see the largest regional effect of NAFTA occurring in the most traded sector: manufacturing. While the benefits of NAFTA in the wholesale/retail sector are also concentrated in larger urban centres, the border has a smaller draw overall. Further, the border appears to have, if anything a repulsive effect for the service sector after NAFTA.

We also see manufacturing being concentrated in those areas with better infrastructure, higher skilled labour and with maquiladoras after NAFTA. This distribution is different for the non-traded sectors. Specifically, it appears as if retail/wholesale are growing faster in regions without maquiladoras and services in particular are being driven out of regions with high-skilled labour after the trade agreement. Thus, it appears as if the redistributive effect of NAFTA is coming from a displacement of the non-traded sectors, while the traded sectors are if anything being concentrated in wealthier regions.

In summary, we find evidence supporting the claim that NAFTAs benefits primarily went to those regions already doing well economically. Of particular concern is that these disparities appear to be increasing even after NAFTA. Thus, if a government objective is to reduce economic disparity, one can argue that there is a need for redistributive policies to go alongside trade agreements. That said, regional development policy might try to make use of the fact that non-traded sectors appear to be willing to move to poorer regions, mitigating some of the economic disparity enhanced by trade.

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Table 1: Summary Statistics. Reported statistics are mean, (standard errors), and [minimum, maximum] values.

Variable	Definition	1980	1985	1988	1993	1998	2003
n	Number of observations	2377	2377	2377	2377	2377	2377
gva_r2	Gross Value Added (for Commerce, Manufacturing and Service sectors) in real thousands of pesos	413,242 (3,287,181) [-4,699,098; 8.93e+07]	404,887 (2,559,055) [-470,366; 5.03e+07]	437,630 (2,754,360) [-864,449; 4.95e+07]	638,230 (4,100,484) [-74,053; 9.26e+07]	733,772 (4,610,239) [-952,761; 1.17e+08]	852,376 (5,037,900) [-634,266; 1.38e+08]
gva_com	Gross Value Added (Commerce sector) in real thousands of pesos	88,685 (760,407) [-216,025; 2.32e+07]	115,479 (789,109) [-4,629; 1.84e+07]	121,063 (827,241) [-5,995; 2.12e+07]	181,859 (1,226,223) [-120; 2.84e+07]	208,144 (1,242,739) [-3,685; 2.18e+07]	243,958 (1,315,894) [-760,539; 2.37e+07]
gva_mfng	Gross Value Added (Manufacturing sector) in real thousands of pesos	253,881 (1,919,896) [-4,809,919; 3.40e+07]	234,784 (1,477,370) [-627,251; 3.26e+07]	259,211 (1,753,279) [-885,130; 4.19e+07]	312,335 (1,887,889) [-98,211; 3.80e+07]	336,780 (1,892,800) [-2,502,298; 2.96e+07]	390,394 (2,084,692) [-4,455,232; 3.89E+07]
gva_serv	Gross Value Added (Service sector) in real thousands of pesos	70,676 (901,260) [-8,698; 3.66e+07]	54,624 (557,894) [-2,604; 1.67e+07]	57,356 (526,354) [-208,783; 1.69e+07]	144,035 (1,424,952) [-1,605; 4.74e+07]	188,847 (2,502,805) [-48,945; 8.85e+07]	218,024 (2,878,753) [-7,444; 1.13e+08]
lndist	Logarithm of the Road Distance from the municipality head to the nearest border crossing point	1.08 (0.435) [0;2.39]	1.08 (0.435) [0;2.39]	1.08 (0.435) [0;2.39]	1.08 (0.435) [0;2.39]	1.08 (0.435) [0;2.39]	1.08 (0.435) [0;2.39]
density	population (thousands) per square kilometer	0.19 (1.27) [0;24.98]	0.20 (1.18) [0.00;21.62]	0.21 (1.11) [0.00;18.27]	0.23 (1.12) [0.00;17.79]	0.24 (1.14) [0.00;17.68]	0.25 (1.11) [0.00;16.03]
mexcap	Dummy variable =1 if state=D.F or Mexico	0.06 (0.23) [0;1]	0.06 (0.23) [0;1]	0.06 (0.23) [0;1]	0.06 (0.23) [0;1]	0.06 (0.23) [0;1]	0.06 (0.23) [0;1]
inmigration	% of Population (>5years old) that resided in a different entity 5 years ago	0.08 (0.08) [0;0.29]	0.05 (0.04) [0;0.30]	0.03 (0.027) [0;0.40]	0.3 (0.024) [0;0.32]	0.03 (0.024) [0;0.26]	0.02 (0.019) [0;0.24]
hs	% of Population with High school or equivalent	0.016 (0.042) [0;0.32]	0.022 (0.031) [0;0.0.36]	0.028 (0.032) [0;0.35]	0.034 (0.036) [0;0.39]	0.039 (0.042) [0;0.42]	0.11 (0.057) [0;0.34]
lit614	% of Literacy (6-14 years old)	0.72 (0.128) [0.13;1]	0.78 (0.031) [0.23;0.95]	0.83 (0.093) [0.18;0.99]	0.82 (0.104) [0.16;0.99]	0.84 (0.790) [0.31;1]	0.78 (0.061) [0.34;1]
drain	% of Households with tap drainage	0.19 (0.22) [0;0.98]	0.26 (0.23) [0;0.98]	0.32 (0.25) [0;0.98]	0.45 (0.30) [0;1]	0.50 (0.29) [0;0.99]	0.67 (0.28) [0;1]
maquila	number of maquiladora establishments	0.23 (4.29) [0;0]	0.32 (6.63) [0;0]	0.57 (10.74) [0;0]	0.67 (13.05) [0;0]	0.83 (15.93) [1;1]	0.77 (14.24) [1;1]
NAFTA	Dummy variable for NAFTA years (1998 and 2003)	0 (0) [0;123]	0 (0) [0;238]	0 (0) [0;414]	0 (0) [0;531]	1 (0) [0;667]	1 (0) [0;568]

Table 2: Total Gva and growth rate of GVA

Dependent variable:	ln GVA (1)	growth GVA (2)	ln GVA (3)	growth GVA (4)
Intercept	15.5426***	0.0036**	15.5142***	0.0011
	(0.0340)	(0.0012)	(0.0272)	(0.0014)
lndist	-0.0267***	-0.0005***	-0.0239***	-0.0002
	(0.0041)	(0.0001)	(0.0035)	(0.0001)
density	0.0785***	0.0002·	0.0730***	0.0004***
	(0.0024)	(0.0001)	(0.0024)	(0.0001)
mexcap	0.0752***	0.0007·	0.0761***	0.0010·
	(0.0141)	(0.0004)	(0.0142)	(0.0005)
inmigration	-0.2932***	0.0092***	-0.1093***	0.0024
	(0.0273)	(0.0022)	(0.0252)	(0.0023)
hs	0.7994***	0.0462***	0.4260***	0.0385***
	(0.0387)	(0.0030)	(0.0419)	(0.0037)
lit614	0.0252	-0.0023*	0.0373**	-0.0014
	(0.0160)	(0.0010)	(0.0139)	(0.0011)
drain	0.0398***	0.0035***	0.0485***	0.0059***
	(0.0067)	(0.0004)	(0.0084)	(0.0006)
maquila	0.0031***	0.0001***	0.0024***	0.0002***
	(0.0001)	(8.39e-06)	(0.0002)	(1.51e-05)
nafta			0.0828***	0.0050*
			(0.0193)	(0.0024)
nafta*lndist			-0.0065***	-0.0004
			(0.0017)	(0.0002)
nafta*density			0.0963***	0.0077**
			(0.0257)	(0.0025)
nafta*mexcap			-0.0086	-0.0004
			(0.0068)	(0.0008)
nafta*inmigration			0.3799***	0.0321***
			(0.0685)	(0.0070)
nafta*hs			0.8662***	0.0223***
			(0.0579)	(0.0062)
nafta*lit614			-0.0842***	-0.0036·
			(0.0178)	(0.0020)
nafta*maquila			0.0003·	-0.0001***
			(0.0002)	(1.80e-05)
nafta*drain			-0.0254**	-0.0049***
			(0.0078)	(0.0008)
nafta*densdist			-0.0125***	-0.0012***
			(0.0037)	(0.0004)
ρ	0.7679	0.749	0.0384	0.6491
σ_v^2	0.0061	8.50e-05	0.0059	8.42e-05
σ_1^2	0.1184	9.32e-05	0.1131	9.16e-05
θ	0.7725	0.0454	0.7715	0.0415
Number of time periods	6	5	6	5
Number of municipalities	2377	2377	2377	2377
Total observations	14262	11885	14262	11885

Table 3: Total Gva and growth rate of GVA for different sectors

	Manufacturing		Commerce		Services	
Dependent variable:	ln GVA (1)	growth GVA (2)	ln GVA (3)	growth GVA (4)	ln GVA (5)	growth GVA (6)
Intercept	15.4865***	0.0006	13.6509***	-0.0028	12.4018***	0.0038
	(0.0209)	(0.0011)	(0.0395)	(0.0019)	(0.0585)	(0.0028)
lndist	-0.0150***	-0.0002	-0.0229***	0.0003	-0.0336***	-0.0004
	(0.0026)	(0.0001)	(0.0046)	(0.0002)	(0.0070)	(0.0003)
density	0.0663***	-0.0002*	0.1207***	0.0014***	0.1326***	0.0009***
	(0.0020)	(0.0001)	(0.0036)	(0.0001)	(0.0046)	(0.0002)
mexcap	0.0250*	0.0010*	0.0038	0.0001	0.0064	0.0024*
	(0.0114)	(0.0005)	(0.0191)	(0.0006)	(0.0253)	(0.0010)
inmigration	0.0076	-0.0022	0.1019*	0.0247***	-0.3290***	0.0097*
	(0.0218)	(0.0019)	(0.0464)	(0.0027)	(0.0627)	(0.0046)
hs	0.2990***	0.0089**	0.9260***	0.0607***	1.3795***	0.1326***
	(0.0381)	(0.0034)	(0.0807)	(0.0043)	(0.0986)	(0.0074)
lit614	0.0077	0.0004	0.0585*	-0.0014	0.1130**	-0.0064**
	(0.0119)	(0.0009)	(0.0256)	(0.0014)	(0.0355)	(0.0022)
drain	0.0294***	0.0027***	0.1046***	0.0087***	0.1965***	0.0182***
	(0.0075)	(0.0005)	(0.0153)	(0.0007)	(0.0193)	(0.0012)
maquila	0.0018***	0.0001***	0.0037***	0.0002***	0.0060***	0.0003***
	(0.0002)	(1.36e-05)	(0.0004)	(1.76e-05)	(0.0005)	(3.02e-05)
nafta	0.0512**	0.0036·	0.1135**	0.0121***	0.1301**	-0.0028
	(0.0174)	(0.0021)	(0.0384)	(0.0029)	(0.0483)	(0.0053)
nafta*lndist	-0.0075***	-0.0004·	-0.0034	-0.0008**	-0.0005	0.0008
	(0.0015)	(0.0002)	(0.0034)	(0.0003)	(0.0046)	(0.0005)
nafta*density	0.0707**	0.0045*	0.2913***	0.0103***	0.2260***	0.0042
	(0.0237)	(0.0022)	(0.0506)	(0.0028)	(0.0613)	(0.0049)
nafta*mexcap	-0.0122·	-0.0009	-0.0485***	0.0023**	0.0330*	-0.0007
	(0.0063)	(0.0008)	(0.0137)	(0.0009)	(0.0164)	(0.0018)
nafta*inmigration	0.0632	0.0157*	0.4701***	0.0261***	0.7281***	0.0221
	(0.0628)	(0.0064)	(0.1345)	(0.0079)	(0.1633)	(0.0147)
nafta*hs	0.0311	0.0183**	1.6841***	0.0293***	2.4846***	-0.0219·
	(0.0533)	(0.0058)	(0.1149)	(0.0070)	(0.1385)	(0.0131)
nafta*lit614	-0.0104	-0.0018	-0.1642***	-0.0085***	-0.2475***	-0.0007
	(0.0163)	(0.0019)	(0.0354)	(0.0023)	(0.0433)	(0.0044)
nafta*maquila	0.0007***	4.93e-05**	-0.0009**	-0.0001***	-0.0017***	-0.0003***
	(0.0001)	(1.70e-05)	(0.0003)	(2.00e-05)	(0.0004)	(3.96e-05)
nafta*drain	0.0118	-0.0019*	-0.0690**	-0.0051***	-0.1519***	-0.0223***
	(0.0073)	(0.0008)	(0.0155)	(0.0009)	(0.0185)	(0.0018)
nafta*densdist	-0.0123***	-0.0008*	-0.0412***	-0.0018***	-0.0285**	-0.0008
	(0.0034)	(0.0003)	(0.0073)	(0.0004)	(0.0089)	(0.0007)
ρ	-0.3011	1.93e-08	-0.0418	0.8476	0.5331	0.6947
$\sigma_{\overline{\chi}}^2$	0.0050	7.64e-05	0.0239	0.0001	0.0344	0.0004
σ_1^2	0.0715	6.38e-05	0.1913	0.0001	0.3464	0.0003
θ	0.7342	-0.0944	0.6464	0.1515	0.6847	-0.2617
T (time)	6	5	6	5	6	5
N (cross-sections)	2377	2377	2377	2377	2377	2377
NT (Observations)	14262	11885	14262	11885	14262	11885

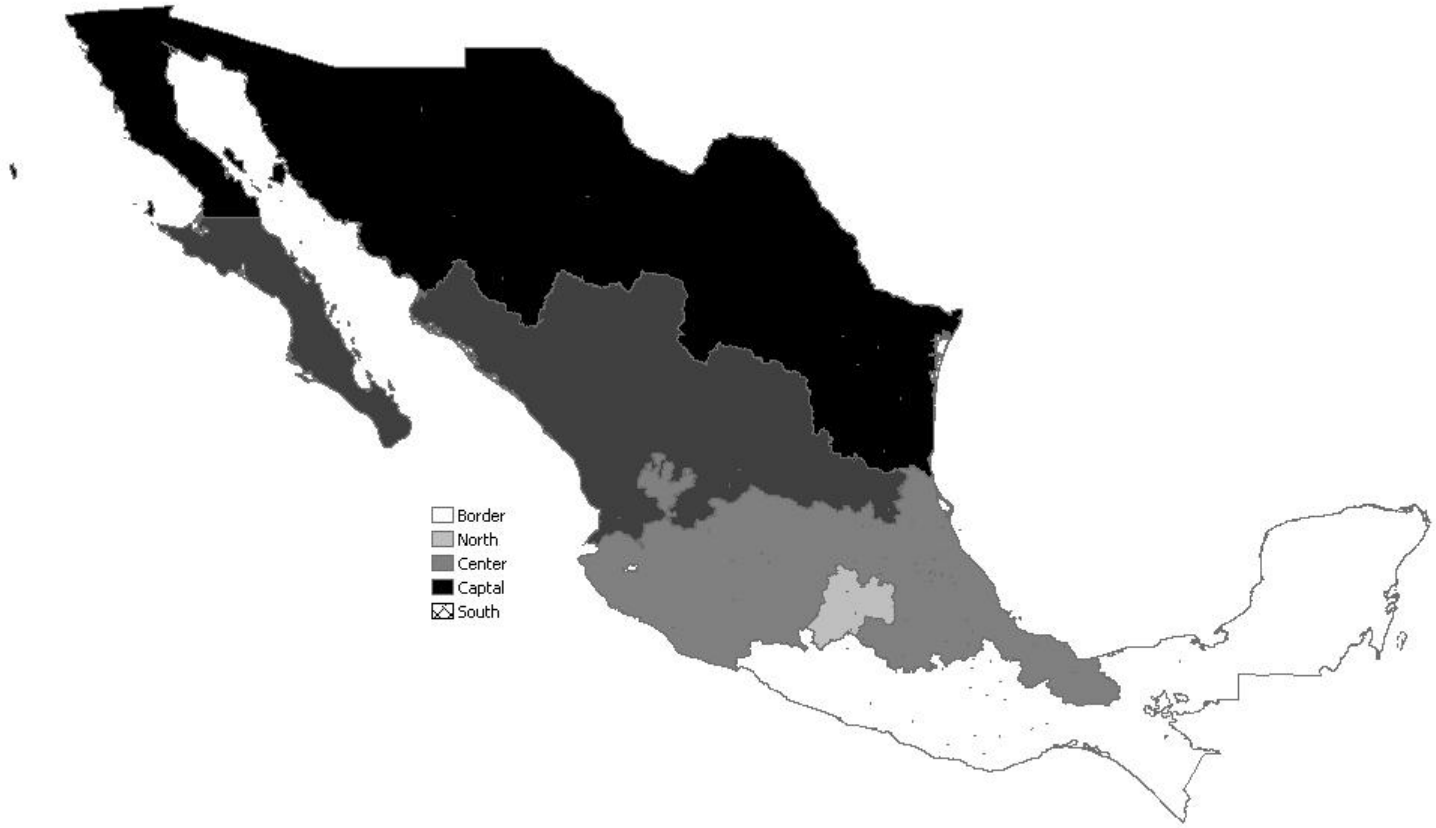


Figure 1: Mexico regional sub-division.

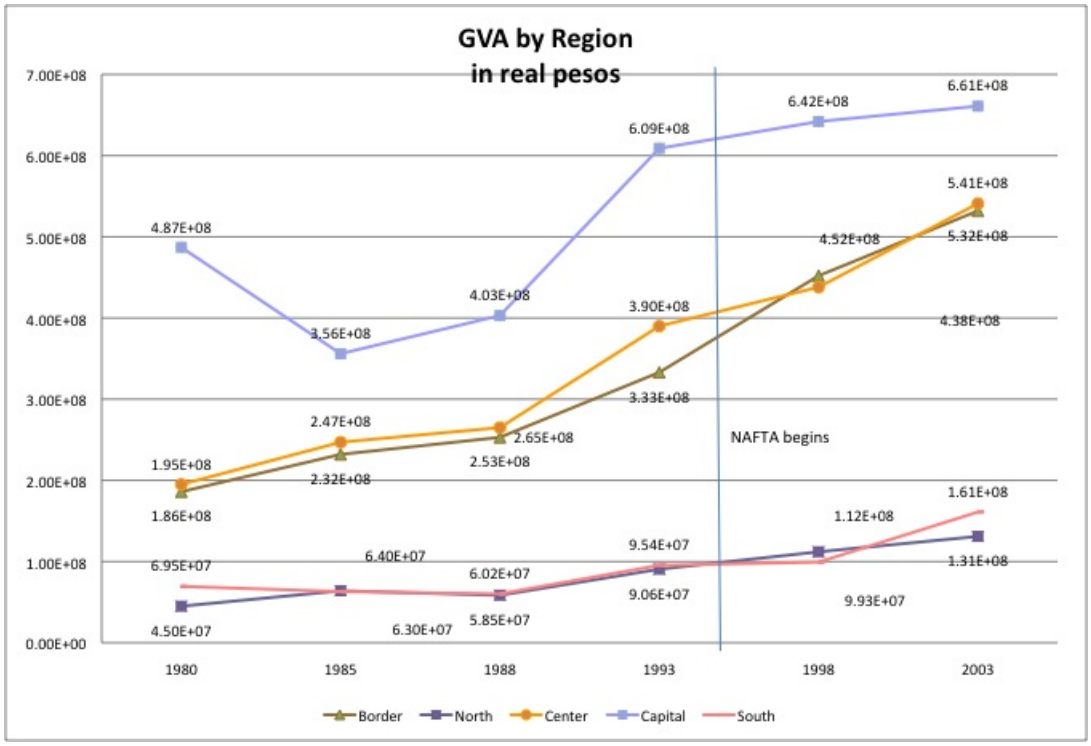
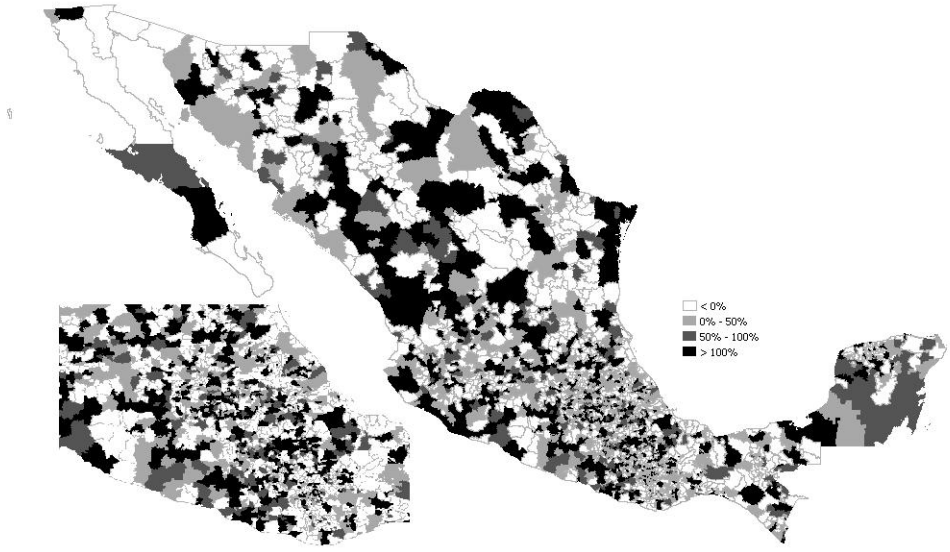
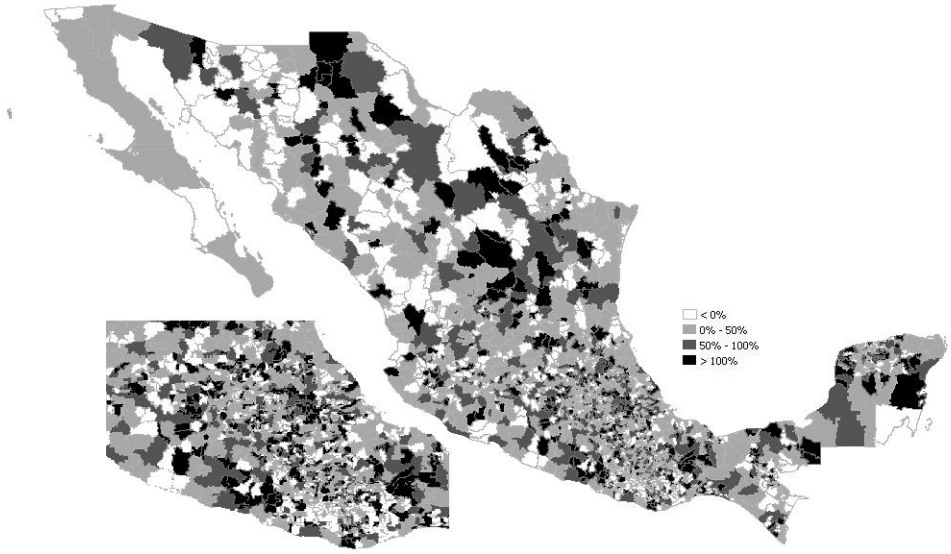


Figure 2: Gross Value Added in real pesos by Region.



(a)



(b)

Figure 3: Growth of GVA before NAFTA from 1980 to 1985 is reported in panel (a). Growth of GVA after NAFTA from 1998 to 2003 is reported in panel (b).

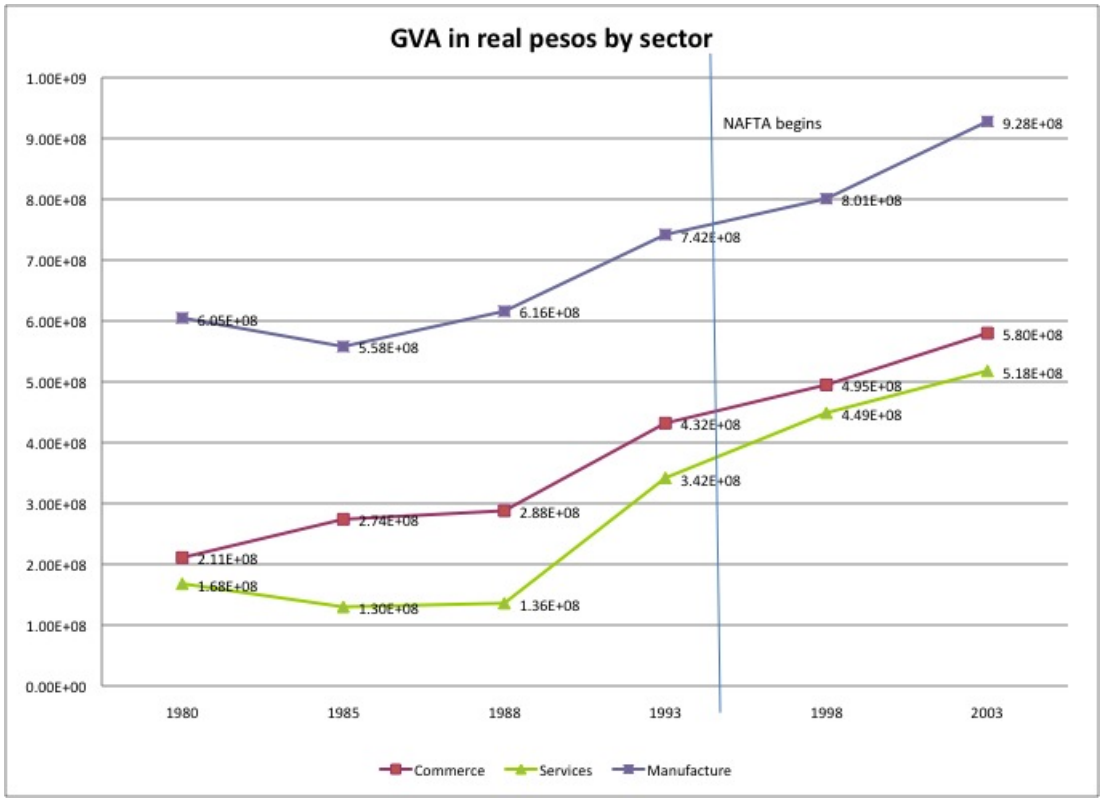


Figure 4: Distribution of the growth rate of GVA by sector (real pesos): manufacturing, commerce and services.