THE IMPLICATIONS OF TRADE OPENNESS FOR REGIONAL INEQUALITY IN MEXICO

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ABSTRACT

MARCELA GONZALEZ RIVAS: The Implications of Trade Openness for Regional Inequality in Mexico
(Under the direction of Harvey Goldstein)

This dissertation sheds light on the debate about the effect of trade openness on regional inequality (income inequality across states), by exploring the mechanisms through which this relationship has operated in Mexico. Specifically, I analyze the extent to which key state endowments—income, infrastructure, human capital—determine the impact that trade openness has on states' economic performance. Integrating existing competing hypotheses from the literature into a theoretical framework based on endogenous growth theory, I test these hypotheses in three ways. First, I use a state-level data set I constructed covering the period of 1940-2000 in Mexico, a period that ensures variation in levels of both trade openness and regional inequality. Second, I analyze data at the economic sector level, for the same period, to uncover dynamics specific to certain economic sectors that are regionally concentrated in Mexico. Finally, I study in-depth the experience of three states, with regard to their economic performance in the context of changing trade policy. My research has important implications for three bodies of literature. First, it will contribute to the literature on regional inequality and regional convergence, by testing various hypotheses against one another and providing a more detailed understanding of the

mechanisms though which trade affects economic performance at the regional level. Second, it will advance the broad literature on the impact of trade openness on developing countries. Many studies have looked at the relationship between trade and economic development at the cross-national level and the effect of trade reform on different socio-economic groups within countries. There has, however, been relatively little analysis of how trade reform affects regional inequality, and this study contributes to fill that gap. Finally, it will contribute indirectly to bodies of work that look at the relationship between development and levels of infrastructure and human capital. Like the literature on trade, these literatures have largely focused on cross-national statistical work.

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1. Introduction

1.1 Question, Motivation and Methods

Recent studies have found that regional inequality—that is, per capita income inequality across sub-national units—is rising across the world, in both developed and developing countries.[1] According to the World Bank (2000), inequality across regions is growing in Brazil, Argentina, Colombia, Chile, and Mexico. Noorbakhsh (2003) and Haaparanta (1998) have shown that various measures of regional income inequality in India are diverging rather than converging. Hu (2002) finds that the income gap between Chinese coastal provinces and the hinterland has grown fast since the country opened its doors to foreign investment in the early 1980s. Kanbur and Zhang (2005) in an analysis of regional inequality over the last 50 years, find that the latest increase in regional inequality is due to trade openness. And the phenomenon is not unique to developing countries. Similar divergent patterns in the context of openness have been found in Italy (Gaetano and Mauro, 2002), England (Duranton and Monastiriotis, 2002), Spain (Paluzie, 2001), Australia (Webber and Weller, 2001), Russia (Fedorov, 2002) and Europe as a whole (Puga, 2002, and Cuadrado-Roura, 2001).

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[1] See: Ferranti, et al (2005); Rodriguez Oreggia (2005); Markusen and Campolina Diniz (2005); Esquivel and Messmacher (2003); Mansori (2003); Duranton and Monastiriotis (2002); Gaetano and Mauro (2002); Hu (2002); Fujita and Hu (2001); Paluzie (2001); Webber and Weller (2001); Magrini (1999); Haaparanta (1998); Cragg and Epelbaum (1996); and Fuchs and Pernia (1987).

Since this latest increase in regional inequality has taken place during an era of increasing economic openness and international linkages, a number of researchers have proposed a link between inequality and globalization.[2] Yet this goes directly against what mainstream economic theorists have proposed: that increased economic openness actually serves to reduce spatial inequalities (Krugman and Venables, 1990; Krugman and Livas Elizondo, 1996). Empirical tests of this relationship have come to conflicting conclusions.

Understanding this relationship is particularly important given the increasing prominence of regional inequality in policy debates around the world. There are arguments in favor of the reduction of these inequalities due to the social and political instability that can result from extreme inequality across regions within a country (Kanbur, Venables and Wan, 2005). Moreover, regional disparities have been a topic on the political agenda of the European Union (EU) since the 1980s, when convergence across regions came to a halt (Lange, 2004). According to Lange (2004), the EU utilizes a variety of policy instruments to promote regional convergence, such as cohesion funds channeled to lagging regions within countries. Puga (2002) has noted that these funds constitute the fastest growing component of the EU budget. A greater understanding of the relationship between trade and regional

[2] For example, Rodriguez Oreggia (2005), Sánchez-Reaza and Rodríguez-Pose (2002), Chiquiar Cikurel (2002) and Puga (1999).

inequality could make such policy instruments more effective, both in Europe and elsewhere.[3]

My research attempts to shed light on these debates by integrating competing hypotheses from the literature into a theoretical framework based on endogenous growth theory, and then testing those hypotheses in Mexico, a country representative of many middle-income countries that have opened themselves to trade in recent decades.[4] In testing the hypotheses, I draw on statistical analysis and studies of carefully chosen cases, attempting to use the strengths of each methodology to maximize the validity of my overall findings. As Lieberman (2005) argues, the strength of statistical analysis is its ability to test hypotheses and rule out alternative hypotheses in a systematic manner; while case studies can be used for two distinct purposes: model testing and model building. After substantial statistical analysis, I use the case studies for both of their potential purposes. I further test the robustness of the hypotheses by examining how they explain the difference in economic performance between particular states in Mexico, and in examining the experience of these states I also encounter new directions for future research.

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[3] According to Cappelen, et al, (2003) and Dall'erba and Le Gallo (2003) such regional policies have had a positive impact on regional development.

[4] Although the findings of this dissertation may be relevant to middle income countries similar to Mexico, one must be cautious in generalizing the findings, as each country has particular characteristics. For example, economic development in Mexico has been profoundly influenced by its unique proximity to the United States.

1.2 Plan of the dissertation and summary of findings

The plan of the dissertation is the following. The second chapter aims at answering the question: what is the extent of regional inequality in Mexico? First, I seek to give a sense of the evolution over the last six decades of regional inequality in Mexico along different socio-economic dimensions. Second I provide a brief history of major policies that have had influences over the development of regions in Mexico, like transportation policy, industrial development policies, and trade policy. The chapter shows how development in Mexico seems to be path-dependent, as the poorest regions during the early parts of the period continue to have the lowest rankings in socio-economic indicators at the end of the period. Similarly, the states that began the period with high values continue to be the most developed states in Mexico.

Based on the existing literature, the third chapter develops a set of hypotheses relating trade openness to regional inequality—the hypotheses that will be tested in the rest of the dissertation. The first hypothesis is that poorer states will grow faster than rich ones as trade openness increases. The second is that states better endowed with infrastructure will grow faster than those with less infrastructure endowments as trade openness increases. Finally, the third hypothesis is that states with higher levels of human capital will tend to grow faster than those with lower levels of it as trade openness increases.

The first hypothesis stems from the core-periphery model of Krugman and Livas Elizondo (1996) and Krugman (1991b). The model shows that if there is one region where the majority of manufacturing activity is already located in a closed economy, that region will also be where *new* manufacturing activities locate, since the large part of the market will be there. The concentration of economic activities in a core area will tend to be reinforced, contributing to increased regional inequality. However, in the model of Krugman and Livas (1996), the concentration of economic activities is *less* beneficial in the face of trade openness, because the costs of concentration gain more relevance. Krugman and Livas (1996) argue that protectionist policies encourage the concentration of economic activities, because firms want to take advantage of being close to suppliers and buyers. Once trade barriers fall, the Krugman-Livas theory predicts the dispersion of activities and therefore more equal regional development. Instead of relying on the core for inputs and markets, firms will now seek to access foreign markets and rely on imports for inputs. Therefore manufacturing does not need to be located at the core. Firms can now locate outside the core and avoid external diseconomies of concentration that arise in large centers (like pollution and traffic) as well as high land prices and labor costs. In sum, the benefits of concentration are greater in closed economies compared to open economies.[5]

The second and third hypotheses arise from comparing the predictions of the model of Krugman and Livas (1996) to the work of Myrdal (1971 [1957]) on cumulative causation, specifically focusing on two factors: infrastructure and human capital. The process of cumulative causation refers to a process of growth or decay in which one factor can be the cause and effect of other factors, therefore resulting in a continuous process of circular interdependence. In Myrdal's theory, trade is one of the forces through which the cumulative causation process operates, as the growing regions will see their markets become larger and develop competitive advantages relative to other regions. In this sense, the Krugman and Livas (1996) prediction of dispersion of economic activities as trade openness increases goes in the opposite direction of Myrdal's. The second hypothesis arises from a literature that has built on the core-periphery model but that predicts concentration rather than dispersion, due to the advantages that states well endowed with infrastructure have over those with relatively low levels of infrastructure endowments (Mansori, 2003). This is based on the idea that infrastructure has externalities due to its high sunk costs. The third hypothesis comes from a separate literature on human capital, which also is predicted

[5] The Krugman and Livas (1996) model has been extended to include initial endowments and initial beliefs (Ottaviano, 2001) and the size of population (Villar, 1999), to see how the spatial distribution of activities change once controlling for these factors. However, the original results still hold.

to have concentration effects in the context of trade openness, as human capital fosters the incorporation, adoption, and application of the newer technology available through trade (Nelson and Phelps, 1966; Benhabib and Spiegel 1994; Connolly 2003). One of the innovations of this project is the integration of each of these hypotheses into one consistent theoretical and empirical framework, thus enabling them to be tested against each other. I do this by using endogenous growth theory, which suggests that unbalanced development across regions can occur because regions have different endowments of factors and, in turn, positive externalities (or spillover effects) that these factors generate.

The next two chapters offer statistical tests of the hypotheses. Chapter Four presents statistical tests at the state level, in which the dependent variable is growth in state per capita gross domestic product. Using a dataset that I compiled from various archival sources at the National Statistical Institute in Mexico (INEGI), including data for all states over the period 1940-2000, I show that income, infrastructure, and human capital mediate the effect of trade openness and regional inequality, but that they operate in differing directions. Specifically, the results indicate that, contrary to expectation, opening up to trade benefits more those regions with lower levels of education, thereby tending to reduce regional inequality. However, opening up to trade also benefits more those regions with higher levels of income and infrastructure, thereby tending to increase regional inequality.

This latter effect is greater than the former, so that the overall effect of trade openness is to increase regional inequality.

While Chapter Four presents evidence of the importance of income, infrastructure, and education in mediating the effect of trade openness on state's economic growth, it is possible that this effect varies by sector. If true, this would have important implications for policy. Moreover, the patterns observed at the aggregate level might be explained by the industrial differences that exist across states. Therefore, Chapter Five provides tests of the three hypotheses at the economic sector level within states. In this chapter, the dependent variable is the growth of state per worker gross domestic product by economic sector. Using another dataset I compiled from Unikel (1978) and INEGI, I test the extent to which state endowments—income, infrastructure, and human capital—mediate the effect of trade openness on growth of GDP at the state level within a given sector. The data include observations for the same period of time, 1940 to 2000.

The findings indicate once again that there are offsetting effects in the three sectors: regional inequality is growing, but this is mitigated slightly by the effect of human capital, but also in the reverse direction than expected. Specifically, the results for the primary sector indicate support of a divergent trend, i.e. contrary to expectation of the hypothesis that increases in trade openness will lead to faster growth for poorer states; however there is not evidence of this for the secondary and tertiary sectors. For the second hypothesis, the results are consistent across economic sectors, as states with higher infrastructure levels consistently performed better than those with lower ones in the context of trade openness. For the third hypothesis there are mixed findings. On the one hand, the results of the primary sector are contrary to expectation (consistent with findings of the previous chapter), indicating that states with lower levels of human capital will tend to grow faster as trade openness increases. On the other hand, the results for the secondary sector indicate that there is evidence of a divergent trend, as states with higher levels of human capital will grow faster as trade openness increases (as expected). Finally, for the tertiary sector there is no evidence in support or contrary to this hypothesis.

Chapter Six presents the analysis of three cases, exploring in particular the effects of infrastructure and education on economic performance in the context of trade openness. From my dataset, I choose three states—Aguascalientes, Guanajuato, and Nayarit—that have different levels of infrastructure and human capital but are similar in other important respects, following the case selection strategy of King, Keohane, and Verba (1994). The findings from this chapter are consistent with the statistical analyses and demonstrate that there is a clear cumulative causation effect emerging from infrastructure. Aguascalientes' early access to transportation networks represented an advantage in the development of economic activities. In contrast, Nayarit had relatively late access to infrastructure networks and consequently was unable to industrialize and move away from its dependence upon natural resource activities. Moreover, Aguascalientes continues to do better than Nayarit, and the evidence indicates that this trend is likely to continue as trade openness increases. This is because infrastructure networks play a key role for the development of regions, not only for the efficient distribution of final products to other markets—domestic and international—but also for the transportation of inputs for production. Furthermore, the case study analysis indicates that the provision of infrastructure alone is not sufficient for growth. Rather, the provision of a range of services that complement the availability of infrastructure in Aguascalientes fostered the rapid transformation of its economy.

The evidence from the comparison of Aguascalientes and Guanajuato indicates that the role of human capital has been crucial in the recent industrial growth of Aguascalientes and specifically in the maintenance of its competitiveness. In Guanajuato, however, although the role of human capital has started to gain relevance in some business circles, the traditional way of doing business has undervalued skilled labor and professional operations. This has resulted in the limited innovation of products and consequently limited access to higher value markets, domestically and internationally. In this sense, the case studies point to the fact that the idea of human capital mediating the effect of trade openness on regional inequality can be broadened so as to include a more general concept;

one that includes business culture and attitudes that enable the adoption of new technologies and practices in the context of increased competition.

The dissertation concludes with a brief summary of the argument and findings of the dissertation and points to policy implications as well as areas in which future research is needed.

2. Background on regional inequality in Mexico

Mexico is a highly unequal country by any measure. The richest 10 percent of the population receives 43 percent of the country's income, and the poorest 60 percent of the population receives only 23 percent of the income.[6] In addition, inequality has a spatial pattern, as there seems to be a divide between southern and northern states. In each decade between 1940 and 2000, the states more than one standard deviation *below* the mean of state per capita GDP were all in the south. Similarly, the states that were between one and two standard deviations *above* the mean were all in the north, except for Quintana Roo (see Appendix 1 for a list of Mexican states' abbreviations and a map). The magnitude of the difference between north and south is such that in 2000 the southern states of Chiapas and Oaxaca had an average income per capita roughly 24 percent of that of the richest northern state, and 16 percent of that of the Federal District, the richest "state" overall.[7] In addition, the data show that regional inequality may follow somewhat of a "path dependent" development process (David, 1985). For example, Oaxaca is the poorest state during the entire sixty-year period (measured every ten years), except for 1950—but even that year it

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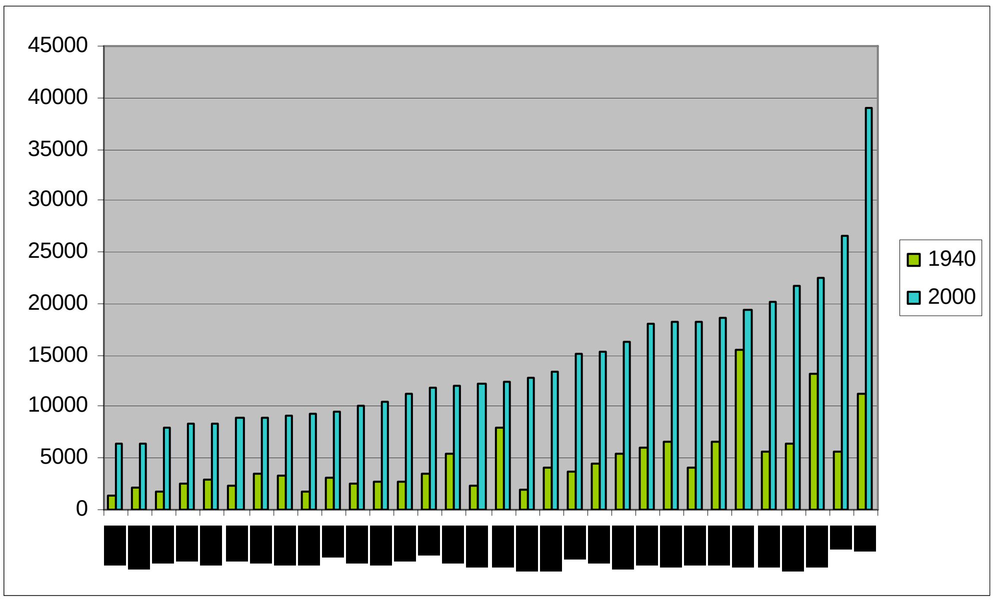
[6] Ferranti, et al 2004, p. 7. By comparison, in the average developed country, the top decile of the population receives 29 percent of the income, and the bottom 60 percent of the population receives 33.4 of the income (Ibid, p. 31).

[7] This analysis of per capita income is based on data from Esquivel, et al. 2002. This inequality is substantial compared to the ratio of richest to poorest states' per capita income in other countries. For example in the USA the ratio is 2; in Germany 3; and in India, Brazil, and China 4, 7, and 12, respectively. Milanovic, 2004 and Lange, 2005.

was among the poorest states. Similarly, the Federal District has been the richest state since 1950, and it has consistently been more than two standard deviations above the mean. Figure 1 shows that similar patterns of inequality existed in 1940 and 2000.

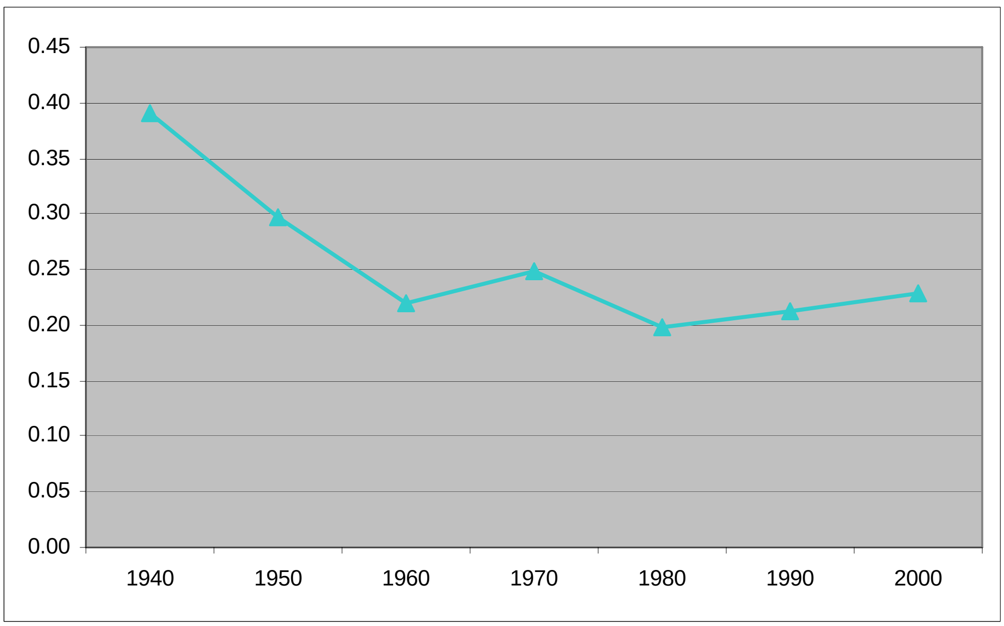
Figure 1: Per capita GDP for states in Mexico, 1940 vs. 2000, in 1993 pesos



Source: Data from Esquivel, 1999.

However, despite the apparent rigidities in ordinal rankings, there has been variation in the extent of regional inequality over time. Studies have shown that incomes converged across states in Mexico in the period between 1940 and 1980, but that divergence has been observed since the beginning of the 1990s.[8] This is reflected in Figure 2, which shows the evolution of the nation's Gini coefficient (measuring inequality across states) over the period of 1940 to 2000. Inequality decreases rapidly from 1940 to 1960, stabilizes during the 1960s and 1970s, and then grows in the 1980s and 1990s.

Figure 2: Gini coefficients for states per capita income in Mexico, 1940-2000



Source: Author's calculation with data from Esquivel, 1999.

Regional inequality matters because it is a reflection of a country's overall economic and social inequality. Unfortunately, despite a great deal of research, we still know relatively little about what drives regional inequality. One of the reasons for the relative

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[8] Juan-Ramón, V. Hugo and Rivera Bátiz, 1996; Esquivel, 1999; Esquivel and Messmacher 2002; and Sánchez Reaza and Rodríguez Posé, 2002.

little knowledge on this area is almost certainly a lack of good historical data at the sub-national level, with which to build a time-series. Without a basic understanding of how regional inequality has evolved in countries, it is almost impossible to proceed with analysis and theory-building. The aim of this chapter is to provide such an understanding of regional inequality in Mexico, using panel data to explore the evolution of different socio-economic indicators across Mexican states for the period 1940-2000.

The indicators analyzed include literacy, basic infrastructure, as well as per capita income and the share of labor occupied by different economic sectors. The indicators are chosen because they reflect various aspects of development. For example, I look at share of labor occupied by different economic sectors because economic development theories comparing the development gaps across countries pay particular attention to the sectoral composition of the economy.[9] In general there is a negative correlation between the level of development and the relative size of the primary sector, consisting of agriculture, livestock, forestry, fishing, and hunting. Thus looking at the shares of labor employed by economic sectors can reveal patterns of regional inequality. All data come from the National Statistical Institute (INEGI). Table 1 lists the various indicators and their sources.

[9] For example, Kuznets, 1955; Lewis, 1954, Harris and Todaro, 1970; Rostow, 1960.

Table 1: Indicators and sources

Indicator	*Definition*	*Source*
Income	Per capita GDP by state	Esquivel, et al, 2003
Literacy	Percentage of population 10 years and older that is literate	INEGI, 1998, Estadísticas Históricas de México
Road density	Length of highway networks divided by the area	INEGI, various years, Anuario Estadístico
Urbanization	State share of urban population	INEGI, various years, Anuario Estadístico
Water access	State share of housing directly connected to the water network	INEGI, various years, Population and Housing Census
Employment by sector	State share of labor employed in each economic sector	INEGI, various years, Anuario Estadístico

The chapter is organized as follows. Using statistical analysis of standard measures of convergence, the next section analyzes the convergence-divergence pattern of the indicators just mentioned over the entire period. Looking at the convergence or divergence patterns of each indicator is useful because it give us a sense of whether states are generally getting closer to or further away from each other. However, such tests can only give broad outlines and cannot reveal any spatial patterns that may exist. Therefore, the third section graphically illustrates the extent of regional inequality over the same indicators, using maps showing which states have particularly high and low values of each indicator relative to the national mean. The fourth section uses the Local Moran test to identify convergence clubs along each indicator. The formation of clubs or different groups of states that are unequal across each group but very similar within the group provides another idea of the extent of regional inequality. Again, maps are used to illustrate these clusters, emphasizing the cluster of consistently underperforming southern states. The fifth section of the chapter provides some initial thoughts on why these patterns are observed, looking at the historical influence of trade, transportation, agriculture, and labor policies in Mexico. A final section concludes.

2.1 The patterns of convergence or divergence of each indicator

The belief that regional economies tend to converge is rooted in neo-classical theories of growth which argue that market forces lead, in the long run, to equilibrium of economic factors equalizing prices, wages and capital. This should be especially true across regions within countries (as opposed to across countries) because regions are, in general, more alike than countries, with more similar culture, technology, tastes and institutions. In addition, inputs for production tend to be more mobile within a country than across countries. Two common concepts of convergence are β-convergence and δ-convergence. To study absolute convergence or β-convergence—which measures the hypothesis that poorer regions tend to grow faster in per capita terms than rich ones, leading to a reduction in overall regional inequality—I use a common growth regression (Barro and Sala-i-Martin, 1995). [10] In this formulation, the neo-classical production function is based on the idea that the rate of growth of states' income per capita depends on their level of income per capita (expressed in natural log terms) in the original period. This is expressed as:

[10] It is absolute convergence because the regression does not consider any other characteristics that might condition the growth rate.

$$LN(\frac{y_{it+1}}{y_{it}}) = \alpha + \beta(LN(y_{it})) + \varepsilon_{it}$$

where, i and t refer to state i and time t, α is the intercept, β the convergence coefficient and, ε is a disturbance term.

An observed negative value of β is an indication that income tends to equalize in the long run, due to the higher rate of growth experienced by poorer states. The β coefficient refers to the average convergence speed from one period to the next (which for this panel refers to a rate for every ten years).

Although the idea of convergence or divergence is generally applied to per capita income, I extend it to other indicators assuming they generally behave in a fashion similar to income. It is important to note that it is hard to predict the extent to which the share of employment in economic sectors behaves given that they depend heavily on both, mobile and non-mobile factors. This is especially true for the primary sector case. Moreover, employment shares by economic sectors do not need to converge necessarily given that regional specialization might occur. However, looking at employment shares by economic sectors can be helpful when comparing development levels across economies. Although in neo-classical growth models, total GDP consists of the homogeneous product of a single sector, economic development theories (e.g. Kuznets, 1955; Lewis, 1954, Harris and Todaro, 1970; Rostow, 1960) comparing the development gaps across countries pay particular attention to the sectoral composition of the economy. As stated above, there is a general negative correlation between the level of development and the share of agriculture in GDP. Thus looking at the shares of labor employed by economic sectors can reveal patterns of regional inequality.

Table 2 shows the results of the regressions, which indicate that there is strong evidence of convergence in all variables for the entire period, with the exception of employment in the primary sector, for which there is a divergence trend.[11] All of the coefficients are negative and statistically significant.

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[11] This could be interpreted as specialization in this sector. In general, natural resource based industries or those with fixed attributes, like tourism, can be expected to be less mobile, while industries that serve a national or international market, like manufacturing can be expected to be more mobile and thus tend to converge.

Table 2: Comparison of results from β convergence regressions

	α		β		R^2	R^2	R^2
	Coef.	Std. Err.	Coef.	Std. Err.	within	between	overall
Per capita income	2.48	(0.32)	-0.26	(0.03)	0.25	0.20	0.19
Primary sector employment	-0.72	(0.15)	**0.13**	**(0.04)**	0.06	0.54	0.10
Secondary sector employment	0.64	(0.12)	-0.19	(0.05)	0.08	0.04	0.06
Tertiary sector employment	0.76	(0.11)	-0.17	(0.04)	0.10	0.75	0.13
Water	1.98	(0.25)	-0.55	(0.07)	0.27	0.04	0.20
Literacy	0.94	(0.07)	-0.20	(0.02)	0.46	0.01	0.10
Road density	1.18	(0.42)	-0.27	(0.13)	0.02	0.10	0.03

Numbers in bold highlight divergence.

Dispersion, or δ-convergence, measures the extent to which the variance of an indicator tends to decrease over time. It is interesting to note that the existence of β-convergence does not guarantee the existence of δ-convergence. This is due to the fact that the decrease in dispersion depends not only on the existence of β-convergence, but also on the variance of the error terms (Martin and Sunley, 1998, p. 203). β- and δ-convergence, are closely related, but the former is a necessary but not sufficient condition for the latter to take place. For example, if poor states are affected by an external shock to the economy, like a weather disaster or a social conflict, the shock to the economy might increase dispersion, even if in general poor states tend to converge toward richer ones. The relationship between the two measures is expressed in the formula below, where it is clear that the existence of β-convergence reduces dispersion, but dispersion also depends on the variance of the error term:

$$\delta_y^2 = \frac{\delta^2 \varepsilon}{[1-(1-\beta)^2]}$$

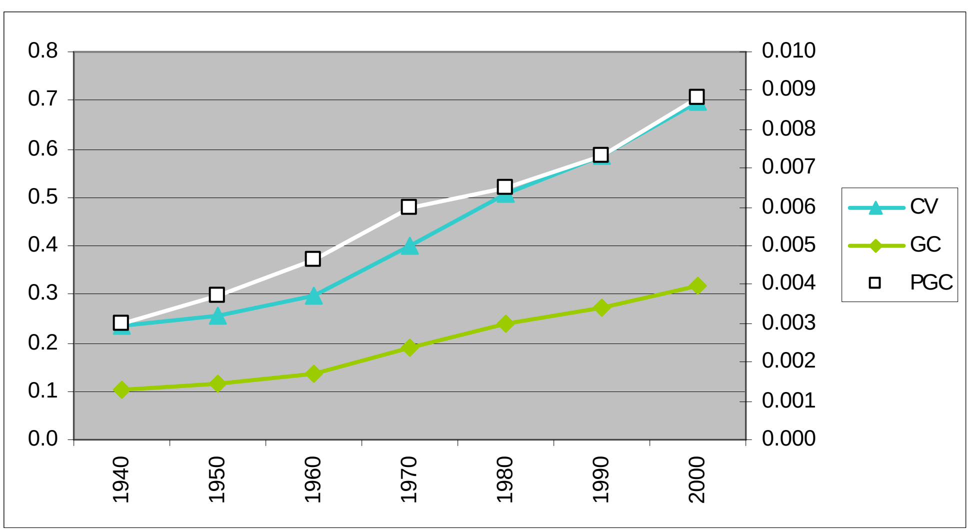
I use three measures for the analysis of δ-convergence. The first is the coefficient of variation (CV) of each variable. Although the standard deviation is a common measure used to test δ-convergence, as it measures the extent of the spread of the data, the CV is useful to compare the degree of variation of one data series to another. The CV represents the ratio of the standard deviation to the mean. This is particularly useful for comparing data series with different means, which of course is the case with the various variables in this chapter. The other two measures I use are the Gini coefficient (GC) and the population weighted Gini coefficient (PGC) of each indicator, both of which are measures of the degree of concentration of a particular variable. The Gini coefficient measures the degree to which two frequency (percentage) distributions correspond. It ranges from 0 (perfect equality) to 1 (perfect inequality). It is defined as the area between the Lorenz curve and the perfect equality line, divided by the total area underneath the perfect equality line.[12] The difference between the GC and the PGC is that for the former, each state, regardless of its population size, has the same contribution to the total summation of the values of a variable, whereas the PGC takes into account the share of the total population of each state. For all of these

[12] The Lorenz curve represents graphically the cumulative distribution function of a probability distribution.

measures, a decrease in the dispersion of an indicator indicates a reduction in regional inequality.

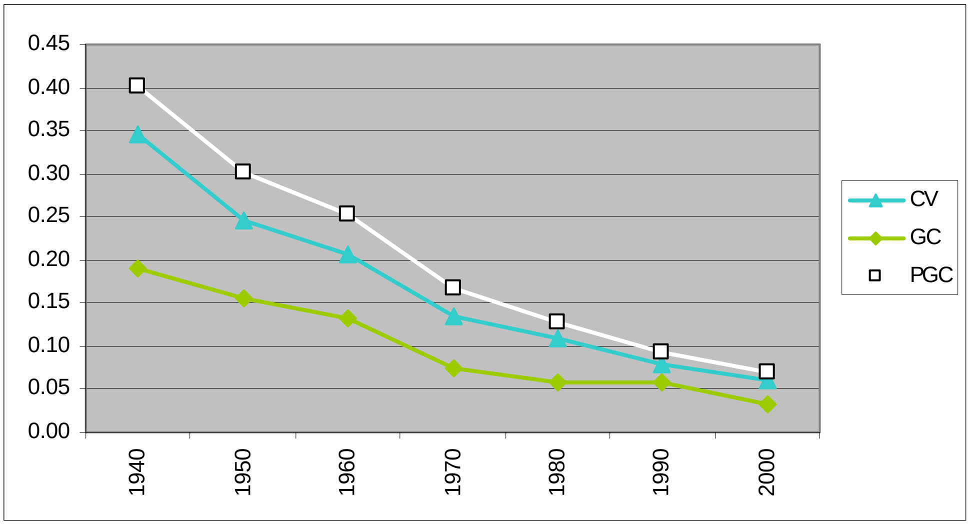
Figures 3 through 10 show the three dispersion measures for each of the indicators for the period 1940 to 2000. The dispersion of employment in the primary sector increased in general for the entire period (Figure 3), while figures 4 and 5 show that dispersion decreased consistently for literacy and in general for the share of labor employed in the tertiary sector. The tertiary sector includes an array of service industries, like commerce, transport, communication, storage, financial and insurance services, hotels, restaurants, personal and maintenance services, and government activities like public administration and defense.

Figure 3: Dispersion measures of the states' share of labor employed in primary sector activities



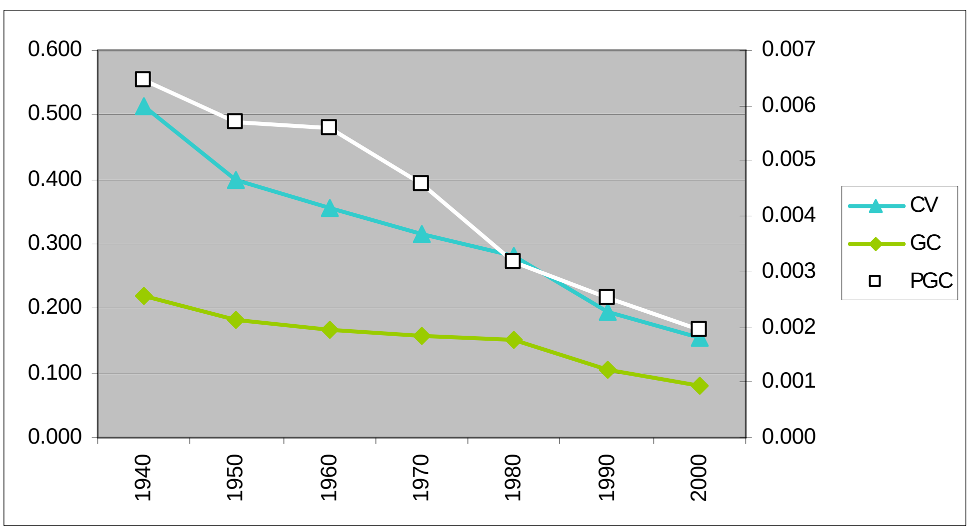
Source: Data from INEGI, Population Censuses, various years. The PGC refers to the right axis.

Figure 4: Dispersion measures of the states' share of literate population



Source: Data from INEGI, Population Censuses, various years.

Figure 5: Dispersion measures of the states' share of labor employed in tertiary sector activities

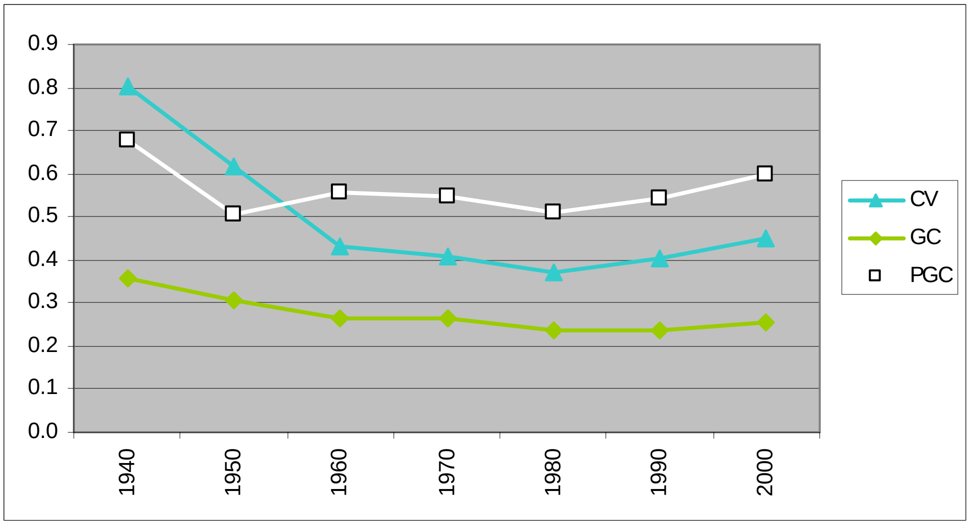


Source: Data from INEGI, Population Censuses, various years.

Aside from the three variables just mentioned, which show a clear pattern, we observe that inequality increased and decreased at different periods of time for the rest of the variables. For example, per capita income, shown in Figure 6, has a predominantly decreasing trend from 1940 to 1980 (with the exception of the PGC, which shows a pronounced increase from 1950 to 1960) and then an increasing one.[13] The dispersion of water connection, shown in Figure 7 shows an increase from 1940 to 1950, and then a general decrease until 1990, when it again begins to increase. Finally, the inequality measures for road density and share of labor employed in the secondary sector—which is composed of mining, manufacturing, electricity, water, construction, and extractive industries like oil and gas—in Figure 8 and Figure 9, show a different pattern: rising and falling throughout the period. Figure 10 shows the different trend of the CV for the share of labor employed in the three economic sectors.

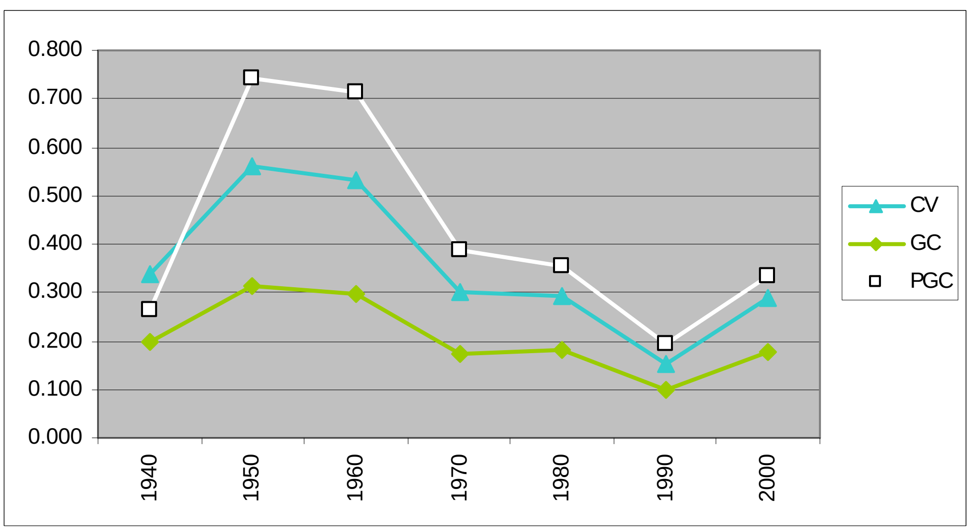
[13] This pattern is consistent with the regional convergence trend found by Unikel (1978) for the period 1940-1970.

Figure 6: Dispersion measures for states' per capita income



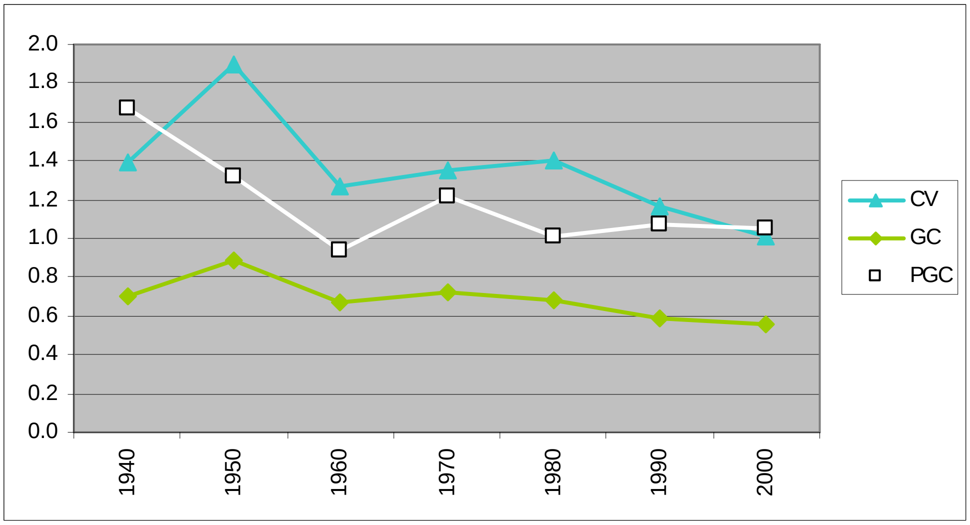
Source: Data from Esquivel, 1999.

Figure 7: Dispersion measures for states' share of housing with direct access to the water network



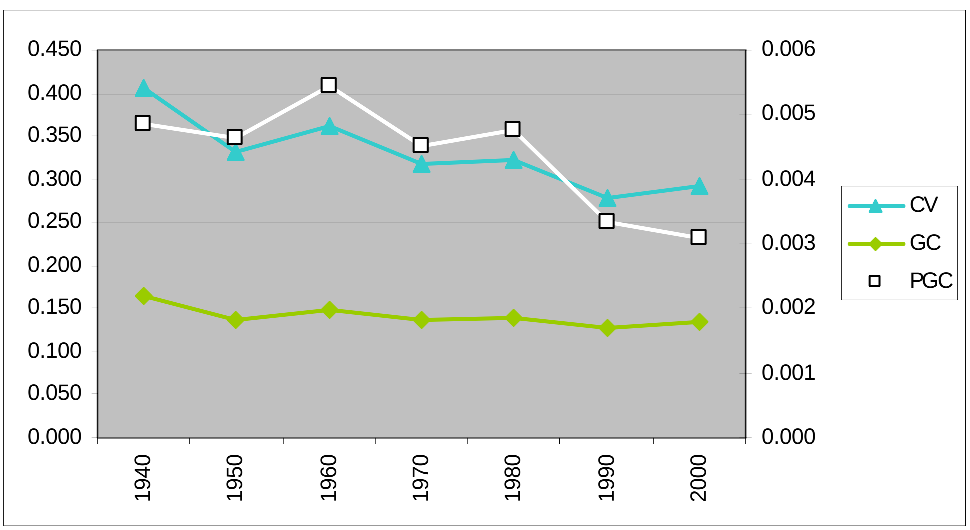
Source: Data from INEGI, Population Censuses, various years.

Figure 8: Dispersion measures for states' highway density



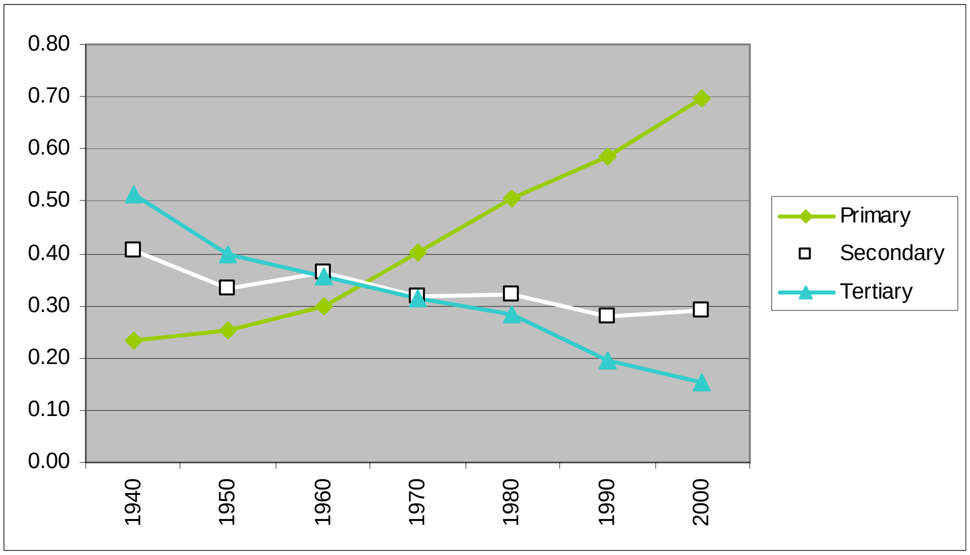
Source: Data from INEGI, Mexico's Statistical Annual, various years.

Figure 9: Dispersion measures for states' share of labor employed in secondary sector activities



Source: Data from INEGI, Population Censuses, various years. The PGC refers to the right axis.

Figure 10: Evolution of the coefficient of variation of the states' share of labor employed by economic sectors



Source: Data from INEGI, Population Censuses, various years.

In sum, the results of the tests coincide in that all the dispersion measures are lower in 2000 than in 1940, reflecting a general decreasing trend in inequality in these variables over the period, but the increases in δ-convergence show that the trend has not been a smooth one, as the δ-convergence refers to the change in dispersion from one decade to the next, whereas β-convergence refers to the trend over the entire period.

2.2 Mapping the spatial dimensions of regional inequality

The tests of β- and δ-convergence above, while indicative of overall trends, ignore spatial dynamics. For example, the test of β-convergence for income assumes that the growth rate of an economy is independent of its context—e.g. the contagion effect that might exist in adjacent regions (Rey and Montouri, 1999; Rey, 2001; Rey, 2005). Moreover, the regression test assumes that the process of convergence is homogenous across regions, ignoring the structural differences across them. For this reason, the next two sections explore—using maps and other statistical methods—the spatial dimensions of convergence and divergence processes in Mexico.

This section presents maps of Mexico indicating which states have higher and lower values of various indicators across the period 1940-2000. In all of the indicator maps, higher levels of each indicator are represented by darker colors. The most important spatial dynamic in the indicator maps is a cluster of low values in the south of the country, specifically, concentrated in Guerrero, Oaxaca and Chiapas. This pattern is generally consistent across variables and time. However, the variables and time periods change with regard to which states have high values. The result is that three spatial patterns are observed. The first one is a north-south pattern (high values in the north and low values in the south), observed for per capita income, literacy, and the share of housing with direct access to water. The second pattern is a center-south one, where the center has the high values. This is observed for road density. Finally, the third pattern is of generally high values everywhere but the south: that is, in the center and the north. This is observed for the shares of labor employed by economic sectors and urbanization. These are now discussed in detail.

2.2.1 The north-south pattern

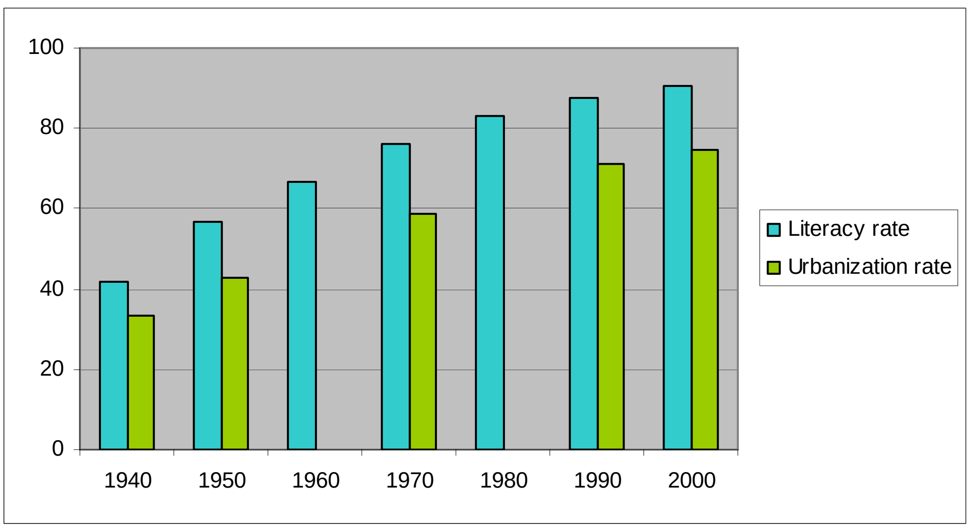
The maps of states' per capita income in Appendix 2 show that northern states (and particularly states bordering the USA), in general and especially since 1970, have a higher income level than the southern ones. There are a few states that are not in the north that do relatively well in certain decades. Some of these relatively consistent exceptions are the southern state of Quintana Roo and the center-north states of Jalisco, Colima, and Aguascalientes. However, the Federal District has the highest level over the entire period. On the opposite extreme—i.e. the lowest ranking states for the entire period—are Guerrero, Oaxaca, and Chiapas. Oaxaca is at least 50% below the mean for almost the entire period, while Guerrero and Chiapas are around 50% of the mean for the entire period.

The literacy maps in Appendix 3 measure the percentage of literate population of each state relative to the national mean. In general, literacy has been increasing in Mexico for the entire period under study (just like the urbanization rate), as Figure 11 shows.[14] However, there are three distinct spatial patterns in the literacy maps: southern states are below the mean for the entire period; northern states are above the mean for the entire period; and the Federal District has the highest value for the entire period (except for 1940). In particular, Guerrero, Oaxaca and Chiapas are the three states that have the lowest literacy levels for the entire period; in fact, in 2000 their share of literate population is 85-87% of the

[14] Note in Graph 11 that data on the urbanization rate for 1960 and 1980 are not available.

national mean, while the rest of the states are at the mean or above. It should be noted, however, that the gap seems to be closing: in 1940, the share of literate population in these three states was about 60% of the national mean.

Figure 11: Mexico's national literacy and urbanization rates



Source: Data from INEGI, 1998.

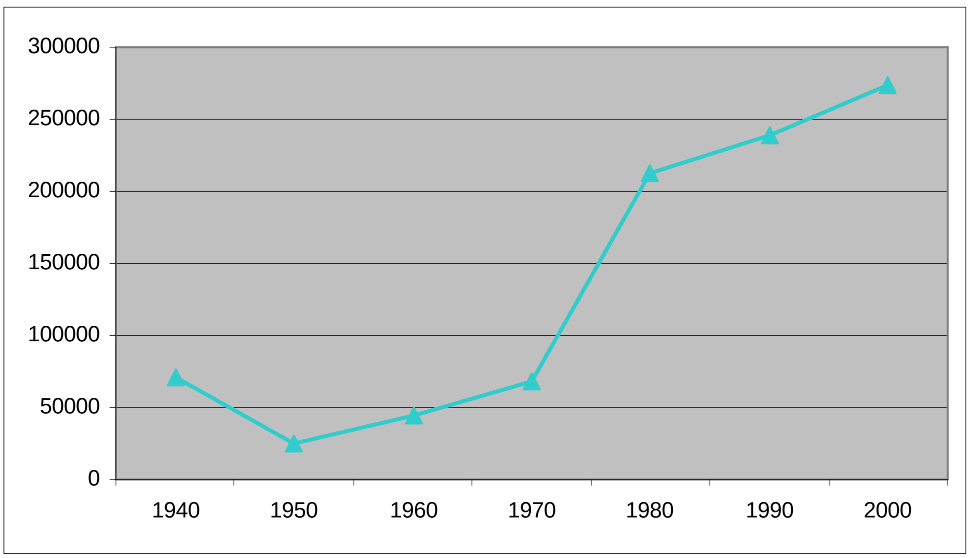
States' percentages of housing units with direct access to the water network (henceforth refer to as "water connection"), reported in Appendix 4, show that southern states have generally had lower shares of water connection relative to the northern states. The Federal District is among the states with the highest shares during the entire period. It should be noted that the states with the lowest shares for the early part of the period are Guerrero, Hidalgo, and Nayarit, located in the south, center and center-north. Thus, the pattern is not a straightforward north-south divide for 1940 to 1970. However, for the later part of the period, the states with shares lower then the mean are mainly located in the south. Moreover, the three southern states that show the lowest ranks in per capita income and literacy—i.e. Guerrero, Oaxaca, and Chiapas—are also among the states with the lowest shares of water connection since 1980.

2.2.2 The center pattern

The maps of states' density of roads relative to the national density, in Appendix 5, show that the center of the country has had a higher road density than the rest of the states. Specifically, the states surrounding the Federal District—i.e. Estado de México, Morelos, Tlaxcala, Hidalgo, Queretaro, Guanajuato, and Aguascalientes—consistently have the highest road density. On the opposite extreme is Chihuahua in the north (the largest state), with the lowest share of road density. It is interesting to note that, while Chiapas (in the south) is the state with the lowest share of relative road density since 1950, Coahuila and Durango (in the north) are also among the states with lower shares since 1970. This pattern is therefore certainly different than the one with high values in the north, reflecting the fact that the Federal District is the capital of the country and is located in the center implies that roads radiate out to the rest of the country.

However, it is important to note that road density is a limited measure of infrastructure, given the tendency of larger states to exhibit lower road density simply because of their size. An ideal measure would capture both the quality of roads and their functionality in terms of whether they serve local populations or populations from other states (in transit). Moreover, road density is the only variable in which the Federal District is slightly below the national mean, although only after 1970. This coincides with the substantial increase in the road network in the country since the 1970s, as Figure 12 shows.

Figure 12: Evolution of the length of highways in Mexico



Source: Data from Mexico's Statistical Annual, various years.

2.2.3 The north and center pattern

The final pattern observed is that the states on the US border and states in the center have higher values for employment levels in secondary and tertiary sectors as well as urbanization. Obviously, this means that in the south has higher shares of labor is employed in the primary sector (and therefore less diversified economies). The maps reveal the differences that exist across states in their shares of labor employed in the different sectors, as will be discussed in a moment.

The opposite pattern of the shares of labor in secondary and tertiary sectors, as well as urbanization, to the pattern of share of labor employed in primary sector makes sense given that an increase in the share of labor in the secondary and tertiary sectors implies a reduction in the primary sector, and thus an expansion in the urban area relative to rural areas. In general, the patterns of urbanization and the labor share employed by economic sectors are therefore consistent with the regularities observed across countries regarding the sectoral composition of GDP and the level of development.

This is confirmed by the pattern shown in Appendix 6 of the share of labor employed in the primary sector. One can see that from 1930-1960 lower shares of labor were generally employed in the *primary* sector in states bordering the USA than elsewhere. Since 1970, however, the difference in states' shares has become more pronounced: Nuevo León, and Baja California Norte on the border, and Estado de Mexico, surrounding Mexico City, reduced their share. Meanwhile, Chiapas, Guerrero, and Veracruz, in the south and center, increased their share. Not surprisingly, the Federal District has the lowest share during the entire period, as it is the largest metropolitan area of the country. Thus, it is clear that since

1970 the differences have become more pronounced, showing a clear north/ center and south pattern of low-high values related to primary sector employment.

The share of the population employed by the secondary sector seems to show that the variation in states' shares has been decreasing over time, although one can still find important differences. The maps in Appendix 7 show that the Federal District held the lead until 1960. Since 1970, there seems to be an expansion of secondary sector employment in two groups of states: one in the center of the country (states surrounding and north of the Federal District) and another group bordering the USA. This apparent reduction of the concentration of secondary sector activities in the Federal District in 1980 is really an expansion of this core area, as Aguilar (1990) observes. Aguilar notes in his evaluation of an industry decentralization program that although there is a de-concentration process of manufacturing establishments from 1970 to 1985 from the Mexico City metropolitan area (50% to 43%), they are going to the surrounding states (Puebla, Queretaro, Hidalgo, and Tlaxcala). Thus "de-concentration" does not imply a diminishing of the core area. In addition the reduced share of labor employed in the secondary sector since the 1990s in the Federal District reflects an expansion of the labor share employed in the tertiary sector (henceforth referred to as "tertiary sector employment), as we will see now.

The maps of the tertiary sector employment, in Appendix 8, show a similar trend to the secondary sector employment, in that the differences in states' shares have tended to decrease over time. However, the general pattern seems to be that the Federal District and surrounding states, as well as the states bordering the USA, have the highest share of their labor employed in the tertiary sector for almost the entire period. Jalisco, Colima, and Aguascalientes, located in the northern center of the country, also have a share above the mean since 1940. Thus, although the states' differences in tertiary employment seems to decrease over time, this pattern, like the pattern for the secondary sector, seems to be reversed in 2000, when the highest employment is concentrated in a few states.

Appendix 9 shows that urbanization has generally increased in Mexico, and since 1970, one can identify three groups of highly urbanized states: the states bordering the USA, the Federal District and surrounding states (including Jalisco, Colima, and Aguascalientes), and the Yucatán peninsula. The urbanization pattern coincides in general with the pattern of employment in the secondary and tertiary sectors. It is important to note that the three states that are the least urbanized (Hidalgo, Oaxaca and Chiapas), remain within the 25 to 50% rank since 1970, seeming to resist the overall urbanization evolution of the country (see Figure 11). This may be an indication of a "path dependent process" (David, 1985), especially considering that Oaxaca and Chiapas are also among the lowest ranking states in per capita income, water connection, and literacy.

Thus in general the indicators show three main patterns that illustrate the extent of regional inequality: high and low values in the north and south respectively; high values in the center and north; and high values concentrated in the center (see Table 3 for a summary). These three patterns imply a consistent cluster of low values in the south. Moreover, aside from the spatial patterns described above, one can distinguish a break in the time trend consistent across variables. The differences among states become more pronounced in the later part of the period for most variables, and the spatial patterns become generally more pronounced. Specifically, for per capita income and water connection since 1970, the north-south pattern becomes clear, whereas before it is not. The employment by sector variables also show a time trend as their differences become more pronounced since 1980. Finally, urbanization shows a pattern similar to that of the secondary and tertiary sectors.

Table 3: Summary table of spatial patterns from indicators maps

Type of spatial pattern	*Description*	*Variables with clear tendency*
North-South pattern	High values in the north and low values in the south	Per capita income, literacy and water connection
Center	High values in the center	Population and road density
Center and border states	High values	Secondary, tertiary sectors and urbanization.

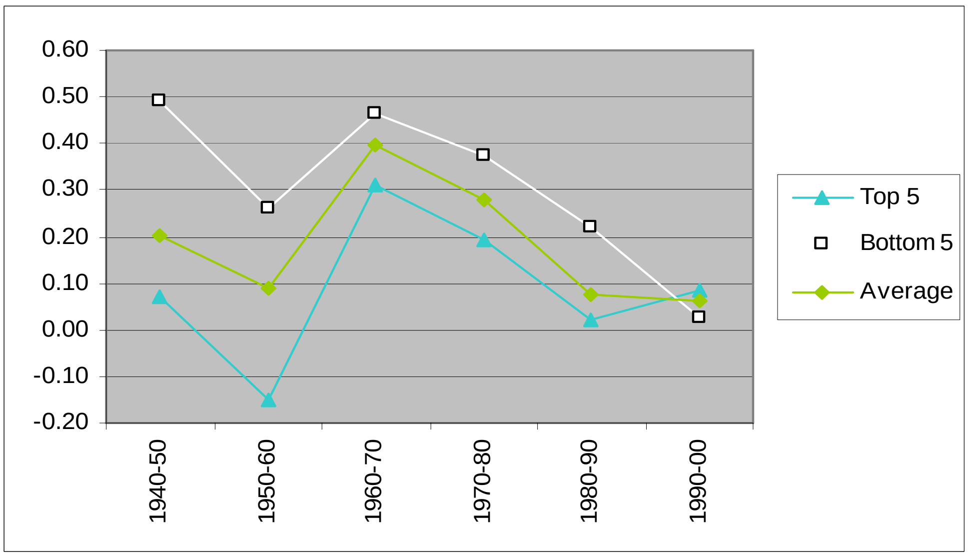
It is important to consider the nature of the observed time break in the convergence trend of most of the variables. For example, it is possible that the break in the 1980s is caused by some states growing much faster in the later part of the period, even if all states are growing. In this case, a convergence trend break would not necessarily be bad news. However, it is also possible that the trend break reflects some states actually experiencing a decline in growth. By looking at the average state growth rate in different decades and the growth rates in the poorest and richest states over the various decades, I find unfortunately that the trend break reflects an actual decline for some states.[15]

Figure 13 shows that the average state growth rate in Mexico has declined in every decade since 1970. It is interesting to note, however, that in every decade before 1990, the poorest five states had an average growth rate higher than that of the richest five states. Both of these growth rates were declining at about the same rate from 1970 to 1990. From 1990-2000, however, the growth rates of the five poorest states continued to fall, while the growth rates of the five richest rebounded. In fact, the growth rates of the poor states fell so much, and the growth rates of the rich states rose enough, that for the first time in the period of observation, the average growth rate of the richest states was above that of the

[15] For this analysis, I took the richest and poorest states in 1940 and compared their average growth rates over 1940-50, and I repeated the same exercise in the other decades (i.e. not necessarily using the same particular states but comparing richest to poorest).

poorest states. Obviously it is not surprising therefore that we begin to see divergence from 1990-2000.

Figure 13: Average growth rates of states per capita income, by groups of states



Source: Author's calculation with data from Esquivel, 1999.

2.3 Regional polarization for each variable

The different spatial patterns observed in the previous section show that regional inequality in Mexico is not random. Instead, there seem to be systematic spatial patterns. Specifically, the south does not excel in any of the variables examined above, while the north and center do well in many of them. Therefore, in this section I explore the potential existence of different spatial regimes, or groups of states that become more similar within their group but more different across groups. I use the Local Moran test (Anselin, 1995) to distinguish local spatial autocorrelation, which refers to the identification of groups, local clusters, or spatial outliers.

Local clusters are regions where adjacent areas have similar values, whereas spatial outliers are areas very distinct from their neighbors. The cluster maps indicate locations with a statistically significant measure of spatial autocorrelation (Local Moran) by type of association. There are four types of association: the areas shaded in red refer to clusters of high values; the areas in blue refer to clusters of low values; light-red and light-blue refer to states that are dissimilar to the adjacent areas, i.e. that the adjacent areas show values different to the outlier state. The maps report only clusters statistically significant at least at the five percent level.[16]

In general, the results of the Local Moran tests show the existence of two spatial dynamics, which, for the most part, coincide with the spatial patterns mentioned above (see Table 4 for a summary). Moreover, just like the previous section, the cluster maps indicate a time trend.

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[16] The weights matrix is an average of the adjacent states using the queen contiguity type.

Table 4: Summary table of spatial patterns of indicator and cluster maps

Type of spatial pattern	*Description*	*Variables with clear tendency*	*Cluster maps pattern*
North-South pattern	High values in the north and low values in the south	Per capita income, literacy and water connection	Cluster maps show a cluster of low values in the south for income and water connection. Whereas for literacy there's also a significant cluster of high values in the north
Center	High values in the center	Road density	Cluster maps show significant cluster of high values in the center as well as low values in the north
Center and border states	High values (low values)	Secondary, tertiary sectors and urbanization. (Primary sector)	Cluster maps show a significant cluster of low values in the south (high values for primary sector)

The first spatial pattern is a southern regime of low values for most of the variables (per capita income, water connection, urban population, employment in the tertiary sector, and literacy). The cluster map of states' per capita income, in Appendix 10, shows that although in the three years analyzed there are somewhat different spatial dynamics (such as a few outliers of states with dissimilar values compared to its neighbors), the cluster of low values in the south is consistent for the three years analyzed: 1940, 1970, and 2000. Moreover, the cluster of low values is the only spatial dynamic in 2000. Appendices 11 and 12 show the cluster maps of water connection and urbanization, which like the per capita income variable, show a consistent cluster of low values in the south in the three years. The share of labor employed in secondary and tertiary sectors also show a clear pattern of low values in the south, in Appendices 13 and 14, but the secondary sector also shows a cluster of high values in the north. The cluster maps of literacy, in Appendix 15, show a cluster of low values in the south and a cluster of high values in the north. Finally, the share of labor employed in the primary sector (in Appendix 16) reveals a pattern consistent with the patterns shown by the maps of the other economic sectors, as it is the opposite trend, i.e. a clear cluster of high values in the south.

The second spatial dynamic is a cluster of high values in the center of the country. The maps of road density (in Appendix 17) have a cluster of high values in the center of the country for most of the years, and also have a cluster of low values in the north of the country.

2.4 Some historical background

The last two sections of this chapter have indicated a broad spatial pattern over the last six decades in Mexico, characterized most importantly by underperforming southern states. The concerned reader will at this point likely be wondering, "Why?" While the issue is complex enough to warrant its own paper (or book!), here I offer some initial thoughts regarding policies that have led to the current situation.[17] I focus in turn on trade, transportation, agricultural, and labor (migration) policies.

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[17] This is certainly not to imply that policies are the only factors—other factors would include natural resources and original factor endowments.

In the late 1940s Mexico established a system of import barriers, licensing restrictions and official reference pricing as part of the Import Substitution Strategy for industrialization, which was a common strategy in Latin America.[18] However, as a result of the economic crisis in the 1970s and 1980s, Mexico underwent a major economic reform (Quintana Romero, 2004). One of the main characteristics of the new economic regime is the promotion of the external sector of the economy. The change of regime included the elimination of the protection for domestic industry that was maintained during the import substitution period, as well as the institution of additional policies to boost exports. Mexico joined the General Agreement on Tariffs and Trade in 1986, shifting from a system of license controls and trade barriers to a tariff regime (Pacheco—López and Thirlwall, 2004). During 1982 and 1990, the share of total imports that were subject to import licenses decreased from 100% to 14.1%, and the highest tariff barrier went from 100% to 20% (Quintana Romero, 2004). The aim was to allow the national industry to compete with the international industry and thus make it more efficient. Moreover, since the 1990s, Mexico has signed twelve free trade agreements, including the North American Free Trade Agreement in 1994 (see Table 5), and revenue from trade taxes as percentage of GDP has decreased as shown in

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[18] The aim under the Import Substitution Industrialization was to achieve industrialization avoiding external disequilibria that arise from unfavorable terms of trade and consequently avoiding structural unemployment. This strategy is the based on the influential ideas of center periphery development theory of Raúl Prebisch. Solís, 1988.

Figure 14 and Figure 15.[19] As might be expected, the volume of trade has increased substantially, as shown in Figure 14.

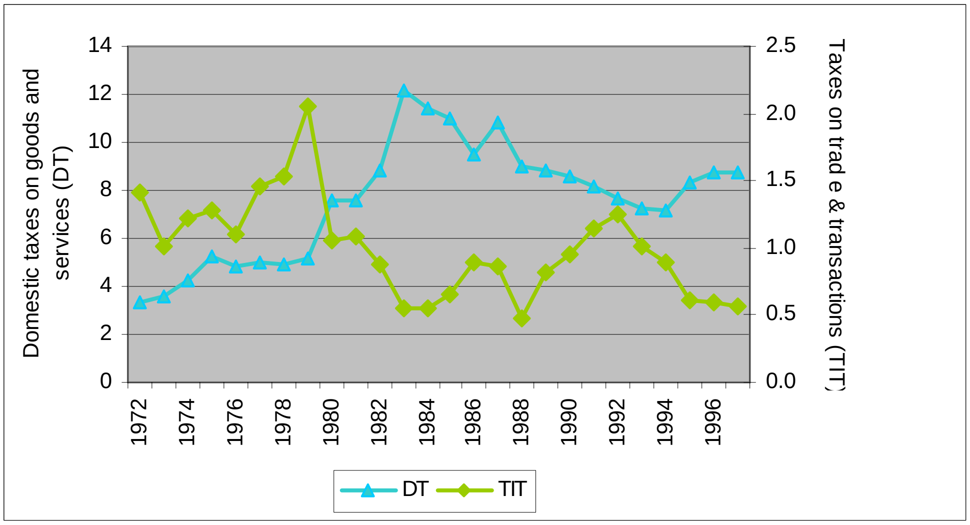
Table 5: Free trade agreements that Mexico has ratified

Treaty	Countries	Year
FTA Mexico-Chile	Chile	1992
NAFTA	USA and Canada	1994
FTA-G3	Colombia and Venezuela	1995
FTA Mexico - Costa Rica	Costa Rica	1995
FTA Mexico - Bolivia	Bolivia	1995
FTA Mexico – Nicaragua	Nicaragua	1998
FTAUEM	European Union	2000
FTA Mexico - Israel	Israel	2000
FTA Mexico – TN	El Salvador, Guatemala and Honduras	2001
FTA Mexico - AELC	Iceland, Norway, Liechtenstein and Switzerland	2001
FTA Mexico – Uruguay	Uruguay	2004
EPA Mexico-Japan	Japan	2005

Source: Mexico's Ministry of Economics. Available on-line at:
http://www.economia.gob.mx/?P=2113&NLanguage=es#

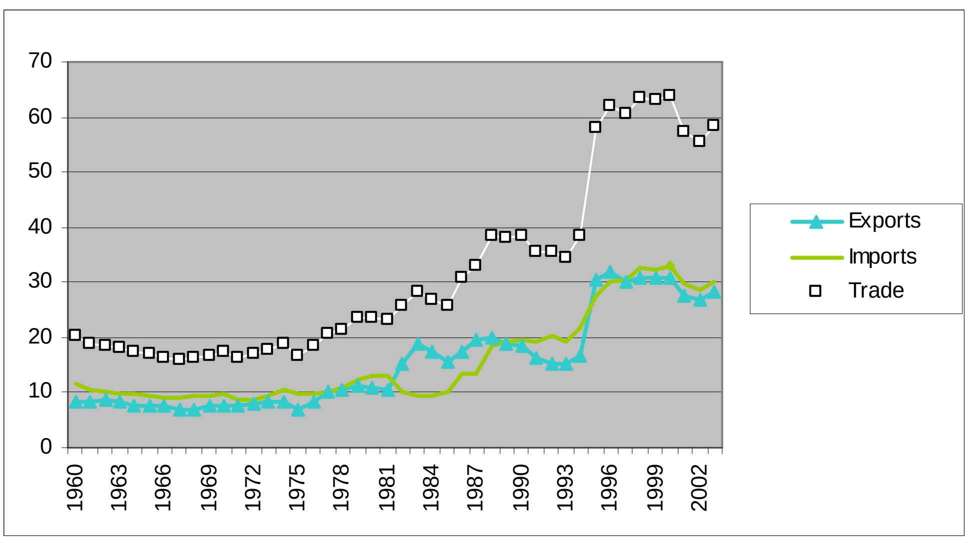
[19] Note that although free trade agreements were signed in the early 1990s, the taxes on trade started to decrease in the 1970s. As Pacheco-López and Thirlwall (2004) discuss, the import restrictions were relaxed during the oil boom of the late 1970s. During the 1980s, restrictions were put back in place.

Figure 14: Evolution of tax revenue in Mexico (as a % of GDP)



Source: World Bank, World Development Indicators 2005.

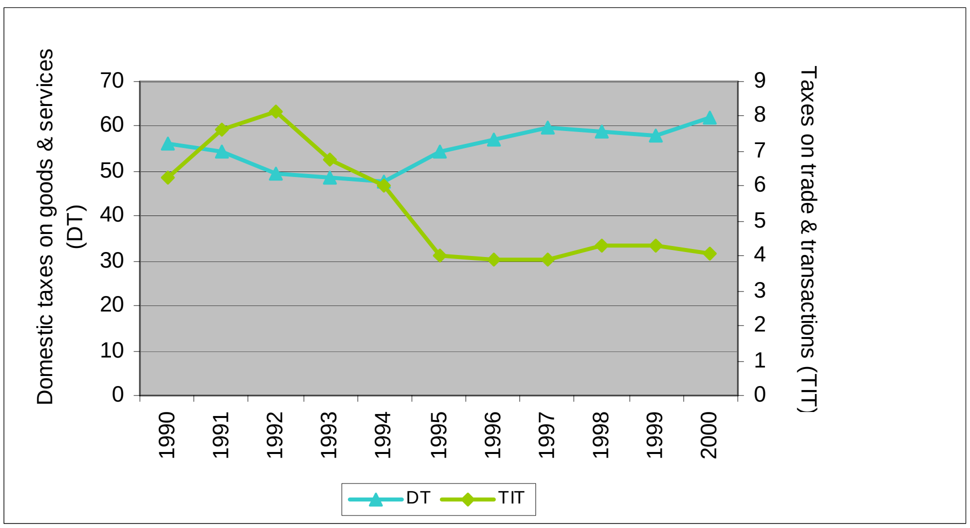
Figure 15: Trade volume in Mexico (as % of GDP)



Source: World Bank, World Development Indicators 2005.

Figure 16 shows the evolution of trade policy since the 1990s. Although, tax revenue from trade and the volume of trade (exports plus imports as a share of GDP) are not direct measures of trade policy, they give a good indication of the changes in trade regime.

Figure 16: Evolution of different sources of tax revenue in Mexico (as a % of total government revenue)



Source: IMF, Government Financial Statistics.

It is unclear, from the spatial patterns described above, whether one could observe a causal relationship between trade policy and regional inequality. However, it is interesting to note that the combination of policies may have had resulted in the polarization of the south. The south in fact has lagged behind other regions in Mexico for long before 1940. The concentration of economic activities in the core urban areas in the center and north of the country has its origins in the colonial period, when the first roads were established. Subsequently, this concentration has only been strengthened by the transportation decisions pursued by the government, first with regard to the pre-revolutionary establishment of the railroad network that started to function in 1850, and later with the construction of the national highway system, that started in 1925 (López Malo, 1960; Unikel, 1978; and Haber, 1989).

The railroad system was designed originally to connect the political center of the country, i.e. Mexico City, to the port of Veracruz, as it was the main port for European products. In the following years the railroad connected the capital to the mining and agricultural areas in the center and north of the country. In 1881 the longest railroad line connected the capital to the north (Paso del Norte), as primary commodities were exported to the USA (Haber, 1989 and Jáuregui, 2004). In general, the south remained largely disconnected. According to Jáuregui (2004), although the railroad network benefited the entire country because it consolidated its union, it tended to benefit regions unequally, as only four stations—Mexico City, Guadalalara, San Luis Potosí, and Chihuahua—accounted for 45% of the total cargo. More importantly, Jáuregui argues that the railroad network mainly linked the country to the world economy, as the two main lines were connecting Mexico City with the port and the northern border (p. 93). The railroad network did not connect the south with the rest of the country due to lack of mineral resources, their topography and remoteness to the US market (Tamayo, 1997).

Before the existence of the railroad, when Mexico was a Spanish colony, roads transported mining production (mainly silver) to Veracruz and foreign imports into Mexico City, basically connecting the center of the country—Mexico City, Zacatecas, San Luis Potosi, and Guanajuato—to the port in the Gulf of Mexico (Haber, 1989). The road system that was built during 1860s and 1870s also benefited the center of the country, but it was not until 1925 that the financing and construction of a national highway system was made officially. Among the main highway projects of this effort was the route that connected Mexico City to the border (Nuevo Laredo) to foster the tourism coming from the USA into Mexico. The major projects during the 1950s mainly connected the center to the north of the country. It was not until the decade of 1980s that new roads were built beyond the established routes.

Thus, the transportation system, giving priority to the center and north of the country, has resulted in marked regional differentiation and therefore disparities in the welfare of the people, as is evident from the indicator maps in the Appendices.

Agricultural policies have also played a role in the spatial pattern observed above, particularly since the 1950s, when the period of import substitution industrialization (ISI) began. As Little, Scitovsky, and Scott (1970) argued in their comparative study of seven developing countries' industrialization experiences, the ISI strategy was implicitly biased against the agricultural sector. As Rubio (2004) states, during ISI most countries satisfied their internal food demand through domestic production because of the high protectionist measures required by ISI.[20] It was important to keep food prices low, so as to keep worker's salaries high in terms of purchasing power and thereby increase demand for industrial goods. Thus, food prices were kept low within countries through internal competition and regulation by the state. Little, Scitovsky, and Scott (1970) argue that Mexico implemented a successful agricultural development program during the 1950s and 1960s that aimed to compensate, at least partially, the bias against the agricultural sector.[21] However, as Unikel (1978) points out, this program mainly benefited the already modern mechanized agriculture sector of the northern and central part of the country, because the policy rewarded capital-intensive export crops with high productivity. Thus the agricultural sector in the south did not benefit from these compensation policies and suffered the most under ISI.

[20] It is important to note that protectionist measures were in place in most countries during the postwar period.

[21] The incentives provided were cheap fertilizers, improved seeds, farm machinery, credit and irrigation infrastructure investment (p. 107).

The main reason the northern states could take advantage of the compensation programs was because they had been the principal beneficiaries of infrastructure investment. Fujigaki (2004) and Hewitt (1978) argue that the government played a key role in the modernization of agriculture of the country, which mainly consisted of large investments in infrastructure (irrigation, highways, and electricity) and the extension of credit. These investments mainly benefited the northern states, specifically Baja California Norte, Chihuahua, Sinaloa, Sonora, and Tamaulipas, where 53% of the irrigation investments took place between 1940 to 1970 (Fujigaki, p. 123). Thus, the infrastructure, incentives, and technical support provided since the 1930s to the northern states resulted in substantial differences in the productivity of the land compared with the rest of the country: on average the rate of growth of yield during 1946 to 1962 was 3.6 percent in the north, whereas in the rest of the country it was 1.8 percent (Hewitt, p. 107). This also resulted in a much faster rate of growth of land under cultivation in the irrigated northern states—8.4 percent annually—compared to the slow growth of 1.3 percent per year in the center and south (Hewitt, 1978, p. 107).

Moreover (and likely as a result of the dynamics just mentioned), Fujigaki states that the agricultural sector has been geographically bifurcated: specialization in more profitable crops like cotton and wheat in the north (due to the availability of infrastructure and production inputs) and concentration in the center and south on production of maize and beans, due to the lack of inputs and irrigation infrastructure. It is the crops in the center and south that compete directly with the USA and Canada. In addition, in the 1980s, as part of the general shift to a more market-led economy, Mexico removed price controls and subsidies in the agricultural sector (Pacheo-López and Thirlwall, 2004).[22] Thus, the latest liberalization process has negatively affected those states where agriculture employs a large share of their population, which is consistent with the divergent trend found for the share of labor in the primary sector in the β-convergence tests discussed in section 2.1, as well as in the spatial regimes tests of section 2.3. Thus, productivity in the agricultural sector in the south has not increased. Morever, even in the 1990s, the government programs that were set up to help farmers face the increased competition arising from NAFTA benefited largely the northern modernized agricultural producers. Yunez Naude and Taylor (2006), in their analysis of the effects of NAFTA on the Mexican agricultural sector, state that the program "aids large farms, those with the capacity to produce surplus; therefore, most of its sponsorship goes to surplus producing regions of the irrigated areas of the northern states" (p. 164).

Finally, northern states have been positively affected by migration policies, because of their proximity to the USA. The policies enabling Mexican labor to work in the USA

[22] The dismantling of agricultural subsidies will continue under NAFTA in 2008.

mainly affected the northern states, particularly beginning in the early 1940s with the Bracero Treaty. Although there had been labor agreements between the US and Mexico since 1920–and Mexican migration to the USA dates back to 1850, right after the War between both countries—the Bracero Treaty of 1942 was the most important to date. It was signed between Mexico and the USA initially with the aim to provide labor for the construction of the US railroad, but later also provided labor for American farms. Mexican workers, mainly from the northern areas, moved to the USA to work in the fields.

The Bracero Program lasted until 1964 under different forms, and as a response to the high unemployment of Mexicans returning to bordering states (and in the USA) after the program was terminated, the Border Industrialization Program was established in 1965.[23] This program allowed free US imports used for manufacturing products for export from Mexico, with the aim not only to employ the workers coming back from the United States but also to enable Mexico to attain valuable international currency and technology. This program also benefited the northern states and specifically those on the border, as it fostered the growth of manufacturing industry limited to this geographic zone. This advantage of the north has only been strengthened by the more recent set of export promotion policies of

[23] The program is more commonly known as the Maquiladora program which is still functioning at the moment. The program was part of a federal program (Programa Nacional Fronterizo) that started in 1961 with the objective of fostering the economic development of the border region, even though the border region already had a higher level of development than the national mean, the idea was to take advantage of the geographic opportunity that bordering the US market represented. SPP, p. 17.

the mid-1980, which benefited those states with already established manufacturing sectors—states which were in the north and center.[24]

In sum, the combination of trade, transportation, agricultural, and labor policies has had a direct effect on the uneven development across states in Mexico. They have promoted the growth of the secondary and tertiary sectors in the northern part of the country as well as (more indirectly) in those regions where manufacturing has had a long existence, i.e. the center of the country. Unfortunately, there is no particular reason to expect these trends to change. Southern states' economies have remained predominantly agricultural, while the rest of the country has generally expanded into the other economic sectors. The agricultural situation has been exacerbated under NAFTA, as, aside from enjoying less government support, the Mexican traditional sector can't compete against the subsidized agricultural products from the USA and Canada. This is especially true for the case of grains, like maize.

2.4 Conclusion

The different tests discussed in this chapter show the complex dynamics of regional inequality for Mexican states across different socio-economic indicators in the period 1940-2000. Three main points can be emphasized from this analysis. First, the convergence tests

[24] These policies mainly gave incentives to firms to export by providing rebates, and facilitating the administrative and fiscal process of exporting goods.

indicate a substantial convergence pattern across indicators, with the exception of the share of labor employed in the primary sector. This indicates a general trend of narrowing inequalities with regard to these different indicators.

Second, the different indicator maps and spatial correlation tests show that the relative ranking of different states with regard to these indicators is remarkably constant. Those states that were more advanced in 1940 continued to be so in 2000, while the reverse is also true: states that lagged behind in 1940 continue to lag behind. Thus, inequality that existed across states in 1940 remains, though to a lesser degree. The overwhelming spatial pattern observed in this chapter is that the lagging states have been in the south of the country. The local spatial autocorrelation tests show these consistent dynamics across variables. The most pronounced is the existence of a cluster of low values in the south of the country, a fact that coincides with the observations of the indicator maps discussed in the second section, which show consistently the predominance of low values for southern states. Literacy and housing, in addition to the cluster of low values in the south, have a cluster of high values in the north.

Finally, the third point worth emphasizing is the trend break, in 1980 and 1990, observed for some of the variables, including per capita income, water access, and share of labor employed in the secondary sector.[25] As mentioned above, during the period of 1940 to 1980 there was a general convergence pattern, which gets reversed afterwards. As this was exactly the time period in which economic reforms were launched, it is important to investigate further the potential effect that these economic reforms had on regional inequality. The following chapter begins that investigation.

[25] See Figures 6, 7, and 9.

3. Literature review: A model of Regional Inequality

This chapter discusses the literature on trade and regional inequality and presents a model which integrates existing competing hypotheses from the literature into a theoretical framework based on endogenous growth theory. Specifically, the model integrates three of the most important hypotheses in the literature. The first one is that trade openness has contributed to the dispersion of economic activities from core areas in Mexico, following Krugman and Livas Elizondo (1996) core-periphery model.[26] The second and third hypotheses are that trade openness has led states with higher levels of infrastructure and human capital to grow faster than those with low levels.

The chapter is organized as follows. I review the previous literature on trade openness and economic growth that has influenced the work on regional inequality in the next section. In Section 3.3 I lay out the hypotheses of the model, followed by the model. The last section concludes.

3.1 Prior literature on regional inequality

The relationship between trade openness and regional inequality remains unresolved in the literature. A variety of empirical analyses have arrived at conflicting conclusions, and this almost certainly reflects the lack of a synthetic theoretical approach to

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[26] This model is also presented in Chapter 18 of Fujita, Krugman, and Venables, 2000.

the problem. An innovation of this analysis is the integration of various existing hypotheses into a coherent theoretical and empirical framework, thereby allowing the hypotheses to be tested against one another. I do this by using endogenous growth theory, which suggests that unbalanced development across regions can occur because regions have different endowments of production factors and, in turn, different levels of positive externalities (or spillover effects) that those factors generate.

While the same basic approach has been used by others to study the relationship between *global* (i.e., cross-national) trade openness and *global* inequality (Aghion and Howitt, 1998), it has not been used to a significant degree in the literature on sub-national regional inequality. This is surprising. If factor endowments are important, the location of those endowments is important, and variations in the distribution of endowments within a country may impact which regions benefit from national trade openness. In fact, much of the existing literature on trade and regional inequality can be viewed as focusing on one or another of three types of endowments that involve externalities: firm linkages, infrastructure, and education. These are reviewed here in turn.

Demand or supply *firm linkages,* and the pecuniary externalities they create, play a large role in Krugman's (1991b) classic core-periphery model. In a model of firm location, he shows that if there is one region where the majority of manufacturing activity is already situated, that region will also be the place where *new* manufacturing activities locate, since a large part of the market will be there. Thus, according to Krugman (1991a), there is a "circularity that tends to keep the manufacturing core in existence once it is established" (p. 81).

To this point, Krugman's work is similar in important ways to Myrdal's (1971) theory of cumulative causation, which refers to a vicious or virtuous circle in which one factor is both cause and effect of other factors, resulting in a circular process of improvement or decline.[27] However, Myrdal and Krugman diverge in their prediction of how trade will affect this process. In Myrdal's theory, trade is one of the forces through which the cumulative causation process operates, as the growing regions will see their markets become larger and develop competitive advantages relative to other regions. In Krugman's model with Livas Elizondo (1996), the concentration of economic activities is *less* beneficial in the face of trade openness. The costs of agglomeration or concentration, such as congestion and higher prices at the core, gain more relevance as centripetal forces come to

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[27] For Myrdal's (1957), "backwash" and "spread" effects are the forces driving the cumulative causation process. Backwash effects refer to the expansionary process of a region while others are being left behind, and they will tend to dominate the spread effect, which promotes the expansion from the growing center to other regions. The spread effect operates through increased demand from the growing center, stimulating production of other regions. However, Myrdal argued that this effect should not be conceived of as a force balancing the backwash effects. "In no circumstances do the spread effects establish the assumptions of an equilibrium analysis. In the marginal case the two kinds of effects will balance each other and a region will be "stagnating". But this balance is not a stable equilibrium, for any forces will start a cumulative movement upward or downward" (p. 32).

dominate. Following this logic, Krugman and Livas Elizondo (1996) argue that protectionist policies encourage the concentration of economic activities, and thus regional inequality, because firms want to take advantage of externalities and market size effects, such as the linkages developed between firms, consumers, and suppliers aimed at serving a small, closed economy. Once trade barriers fall, the Krugman-Livas Elizondo theory predicts the dispersion of activities and therefore more equal regional development. Instead of relying on the core for inputs and markets, firms will now seek to access foreign markets and rely on imports for inputs. Therefore, manufacturing does not need to be located at the core. Firms can now locate outside the core and avoid the costs of concentration that arise in large centers, like pollution, traffic, and high land prices and labor costs. In sum, agglomeration effects, or the benefits of concentration, are greater in closed economies compared to open economies.[28]

This theory has received empirical support from, for example, Pernia and Quising (2003) who observe that in the Philippines, trade openness has indirectly fostered regional equality through the reduction of poverty. In addition, Hanson (1998) finds evidence that trade contributed to the breakup of urban primacy in Mexico, by encouraging a shift in the

[28] The Krugman and Livas Elizondo (1996) theoretical model has been extended to include factors such as initial endowments and beliefs (Ottaviano, 2001) and the size of the population (Villar, 1999). The core predictions of Krugman and Livas Elizondo hold even with these additions.

location of manufacturing activities from the main urban center to the north, where there is greater access to foreign markets.

Despite this empirical support, Krugman's models have been the focus of important critiques. In particular, some scholars have criticized Krugman for only focusing on pecuniary externalities and neglecting other important externalities, such as *infrastructure*. Mansori (2003), for example, presents a model in which transportation costs are subject to increasing returns to scale that arise due to large fixed costs. As he puts it, "an airport, a railway line connecting two cities, or a port can easily cost billions of dollars to construct before any transportation services can be provided, and then require periodic and costly maintenance thereafter" (p. 251). Because of the large fixed costs relative to variable costs in infrastructure projects, infrastructure exhibits increasing returns and therefore tends to be highly concentrated (see Neary, 2001). Since trade increases the use of the infrastructure, the average costs of that infrastructure decline, thereby giving an additional advantage to those regions with already existing infrastructure. Mansori argues that these regions with already existing infrastructure are likely to have innate geographic or topographic advantages that lowered their transportation costs in the first place, and trade essentially augments this advantage.[29] Empirical support for Mansori's argument is supplied, for

[29] In assuming variation in transportation costs across regions, Mansori differs from Krugman and Livas Elizondo, who assume constant transportation costs across regions.

example, by Hu (2002), who argues that trade openness aggravates natural geographic advantages already inherent in regions, positing that port and border areas will benefit from open trade more than hinterland regions.[30]

In addition to the critiques regarding infrastructure, another body of work has centered on the endowments on which much work in endogenous growth theory originally focused: *education and knowledge*. One of the benefits of trade openness, as Connolly (2003) has argued, is that openness allows the use of newer technology, especially when trade takes place among countries with different levels of technology and endowment of factors. This access to new technology can improve production processes and thus increase output levels, leading to higher rates of economic growth. If that is true, areas with higher levels of human capital may be better positioned to understand, adopt, and modify the new technologies available from trade openness. According to Benhabib and Spiegel (1994), "the

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[30] If one considers trade openness as part of economic openness more broadly, one might consider Mansori's argument supported also by Fuchs and Pernia (1987), who study Japanese FDI in six Asian countries and emphasize the importance of infrastructure for the dispersion of economic activities. They argue that in developing countries the availability of infrastructure outside the main urban center is very limited, and thus dispersion does not take place. Along the same lines, Fujita and Hu (2001) analyze different factors that could have contributed to increasing inequality across regions in China and find that foreign direct investment (FDI) and economic liberalization in general have been among the most important, as new investment located in areas with better infrastructure.

ability of a nation to adopt and implement new technology from abroad is a function of its domestic human capital stock" (p. 145).[31]

This hypothesis was originally posed by Nelson and Phelps (1966), who argued that "education speeds the process of technological diffusion" (p. 70). The greater the diffusion of knowledge, ideas, and technology, the greater are the productivity gains derived from new techniques, production processes, management practices, and so forth, and therefore the greater the output growth. The diffusion of technology depends on the initial endowment of human capital; the higher the education level in an economy, the faster its knowledge diffusion process, and the higher its growth. Thus trade openness, by increasing the exchange of technology between countries, can enable those areas with higher human capital levels to widen the gap between themselves and other regions. In general, the human capital argument suggests that trade will have a concentrating effect on economic activity within a country, rather than the dispersing influence predicted by Krugman and Livas Elizondo (1996).

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[31] In fact, Benhabib and Spiegel, based on their negative result on the growth of human capital on per capita income growth and an insignificant on the level of human capital, question the direct role of human capital on growth and instead provide evidence of its mediating effect in the adoption of technology.

3.3 Research Hypotheses

To put them succinctly, the three distinct null hypotheses—and their alternative hypothesis—from the scholarly literature on the relationship between trade openness and regional inequality are as follows:

Null Hypothesis I: The effect of increasing trade openness on the per capita income growth rate of a state is not dependent on the level of income in that state.

> *Hypothesis I_A: Increasing trade openness leads to higher growth rates in poorer regions and therefore a reduction in the overall level of regional inequality.*

Null Hypothesis II: The effect of increasing trade openness on the per capita income growth rate of a state is not dependent on the level of infrastructure in the state.

> *Hypothesis II_A: Increasing trade openness leads to higher growth rates in those regions with higher infrastructure levels and therefore increases the overall level of regional inequality.*

Null Hypothesis III: The effect of increasing trade openness on the per capita income growth rate of a state is not dependent on the level of human capital in the state.

> *Hypothesis III_A: Increasing trade openness leads to higher growth rates in regions with higher human capital levels and therefore increases the overall level of regional inequality.*

While many studies have focused on these hypotheses individually, I know of no work that has explicitly attempted to test the hypotheses simultaneously. Doing so is important, because the estimated effect of one factor (e.g. infrastructure) may change quite a bit if another factor (e.g. education) is taken into account. While it is possible that a factor might even become insignificant in the presence of another, it is also possible that they are all simultaneously important. For example, consider two states that are poorer than the rest of the states in a closed economy. Hypothesis I_A suggests that trade openness will disperse economic activities, benefiting these two poor states more than the other states. However, if one of these two states has more infrastructure, Hypothesis II_A suggests that that state will benefit more than the other poor state with lower infrastructure levels. Similarly, according to Hypothesis III_A, if one of these poor states has a higher level of human capital relative to the other poor state, it would benefit more from trade openness. In Table 6 I summarize the main predictions in the literature regarding these three hypotheses.

Table 6: Expected effects of increasing trade openness on regional inequality

Authors	**Hypothesis 1: Agglomeration economies**	**Hypothesis 2: Infrastructure**	**Hypothesis 3: Human capital**
Myrdal, 1971	(+)	(+)	(+)
Krugman and Livas Elizondo, 1996	(-)		
Mansori, 2003		(+)	
Benhabib and Spiegel, 1994 and Nelson and Phelps, 1966			(+)
The "+" sign means an increase in inequality is expected			

3.4 A model of regional inequality and trade openness

To develop a regression equation with which I can test the hypotheses above simultaneously, I use the approach of Barro (1991), in which per capita income growth is dependent on the accumulation of labor, and physical capital. I begin with a Cobb-Douglas production function:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} \varepsilon_{it} \tag{1}$$

where the *i* and *t* subscripts represent region and time period respectively. *Y* is real income, *A* reflects the level of technology, *K* refers to the physical capital stock, and *L* is labor. Expressing (1) in per worker terms and taking natural logarithms gives the following:

$$\ln y_{it} = \ln A_{it} + \alpha \ln k_{it} + (\beta + \alpha - 1) \ln L_{it} + \ln \varepsilon_{it} \tag{2}$$

where all variables are the same as equation (1), but those in lowercase are expressed in per worker terms. To calculate the income growth per worker in each state, equation (2) is modified to take the natural log differences for each period as follows:

$$\begin{aligned} \ln y_{it} - \ln y_{it-1} &= \left(\ln A_{it} - \ln A_{it-1}\right) + \alpha\left(\ln k_{it} - \ln k_{it-1}\right) \\ &+ (\beta + \alpha - 1)\left(\ln L_{it} - \ln L_{it-1}\right) + \left(\ln \varepsilon_{it} - \ln \varepsilon_{it-1}\right) \end{aligned} \tag{3}$$

I incorporate my hypotheses into this basic model. Specifically, I incorporate Hypotheses I and II into the $\alpha\left(\ln k_{it} - \ln k_{it-1}\right)$ term and Hypothesis III into the $\left(\ln A_{it} - \ln A_{it-1}\right)$ term. I also incorporate various control variables into these terms.

Beginning with the $\alpha(\ln k_{it} - \ln k_{it-1})$ term, I separate physical capital stock K into two different terms, C and I. C is physical capital that is used in the production process and therefore affects production growth directly. The term I refers to physical capital that affects the production process indirectly, such as general public infrastructure.[32] Therefore:

$$\ln k_{it} - \ln k_{it-1} = f(\ln C_{it} - \ln C_{it-1}) + w(\ln I_{it} - \ln I_{it-1}) \tag{4}$$

where f and w are linear functions. I use this equation to incorporate Hypotheses I and II. Because the core-periphery model of Krugman and Livas (1996) focuses on the

[32] This term I is similar to Hansen's (1965) economic overhead capital, which refers to public investment in general infrastructure, such as roads, gas, electricity and water supply, drainage and sewer systems, bridges, harbors, river transportation systems, etc.

changes in the location of economic activities due to trade openness, I make $f(\ln C_{it} - \ln C_{it-1})$ a function of three terms. The first term is the level of the private physical capital stock available in each state. The second is an interaction term of state income level and trade openness. And finally, the last term is the level of income per capita as a control variable, to capture the convergence effect established in the growth literature (Barro and Sala-i-Martin, 1995). That is, I define:

$$f(\ln C_{it} - \ln C_{it-1}) = d\ln(C_{it-1}) + r(\ln O_{t-1} \ln y_{it-1}) + z(\ln y_{it-1}) \tag{5}$$

where *d*, *r* and *z* are linear functions.

In addition, since Hypothesis II focuses on the effect of trade in augmenting the already existing advantage of certain regions in generating public infrastructure (Mansori 2003), I make $w(\ln I_{it} - \ln I_{it-1})$ a function of the already existing level of infrastructure interacted with the trade openness term, *O*. I also include the lagged level of infrastructure, following the advice of Brambor, et al (2006) regarding interaction terms. That is, I define:

$$w(\ln I_{it} - \ln I_{it-1}) = p(I_{it-1}) + q(\ln O_{t-1} \ln I_{it-1}) \tag{6}$$

where *p* and *q* are linear functions. Incorporating (5) and (6) into (4) leads to:

$$\begin{aligned} \ln k_{it} - \ln k_{it-1} = {} & p(I_{it-1}) + q(\ln O_{t-1} \ln I_{it-1}) + d\ln(C_{it-1}) \\ & + r(\ln O_{t-1} \ln y_{it-1}) + z(\ln y_{it-1}) \end{aligned} \tag{7}$$

Next, I conceive of the growth in technology $(\ln A_{it} - \ln A_{it-1})$ as being composed of four parts, as represented in equation (8):

$$\ln A_{it} - \ln A_{it-1} = g(\ln h_{it-1}) + m\left[\ln h_{it-1}\left(\frac{A_{\max t-1} - A_{it-1}}{A_{it-1}}\right)\right] + s(\ln O_{t-1}) + n(\ln O_{t-1} \ln h_{it-1}) \qquad (8)$$

where the functions g, m, s, and n are linear.[33] From the perspective of this study, the most important term in this equation is the last one. This term multiplies trade openness, O (subscripted only with t because it is a national level variable), by the state's human capital level, h, to capture the effect of trade given the levels of human capital (Nelson and Phelps, 1966 and Benhabib and Spiegel, 1994). That is, this term specifically tests Hypothesis III above. The other terms are important controls included on the basis of prior literature. The first term on the right hand side expresses the direct and independent effect that human capital stock has on the technology rate of growth (Romer, 1986). The second term is a domestic diffusion (or catch up) term incorporating the difference in technology levels between region i and the region with the highest technology level, following Nelson and Phelps (1966). Finally, the third term captures the effect of trade openness on the change in

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[33] A variation of this specification, though without the international component, has been used in various empirical papers (including Benhabib and Spiegel, 1994 and Connolly, 2004) to model the way in which the diffusion of technology within a country is dependent on human capital.

technology, since trade can potentially foster the use of newer technology (Connolly, 2003). A few notes are necessary with regard to what we expect from these controls.

With regard to endogenous human capital accumulation, there is a theoretical consensus that the effect of human capital on growth should be positive; however, it is important to note the discrepancy that exists between the positive theorized effect of human capital on growth and the negative effect found in parts of the empirical literature. While it has been established that increases in education are generally correlated with higher wages at the individual level, the evidence at the aggregate (national) level shows that the relationship between growth of education and growth of output is often negative (e.g. Romer, 1990, Barro and Lee, 1994; Benhabib and Spiegel, 1994, Barro and Sala-i-Martin, 1995; Barro, 1997). Although different explanations have been offered to explain this contradiction, the inconsistent finding at different levels of aggregation remains a puzzle (see Pritchett, 2001 and Krueger and Lindhal, 2001 for a discussion).

The second term of equation 4, the domestic diffusion or "catch up term" is expected to be positive, as it expresses the rate at which the level of technology has to grow in region *i* in order to "catch up" with the leading region. Thus this term refers to the adoption of technology available domestically from other regions, affected by the initial level of human capital in a region.

Unlike education, a theoretical consensus does not exist with regard to trade's effects on technology and growth (Fernández and Rodrik, 2000). While many economists believe trade openness to be good for growth, Yanikkaya (2003), for example, finds in a cross-country analysis a positive effect of trade barriers on growth, especially in developing countries engaging in trade with developed countries. Yanikkaya argues that differences between trade partners in technology levels and endowments can lock developing countries in an asymmetric trade relationship, leading developing countries to specialize in low-cost production industries. Thus theories that predict a negative effect of trade openness on growth focus mainly on the fact that there are different levels of technology and development across countries, and that as trade among them increases, it can foster the specialization of developing countries in low productivity industries with low value added, resulting in lower growth rates than in autarky (Rivera Batiz and Xie, 1993, Young, 1991).[34]

Incorporating (7) and (8) into (3) yields the following, which is the final form of the regression equation:

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[34] The literature of endogenous growth theory and trade includes a variety of models in which increased trade openness predicts both positive and negative effects on growth. In particular the models that look into trade among dissimilar countries (i.e. asymmetric technologies and factor endowments) find that trade openness can have a negative effect on growth of the least developed countries. Although these models refer to the cross national effect of trade openness on growth, the discussion is relevant to this study given that there are different expectations for the direction of the relationship between trade openness and growth.

$$\ln y_{it} - \ln y_{it-1} = (g - m)(\ln h_{it-1}) + m\left[\ln h_{it-1}\left(\frac{A_{\max t-1}}{A_{it-1}}\right)\right] + s(\ln O_{t-1}) + n(\ln O_{t-1} \ln h_{it-1})$$
$$+ p(I_{it-1}) + q(\ln O_{t-1} \ln I_{it-1}) + f(\ln C_{it-1}) + r(\ln O_{t-1} \ln y_{it-1}) + z(\ln y_{it-1})$$
$$+ (\beta + \alpha - 1)(\ln L_{it} - \ln L_{it-1}) + (\ln \varepsilon_{it} - \ln \varepsilon_{it-1}) \quad (9)$$

Table 7 shows the expected result for each of the terms of the model.

3.5 Conclusion

This chapter has laid the hypotheses and the theoretical model that is tested in the following chapters. Chapter 4 presents the analysis of an empirical model of the effect of trade openness on regional inequality. Chapter 5 presents an analysis of the same model at the economic sector level within states. Finally, in Chapter 6, the statistical analyses are complemented by the analysis of three cases.

Table 7: Expected results of each model's term

Concept	Measurement	Expected effect
Dependent variable		
Growth of state GDP per worker	$\ln y_{it} - \ln y_{it-1}$	
Independent variables		
Hypothesis 1: Trade openness * per worker income	$r(\ln O_{t-1} \ln y_{it-1})$	-
Hypothesis 2: Trade openness * highway density	$q(\ln O_{t-1} I_{it-1})$	+
Hypothesis 3: Trade openness * human capital	$n(\ln O_{t-1} \ln h_{it-1})$	+
Trade openness	$s(\ln O_{t-1})$	?
Per worker income	$z(\ln y_{it-1})$	-
General infrastructure	$p(I_{it-1})$	?
Endogenous human capital accumulation process	$(g-m)(\ln h_{it-1})$	?
Domestic diffusion term	$m\left[\ln h_{it-1}\left(\frac{A_{\max t-1}}{A_{it-1}}\right)\right]$	+
Growth of workforce	$(\ln L_{it} - \ln L_{it-1})$	+
Capital for production	$f(\ln C_{it})$	+
Spatial lag variable	$\rho(Wy)$	?

4. A test of the models' hypotheses at the regional level

This chapter presents a statistical test of the hypotheses and model presented in the previous chapter. The dependent variable is the growth of state per capita gross domestic product, and I use a dataset that I compiled from various archival sources from the National Statistical Institute in Mexico (INEGI), which include data for all states over the period 1940-2000. The results indicate that the transition to an open trade regime has benefited states with higher levels of income (contrary to Hypothesis I), higher levels of infrastructure (supporting Hypothesis II), and lower levels of education (contrary to Hypothesis III). The analysis therefore indicates that there are opposing forces at work in terms of the effect of trade openness on regional inequality. Nevertheless, as I will show, the net effect of trade openness on regional inequality has been to increase regional inequality.

The chapter is organized as follows. The next section discusses the methodology and data used in the empirical analysis. Section 4.2 is a discussion of the results, followed by the conclusion of the chapter.

4.1 Methodology and data

Panel data models are useful because they allow the incorporation of variables that vary both across cases and time, as in this study. However, because of this structure, panel data often pose potential problems for statistical analysis, such as endogeneity, autocorrelation and heteroskedasticity. I am not concerned about simultaneity bias (endogeneity) in this study, since the human capital and infrastructure variables are lagged, but I have taken measures to account for autocorrelation and heteroskedasticity.

Autocorrelation can be of space and time, both of which I have tried to account for in the structural part of the model laid out in Chapter 3. Specifically, in order to capture the potential spatial autocorrelation, I include a spatial lag variable of the form $\rho(Wy)$, where ρ is the coefficient; W is a matrix of weights based on the population of neighboring states; and y is a vector of the state's per capita income growth rate.[35] This spatial specification aims at capturing the potential contagion effect of neighboring states depending on their population size, rather than just taking the average value of all neighboring states. In order to avoid any problems of serial correlation over time, I analyzed my variables for trends over time and de-trended them as necessary. The variables highway density, literacy, and per worker income were de-trended. The process of de-trending the variables was the following: I regressed each independent variable on a count variable whose value was 1 in 1940, 2 in 1950, and so forth. Next I subtracted the coefficient on the count variable from each observation value of the original variable, in order to subtract the time trend effect.

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[35] The adjacency that I used is "queen" type (i.e. states that share a border or a point), but using the "rook" adjacency (i.e. those states that only share a border) did not make a difference in the results.

Table 34 in Appendix 17 compares the graphs of the variables plotted against time, showing that the de-trended variables do not have a time trend. In addition Table 35 in Appendix 18 reports the autocorrelation function of the residuals at different time lags, showing that there is not a systematic pattern of serial correlation.

Another common problem that can arise from panel data is heteroskedasticity, in this case across states. Thus I estimate (9) using a fixed effects specification, to account for unobservable factors related to economic growth in each region.[36] The choice of fixed effects instead of random effects seems more appropriate for my model for two reasons. One is that I am using the entire population of Mexican states and not a random sample. The second reason is that in the random effects specification, the specific unit effects are modeled as randomly distributed across cross-sectional units, implying that these specific unit effects are not correlated with the independent variables. This assumption is problematic in my model, in which the unobserved specific unit effects are likely to be correlated with the independent variables that are basic characteristics of a state, like literacy, the length of the highway network, the growth of labor force and capital, etc.

[36] A fixed effects model includes a residual term that captures random error (assumed to be independently distributed with zero mean and constant variance and uncorrelated with the independent variables) and a constant term for each state to capture the latent characteristics of each region.

However, just to be sure, I ran a Hausman test, the results of which are reported in Table 36 in Appendix 19 which confirm the desirability of using fixed effects over random effects.

I perform my analysis on an original dataset I collected using archival materials in Mexico's National Institute for Geography and Statistics (INEGI). The entire population of states in Mexico is covered—31 states plus the Federal District—and therefore no sampling design is needed for this study. All data are for the period of 1940-2000, measured in ten-year intervals, in 1993 pesos where relevant.

The dependent variable is the growth rate of state GDP per capita over ten-year intervals. GDP data is originally from INEGI and modified by Esquivel (1999).[37] Time-series measures of human and physical capital are difficult to obtain for Mexico, as they are for most developing countries. Literacy has been used in the literature as a measure for human capital, since it measures the stock levels of education unlike indicators such as expenditures on education or enrollment rates by state, which measure the flow levels of human capital. Benhabib and Spiegel (1994) note that literacy as a measure of human capital might be biased due to skewness of sampling towards urban areas and inconsistencies of measurement across countries. However, these would not present a

[37] Esquivel (1999) modifies the official INEGI data by distributing the income from the national oil industry in the states of Campeche and Villahermosa across all the states, since the federal government distributes such revenues across all Mexican states.

serious problem for my analysis. The data that I use are based on the census, which in theory captures the entire population, and thus any selection bias is likely to be too small to affect the analysis. And of course I am not concerned about inconsistencies of measurement across countries, since my analysis is only of Mexico. However, it is important to note the general problem of using historical series data, which is that techniques of data collection change over time. This is not an argument against a measure of literacy in particular, but rather is a problem that may affect any measurement across time. Unfortunately, this is a problem that those working with historical data must live with if any time series analysis is to be conducted.

The measure for physical capital stock is the value of industries' total capital at the state level. The data refer to industries' gross assets such as land, buildings, machinery and cash, from the Economic Census.

Data for the level of technology for states in Mexico does not exist, especially for years prior to 1960. Therefore, the technology catch-up term has been specified in terms of state per worker income levels rather than technology levels, following Benhabib and Spiegel (1994) and Connolly (2003). The general argument for using income levels as a proxy for technology levels is that income reflects the overall level of technology. I test the extent to which this argument holds for Mexican states by looking at the correlation between various measures of technology across states in 2004 and state GDP for the same year. The result is that there is a high positive correlation between technology and state GDP, as expected.[38] Of course, there is a danger that the technology proxy will pick up other effects of income, especially a potential convergence effect. I believe this possibility is mitigated, however, because I also include income per capita in the model separately (specifically capturing convergence effects). To obtain state GDP in per worker terms I divide the state GDP by a measure of total population that is economically active, obtained from the decennial National Population Censuses.

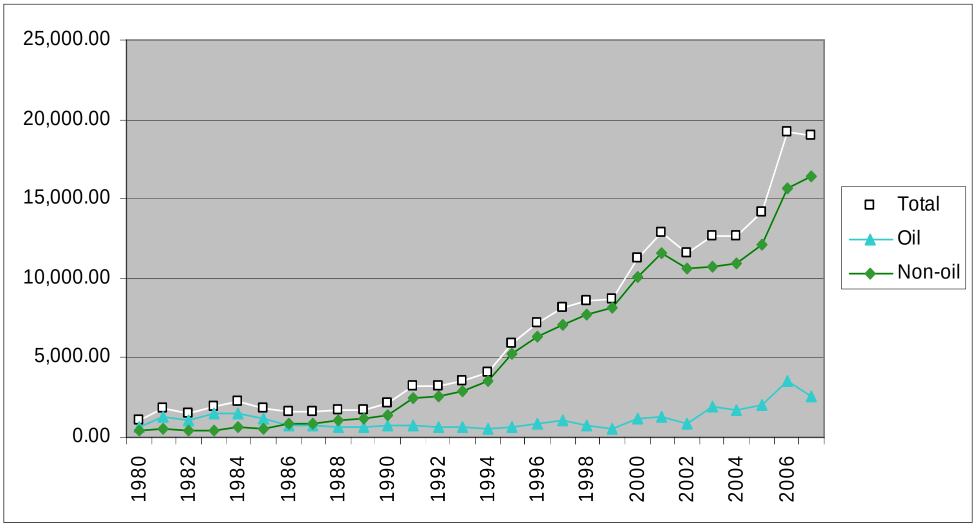
A common measure of trade openness is the sum of exports and imports divided by the GDP in a given year (to control for GDP growth). The volume of trade, although not measuring directly the evolution of a country's trade policy over time—as opposed to tariff rates, for example—can reflect changes in trade restrictions such as tariffs, quotas, licensing agreements, and other regulatory measures. The main problem with using the volume of trade as a measure for trade openness is that it includes changes in volume due to variation in factors other than trade policy, such as transportation costs, production growth, world demand, etc. For example, in countries where exports are mainly composed of a commodity subject to large price fluctuations, like oil, trade volume might reflect such price fluctuations

[38] The technology variables used are the total value of machinery and production equipment for the state, the total value of computer equipment in the state, and the number of patents solicited in the state in 2004. The correlations of these measures and state GDP are 0.90, 0.96, and 0.98, respectively.

rather than a change of policy. However, this is not the case of Mexico. Figure 17 shows the evolution of the composition of trade volume in Mexico, divided into oil exports and non-oil exports, showing that since the late 1980s, non-oil exports have increased substantially. Non-oil exports include a variety of products from agricultural, chemical, and manufacturing products, of which auto parts and automobiles constitute the majority. Thus, trade volume in Mexico is not dominated by oil exports.

In addition, although volume of trade does not strictly measure trade openness, it is better than other alternative measures, which Fernández and Rodrik (2000) have argued can also be problematic. For example, using tariff rates as a measure of trade openness can be more challenging because there are other trade restrictions—like environmental, sanitary, security, and labor restrictions–that are not reflected in the level of tariffs but are reflected in the volume of trade. The measure of openness used here is therefore the sum of exports and imports at the national level divided by GDP in a given year.

Figure 17: Mexico's exports of oil and non-oil products, in constant US dollars



Source: Own calculations with data from INEGI, Banxico, SAT.

For the measure of infrastructure I use highway density (the total length of highways and roads in each state divided by the area of each state). Highways in Mexico are classified into three groups: principal, secondary, and rural. Principal highways are two- to four-lane, paved highways and are federally funded; secondary highways are paved, state-funded highways, and they vary in terms of the number of lanes but rarely exceed two lanes. The third classification refers to rural roads, which are generally not paved. Highways constitute one of the main expenditures by the federal government in terms of infrastructure provision and serve to reduce transportation costs, connect markets, and in general enhance the mobility of factors and inputs for production. Thus this type of measure can serve as a good proxy for measuring the level of infrastructure in a state. However, the data on highway density *per se* can be problematic in capturing the effect of states' infrastructure on growth, given that a highway can either principally serve the population and industries within a state or merely enable trade between surrounding states and thus not necessarily register a positive growth effect on its own state (see Puga, 2002). For example, if a highway is connecting areas of different development levels, it ideally serves to provide access for the population of the less developed area to amenities available in other states (for example specialized health centers). However, as Puga argues, the same highway can also be detrimental for the process of local industry development of the less developed area if the highway enables the provision of inputs from the rich region's industries. Thus, the effect of transportation infrastructure can be ambiguous in the absence of a measure that explicitly captures these characteristics of the transportation infrastructure. Thus the ideal measure would be one that combines highway density and the highways' location and function.[39] Unfortunately, such a measure is unavailable.

Because of this potential ambiguity of the roads variable for infrastructure, I also use an alternative measure: the share of state housing connected to the water network (hereafter referred to as "water connection"). The advantage of this measure is that it measures

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[39] Martin and Rogers (1995) explicitly distinguish between transportation projects that facilitate trade within a region versus those projects that enable trade across regions, arguing that the former can have positive effects on growth as opposed to the latter that actually have negative effects to less developed regions.

directly the beneficiaries of the infrastructure and thus its result is expected to be positive. Although it is a general measure of public infrastructure rather than a direct measure of infrastructure for economic activities, it can serve as a proxy for the overall infrastructure level of a state, as the areas with higher water connection are associated with more infrastructure availability. For example, the correlation of water connection with road density is 0.47 and is significant at the one percent level. In fact, Aguilar (1990) posits that general infrastructure, although not related directly to that infrastructure that serves industry, is perceived as one of the factors for industry location in Mexico. The data for water connection is taken from the Census of Population and Housing.

In order to provide meaningful interpretation to the results, I centered some of the variables at their mean, following Braumoeller (2004) and Brambor, Clark and Golder (2005). Specifically, the centered variables are the trade variable and variables that are interacted with it: per worker income (Hypothesis I), state highway density and water connection (Hypothesis II), and the share of state literate population (Hypothesis III). As Braumoeller and Brambor et al. discuss, centering the variables at the mean is necessary for theoretical and empirical reasons. The theoretical reason is that centering the variables at the mean gives a meaningful interpretation to the results. Because the value of the coefficient on, for example, per worker income, is the effect of an increase in per worker income when the trade variable equals zero, leaving the trade variable uncentered means that interpretation of the effect of per worker income is difficult, given that in reality a zero level trade is nearly impossible. This is of course true with education and transportation levels as well. Centering the trade variable (as well as the other variables with which it is interacted) gives the coefficient on the interacted variable a meaningful interpretation: it is the effect of the interacted variable at the average level of trade. This is also true for all the other interacted variables. In addition to this theoretical reason, there is an empirical reason for centering the variables. Since the sample does not include zero for any of these variables, the confidence in the coefficients on the interacted variables is quite low if the variables are not centered (because, again, they measure the effect of, of example, trade when per worker income is zero). Centering the variables fixes this problem.

All variables in the model vary across cases (states) and time, except trade openness, as it is a national level variable and thus is constant across cases in a given year. The entire panel is composed of a total of 192 observations (32 cases over 6 time periods). Table 8 summarizes the measures of the variables in my model, and Table 37 in Appendix 20 presents descriptive statistics of the variables.

Table 8: Variables and measurement

Variable	Name	Description	Source
Y	Growth rate of State GDP	Growth rate of state GDP in per capita terms	Esquivel, 1999
A	Technology	Level of Gross Domestic Product	Esquivel, 1999
C	Physical capital stock	Value of industries' total capital	INEGI, Industrial Census.
I	Infrastructure	Length of federal highway divided by the state area Share of households with direct access to the water networks	INEGI, Statistical Annual for Mexico and Census of Population and Housing.
h	Human capital	Share of total population 15 years or older that are literate	Census of Population and Housing.
L	Labor force	Economically active population	INEGI, Mexico's Historic Statistics and SIMBAD.
O	Trade openness	Sum of exports and imports divided by national GDP	INEGI, Statistical Annual for Mexico

All variables are measured at the state level, except trade openness

4.2 Results

The results of the fixed effects model are presented in the third and fourth columns of Table 9. The coefficient for Hypothesis I—the interaction term between trade openness and per worker state income—is positive and significant at the one percent level. The results provide evidence against Krugman and Livas Elizondo's theory that increasing trade openness leads to higher growth rates in poorer states and in fact provides evidence that increased trade openness *increases* regional inequality. This might be interpreted as providing support for the ideas of Myrdal (1957), discussed in the previous chapter, in which trade provides additional advantages to already well developed regions.

Myrdal argues that the play of market forces generally tends to increase rather than decrease inequality between regions. This is based on the idea that regions develop competitive advantages dependent upon their geographical position and conditions (or historical accident), which in turn tends to gather or concentrate activities that are beneficial to its development, leaving the rest of regions isolated. The effect of “ever-increasing” internal and external economies assures and fosters the favored region economic growth at the expense of the other stagnant or backward regions (p. 27). For Myrdal trade openness operates in a pro-growing region biased fashion, as the growing regions will increase their markets and develop competitive advantages with respect to the backward regions.

Table 9: Results for the fixed effects regression of per capita income growth using highway density and water connection as infrastructure variables

		Original model		Reduced form model	
Concept	**Measurement**	**Road density**	**Water connection**	**Road density**	**Water connection**
Trade openness * per worker income	$r(\ln O_{t-1} \ln y_{it-1})$	0.005***	0.004**	0.005**	0.004**
		(0.002)	(0.002)	(0.002)	(0.01)
Trade openness * infrastructure	$q(\ln O_{t-1} I_{it-1})$	0.44***	0.60***	0.44***	0.63***
		(0.17)	(0.16)	(0.17)	(0.14)
Trade openness * human capital	$n(\ln O_{t-1} \ln h_{it-1})$	-0.006**	-0.01***	-0.005*	-0.01***
		(0.003)	(0.003)	(0.003)	(0.003)
Trade openness	$s(\ln O_{t-1})$	-0.08***	-0.23***	-0.07***	-0.23***
		(0.021)	(0.036)	(0.021)	(0.03)
Per worker income	$z(\ln y_{it-1})$	-0.014***	-0.02***	-0.01***	-0.02***
		(0.003)	(0.003)	(0.003)	(0.003)
General infrastructure	$p(I_{it-1})$	-0.21	0.95***	-0.22	1.01***
		(0.24)	(0.21)	(0.25)	(0.19)
Endogenous human capital	$(g-m)(\ln h_{it-1})$	-.014***	-0.02***	-0.012**	-0.02***
		(0.005)	(0.005)	(0.005)	(0.01)
Domestic diffusion term	$m\left[\ln h_{it-1}\left(\frac{A_{\max t-1}}{A_{it-1}}\right)\right]$	.00001	-0.0002		
		(0.001)	(0.001)		
Growth of workforce	$(\ln L_{it} - \ln L_{it-1})$	-25.36	-14.27		
		(20.37)	(19.95)		
Capital for production	$f(\ln C_{it})$	0.27***	0.11		
		(0.11)	(0.11)		
Spatial lag variable	$\rho(Wy)$	0.04	-0.09	0.09	-0.08
		(0.12)	(0.12)	(0.11)	(0.1)
	Within R^2=	0.43	0.48	0.40	0.47
	Between R^2=	0.09	0.12	0.13	0.15
	Overall R^2=	0.15	0.19	0.16	0.20

Significance at the one, five and ten percent levels is denoted by ***, ** , and * respectively. N= 192, T= 32; Standard errors in parenthesis.

It should be noted, however, that the effect of increasing trade specifically reduces the overall convergence effect evident in the results. That is, overall, poorer states tend to grow faster than richer ones. This can be seen from the combined effect of interaction term and the income variable on its own. The per worker income variable by itself is significant at the one percent level and negative, and it indicates that at average levels of trade openness over the period of 1940-2000 (when trade openness equals zero in the analysis because of centering) there is evidence of a convergence effect regarding income levels.[40] However, as noted above, as trade increases, this convergence effect decreases.

The coefficient for the highway density variable interacted with trade is significant at the five percent level, and the direction of the coefficient is, as expected, positive. This provides evidence for Hypothesis II, based on Mansori's argument that transportation infrastructure exhibits increasing returns in the context of increasing trade openness, leading to higher growth rates in regions with higher infrastructure levels. This result indicates a mechanism by which trade openness can increase regional inequality. Although the effect of the highway density variable by itself is not significant, this may be the result of the collinearity with fixed effects, because when the model is specified with random effects, the infrastructure variable becomes significant with a negative sign. While perhaps

[40] This convergence result is consistent with Cermeño's findings of a conditional convergence trend across Mexican states (2001).

surprising, other studies have also found a negative or not statistically significant relationship for infrastructure. Moreover, as discussed above, the measurement of highway density may be limited in capturing the effect of infrastructure on state growth. Although a number of studies on the effect of highway infrastructure and growth at the state level in developed countries have shown a positive and significant relationship, other studies, correcting the previous findings on the basis of methodological problems, have found no relationship between the two (for a review see Guild, 1998).

The water connection variable by itself is highly significant (at the one percent level) and positive, as expected. As mentioned above, the difference of the regression results using highway density and water connection as infrastructure variables can be due to the fact that the latter is a measure of general infrastructure that clearly captures its beneficiaries, as opposed to the ambiguity of a measure such as highway density, which lacks information about its beneficiaries. In addition, highway density has a relatively smaller variation within each state compared to water connection (see Table 37 for the summary statistics for both variables). It is clear that for water connection, the variance that exists within each state is much larger than that for highway density, and thus there is much less information on which to base the coefficient for highway density in a fixed effects specification.

The coefficient for the human capital variable interacted with trade is significant at the ten percent level (using highway density) and at the one percent level (using water connection) but with a negative sign, which is contrary to expectations. These results provide evidence against Hypothesis III that increasing trade openness leads to higher growth rates in those regions with higher human capital levels. Moreover, the results are inconsistent with hypotheses on the complementarity of technology and human capital (Nelson and Phelps, 1966, and Keller, 1996, Benhabib and Spiegel, 1994). In addition, the endogenous human capital accumulation variable also has a negative effect and is significant (at the ten and one percent levels). This is the opposite of the expected direction based on the results of previous similar specifications (Connolly, 2003 and Cragg and Epelbaum, 1996). As discussed above, however, results like these with regard to human capital are surprisingly common in the growth literature. Several previous empirical studies (e.g. Barro and Lee, 1994; Barro, 1997; Barro and Sala-i-Martin, 1995; Benhabib and Spiegel, 1994; Romer, 1990) have found a negative correlation between education and growth (see Pritchett, 2001 and Krueger, AB, Lindhal, M, 2001 for a review).[41]

[41] Pritchett (2001) discusses three possible explanations for finding a negative coefficient of human capital. The first is that schooling has not created skills. The second is that as the labor force becomes more educated, the demand for educated labor force does not grow as fast (but individual level evidence does not support this). Finally, a third may be that people have used their education mainly in rent seeking activities rather than in productive activities.

Krueger and Lindhal (2001) argue that a negative effect on the initial level of human capital might refer to an exogenous change in its rate of return. In a cross-country analysis they find that in those countries with low levels of education there is a positive and significant relationship with growth, whereas in countries with high levels the relationship is negative, implying a non-linear effect of human capital. Following this argument, I subdivided my dataset into states with high and low levels of literacy at the initial period (1940) and found evidence in support of their argument—i.e. for states with low levels of literacy its effect on growth is positive and significant, whereas at high levels it is negative and significant. A potential explanation for these findings is that for the greater part of the period of study the Mexican economy was, in general, largely based on activities that do not require high skill levels. Because of this, increasing literacy levels at the macro level may not translate into growth, but rather simply represent a cost to the state. As Lewis states, "while education helps to change economic structure, it is also true that the structure of the economy imposes its own limits to what education can achieve" (Lewis, 1964, p. 227). However, due to the small number of observations in the sub-groupings of states in my sample, it is risky to draw firm conclusions from these results.

The coefficient of the trade openness term by itself is negative and significant at the one percent level in both specifications, consistent with the finding of Yanikkaya (2003) and the models in which trade takes place among asymmetric partners, discussed in the previous chapter. Although the causal mechanism in these models (that developing countries are at a disadvantage when trading when richer countries) is not tested in this analysis, it seems to be relevant for the case of Mexico, given that the majority of its total trade is with developed countries. Table 10 shows Mexico's major trading partners, and the United States is by far Mexico's main commercial partner, representing an average of 73 percent of Mexico's exports and 68 percent of Mexico's imports for the period 1980 to 1997.

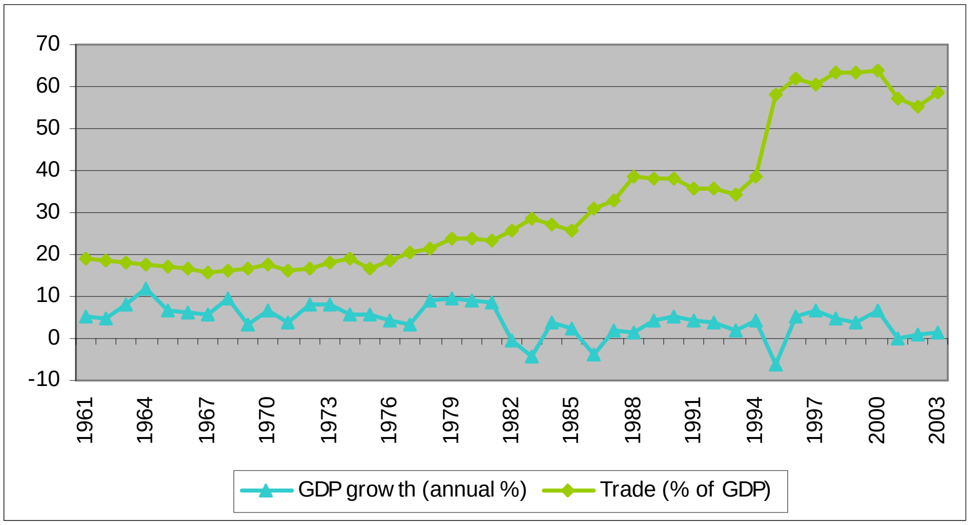
Table 10: Mexico's main trade partners

Trade partners	*Exports*					
	1980	*1985*	*1990*	*1995*	*1997*	*1980-1997*
United States of America	0.65	0.61	0.69	0.84	0.86	0.73
France, Germany, Italy, United Kingdom	0.08	0.19	0.13	0.04	0.04	0.10
Asia (excluding China) mainly Japan	0.05	0.09	0.07	0.02	0.02	0.05
Canada	0.01	0.02	0.02	0.02	0.02	0.02
Rest of Western Europe	0.08	0.00	0.00	0.00	0.00	0.02
Middle East (mainly Israel)	0.04	0.02	0.01	0.00	0.00	0.02
Latin American Association (mainly Brazil)	0.04	0.03	0.00	0.00	0.00	0.01
Rest of the World	0.04	0.05	0.09	0.07	0.07	0.06
Total	1.00	1.00	1.00	1.00	1.00	1.00
	Imports					
	1980	*1985*	*1990*	*1995*	*1997*	*1980-1997*
United States of America	0.65	0.60	0.66	0.75	0.75	0.68
France, Germany, Italy, United Kingdom	0.13	0.12	0.17	0.09	0.09	0.12
Asia (excluding China) mainly Japan	0.06	0.06	0.07	0.09	0.09	0.07
Canada	0.02	0.02	0.01	0.02	0.02	0.02
Latin American Association (mainly Brazil)	0.04	0.04	0.00	0.00	0.00	0.02
Rest of the World	0.10	0.17	0.09	0.05	0.05	0.09
Total	1.00	1.00	1.00	1.00	1.00	1.00

Source: Data from INEGI, 1998, Cuadro 18.4. Figures in percentage terms, where 1 is 100 percent.

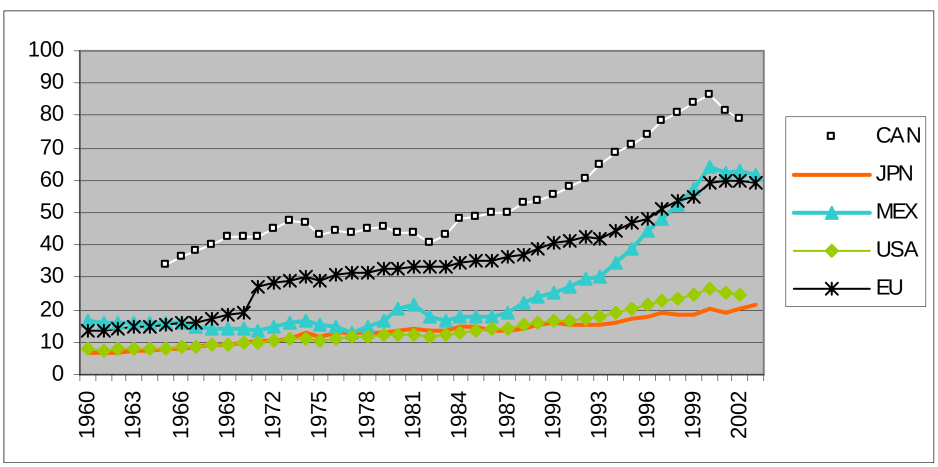
It is important to note also that Mexico's GDP growth rate and its ratio of trade to GDP generally follow opposite trends from 1940 to 2000 (see Figure 18). The negative relationship can potentially be the result of the change of the trade regime that Mexico underwent in the early 1980s. As Quintana Romero (2004) argues, one of the main characteristics of the new regime was the promotion of the external sector of the economy. As a result of the 1980s economic crisis, the government started to eliminate the protection system for domestic industry that was maintained during the import substitution period. From 1982 to 1990, the share of total imports that were subject to import licenses decreased from 100 percent to 14.1 percent; and the highest tariff barrier fell from 100 percent to 20 percent. The aim of the new regime was to allow national industry to compete with international industry and thus make it more efficient. The problem was that the inefficient industries were not the only ones negatively affected; the competitive industries were also affected because Mexican trade openness was generally a unilateral measure. The country's main trade partner (the USA) maintained trade protection measures and industry subsidies, as indicated in Figure 19, which shows the degree of trade openness of Mexico's main trade partners.

Figure 18: Evolution of GDP growth and trade openness in Mexico



Source: Data are from World Bank, World development Indicators, 2003.

Figure 19: Mexico's level of trade openness compared to main trade partners



Source: Data are from World Bank, World development Indicators, 2003.

As for the control variables, the growth of the workforce is positive and statistically significant at the one percent level as expected. The spatial lag variable is not statistically significant, which presumably reflects that the model captures the spatial dynamics that possibly take place across neighboring states. However, it is important to note the high collinearity that exists between variables, as the model includes various interaction terms. Table 38 in Appendix 21 shows the correlations between variables, providing evidence of the high collinearity that exists among variables. To ensure that my results were robust to the exclusion of collinear variables, I tested the three hypotheses in a reduced form model that excludes all the variables that are not interacted with trade. The results are presented in columns five and six of Table 9, which shows that the results from the reduced model are not substantially different from the original model.

In terms of substantive effects, the net effect of international trade on growth is negative, all else equal. However, because of the interaction terms, the effect varies according to a state's level of income, infrastructure, and human capital. Table 11 shows the difference in percentage points of the effect of trade openness on per capita income growth for states with different levels of income, infrastructure, and human capital. For example, when trade openness is at mean levels observed in the sample,[42] all else equal, a state with

[42] These results are from the regression using road density as the infrastructure variable.

the 1940-2000 mean income level of the of Oaxaca (the lowest mean income level) would grow 0.62 percentage points faster than a state with the 1940-2000 mean income level of the Federal District (the highest mean income level). This convergence effect is even stronger—Oaxaca would grow 1.03 percentage points faster—when trade is at the minimum level. However, when trade openness is at the maximum level,[43] this convergence effect vanishes. As discussed above, these results indicate that trade openness reduces the convergence effect.

[43] The maximum level of trade openness corresponds to the 1990 observed level, which is actually lower than current levels.

Table 11: Substantive effect of trade openness on per capita income growth

Effect of Income		
	Difference of the effect of trade for states with high and low income levels: Oaxaca vs. DF	
	Roads	Water
Trade at min	+1.03	+1.15
Trade at mean	+0.62	+0.80
Trade at max	0.00	+0.52
Effect of Infrastructure		
	Difference of the effect of trade for states with high and low infrastructure levels, Oaxaca vs. Aguascalientes	
	Roads	Water
Trade at min	+0.22	-0.15
Trade at mean	0.00	-0.40
Trade at max	0.00	-0.59
Effect of Human capital		
	Difference of the effect of trade for states with high and low human capital levels, Guerrero vs. Mexico	
	Roads	Water
Trade at min	0.00	0.00
Trade at mean	+0.49	+0.63
Trade at max	+0.65	+1.09

Positive numbers represent an advantage for the *less* endowed state and negative numbers represent an advantage for the more endowed one. Effects assume all else is equal. See text for interpretation examples.

In the case of Hypothesis II, the effect of infrastructure, the results provide some evidence of a cumulative causation dynamic, as states with higher levels of infrastructure will tend to grow faster than those with low levels; and this effect is exacerbated as trade openness increases. For example, using water connection as the infrastructure variable, the results indicate that, when trade is at the mean level and all else equal, Aguascalientes (the state with the highest mean level of infrastructure) grows 0.40 percentage points faster than Oaxaca (the state with the lowest mean level). This difference increases to 0.59 percentage points when trade openness is at the maximum levels. However, when trade is the minimum levels the difference among these states is reduced to 0.15 percentage points. Thus the results indicate that the difference in the level of infrastructure across states fosters regional inequality as trade openness increases.

Finally, in the case of Hypothesis III, the effect is in the opposite direction—i.e. there seems to be a convergence effect with regard to the level of human capital, contrary to the expectation of a cumulative causation dynamic of human capital levels. Using the highway density variable, when trade openness is at the mean, all else was equal, Guerrero, the state with the lowest mean level of human capital, would grow 0.49 percentage points faster than Mexico, the state with the highest mean level. However, Guerrero's advantage rises to 0.65 points when trade is at the maximum value.

While there are simultaneous counteracting effects of trade, the overall effect of trade on state income growth in Mexico has been negative. In addition, it has been *more* negative for worse endowed states. Table 12 shows how much faster a low endowed state grows than a high endowed state, all else equal, in percentage points, at different levels of trade openness. The results indicate that using both infrastructure variables, the effect on regional inequality of moving from a minimum to a mean level of trade openness is negative. That is, the advantage of the lower endowed state over the more endowed state is lessened. In sum, as trade openness increases, the benefits accrue to the more endowed states.

Table 12: How much faster a low endowed state grows than a high endowed state, all else equal, in percentage points

	High openness	Mean openness	Low openness
Roads	0.90	1.15	1.34
Water	1.02	1.03	1.11

4.3 Conclusion

Despite the voluminous literature on trade and growth and the many hypotheses that have been developed in it, very few studies have (a) allowed these hypotheses to compete against each other and (b) examined these relationships at the sub-national level. This chapter has attempted to do both, and has illuminated that that there are simultaneous forces for dispersion and concentration within the relationship between trade and economic growth. All else equal, trade openness is likely to benefit more those states with higher overall income, offsetting the income convergence effect across states. In addition, again all else equal, trade openness will benefit more those states with higher levels of infrastructure.

Thus, government programs that increase the relative ranking of lagging states in terms of infrastructure can be beneficial in the context of an increasingly open economy, as long as the infrastructure is actually serving the region where it is located. The results on the human capital variables are, however, opposite to the expectation. It is difficult to imagine how the effect of education on growth would be negative in theory, but, as stated before, the results are consistent with the empirical literature of the effects of education on growth at the national level. In fact, the results here are interesting in that they demonstrate the same (odd) relationship at the sub-national level.

While the results here are notable, obviously more work is needed on this topic. In addition to important robustness checks—such as testing the model in different countries and using different indicators of human capital and infrastructure—additional insights into the relationship of trade openness and regional inequality might be obtained by "unpacking" trade openness to the extent possible. In this chapter, trade openness is operationalized by looking at the overall level of trade activity in a country, but this is obviously a blunt instrument. We know that opening up to trade has taken place at different paces across various sectors, and trade's impact is likely to vary even within sectors. For example, the industrial sector in Mexico has been opened to trade more than the agricultural sector. To the extent that certain industries are concentrated in particular regions, examining the effect of trade across different economic sectors could potentially complement the results of this chapter. The next chapter presents an analysis of regional inequality looking at the three main sectors of the economy.

5. A test of the models' hypothesis at the economic sector level

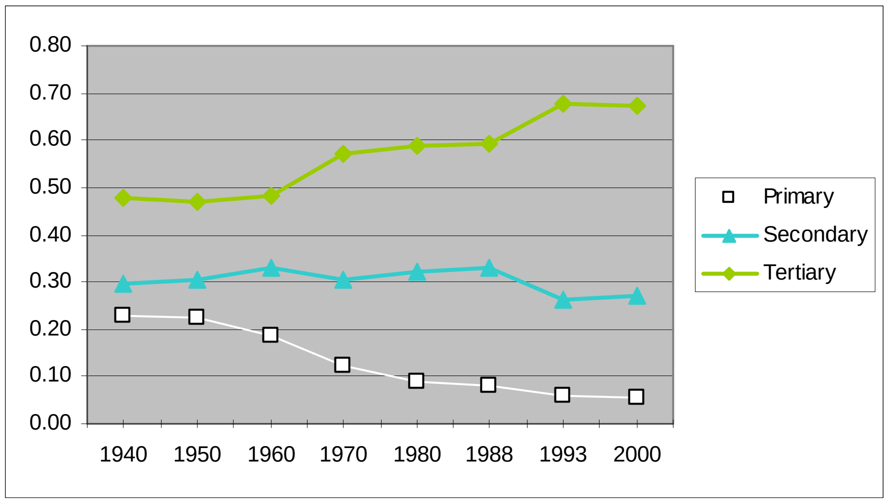
In the previous chapter I used a sub-national dataset to analyze the effect of trade openness on regional inequality in Mexico over the period of 1940-2000. In that analysis, my dependent variable was the growth rate of states' GDP per capita, and I found that the overall effect of trade openness on state income growth was negative. Moreover, the effect was mediated by states' key endowments. Specifically, opening up to trade benefited those states with lower levels of education more, thereby tending to reduce regional inequality. However, opening up to trade also benefited more those regions with higher levels of income and infrastructure, thereby tending to increase regional inequality. This latter effect was greater than the former, so that the overall effect of trade openness was to increase regional inequality (i.e. the trade effect was *more* negative for worse endowed states).

While these results shed light on trade's effect over a long period of time, they are at the aggregate level and do not give insight into trade's effect on each of the economic sectors. Over the period of study (1940-2000), Mexico has been experiencing a substantial economic transformation in its sectoral composition. Figure 20 shows the evolution of the composition of GDP output over the period. The share of the primary sector in total GDP has been consistently decreasing, from 23 percent in 1940 to 5 percent in 2000.[44] Over the same period the tertiary sector has been increasing, from a contribution to total GDP of 48%

[44] The primary sector is composed of agriculture, livestock, forestry, and fishing activities.

in 1940 to 67% in 2000.[45] It is interesting to note that the secondary sector has maintained its contribution to total GDP at around 30% over the period.[46]

Figure 20: Mexico's share of total GDP by economic sector



Source: INEGI, System of National Accounts, in 1993 pesos and Unikel, 1978.

Figure 21 shows the change in the shares of labor over the period of 1940-2000. Once again, there is a consistent decreasing trend of the share of labor employed in the primary sector, which decreases from 65 percent in 1940 to 16 percent in 2000. Over the same period, labor in the tertiary sector has increased, from 19 to 53 percent of total labor. For the

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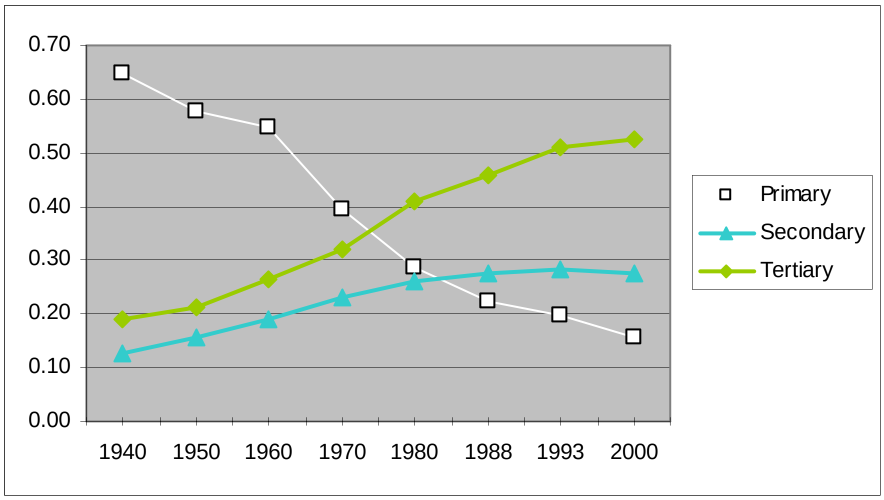
[45] The tertiary sector encompasses a range of service activities including commerce, restaurant and hotel industries; transportation, storing and communications; financial and insurance services, and real estate; and community, social and personal services.

[46] The secondary sector is composed of mining and extraction of oil and gas, manufacturing, water, electricity and construction industries.

secondary sector the trend is also increasing, from 13 percent in 1940 to 27 percent in 2000. However, the trend starts to slow down in 1980, and in the last period it decreases slightly.

Figure 21: Mexico's share of total labor employed by economic sector



Source: INEGI, System of National Accounts, in 1993 pesos and Unikel, 1978.

Given the transformation of the Mexican economy, it is possible that studying only the aggregate economic performance of states—and trade's relationship to that performance—misses important dynamics at work at the sectoral level. If trade's effect on each sector is different, this would have important policy consequences. For example, if the negative effect of trade on GDP per capita growth in my previous analysis were driven by its effect on the primary sector, this would be less important now that the primary sector makes up much less of the Mexican economy. In addition, the possibility that each sector is affected differently by trade openness is particularly important in the context of studying regional inequality, because there is substantial concentration of these sectors in a few states, especially in the case of the secondary and tertiary sectors, as Table 13 and Table 14 show. Thus, if trade openness affects sectors differently, it benefits some states more than others. Understanding the ways in which trade openness affects different sectors is therefore essential to understanding how trade openness affects regional inequality.

Table 13: Top five states' share of total labor employed in economic sectors, 2000

Economic sector	*Share of total*	*Top five states*
Primary	47%	Veracruz, Chiapas, Puebla, Oaxaca and Michoacán
Secondary	43%	México, Federal District, Jalisco, Nuevo León, and Guanajuato
Tertiary	48%	Federal District, México, Jalisco, Veracruz and Nuevo León

Source: INEGI, System of National Accounts and Unikel, 1978.

Table 14: Top five states' share of GDP by economic sectors, 2000

Economic sector	*Share of total*	*Top five states*
Primary	24%	Jalisco, Sinaloa, Veracruz, Michoacán and México
Secondary	51%	Federal District, México, Nuevo León, Jalisco and Coahuila

Tertiary	54%	Federal District, México, Nuevo León, Jalisco and Chihuahua

Source: INEGI, System of National Accounts and Unikel, 1978.

This chapter tests the same three hypotheses analyzed in the previous chapter, but instead of looking at the aggregated level, the analysis is at the three economic sectors within each state. The first hypothesis is that trade openness has contributed to the dispersion of sectoral economic activities from core areas in Mexico, following the core-periphery model of Krugman and Livas (1996). If this is true, states with little activity in a given sector should experience faster growth in that sector in the presence of trade openness than those states in which the sector is well established. The second and the third hypotheses are that trade openness has led to faster growth in states with a) higher levels of infrastructure (Mansori, 2003) and b) education (Benhabib and Spiegel, 1994, Nelson and Phelps, 1966, Keller, 1996). One of the benefits of trade openness is that technology becomes less expensive (Connolly, 2003). However, since the use of new technology requires education, those regions that have advanced levels of human capital will likely benefit from trade openness more than those areas that do not. If that is true, we will see that trade openness reinforces the already existing pattern of development—that is, it will concentrate economic activities in more educated regions. A similar argument can be made for the case of infrastructure. Trade openness allows more investment to take place, but it will tend to locate in areas that have better infrastructure. If this is true, we will observe that trade openness reinforces the already existing concentration of investment in areas that are better endowed with infrastructure. The results, however, may vary. While one could expect that for the secondary and tertiary sectors education and infrastructure are particularly important, the relevance of education for the primary sector might be lower, given the nature of the activities. I test all three of these hypotheses using a sub-national dataset covering the period 1940 to 2000.

The chapter is organized as follows. The next section develops the statistical model. In Section 5.3, I describe the data and methodology. Section 5.4 discusses the results, and Section 5.5 concludes. The findings provide evidence of an income convergence trend in the three economic sectors (all else equal), with the exception of the primary sector. However, the evidence also shows that trade openness has tended to reduce that convergence effect. The results regarding infrastructure and education are more complex, as they vary somewhat by economic sector.

5.1 Model at the economic sector level

The model presented here is identical to that of the previous chapter, except that the variables refer to state economic sector output. I begin with a Cobb-Douglas production function:

$$Y_{irt} = A_{rt} K_{irt}^{\alpha} L_{irt}^{\beta} \varepsilon_{irt} \quad (1)$$

where the i, r and t subscripts represent the economic sector, region, and time period respectively. Y is real income for the sector in each state; A reflects the level of technology for the state, not subscripted by i because technology is assumed to be a public good; K refers to the physical capital stock; L is labor; and ε is a residual term. Expressing (1) in per worker terms and taking natural logarithms gives the following:

$$\ln y_{irt} = \ln A_{rt} + \alpha \ln k_{irt} + (\beta + \alpha - 1) \ln L_{irt} + \ln \varepsilon_{irt} \quad (2)$$

where all variables are the same as equation (1), but those in lowercase are expressed in per worker terms. To calculate the income growth per worker in each state, equation (2) is modified to take the natural log differences for each period as follows:

$$\begin{aligned} \ln y_{irt} - \ln y_{irt-1} &= (\ln A_{rt} - \ln A_{rt-1}) + \alpha(\ln k_{irt} - \ln k_{irt-1}) \\ &+ (\beta + \alpha - 1)(\ln L_{irt} - \ln L_{irt-1}) + (\ln \varepsilon_{irt} - \ln \varepsilon_{irt-1}) \end{aligned} \quad (3)$$

I incorporate the three hypotheses discussed above into this basic model. Beginning with the $\alpha(\ln k_{irt} - \ln k_{irt-1})$ term, I separate physical capital stock K into two different terms, C and I. C is physical capital that is used in the production process and therefore affects production growth directly. The term I refers to physical capital that affects the production process indirectly, such as general public infrastructure.[47] Therefore:

[47] This term I is similar to Hansen's (1965) economic overhead capital, which refers to public investment in general infrastructure.

$$\alpha \ln k_{irt} - \ln k_{irt-1} = f(\ln C_{irt} - \ln C_{irt-1}) + w(\ln I_{rt} - \ln I_{rt-1}) \quad (4)$$

where *f* and *w* are linear functions. Note that the term *I* is not subscripted by *i* because public infrastructure is assumed to be a public good. Because the core-periphery model of Krugman and Livas (1996) focuses on the changes in the location of private capital due to trade openness, I make $f(\ln C_{irt} - \ln C_{irt-1})$ a function of three terms. The first term is the level of the private physical capital stock available in each sector by state. The second is an interaction term of the sector's income per capita at the state level and trade openness, *O*. And finally, the last term is the sectoral income per capita for the state as a control variable, to capture the convergence effect established in the growth literature (Barro and Sala-i-Martin, 1995). That is, I define:

$$f(\ln C_{irt} - \ln C_{irt-1}) = d \ln(C_{irt-1}) + j(\ln O_{r-1} \ln y_{irt-1}) + z(\ln y_{irt-1}) \quad (5)$$

where *d*, j and *z* are linear functions.

In addition, to capture the effect of trade in augmenting the already existing advantage of certain regions in generating public infrastructure (Mansori 2003), I make $w(\ln I_{rt} - \ln I_{rt-1})$ a function of the existing level of infrastructure interacted with the trade openness term, *O*:

$$w(\ln I_{rt} - \ln I_{rt-1}) = q(\ln O_{t-1} \ln I_{rt-1}) \quad (6)$$

where *q* is a linear function. Incorporating (5) and (6) into (4) gives:

$$\ln k_{irt} - \ln k_{irt-1} = q(\ln O_{t-1} \ln I_{rt-1}) + d\ln(C_{irt-1}) + j(\ln O_{t-1} \ln y_{irt-1}) + z(\ln y_{irt-1}) \quad (7)$$

The growth in technology $(\ln A_{it} - \ln A_{it-1})$ is composed of three parts:

$$\ln A_{rt} - \ln A_{rt-1} = g(\ln h_{rt-1}) + m\left[\ln h_{rt-1}\left(\frac{A_{\max t-1} - A_{rt-1}}{A_{rt-1}}\right)\right] + n(\ln O_{t-1} \ln h_{rt-1}) \quad (8)$$

where the functions *g*, *m*, and *n* are linear.[48] From the perspective of this study, the most important term in (8) is the last one. This term multiplies trade openness, *O* (subscripted only with *t* because it is a national level variable), by the state's human capital level, *h*, to capture the effect of trade given levels of human capital (Nelson and Phelps, 1966 and Benhabib and Spiegel, 1994, Keller, 1996). The remaining terms are controls. The first term on the right hand side expresses the direct and independent effect that human capital stock has on the technology rate of growth (Romer, 1986). The second is a domestic diffusion term incorporating the difference in technology levels between region *r* and the region with the highest technology level, following Nelson and Phelps (1966) and Benhabib and Spiegel (1994).

Incorporating (7) and (8) into (3) yields the final form of the regression, equation (9). Note that in this final form I include the lagged level of infrastructure and trade openness on their own, following the recommendation of Brambor, et al (2005) to include the

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[48] A variation of this specification, though without the international component, has been used in various empirical papers (including Benhabib and Spiegel, 1994 and Connolly, 2004) to model the way in which the diffusion of technology within a country is dependent on human capital.

components of interaction terms individually in regressions as well. Thus, the final form of the equation of change of sectoral GDP per worker is:

$$
\begin{aligned}
\ln y_{rt} - \ln y_{rt-1} = (g-m)\left(\ln h_{rt-1}\right) + m\left[\ln h_{rt-1}\left(\frac{A_{\max t-1}}{A_{rt-1}}\right)\right] + s(\ln O_{t-1}) + n\left(\ln O_{t-1}\ln h_{rt-1}\right) \\
+ p(I_{rt-1}) + q(\ln O_{t-1}\ln I_{rt-1}) + f(\ln C_{rt-1}) + j(\ln O_{t-1}\ln y_{irt-1}) + z(\ln y_{irt-1}) \\
+ (\beta+\alpha-1)\left(\ln L_{rt} - \ln L_{rt-1}\right) + \left(\ln \varepsilon_{rt} - \ln \varepsilon_{rt-1}\right)
\end{aligned}
\qquad (9)
$$

5.2 Data and methodology

Data for the study are derived from archival materials in Mexico's National Institute for Geography and Statistics (INEGI). The data cover the entire population of states in Mexico—31 states plus the Federal District—and various years for the period of 1940-2000 (details below). The dependent variable is the growth rate of state sectoral GDP per worker. The data for sectoral GDP are from Unikel (1978) and INEGI's Bank of Economic Information and are in 1993 pesos, and the data for population are from Mexico's decennial National Population Censuses. Because sectoral GDP is observed at uneven intervals, I calculated the average annual growth rate over periods. Table 15 lists the different industries aggregated in each of the sectors.

Table 15: Composition of economic sectors

Economic Sector	*Industry*
I	Agriculture, Livestock, Forestry and Fishing.
II	Mining, Manufacturing, Construction and Utilities (electricity, gas and water).

III	Commerce, restaurant and hotel industry; Transportation, warehousing and communications; Finance and insurance services, real estate and rental and leasing; and Community, social and personal services.

As an indicator of trade openness, I employ the common measure of the sum of exports and imports divided by the GDP in a given year (to control for the size of the economy) (Rodrik and Fernández, 2001). The volume of trade, although not a direct measure of the evolution of a country's trade policy over time, can reflect changes in trade restrictions such as tariffs, quotas, licensing agreements, and other regulatory measures. The main problem with using the volume of trade as a measure for trade openness is that it includes changes in volume due to variation in factors other than trade policy, such as transportation costs, production growth, world demand, etc. However, as Rodrik and Fernández (2001) argue, other measures of trade openness are equally if not more problematic. For example, using tariff rates as a measure of trade openness can be more challenging because there are other trade restrictions—like environmental, sanitary, security, and labor restrictions—that are not reflected in the level of tariffs but are reflected in the volume of trade. Thus, although volume of trade is not a perfect measure of trade openness, it is better than other alternative measures.

I use two measures of infrastructure since the concept of infrastructure is a broad one and different types might affect the production process differently. One measure is state federal highway density: the total length of federal highways in each state divided by the area of each state. The effect of highway density on growth is not obvious. For one, it can serve the population and industries within one state or facilitate trade between surrounding states, with no positive growth effect on the home state (see Puga, 2002). In addition, though highways can provide populations of less developed areas access to amenities available in other states (e.g. specialized health centers), Puga argues that highways can also be detrimental for the process of local industry development in the less developed area. The road can enable the provision of inputs from a rich region's industries and therefore prevent the development of local industry in the less developed area. Other studies have pointed out that transportation infrastructure in non-metropolitan areas shifts investment from the smaller areas to nearby metropolitan areas, due to lower transportation costs (Chandra and Thompson, 2000). Thus, the effect of transportation infrastructure can be ambiguous.

The second measure of infrastructure I use is the share of housing connected to the water network (hereafter referred to as "water connection"). The advantage of this indicator is that it measures directly the beneficiaries of the infrastructure, and thus it is expected to be a positive influence. Although it is a general measure of public infrastructure rather than a direct measure of infrastructure for productive activities, it can serve as a proxy for the overall infrastructure level of a state, as the areas with higher water connection levels are associated with more infrastructure availability. In fact, Aguilar (1990) argues that general infrastructure, although not related directly to the infrastructure that serves industry, is a key influence on industry location in Mexico. The data for state highway density are from the Statistical Annual for Mexico; the information on water connection is taken from the Census of Population and Housing.

To measure human capital I use the level of education of the population (a stock) instead of indicators that measure human capital flows, such as expenditures on education or enrollment rates by state. The specific measure is the share of the population that is literate from the National Population Censuses. Literacy is a fair, if not perfect, indicator of human capital in developing countries, as many people do not know how to read and write. While the measure has been widely used in the literature as an indicator of human capital (Romer, 1989; Mankiw, Romer and Weil, 1992; Barro, 1991; Benhabib and Spiegel, 1994), it might also be useful to use a higher level of educational achievement as an indicator. Unfortunately, such data are unavailable in Mexico for the long time period I am studying. Table 16 lists the independent variables and their measurement, and Appendix 22 presents the summary statistics for each variable by economic sector.

Table 16: Variables and measurement

Variable	Name	Description	Source
Y	Growth rate of State GDP by economic sector	Growth rate of state GDP by economic sector divided by labor employed in each sector annualized	Unikel (1978) and INEGI's Bank of Economic Information, System of National Accounts.
Y	Per worker income by economic sector	State GDP by economic sector divided by labor employed in each sector	Unikel (1978) and INEGI's Bank of Economic Information, System of National Accounts.
I	Infrastructure	Length of federal highway divided by the state area Share of households with direct access to the water networks	INEGI, Statistical Annual for Mexico and Census of Population and Housing.
H	Human capital	Share of total population 15 years or older that are literate	Census of Population and Housing.
O	Trade openness	Sum of exports and imports divided by national GDP	INEGI, Statistical Annual for Mexico

Given the lack of capital and technology data at the economic sector level, I estimate a reduced form of equation (9) using a fixed effects specification, which accounts for unobservable factors related to economic growth in each region. I am not concerned about simultaneity bias in this study, since the income per worker, human capital, and infrastructure variables are lagged; but I have taken measures to account for spatial and temporal autocorrelation and heteroskedasticity. To control for spatial autocorrelation I include a spatial lag variable of the form $\varrho(Wy)$, where ϱ is the coefficient, W is a matrix of weights based on the population of neighboring states, and y is a vector of the dependent variable of neighboring states (state's per worker GDP growth rate by economic sector).[49]

To avoid any problems of serial correlation caused by trends over time, I have taken various measures. First, I analyzed my independent variables—per worker income, highway density, water connection level, and literacy—for trends over time and de-trended them as necessary. The process of de-trending the variables was the following: I regressed each independent variable on a count variable whose value was 1 in 1940, 2 in 1950, and so forth. Next I subtracted the coefficient on the count variable times the count variable from each observation value of the original variable, in order to subtract the time trend effect. The second measure was to analyze the residuals. I obtained the residuals from each of the regressions and then regressed the residuals for each economic sector on the independent variables as well as the lagged residuals. The result for the coefficient of the lag of the residuals was significant only for the tertiary sector, and therefore I estimated the model for that sector utilizing a first-order autoregressive error term model.[50]

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[49] The adjacency that I used is "queen" type (i.e. states that share a border or a point), but using the "rook" adjacency (i.e. those states that only share a border) did not make a difference in the results. This spatial specification aims at capturing the potential contagion effect of neighboring states depending on their population, rather than just taking the average value of all neighboring states.

[50] This is consistent with the autocorrelation function of the residuals at different time lags (the unit lag is a decade), showing that there is not a systematic pattern of serial correlation for the primary and secondary sectors, but a negative one for the tertiary sector.

Finally, in order to provide meaningful interpretation of the results (Braumoeller 2004; Brambor, et al. 2005), I centered the trade variable and variables that are interacted with it: per worker income, state road density, water connection, and the human capital variables. Doing so makes the coefficient on a component variable of an interaction term (when that component variable is entered on its own as well) represent the overall effect of that variable at the average level of the variable with which it is interacted. This makes analyzing the overall effect of trade straightforward.

All variables in the model vary across states and time, except trade openness, as it is a national level variable and thus is constant across states in a given year. Data for the dependent variable, average annual growth rate of the state GDP by economic sector, are available every ten years, except for 1990. The closest available years are 1988 and 1993, and thus the analysis includes the average annual change between 1980 to 1988 and between 1993 to 2000. The panels for the primary and secondary sectors are therefore composed of a total of 192 observations (32 cases over a total of 6 time periods). The panel for the tertiary sector is 160 observations, because it is calculated using the first order autocorrelation residual model.

5.3 Results

The results reported here refer to the reduced form model and are reported by economic sector. For each economic sector, I calculate the substantive effects of trade openness taking into account the different level of states endowments, i.e. income, infrastructure and human capital. The lasts part of this section discusses the common results across economic sectors, including the overall effect of trade openness on states growth.

5.3.1 Primary sector results

The results for the primary sector are presented in Table 17. The third column of the table refers to the results using highway density as the infrastructure variable, and the second one uses the water connection level variable. Negative and significant coefficients for the interaction term consisting of trade openness and per worker income would show up support for the first hypothesis: that poorer states have done better in the context of trade openness in a given sector (in line with the Krugman and Livas' argument). However, the results for the primary sector do not support the hypothesis. In fact, the result for the specification using the highway density variable is *positive* and significant at the ten percent level, indicating the exact opposite of Krugman and Livas' prediction. Thus, states with higher GDP per worker in primary sector activities seem to have done better in the context of trade openness. The result for the specification using the water connection variable is also positive but not significant.

Therefore, the results for Hypothesis I provide some evidence that increased trade openness *increases* regional inequality within the primary sector. Specifically, it should be noted that the effect of increasing trade reduces the overall convergence effect evident in the results, as the coefficient of the per worker income variable by itself is negative and significant at the one percent level. This indicates that at average levels of trade openness over the period of 1940-2000 (when the trade openness variable equals zero because it has been centered) there is evidence of a convergence effect regarding per worker GDP levels in the primary sector. The interaction term indicates that as trade openness increases, this convergence effect decreases.

Table 17: Fixed effects results for the difference of natural log of per worker GDP for the primary sector, 1940-2000

	Measurement	Highway density	Water connection
Hypothesis 1: Trade openness * pw income	$r(\ln O_{t-1} \ln y_{it-1})$	0.00001* (0.00001)	0.00001 (0.00001)
Hypothesis 2: Trade openness * infrastructure	$q(\ln O_{t-1} I_{it-1})$	0.00004** (0.00002)	0.00001** (0.00000)
Hypothesis 3: Trade openness * human capital	$n(\ln O_{t-1} \ln h_{it-1})$	-0.00000 (0.00000)	-0.00000* (0.00000)
Trade openness	$s(\ln O_{t-1})$	-0.00001** (0.00000)	-0.00001*** (0.00000)
Per worker income	$z(\ln y_{it-1})$	-0.04379*** (0.00953)	-0.05063*** (0.00958)
General infrastructure	$p(I_{it-1})$	-0.07629** (0.03668)	-0.01676** (0.00826)
Endogenous human capital	$(g-m)(\ln h_{it-1})$	-0.00049 (0.00072)	-0.00097 (0.00074)
Spatial lag variable	$\rho(Wy)$	0.30771*** (0.07467)	0.36852*** (0.06994)
Constant		0.01232*** (0.00365)	0.00812** (0.00375)
	N =	192	192
	T =	32	32
	Within R^2=	0.45	0.45
	Between R^2=	0.02	0.00
	Overall R^2=	0.30	0.24

Significance at the one, five, and ten percent levels is denoted by ***, ** , and * respectively. Standard errors are reported in parenthesis.

In the case of Hypothesis II, a positive and significant coefficient for the interaction term between trade openness and infrastructure would provide evidence in support of Mansori's argument that states with higher levels of infrastructure tend to benefit more from trade openness. The findings are as expected using both measures of infrastructure, indicating once again that as trade openness increases, regional inequality also increases within the primary sector. However, the results of both infrastructure variables by themselves are negative and significant. While perhaps surprising, other studies have also found a negative or not statistically significant relationship between infrastructure and growth (e.g. Guild, 1998). As stated before, the specific effects of highway density can be ambiguous, because while highways can be beneficial for some areas by enhancing efficiency and fomenting investment, as well as providing access to other areas, they can also drive resources away from lagging regions (Puga, 2002). For example, Chandra and Thompson (2000) find that highways enhance the level of economic activities of areas where they pass through but drive resources away from nearby areas.

In the case of Hypothesis III, a positive coefficient on the interaction term between trade openness and human capital would indicate support for the hypothesis that states with higher human capital levels benefit more from trade openness. The results, however, do not provide evidence in support of this hypothesis. In fact, when using the water connection variable, the result is contrary to expectation, as it is *negative* and significant (at the ten percent level). Although this result seems surprising, it is consistent with previous studies investigating the relationship between growth and education. Moreover, in the previous chapter I also found this negative and significant relationship. Results like these with regard to human capital are surprisingly common in the growth literature.[51] Several

[51] The results at the aggregate level contrast the micro level evidence of a positive relationship of education and income at the individual level.

previous empirical studies (e.g. Barro and Lee, 1994; Barro, 1997; Barro and Sala-i-Martin, 1995; Benhabib and Spiegel, 1994; Romer, 1990) have found no relationship or a negative correlation between education and growth.

The coefficient of the trade openness term by itself is negative and significant at the one percent level, consistent with the findings in the previous chapter of a negative effect of trade openness. Also, the coefficients for the spatial lag variable are positive and significant in both specifications.

In terms of substantive effect, the net effect of international trade on regional growth is negative, all else equal. However, because of the interaction terms, the effect varies according to a state's level of income, infrastructure, and human capital. Table 18 shows the difference in percentage points of the effect of trade openness on per worker income growth of the primary sector for states with different levels of income, infrastructure, and human capital for each economic sector. For example, when trade openness is at mean levels observed in the sample (and all else is equal), a state with the 1940-2000 mean primary sector income level of Oaxaca (the lowest mean primary sector income level) would grow 0.07 percentage points faster than a state with the 1940-2000 mean primary sector income level of Sonora (the highest mean primary sector income level).[52] When trade is at the minimum level, this convergence effect is even stronger: Oaxaca would grow 0.13 percentage points faster. However, when trade openness is at the maximum level, this convergence effect is reversed, as Oaxaca would grow 0.03 percentage points *slower* than Sonora.[53] As discussed above, these results indicate that trade openness reduces (and at upper levels reverses) the income convergence effect within the primary sector.

In the case of infrastructure, the results provide some evidence of a cumulative causation dynamic, as states with higher levels of infrastructure tend to grow faster than those with low levels; and this effect is exacerbated as trade openness increases. For example, using water connection as the infrastructure variable, the results indicate that when trade is at the mean level and all else equal, Aguascalientes (the state with the highest mean level of infrastructure) grows 0.04 percentage points faster than Oaxaca (the state with the lowest mean level). This difference increases to 0.16 percentage points when trade openness is at the maximum levels. However, when trade is the minimum levels the difference among these states gets reversed to an advantage for Oaxaca of 0.09 percentage

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[52] These results are from the regression using highway density as the infrastructure variable.

[53] The maximum level of trade is the 1990 level, which is actually less than the current level. The minimum level is the observed in 1970.

points. Thus the results indicate that the difference in the level of infrastructure across states fosters regional inequality as trade openness increases.

Finally, in the case of human capital, the effect is in the opposite direction—i.e. there seems to be a convergence effect with regard to the level of human capital, contrary to the expectation of a cumulative causation dynamic of human capital levels. Using the water connection variable, the results indicate that if trade was at the mean level and all else was equal, Guerrero (the state with the lowest mean level of human capital) would grow 0.06 percentage points faster than DF (the state with the highest mean level). However, Guerrero's advantage rises to 0.28 points when trade is at the maximum value.

Table 18: Substantive effect of trade openness on per capita income growth of the primary sector

Effect of hypothesis 1: Income	*Difference in growth rate for states with high and low income levels: Oaxaca vs. Sonora*	
	Roads	Water
Trade at min	+0.13	+0.10
Trade at mean	+0.07	+0.08
Trade at max	-0.03	+0.05
Effect of hypothesis 2: Infrastructure	*Difference in growth rate for states with high and low infrastructure levels, Oaxaca vs. Aguascalientes*	
	Roads	Water
Trade at min	+0.04	+0.09
Trade at mean	+0.01	-0.04
Trade at max	-0.01	-0.16
Effect of hypothesis 3: Human capital	*Difference in growth rate for states with high and low human capital levels, Guerrero vs. DF*	
	Roads	Water
Trade at min	0.00	-0.15
Trade at mean	0.00	+0.06
Trade at max	0.00	+0.28

Positive numbers represent an advantage for the less endowed state and negative numbers represent an advantage for the more endowed one. Effects assume all else is equal. See text for interpretation examples.

5.3.2 Secondary sector results

The results for the secondary sector are presented in Table 19. The results do not provide support for Hypothesis I. Moreover, the coefficient of the income per worker term by itself is significant and negative, showing evidence of a convergence trend across states along GDP in this sector when trade is at the mean.

For the secondary sector, utilizing the water connection variable as the infrastructure measure makes a difference in terms of the results, whereas for the primary sector there was no difference between the two measures. For example, the coefficient of Hypothesis II is positive and significant when using the water connection specification. This result, consistent with the one in the previous chapter, provides support for the argument made by Mansori regarding the concentration effect that arises due to the uneven availability of infrastructure across states. Moreover, the water connection variable by itself is *positive* and significant, providing further evidence that inequalities in infrastructure lead to overall regional inequality within the secondary sector.

In terms of Hypothesis III the results are positive but also only significant when using the water connection variable, providing some evidence that education leads to increased inequality. However, the literacy variable by itself is only significant when using the highway density variable. It is interesting to note, however, that the coefficient of the literacy variable is *positive* for the secondary sector whereas it was negative and insignificant for the primary sector. This may reflect the greater importance of education in the secondary sector than in the primary sector. Finally the coefficient for the trade variable in both specifications is—as in the results for the primary sector—negative and significant.

Table 19: Fixed effects results for the difference of natural log of per worker GDP for the secondary sector 1940-2000

	Measurement	**Highway density**	**Water connection**
Hypothesis 1: Trade openness * pw income	$r(\ln O_{t-1} \ln y_{it-1})$	0.000001 (0.00001)	0.000000 (0.00001)
Hypothesis 2: Trade openness * infrastructure	$q(\ln O_{t-1} I_{it-1})$	0.00004 (0.00003)	0.00017*** (0.00004)
Hypothesis 3: Trade openness * human capital	$n(\ln O_{t-1} \ln h_{it-1})$	0.000001 (0.000001)	0.0000002** (0.000001)
Trade openness	$s(\ln O_{t-1})$	-0.00001*** (0.000004)	-0.00003*** (0.00001)
Per worker income	$z(\ln y_{it-1})$	-0.12008*** (0.01277)	-0.11386*** (0.01220)
General infrastructure	$p(I_{it-1})$	-0.08928 (0.06008)	0.24786*** (0.06608)
Endogenous human capital	$(g-m)(\ln h_{it-1})$	0.00394*** (0.00110)	0.00092 (0.00131)
Spatial lag variable	$\rho(Wy)$	0.22269** (0.10744)	0.10184 (0.10804)
Constant		0.00462 (0.00577)	-0.02161*** (0.00845)
	N =	192	192
	T =	32	32
	Within R^2=	0.66	0.67
	Between R^2=	0.16	0.28
	Overall R^2=	0.52	0.54

Significance at the one, five and ten percent levels is denoted by ***, **, and * respectively. Standard errors are reported in parenthesis.

The lack of support for Hypothesis I for the secondary sector is surprising. One possible reason for the results is that the secondary sector is composed of a wide variety of industries: mining and extraction of oil and gas; manufacturing; water, gas and electricity; and construction. Thus, the result might be due to the fact that industries within the secondary sector experience different concentration or dispersion trends.[54] For example, Table 20 presents the states with the highest shares of total GDP in mining, showing that since 1970 the industry has become more unequally distributed across states (more concentrated, as might be expected given the fact that mining is the least footloose industry). This is reflected in the increased coefficient of variation (CV), from 1.62 in 1970 to 2.14 in 2000. However, although the industry has increased its concentration, this concentration is driven mainly by the fact that the largest share of mining GDP is located in Campeche, a state with relatively recent activities of oil extraction.

Table 20: States with highest shares of Total Mining GDP, 1970 and 2000

State	*1970*		*State*	*2000*	
	Rank	*Share of GDP*		*Rank*	*Share of GDP*
Veracruz	1	0.24	Campeche	1	0.37
Chihuahua	2	0.13	Tabasco	2	0.12
Tabasco	3	0.12	Coahuila	3	0.07
Coahuila	4	0.06	Sonora	4	0.04
Sonora	5	0.06	Mexico	5	0.03
Campeche	30	0.00	Veracruz	8	0.03
Mexico	16	0.01	Chihuahua	12	0.02
Mean		0.03	Mean		0.03
St Dev		0.05	St Dev		0.07
CV		1.62	CV		2.14

[54] The industries aggregated in the secondary sector also demand different levels of capital and labor intensity as well as type of labor skills. Unfortunately doing the analysis at a more disaggregated level is not possible due to data availability.

In the rest of the industries aggregated in the secondary sector—manufacturing, construction, and utilities—there is a general decrease in their unequal distribution from 1970 to 2000, reflected in the smaller coefficients of variation in 2000 shown in Table 21. This is consistent with the general per worker income convergence trend found in the regression results. However, while in general all states have increased their secondary sector activities over time, the dispersion is a slow process. Table 21 shows that the states that had the highest shares of the total industry's GDP in 1970 continue to do so in 2000. This is most pronounced in the manufacturing and construction industries, and to a lesser degree in the utilities industry. Therefore, although the concentration for the secondary sector's "core" areas has been maintained, this trend is more pronounced in manufacturing and construction and less in the utilities industry. Thus, the heterogeneity in patterns across different industries in the secondary sector might explain the lack of support for a concentrating effect in core areas as trade openness increases.

Table 21: States with the highest shares in various industries, 1970 and 2000

Manufacturing		*Share 1970*	*Share 2000*
Distrito Federal		0.32	0.19
Mexico		0.18	0.16
Nuevo Leon		0.10	0.09
Jalisco		0.07	0.07
Veracruz		0.05	0.05
Coahuila		0.03	0.06
	Mean	0.03	0.03
	St Dev	0.06	0.04
	CV	2.03	1.39
Construction		*Share 1970*	*Share 2000*
Distrito Federal		0.25	0.22
Mexico		0.11	0.09
Jalisco		0.08	0.07
Nuevo Leon		0.06	0.05
Veracruz		0.06	0.06
	Mean	0.03	0.03
	St Dev	0.05	0.04
	CV	1.48	1.28
Electricity, gas and water		*Share 1970*	*Share 2000*
Distrito Federal		0.18	0.06
Guerrero		0.10	0.05
Chiapas		0.09	0.09
México		0.07	0.05
Nuevo León		0.06	0.05
Veracruz		0.05	0.07
Hidalgo		0.01	0.05
	Mean	0.03	0.03
	St Dev	0.04	0.02
	CV	1.22	0.72

In terms of the substantive effects of trade on the secondary sector, once again because of the interaction terms the effect varies according to a state's level of endowments (income, infrastructure, and human capital). Table 22 shows the difference in percentage points of the effect of trade openness on per worker income growth of the secondary sector for states with different levels of income, infrastructure, and human capital for each economic sector. For example, just considering income levels, trade openness leads to a convergence of secondary sector income growth, all else equals. Table 22 indicates that (all else equal) as trade openness increases from a minimum to a maximum level, the growth rate advantage of a state with the 1940-2000 lowest mean income level in the secondary sector (like Quintana Roo) over a state with the 1940-2000 the highest mean income level, like the Federal District, would grow from 0.22 percentage points to 0.26 percentage points.[55]

In the case of the effect of infrastructure, the results provide some evidence of an effect in the opposite direction, as states with higher water connection levels will tend to grow faster than those with low levels as trade openness increases. For example, when trade is at the mean level and all else equal, the results indicate that Aguascalientes (the state with the highest mean level of infrastructure) grows 0.10 percentage points faster than Oaxaca (the state with the lowest mean level). This difference increases to 0.38 percentage points when trade openness is at the maximum levels. However, when trade is at the minimum level the difference among these states gets reversed to an advantage for Oaxaca of 0.13 percentage points. Thus the results indicate that the difference in the level of infrastructure across states fosters regional inequality as trade openness increases.

[55] These results are from the regression using highway density as the infrastructure variable.

Finally, in the case of human capital, the results indicate effects in both directions (convergence and divergence) depending on the measure of infrastructure that is used. On the one hand, using the water connection variable, the results indicate a convergence effect arising from human capital (opposite to expectation) at a maximum level of trade, as Guerrero, the state with the lowest mean level of human capital, would grow faster than the state with the highest mean level, the Federal District. However, at the minimum level of trade the convergence effect gets reversed, benefiting the Federal District. On the other hand, using the highway density variable, the results indicate a cumulative causation dynamic at all levels of trade: the state with the highest level of human capital (DF) grows faster, but the effect gets exacerbated as trade openness increases, from 0.10 to 0.18 percentage points.

Table 22: Substantive effect of trade openness on per capita income growth of the secondary sector

Effect of hypothesis 1: Income	*Difference of the effect of trade for states with high and low income levels: Quintana Roo vs. DF*	
	Roads	Water
Trade at min	+0.22	+0.23
Trade at mean	+0.24	+0.23
Trade at max	+0.26	+0.23
Effect of hypothesis 2: Infrastructure	*Difference of the effect of trade for states with high and low infrastructure levels, Oaxaca vs. Aguascalientes*	
	Roads	Water
Trade at min	0.00	+0.13
Trade at mean	0.00	-0.10
Trade at max	0.00	-0.38
Effect of hypothesis 3: Human capital	*Difference of the effect of trade for states with high and low human capital levels, Guerrero vs. DF*	
	Roads	Water
Trade at min	-0.10	-0.28
Trade at mean	-0.14	0.00
Trade at max	-0.18	+0.13

Positive numbers represent an advantage for the less endowed state and negative numbers represent an advantage for the more endowed one. See text for interpretation examples.

5.3.3 Tertiary sector results

The results for the tertiary sector are reported in **Error! Reference source not found.**. As mentioned above, the residuals of the fixed effects regression of the tertiary sector showed the presence of serial correlation, and thus I estimated the model using a first-order autoregressive error model. However, the results are not substantially different if I use the same model employed with the primary and secondary sectors (these results are shown in Appendix 23).

The results do not show evidence supporting Hypothesis I in the tertiary sector. Moreover, the coefficient for per worker income by itself is negative and significant, indicating a convergence trend when the trade level is at the mean. In other words, the results here echo those in the secondary sector: there is an overall convergence trend in the tertiary sector, though a slow one. Although in most of the country, tertiary sector activities have become more important over time, the states with the highest share of GDP in service activities in 1940 remain the main core areas in 2000. Table 24 shows that the states that had the highest shares of total GDP in service industries in 1970 generally remain at the top in 2000.

Table 23: Fixed effects (AR-1) results for the difference of natural log of per worker GDP for the tertiary sector, 1940-2000

	Measurement	**Highway density**	**Water connection**
Hypothesis 1: Trade openness * pw income	$r(\ln O_{t-1} \ln y_{it-1})$	0.00001 (0.00001)	0.00001 (0.00001)
Hypothesis 2: Trade openness * infrastructure	$q(\ln O_{t-1} I_{it-1})$	0.00003 (0.00002)	0.00005** (0.00003)
Hypothesis 3: Trade openness * human capital	$n(\ln O_{t-1} \ln h_{it-1})$	-0.0000001 (0.0000003)	-0.0000008 (0.0000005)
Trade openness	$s(\ln O_{t-1})$	-0.00001*** (0.00000)	-0.00001** (0.00001)
Per worker income	$z(\ln y_{it-1})$	-0.03446*** (0.01431)	-0.03747*** (0.01418)
General infrastructure	$p(I_{it-1})$	0.06487 (0.04366)	0.00202 (0.07224)
Endogenous human capital	$(g-m)(\ln h_{it-1})$	0.00053 (0.00085)	-0.00051 (0.00092)
Spatial lag variable	$\rho(Wy)$	0.53400*** (0.06128)	0.50945*** (0.06497)
Constant		0.00519 (0.00342)	-0.00274 (0.00522)
	N =	160	160
	T =	32	32
	Within R^2=	0.71	0.71
	Between R^2=	0.00	0.02
	Overall R^2=	0.67	0.65

Significance at the one, five and ten percent levels is denoted by ***, ** , and * respectively. Standard errors are reported in parenthesis.

Table 24: States with the highest shares of total GDP in the service industries

VI. Commerce, restaurant and hotel		VII. Transportation, storing and communications	
1970	*2000*	*1970*	*2000*
Federal District	Federal District	Federal District	Federal District
Jalisco	Mexico	Mexico	Mexico
Mexico	Jalisco	Veracruz	Nuevo Leon
Nuevo Leon	Nuevo Leon	Jalisco	Jalisco
Veracruz	Chihuahua	Nuevo Leon	Chihuahua
VIII. Financial and insurance services, real estate		**IX. Community, social and personal services**	
1970	*2000*	*1970*	*2000*
Federal District	Federal District	Federal District	Federal District
Mexico	Mexico	Jalisco	Mexico
Veracruz	Nuevo Leon	Nuevo Leon	Nuevo Leon
Jalisco	Jalisco	Mexico	Jalisco
Nuevo Leon	Veracruz	Veracruz	Veracruz

The coefficient of Hypothesis II is positive and significant when using the water connection specification. This result provides support for the argument made by Mansori regarding the concentration effect that arises due to the uneven availability of infrastructure across states. However, the coefficient of the water connection variable by itself, although positive, is not significant. The results do not provide evidence in support of Hypothesis III, as the coefficients are not significant, and neither is the coefficient for literacy by itself. The coefficient for trade openness is negative and significant, also consistent with findings in the other two sectors. Finally the spatial lag variable is positive and significant.

Table 25 shows the substantive effects for the tertiary sector in terms of the difference in percentage points of the effect of trade openness on per worker income growth of the tertiary sector for states with different levels of income, infrastructure, and human capital. In the case of Hypothesis I, i.e. just considering income levels, the results show that trade openness reduces the convergence effect of tertiary sector income growth. All else equal, when trade is at the minimum level, a state with the 1940-2000 lowest mean income level in the tertiary sector (like Guerrero) would grow 0.06 percentage points faster than a state with the 1940-2000 highest mean income level (like the Federal District).[56] However, this convergence effect is reduced to zero as trade openness increases to its maximum level.

In the case of infrastructure, using the water connection variable, the results provide evidence of an effect in the same direction. For example, when trade is at the minimum level and all else equal, the results indicate that Oaxaca (the state with the lowest mean level) grows 0.08 percentage points faster than Aguascalientes (the state with the highest mean level of infrastructure). However, this convergence effect disappears when trade is at the mean level and gets reversed when trade openness is at the maximum levels. Thus the results indicate, once again, that the difference in the level of infrastructure across states fosters regional inequality as trade openness increases. In the case of human capital, the results do not show evidence of any effect, as the coefficients for the interaction term of

[56] These results are from the regression using highway density as the infrastructure variable.

trade openness and human capital level and the human capital level by itself are not significant.

Table 25: Substantive effect of trade openness on per capita income growth of the tertiary sector

Effect of hypothesis 1: Income	*Difference of the effect of trade for states with high and low income levels: Guerrero vs. DF*	
	Roads	Water
Trade at min	+0.06	+0.05
Trade at mean	+0.04	+0.04
Trade at max	0.00	0.00
Effect of hypothesis 2: Infrastructure	*Difference of the effect of trade for states with high and low infrastructure levels, Oaxaca vs. Aguascalientes*	
	Roads	Water
Trade at min	0.00	+0.08
Trade at mean	0.00	0.00
Trade at max	0.00	-0.09
Effect of hypothesis 3: Human capital	*Difference of the effect of trade for states with high and low human capital levels, Guerrero vs. DF*	
	Roads	Water
Trade at min	0.00	0.00
Trade at mean	0.00	0.00
Trade at max	0.00	0.00

Positive numbers represent an advantage for the less endowed state and negative number represent an advantage for the more endowed one. See text for interpretation examples.

5.3.4 Results across sectors

The findings across sectors are fairly consistent (see Table 40 in Appendix 24). In all three sectors (with both infrastructure specifications), the coefficient for the per worker income term is negative and significant, reflecting a strong income convergence trend across states over the period 1940-2000. However, for the primary sector, the results using the highway density variable show that as trade openness increases, this convergence tends to be diminished, due to the positive and significant coefficient of the variable capturing Hypothesis I in this sector. In other words, trade openness serves to reduce the convergence tendency and therefore increases regional inequality. In addition, the results show that infrastructure inequalities, especially water connection, lead to greater regional inequality in the context of trade openness. The results also show some evidence that education mediates the effect of trade openness on regional inequality, specifically in the case of the primary and secondary sectors using the water connection variable. However, the effect in the primary sector is opposite to what one might suspect. More educated states tend to do worse in the context of trade openness than less educated states.

The trade openness term is negative and significant for all three sectors. Because the income, infrastructure, and education variables were centered, the coefficient on the trade variable alone indicates the total effect of trade openness on a state with average income, infrastructure, and education levels. This robust finding is important, as it indicates that the negative effect of trade on economic growth I found in the previous chapter is not due to trade's effect on one particular sector. Trade openness seems to have affected all economic sectors in Mexico negatively. This is consistent with the finding of Yanikkaya (2003), who argues that when trade takes place among asymmetric partners, less developed countries are at a disadvantage. As argued in the previous chapter, this explanation seems relevant for the case of Mexico, given that the majority of its total trade is with developed countries, and more specifically with the USA.[57]

Although mainstream trade theory would expect that the complementarities between different economies would be beneficial for trading partners, these benefits do not seem to have materialized for Mexico. For example, one would have expected that in the USA-Mexico trade partnership Mexico would specialize in labor intensive industries, like most primary sector activities, to take advantage of its labor supply and climate. However, the primary sector has been hard hit in Mexico since the trade regime change (Rubio, 2004), and since the early 1990s the number of migrants from rural Mexico to the USA has significantly risen (Durand, et al. 2001). In a study of Mexican immigration in the US over the period of 1970-1995, Durand et al. find that the patterns of migration have remained pretty steady for the period, with the only change being that there seems to be a decline in the education level of migrants. They observe a rise in the share of immigrants in the low

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[57] The United States is by far Mexico's main commercial partner, as it represents an average of 73 percent of Mexico's exports and 68 percent of Mexico's imports for the period 1980 to 1997.

skilled categories migrating from rural areas in Mexico, from 61 percent for the period of 1970-1974 to 73 percent for the period 1990-1994.

Moreover, the negative relationship between trade and growth can potentially be the result of the way in which the trade regime change took place in Mexico.[58] As Quintana Romero (2004) argues, one of the main characteristics of the new regime was the promotion of the external sector of the economy. As a result of the 1980s economic crisis, the government started to eliminate the protection system for domestic industry that was maintained during the import substitution period. Between 1982 and 1990, the share of total imports that were subject to import licenses decreased from 100 percent to 14.1 percent; and the highest tariff barrier went from 100 percent to 20 percent. The aim of the new regime was to allow national industry to compete with international industry, thus making it more efficient. The problem with the trade regime change was that it was not only inefficient industries that were negatively affected. Competitive industries were also negatively affected because Mexican trade openness was in general a unilateral measure: Mexico's main trade partner (70% of Mexico total trade is with the the USA) maintained protection measures in the form of subsidies, in particular agricultural subsidies, while Mexico's were

[58] As opposed to East Asian countries that successfully transitioned from protectionist regimes to export-based liberalized regimes. According to Stiglitz (2006) the South East Asian countries only lowered tariffs as their exports grew. In addition, they used intervention to foster exports, thus avoiding zero-productivity unemployment—which results when inefficient industries disappear—by maintaining close economies and thus creating full employment situations.

declining. This would explain at least partially why labor labor-intensive industries did not respond in Mexico after NAFTA was implemented. In this sense, the fact that NAFTA has not benefited Mexico is not an argument against free trade theory as much as it evidence that NAFTA was not really a "free trade" agreement. Figure 3 shows the degree of trade openness in Mexico compared to that of the USA and an average of Mexico's main trade partners. The main trade partners' average is composed of the following countries: France, Germany, Italy, and the United Kingdom. Together, these countries represent approximately 12 percent of Mexico's exports and imports. The figure shows that the level of trade openness in Mexico over the period of 1960-2000 was close to the level of (actually slightly higher than) the USA's until the late 1980s. Since then Mexico's trade openness level increased rapidly, while the level of the USA did not increase at a similar rate. In fact, Mexico's level of trade openness in 1996 was above the mean level of its main partners for the first time since 1964.[59]

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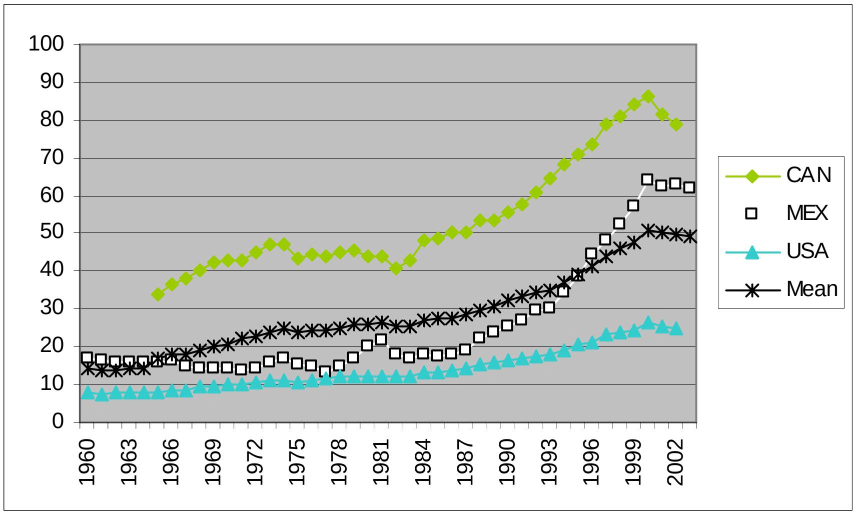
[59] Mexico's experience in this regard is not unique. The general discontent of developing countries against the world trade regime focuses on the disadvantages that the trading system presents for developing countries' economies. For example, since the Uruguay round of trade negotiations developing countries have generally dismantled subsidies and opened up their agricultural sectors—the crucial sectors for most developing countries economies—while developed countries have maintained agricultural protection and subsidies. In addition, developing countries find it hard to move into higher value-added activities, since developed countries have increasingly become more protected by non-tariff barriers. For an excellent review see Stiglitz, 2006.

Figure 22: Trade openness of Mexico's partners



Source: Trade openness equals the sum of exports plus imports divided by GDP. Data from World Bank, World Development Indicators 2005.

The substantive effects for each sector show that there are simultaneous counteracting effects of trade; however, the overall effect of trade openness on state income growth in the three sectors has been negative. In addition, it has been *more* negative for less endowed states. Table 26 shows how much faster a poorly endowed state grows than a high endowed state, all else equal, in percentage points, at different levels of trade openness. In the three sectors, using both infrastructure variables, the effect on regional inequality of moving from a minimum to a mean level of trade openness is negative. That is, the advantage of the lower endowed state over the more endowed state is lessened. In fact, in some cases, moving to a maximum level of trade openness results in a reversal of the convergence effect, so that the more endowed states grow faster than less endowed states.

In sum, as trade openness increases, the benefits accrue to the more endowed states in the three sectors.

Table 26: How much faster a low endowed state grows than a high endowed state, all else equal, in percentage points

	High openness	Mean openness	Low openness
Primary Sector			
Roads	-0.04	0.08	0.16
Water	0.06	0.10	0.14
Secondary Sector			
Roads	0.08	0.10	0.12
Water	-0.02	0.12	0.21
Tertiary Sector			
Roads	0.00	0.04	0.06
Water	-0.09	0.04	0.13

5.4 Conclusion

The aim of this chapter has been to examine the effect that trade has had on regional inequality in Mexico over the period of 1940-2000, by testing how levels of income, infrastructure, and human capital have mediated the effect of trade openness on the states' economic growth in the primary, secondary, and tertiary sectors. I have shown that the effect of trade openness has been similar across sectors. With the exception of the primary sector using the highway density variable, the results indicate no support for the hypothesis that trade's effect on states' performance in economic sectors has been mediated by income. However, a more consistent mediating effect was found with regard to infrastructure, especially measured by water connection level. Across economic sectors, states with higher water connection levels consistently performed better than those with lower ones. The mediating effect of human capital is not as straightforward, as its effect is not robustly in the same direction across different sectors and different indicators of infrastructure.

The results show that there is strong evidence of an income convergence trend in the three economic sectors, all else equal. However, the evidence also shows that trade openness has tended to reduce that convergence effect.

Although the findings of this chapter are fairly consistent, the analysis could be augmented in two ways. The first would be to test the robustness of the findings by exploring contextual evidence of how well the model fits the reality in particular cases. The second would be to fine tune Hypothesis III, as the results are not consistent across sectors. The following chapter focuses on both of these through case studies, a methodology well suited to them both. Rather than focusing on generalizing findings from the case studies—(as case studies have low external validity), —the idea is to examine closely the historical sequence of the relationships. In this sense the case studies can explore, with particular examples, the robustness of the findings and the reasons behind the unexpected statistical findings. In combination with the statistical analyses in this chapter and the previous, the result should be a more complete understanding of the relationship between trade and regional inequality in Mexico.

6. Case Studies

6.1 Introduction

In this chapter, I turn to case studies of certain Mexican states to further examine the hypotheses in this dissertation. Combining case studies and statistical analysis, as I am doing in this dissertation, has particular advantages, as Lieberman (2005) has emphasized. Statistical analysis provides the ability to study the relationship between two or more variables across many cases and while controlling for other factors. Case studies can be combined with this analysis for two distinct purposes: model testing and model building. In the case of model testing, the aim of using case studies is not to generalize findings but rather to examine closely the historical sequence of the relationships of interest. Thus case studies allow the researcher "to gain contextually based evidence that a particular causal model or theory actually 'worked' in a manner specified by the model" (p. 442).

For model building, case studies are appropriate because they can incorporate current and historical contextual factors into the analysis through interviews, primary data collection, and the examination of historical records (Yin, 2003). As Gerring (2004) states, the virtue of the case study as a method is its ability to "elucidate mechanisms connecting a particular X with a particular Y. By watching the progress of a single unit (a country, a city, a person) over time and by paying attention to variation within that case we can often observe, or at least intuit, a complex causal relationship at work" (p. 215).

In this chapter, I use case studies for both model testing and model building. In terms of model testing, I further examine the robustness of the findings of the statistical analysis of previous chapters by exploring contextual evidence of how well the model fits the reality in the particular cases. In terms of model building, I particularly focus on refining Hypothesis III, as the statistical findings of previous chapters with regard to this hypothesis are particularly puzzling, and against essentially all existing theory regarding education and economic growth.

In order to achieve these goals, this chapter compares the experience of three states with regard to regional growth and trade openness: Aguascalientes, Guanajuato, and Nayarit. The comparisons focus on the mediating effect of infrastructure and human capital on the relationship between trade openness and growth, and specifically how the existing levels of these endowments in the three states have resulted in different effects of trade on their growth. I focus on the second and third hypotheses for both practical and policy-related reasons. In terms of practicality, studying all three hypotheses would have necessitated at least an additional two case studies, and time and financial constraints did not permit this. Prioritizing the hypotheses was therefore necessary. I chose the second and third hypotheses because it seemed that the policy implications of these hypotheses—regarding infrastructure and education policy—were more direct than for Hypothesis I. I will likely conduct additional case studies in the future to examine Hypothesis I as well.

Therefore the case studies explore the dynamics of the statistical findings with regard to infrastructure and human capital. With regard to infrastructure, in some regressions the infrastructure term by itself was insignificant. With regard to education, in many regressions the term was usually *negative* and significant, both by itself and in interaction with trade openness. Focusing more in-depth on infrastructure and human capital will hopefully enable a better understanding of the dynamics behind the statistical results for these hypotheses.

The information used in the case study analyses comes from published academic studies and case studies of the states; data on each state from federal and state governments; and open-question interviews with state policy makers, directors of industry associations and chambers, and some business directors and academics. By gathering information from a variety of sources, my goal was to find a consistent perspective for the analysis. The methodology of compiling the information was the following. After reading published academic case studies and histories of each case I gathered the relevant secondary data on each case from different sources of the National Statistical Agency (INEGI), as well as state level agencies, and constructed the tables and figures of this chapter.[60] Finally, I conducted

[60] It is important to note the unevenness in the availability of published analyses on the cases, i.e. Aguascalientes has been studied more than the other two cases.

face-to-face interviews that included open-ended-questions centered on the role of infrastructure and education in the development of each state and the extent of its change since the opening of the trade regime. I also conducted interviews by phone and email. For each interview I took notes, and a file was created. For those interviews that needed followed up, telephone interviews complemented the first one.[61] The interviews were semi-structured, as a questionnaire guided the order of the questions. However, because the research aimed at obtaining historical perspectives of the development of the state, the interviews were flexible so as to allow the respondent to include whatever factors he or she deemed important. In this sense, although the research was focused on particular state endowments (infrastructure and human capital) and their interaction with trade openness, the questions allowed the respondents to incorporate whatever factors they deemed relevant.

The next section of this chapter describes the method of selection of the cases. The third section compares the states' economic growth over time and then focuses on the role of infrastructure and education, followed by a discussion of possible alternative explanations. The last section concludes the chapter.

[61] Case studies materials are available from the author upon request.

6.2 Case selection

To select the cases, I followed King, Keohane, and Verba's (1994) advice to maximize variation on my key independent variables: infrastructure and human capital. Because of my need to observe variations in these indicators I needed cases that filled a 2-by-2 table such as Table 27.

Table 27: Ideal Matrix for Case-Study Observations

	High infrastructure	Low infrastructure
High human capital	A	B
Low human capital	C	D

In my dataset, I looked at states that fit the above combinations of levels of both indicators. However, it was hard to find cases that perfectly fit Table 27 for two reasons. First, extreme cases are generally atypical cases. For example, states in the low-low quadrant (D) are in general in the south of the country (specifically the cases of Guerrero, Chiapas, and Oaxaca) and face substantial problems of instability due to political factors (Trejo, 2004). Similarly unique are the states in the high-high quadrant (A), which generally border the United States and have been affected by the immigration and economic policies unique to their geography. Second, in general, for quadrants B and C it is hard to find a state that has a very high level on one indicator and a very low level on the other.

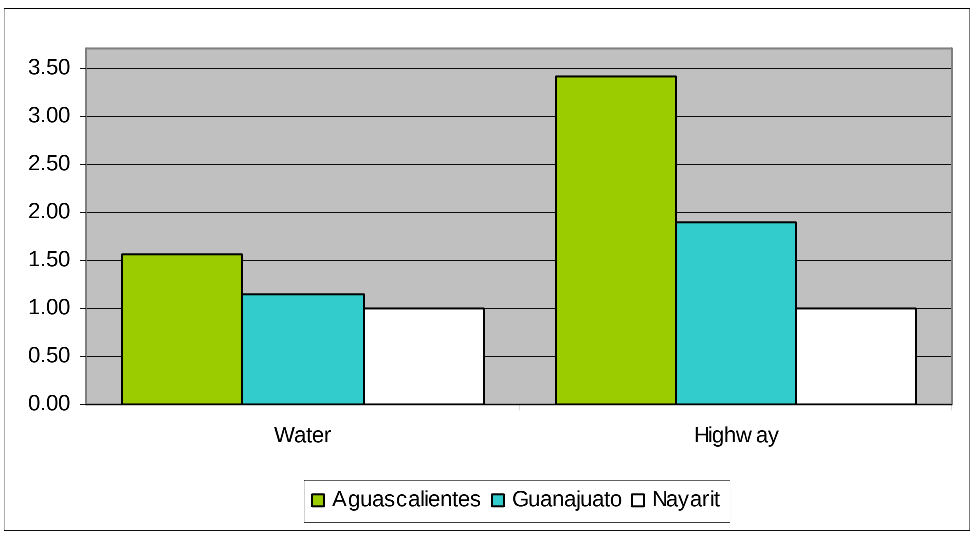
The three selected cases—Aguascalientes, Guanajuato, and Nayarit—represent the best approximation of the necessary variation, as I will discuss in a moment. Because the focus of this chapter is the role of infrastructure and human capital, only three case studies are necessary to conduct the comparisons. The comparison on infrastructure is between Aguascalientes and Nayarit, and the human capital comparison is between Aguascalientes and Guanajuato. As Table 28 shows, each of these comparisons holds either infrastructure or human capital relatively constant, so this way one can more easily view the effect of the other key variable. To select the cases I used the indicators observed in 1980, two years before import substitution industrialization ended and neo-liberal policies were put into place.

Table 28: Real Matrix for Case-Study Observations

	High infrastructure	Low infrastructure
High and middle human capital level	Aguascalientes	Nayarit
Low human capital level	Guanajuato	

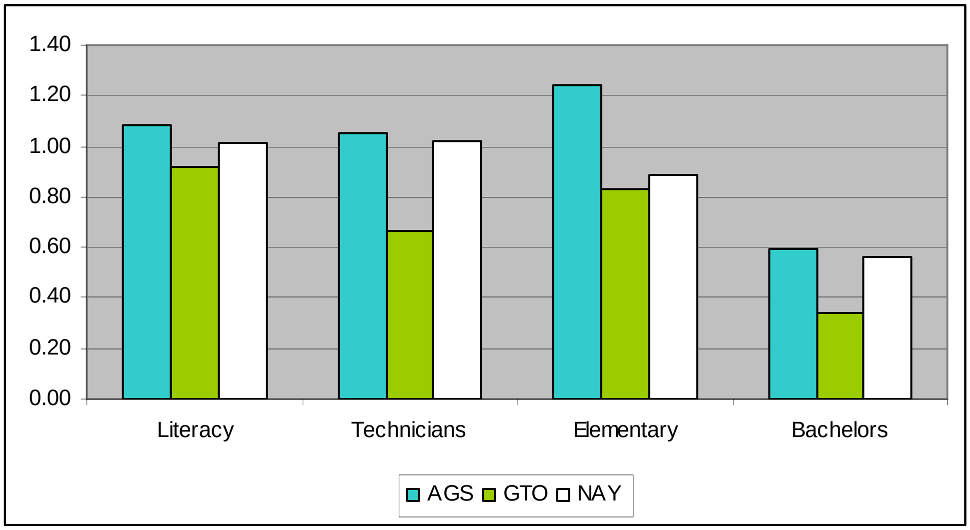
Aguascalientes in 1980 was above the national mean in almost all indicators in my dataset. The only exception was the share of bachelor's degrees (rank #17 out of 32). Its rankings are very high for infrastructure (#1 in highways and water access) and above the mean in literacy (#10). Guanajuato also had relatively high levels of infrastructure (#10 in highway density and #7 in water) but low levels of human capital (#25 in literacy and #28 in bachelor's degrees). Finally, Nayarit had relatively low levels of infrastructure (#22 in highway density and #15 in water) but was closer to Aguascalientes in that it had medium levels of education (#16 in literacy and #18 in bachelor's degrees). Figure 23 and Figure 24 show a comparison of the states in terms of infrastructure and human capital relative to the national mean.

Figure 23: Levels of infrastructure relative to national mean in 1980



Source: Data are from INEGI. Share of total households with direct access to the water network and highway density.

Figure 24: Levels of human capital relative to the national mean in 1980



Data are from INEGI. Share of population that is literate and share of population with a four-year bachelor's degree.

In addition to their accordance with the selection criteria, these states also make an interesting comparison because their industrial composition in 1980 was very similar to each other, and also similar to that of the country. The coefficients of specialization for the three states' GDP are each less than 0.2. The states' industrial diversification is corroborated by the fact that their Herfindahl Index (0.17) is very close to the minimum possible value obtainable (0.10), implying that, in general, their output is evenly distributed across industries. Table 29 shows the location quotients of each state's GDP in 1980, relative to national GDP, by economic sectors and manufacturing industries. A value higher than 1.0 reflects a higher concentration of output in that sector relative to the national economy. Table 29 also shows the similar composition of the three states' economies in terms of location quotients. For example, the three cases were in 1980 relatively more specialized in the primary industries—agriculture, forestry, and fishing—than in the rest of the industries. However, Nayarit's specialization was much higher (with a value close to 3) than Aguascalientes (1.6) and Guanajuato (2). The other two main differences across the three cases are that (a) Guanajuato had a relatively high concentration in the electricity, gas, and water industry (with a location quotient of 1.4) and that (b) Aguascalientes had a relatively high concentration in the transportation, storing, and communications industry (with a location quotient of 1.2). However, despite these differences, the states had a similar overall industrial composition.

Table 29: Location quotients of Gross Domestic Product by economic sectors and manufacturing industries in 1980

	AGS	GTO	NAY
Economic Sectors			
I. Agriculture, forestry and fishing	1.57	2.04	2.92
II. Mining	0.15	0.36	0.06
III. Manufacturing	0.66	0.77	0.82
IV. Construction	1.30	0.93	1.10
V. Electricity, gas and water	0.62	1.41	0.47
VI. Commerce, restaurant and hotel	1.26	1.19	0.84
VII. Transportation, storing and communications	1.24	0.73	0.82
VIII. Financial and insurance services, real estate	1.14	1.27	1.17
IX. Community, social and personal services	0.92	0.79	0.88
Manufacturing Industries			
1. Food, beverage and tobacco	2.34	1.00	3.61
2. Textiles	1.62	2.21	0.30
3. Wood and wood products	0.32	0.25	1.36
4. Paper, printing and editing	0.16	0.21	0.04
5. Chemical, oil and plastics	0.08	1.80	0.07
6. Mineral non metallic products	0.63	0.80	0.15
7. Basic metallic industry	0.01	0.03	0.00
8. Metal, machinery and equipment	0.73	0.32	0.05
9. Other manufacturing industries	0.06	0.27	0.11

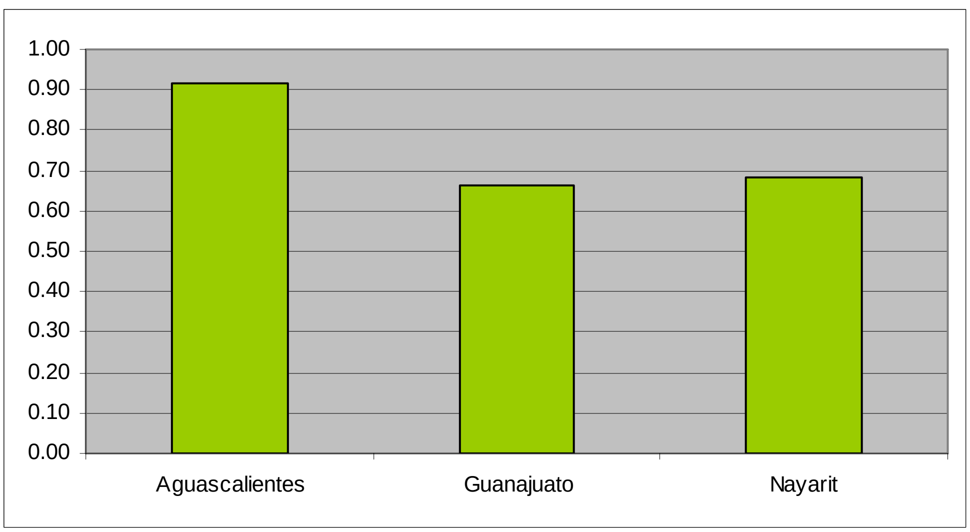
Source: INEGI, National Accounts System. The sectors are: I. Agriculture, forestry and fishing; II. Mining; III. Manufacturing; IV. Construction; V. Electricity, gas and water; VI. Commerce, restaurant and hotel; VII. Transportation, storing and communications; VIII. Financial and insurance services, real estate; IX. Community, social and personal services. The manufacturing industries are: 1. Food, beverage and tobacco; 2. Textiles; 3. Wood and wood products; 4. Paper, printing and editing; 5. Chemical, oil and plastics; 6. Mineral non metallic products (excluding non oil products); 7. Basic metallic industry; 8. Metal, machinery and equipment; 9. Other manufacturing industries.

The composition of the manufacturing industries across the three cases shows a more diverse picture. Table 29 also shows the states' relative concentration of GDP in manufacturing industries with respect to the national economy in 1980. Nayarit and Aguascalientes had a very high concentration in the food, beverage, and tobacco industry, with GDP location quotients of 3.6 and 2.3 respectively. Guanajuato and Aguascalientes also had a relative concentration in textiles manufacturing, with location quotients of 2.21

and 1.62 respectively. Finally, Guanajuato had a concentration in the chemical, oil, and plastics industry (1.80), and Nayarit in the wood and wood products industry (1.36).

Finally, the income levels of the three cases compared to the national mean in 1980 are shown in Figure 25. Aguascalientes had a higher level of GDP per capita (rank #12) than Nayarit (#22) and Guanajuato (#23). However, all three were within one standard deviation of the mean.

Figure 25: GDP per capita relative to the national mean in 1980

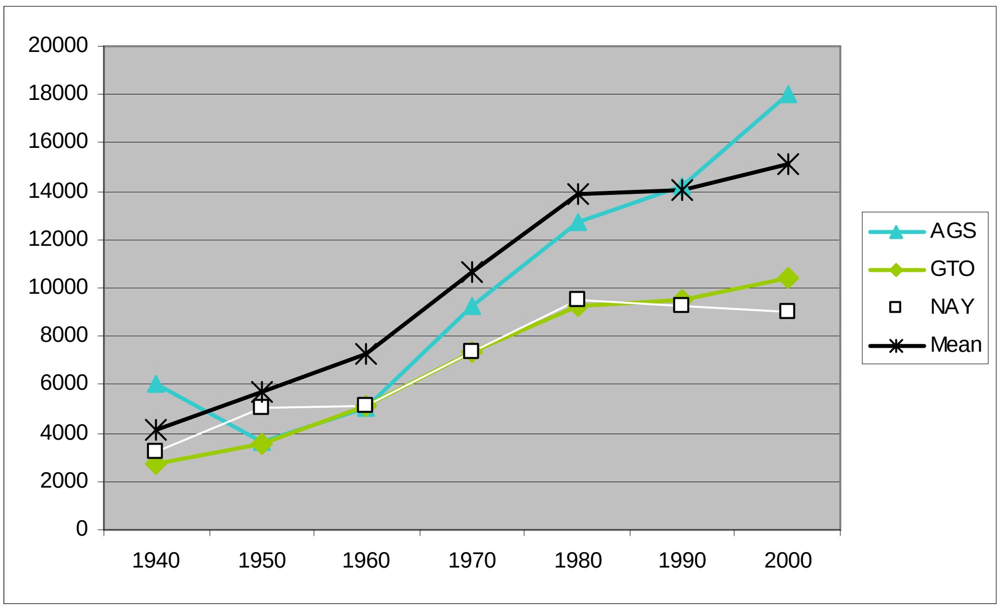


Source: Data are from Esquivel, 1998.

6.3 Comparison of the economic growth across cases

Figure 26 shows the evolution of the three states' per capita GDP, as well as the mean per capita GDP of the all states. It is interesting to note that the trends of the three states are pretty similar until 1970, when Aguascalientes increases its level rapidly. Since 1990, Aguascalientes is above the mean of all states, and the level of Nayarit has decreased slightly.

Figure 26: State per capita GDP in constant 1993 pesos



Source: Data from Esquivel, 1999, author's calculations.

6.3.1 The impact of infrastructure in Aguascalientes and Nayarit

This section describes the development of Aguascalientes and Nayarit, focusing on the role of infrastructure. The two states have had a very different development process and different levels of infrastructure endowment for a long time. In fact, one of the clear advantages that Aguascalientes has had is its access to transportation networks since the colonial period. This is in stark contrast to Nayarit, which only had access to the railroad since the late 1920s. Thus, this section emphasizes the large differences in their development processes and the role of infrastructure.

Aguascalientes constitutes a successful case of rapid industrialization. During the 1980s Aguascalientes experienced an important economic transformation, from being a predominantly agricultural economy to one based on manufacturing and services industries (Decuir, 2005, Henández Romo, 2003, Camacho Sandoval, 2002 and 2000, Díaz Flores, 2003, Gutierrez Castorena et al, 1999, Aguilar, 1990). The economic transformation of Aguascalientes is in fact related to the transformation the country experienced in the early 1980s, originating in the crisis of the import substitution model and being mainly based on manufacturing growth as well as the participation of foreign capital and trade openness. The country's market-oriented government emphasized the promotion of the export sector and the attraction of national and international companies. Decentralization of industry was an important part of the strategy, and Aguascalientes had some of the characteristics that were attractive to investors looking for new locations: a weak labor tradition; a location near Mexico City, Guadalajara, Nuevo León, and on the way to the USA from Mexico City; and great access to transport and communication networks (Rojas Serrano, et al, 1994).

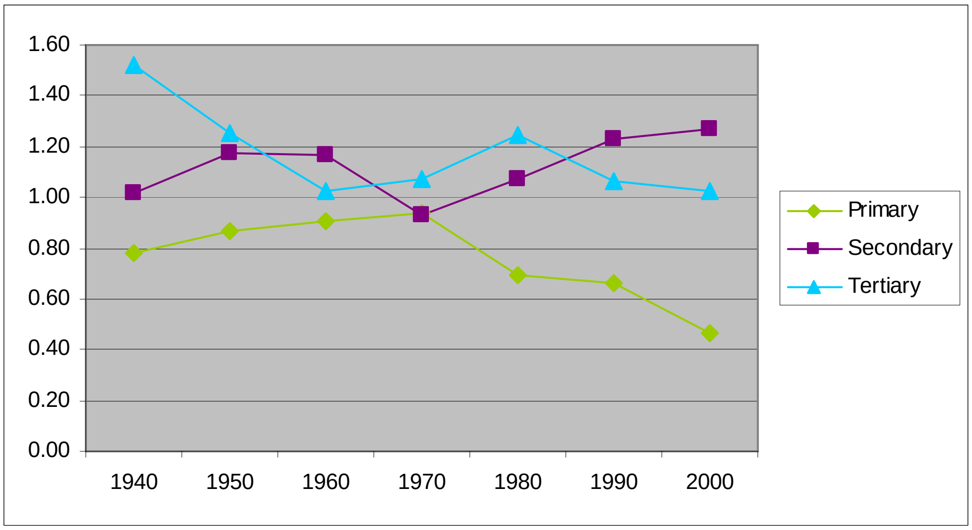
In fact, an analysis of the federal industry decentralization program argues that Aguascalientes' high level of infrastructure originated in the colonial period, due to its proximity to the main mining centers (Zacatecas and Guanajuato), and this early advantage gave a boost to the local commercial and textile industries. After independence, during the country's first wave of industrial development, economic activities prospered because of the development of the railway, which brought the establishment of one of the major steel corporations of the country in the late 1890s (Aguilar, 1990). Other economic activities (non-agricultural) in the state have their roots in 1898 when the National Railroad Repair Center was established (Aguilar, 1990). Local industrial and commercial activities were further spurred when the highway network reached Aguascalientes in 1945.

Therefore, early access to infrastructure was a fundamental factor in the development of local commercial and textile activities in the state. The expansion of the main highway network during the 1970s allowed the state to attract large firms that were key to the promotion of industrial activity in the state. For example, in the period of 1987 to 1990, 24 large firms located in the state (Decuir, 2005). However, the state's infrastructure advantage was not limited to transportation. By the end of the 1990s, Aguascalientes had seven industrial parks with service availability (Gutierrez Castorena et. al 1999). In fact, Aguilar (1990) argues in his analysis of the program of Mexican industrial decentralization that Aguascalientes was one of the main receivers of new firms, and one decisive factor was the availability of infrastructure endowments like access to main transportation networks and industrial park services.[62] As part of the infrastructure provision for industry, the state provides incentives to make such infrastructure easy to access, such as fiscal and financial incentives to buy property in the industrial parks, a straightforward process to obtain construction licenses, and substantially diminished red tape for registering property and contracting water and electricity services (World Bank, 2007). In a World Bank study of the ease of doing business in the different states in Mexico, the World Bank found that the top state was Aguascalientes, and the reason was its provision of infrastructure and services. In this sense, it has not only been the availability of infrastructure that has attracted industry to Aguascalientes, but also the services that complement it.

Figures Figure 27 and Figure 28 demonstrate how successful Aguascalientes was in attracting secondary and industries. Figure 27 shows the evolution of the share of Aguascalientes' labor employed in the primary, secondary, and tertiary sectors, relative to the national mean. It is clear that since 1970, Aguascalientes' secondary sector has maintained a trend above the national mean.

[62] Aguilar's (1990) main findings in his evaluation of the industrial decentralization program were that most firms relocated near the main centers, especially the industrial parks outside Mexico City. However, Aguascalientes was one of the main locations of new firms.

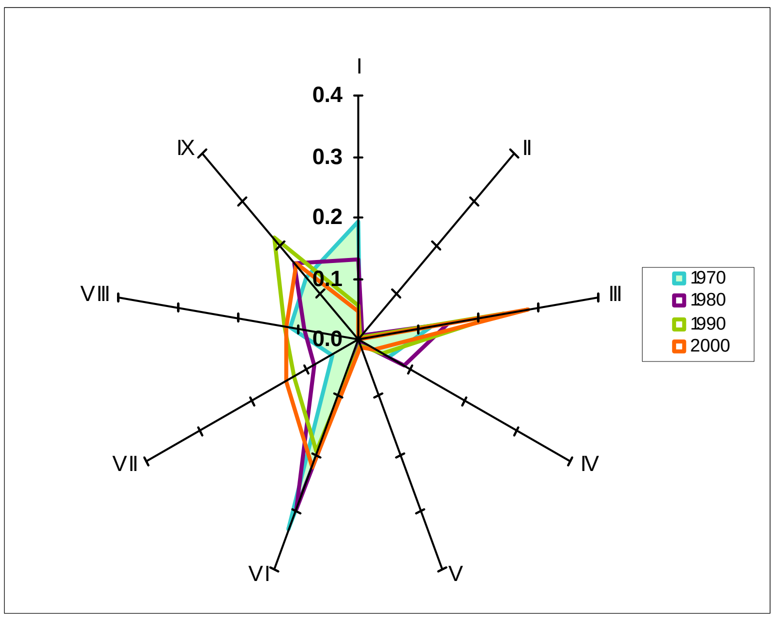
Figure 27: Evolution of share of labor employed by economic sectors in Aguascalientes, relative to the national mean



Data are from INEGI, Population Censuses, various years. The primary sector consists of agriculture, livestock, forestry, fishing, and hunting. The secondary sector is composed of mining, manufacturing, electricity, water, construction, and extractive industries like oil and gas. Finally the tertiary sector constitutes an array of service industries, like commerce, transport, communication, storage, financial and insurance services, hotels, restaurants, personal and maintenance services, and government activities like public administration and defense.

A more disaggregated look at the state economy is shown in Figure 28, which shows the changes of GDP by industry from 1970 to 2000. Consistent with Figure 27, the largest change takes place in the agriculture and forestry sector (I), as its contribution to total state GDP declines from 19 to 5 percent over the period. Similarly, the commerce, restaurant, and hotel industry (VI) loses 11 percentage points. The industries that increase their share of the state GDP substantially are manufacturing (III), gaining 16 percentage points, and transportation, storage, and communications (VII), gaining 9 percentage points. Camacho Sandoval (2002) and Aguilar (1990) argue that the rapid decline in the agricultural sector was a result of the determined efforts of the state government to reorient the economy into other sectors. This is not surprising given that Aguascalientes does not have the natural conditions to house a competitive agricultural sector compared to other states in the country. It is one of the smallest states, constituting only 0.28 percent of the national territory, and 70 percent of its territory is semi-desert land and thus has limited availability of water with which to sustain a large agricultural sector.[63]

Figure 28: Industrial composition of Aguascalientes' GDP



Note: Numbers correspond to industries as detailed in Table 29 Source: INEGI, National Accounts System.

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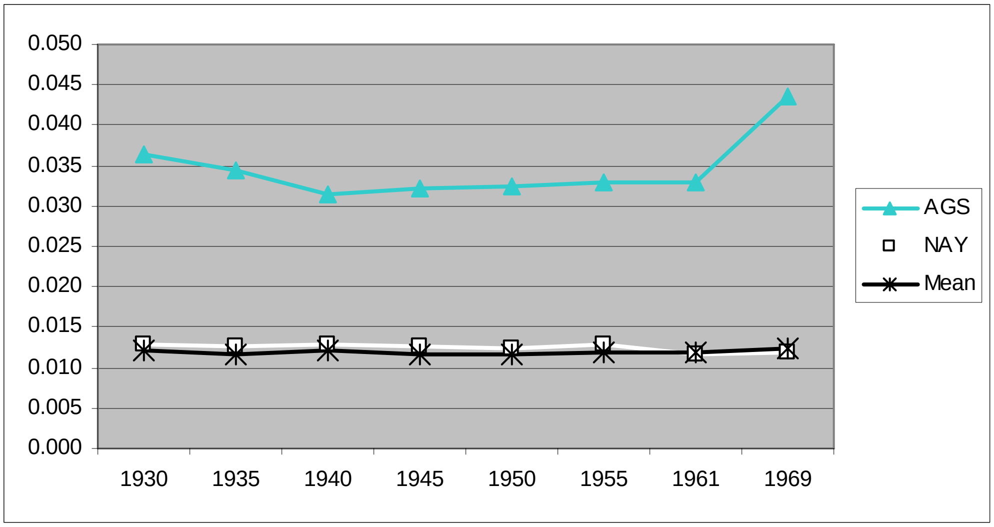
[63] In fact, earlier increases in the industrial activities vis-à-vis the agricultural sector decline are related to severe droughts. For example, in 1940 the economy of Aguascalientes experienced a relatively rapid increase of industrial activities due to the decline of the agricultural sector in a severe drought (Camacho Sandoval, 2002).

While infrastructure seems to have been essential to Aguascalientes' development path, the same might be said of Nayarit's *lack* of infrastructure. Nayarit has had a disadvantage in infrastructure since the construction of the railroads during the dictatorship of Porfirio Diaz (which lasted for the last three decades of the 1800s and until the Revolution of 1910). Railroad development was done mainly through foreign direct investment from American and British companies (and later with Mexican ones), and as such the railway network's main objective was to connect Mexican mining centers to the USA and European markets.[64] Although Nayarit had some mining during the colonial times, it was not substantial relative to other mining centers. Because of this, the railway network expanded to the state only until 1928 (Meyer 1997), whereas in Aguascalientes it dates to the colonial times. Figure 29 shows that Aguascalientes has kept this advantage. The figure shows that the relative density of the rail networks from 1930 to 1960 was in general unchanged; however, Aguascalientes was for the entire period well above the mean while Nayarit was right at the mean. Moreover, since 1961, Aguascalientes rail density increased significantly, whereas Nayarit's remained the same.

[64] The first line to be completed was from Mexico City to the Port of Veracruz in the Gulf Coast (the main port for trade with Europe). The second was the line that connected Mexico City to the northern border to the USA, through the main mining centers of the country in the center north. In this sense the railroad network exacerbated existing differences across regions, as instead of connecting the country it mainly served to connect export markets (Bassols, 1979). See Map 1 in Appendix.

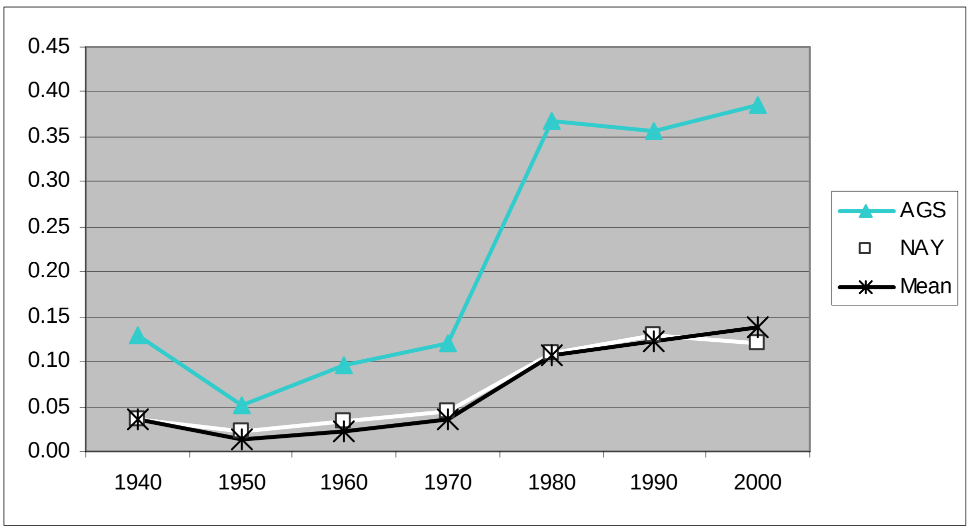
Figure 29: Evolution of the rail network density, Aguascalientes vs. Nayarit



Source: Data from INEGI, Anuarios Estadísticos de los Estados Unidos Mexicanos.

This early shortcoming in railroads has been accentuated by (and has perhaps even contributed to) the state's lack of other kinds of infrastructure. For example, even though it has a coast line, Nayarit's one port (San Blas) has only become important recently, and it is still modest compared to other ports in the Pacific Coast of neighboring states, like Manzanillo in neighboring Colima and Culiacan in neighboring Sinaloa. In sum, although there are current efforts in expanding infrastructure in Nayarit, the historical limited access to early transportation networks contrasts Aguascalientes historical advantage. In addition, although the highway network reached the state at the same time that it reached Aguascalientes (during the late 1950s), it had far more limited coverage in Nayarit, as shown in Figure 30. This was not only because the state is larger in absolute terms (Nayarit's territory is close to five times that of Aguascalientes) but also because its population is smaller, resulting in a much lower population density.[65] This makes serving the state fully with highways more difficult. The state has also been slow to develop irrigation, airport infrastructure, and even electricity. An important study thirty years ago found this lack of infrastructure to be a major obstacle to the development of the state (IEPES, 1975), and the same seems to be true even today.[66]

Figure 30: Evolution of highway density Aguascalientes vs. Nayarit



Source: INEGI, Anuarios Estadísticos de los Estados Unidos Mexicanos.

This overall lack of infrastructure resulted in the slow (or even lack of) industrial development of the state, reflected in its high dependency on primary sector activities until

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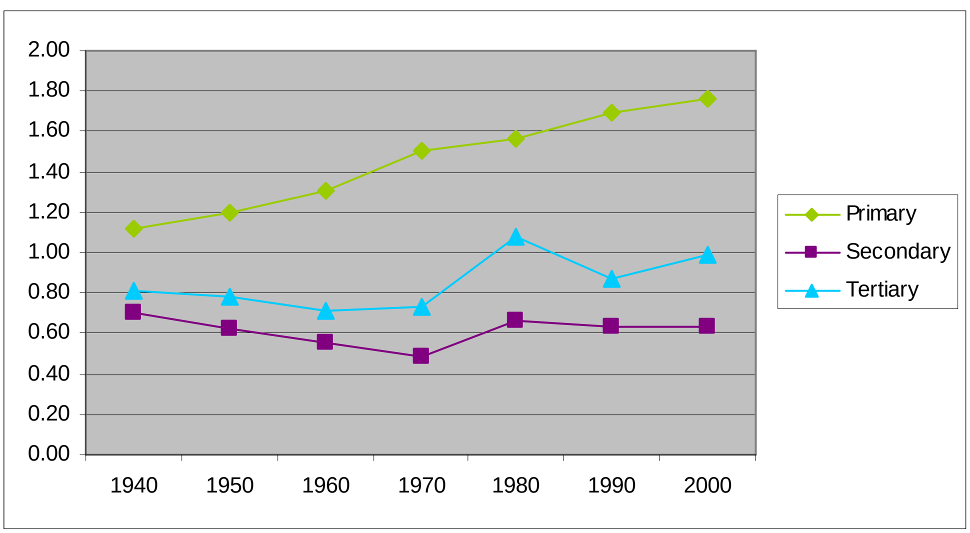
[65] Nayarit represented below one percent of the total population of the country in 2004 (which is less than that of Aguascalientes).

[66] In fact, the governor recently complained about the poor conditions of a section of one of the major highways in the state, connecting the San Blas port (Notimex, 2007).

relatively recently.[67] Figure 31 presents the evolution of the share of labor employed by economic sectors in Nayarit, showing that in 1990 a large share of the labor force was still employed in the primary sector (close to three times that of Aguascalientes and well above the mean). In terms of the secondary sector, Nayarit's share of labor is well below the mean throughout the period and roughly half that of Aguascalientes in 2000. However, for the tertiary sector, the state's share is close to the mean and that of Aguascalientes. The tertiary sector activities mainly refer to wholesale and retail trade of food, beverage and tobacco products, hotel and restaurant services and automobile repair services.

Figure 31: Evolution of the share of labor employed by economic sector for Nayarit, relative to the national mean

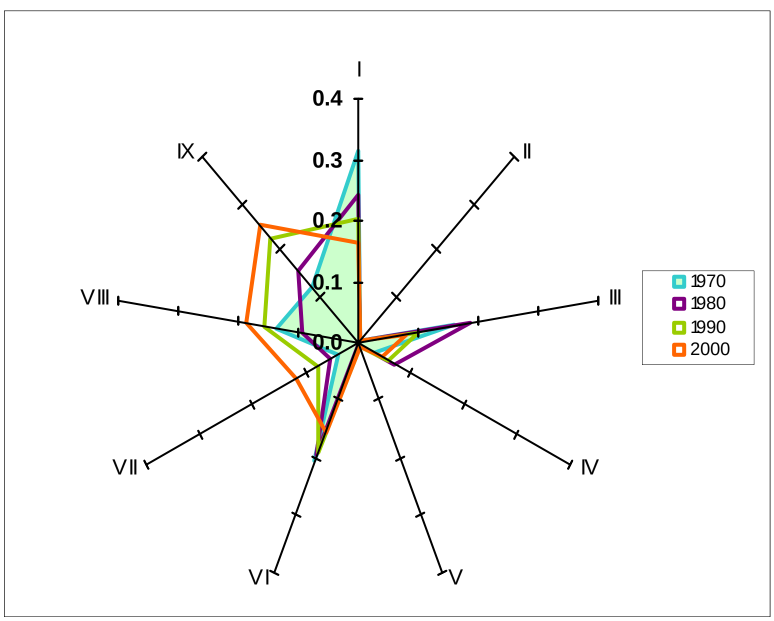


[67] The state government is currently, in addition to expanding and improving highway networks, supporting agricultural firms in the food processing stage, aiming at increasing added value to basic primary activities.

Source: Data are from INEGI, Population Censuses, various years. The composition of each sector detailed in Table 29.

In terms of the evolution of the state's GDP by economic sectors, Figure 32 shows that the service industries have increased their share of state GDP since 1970. Community, social, and personal services experienced the largest increase over the period of 1970 to 2000, from 12 percent to 25. The other service activities that also increased their share of GDP are transportation, storage, and communication (from 3 to 12 percent) and financial, insurance, and real state services (from 14 to 19 percent). It is interesting to note that not only did the primary sector experience a decrease in its contribution to state GDP (from 31 to 17 percent) but so did the manufacturing industry, from 16 to 8 percent.

Figure 32: Industrial composition of Nayarit's GDP



Note: Numbers correspond to industries as detailed in Table 29. Source: INEGI, National Accounts System.

The diversity of the manufacturing composition of the state is limited, as most of its manufacturing GDP is composed of one industry: food, beverage, and tobacco. In 1970, this industry contributed 87 percent of manufacturing GDP, and although it decreased slightly to 81 percent in 2000, it remains by far the main manufacturing industry in the state. Other manufacturing industries in the state are increasing their contribution to manufacturing GDP, like wood and wood related products and metal, machinery, and equipment (see Figure 33). It is interesting to note that Nayarit's growing manufacturing industries are related to agricultural sector activities, like food processing (agribusinesses are the main exporting firms of the state) and wood and wood products industry. The only other (non-natural resource based) industry that has grown recently is the metal, machinery, and equipment industry, referring mainly to the production of metal structures production and blacksmith products.[68] The growth of these activities is closely related to the construction activities driven by tourism in the southern coast of the state (Nayarit's Government, 2005, p. 18).[69]

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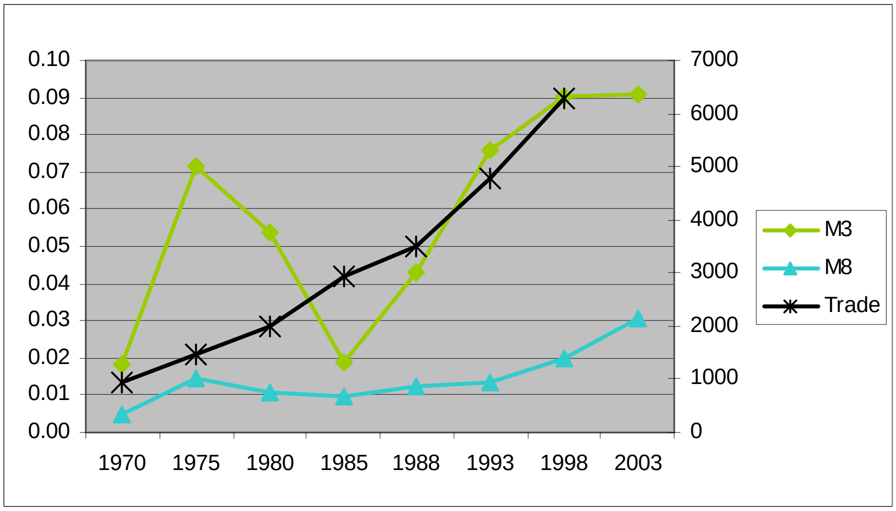
[68] The metal, machinery and equipment industry is the fastest growing in the country, but as opposed to the case in Nayarit, it due mainly to the growth of automotive and auto parts industry.

[69] In fact, 97 percent of all foreign direct investment that Nayarit receives is in tourism activities, whereas Aguascalientes' 93 percent of FDI is in manufacturing industries, mainly the auto and auto-parts industry (INEGI, 2007).

Figure 33: Evolution of various manufacturing industries in Nayarit



Source: INEGI, National Accounts System. Trade is measured on the right axis.

One of the main challenges for Nayarit and its incipient industrial activity is still its limited infrastructure (SEDECO, 2007). The agricultural sector expansion during the 1960s and 1970s was severely restricted by the limited transportation networks to distribute products to other states and externally. It was not until 1989 that a dam project was established. There continues to be a need in the state for productive infrastructure to support efficiency in the agricultural sector, like irrigation and electricity as well as telecommunication infrastructure that allows agribusinesses (food processing plants) to link their productive process in time to other processes in other states (for example, mango pulp might be used in a different food processing industry in nearby states like Jalisco and Sinaloa). The state is focusing its infrastructure efforts on increasing its connection with other states (mainly to distribute agricultural products and processed food to the national market and abroad) as well as making inputs like oil, cement, and fertilizers less costly. Another main area on which the government is focusing is tourism, aiming at incorporating the southern coasts of the state with the Pacific tourist development that starts in Jalisco and goes all the way north to Baja California. Thus, the state's needs also include highways and railroad networks that enable the distribution of agricultural products and food processed goods, as well as allow tourism transit in an efficient, low-cost, and safe manner.

The difference between the development experiences of Aguascalientes and Nayarit therefore seems closely linked to the difference in their infrastructure levels. Aguascalientes had a historical advantage in terms of early access to transportation network, and this helped lead to a rapid industrialization of the state. In contrast, Nayarit's limited infrastructure access prevented the economy from establishing links to the national economy and developing local industries. Their experiences also provide evidence of one of the principal implications of the increasing returns to scale argument regarding infrastructure, in the sense that both states exhibit a path-dependent development process. The state with an early advantage in infrastructure continues to do better, while the state with late access to infrastructure has been slow to catch up. This is also reflected by their different levels of participation in international markets. For example, Aguascalientes trade openness in 2002 (i.e. exports plus imports relative to state GDP) is roughly 32 times that of

Nayarit, as Table 30 shows.[70] Moreover, as the trade openness increases, infrastructure becomes more relevant as a development factor of regions in order to reach national and international markets. In the case of Nayarit, although the emphasis has been on expanding the highway and rail networks in order to transport agricultural products to neighboring states and international markets, a common concern expressed in interviews with industry associations at the national level was that in order to keep expanding trade with the Asia-Pacific region, Mexico needs to expand the transportation network that runs west to east. The main emphasis in the past has been given to the north-south corridors (given that trade relations have been dominated by trade with the US). Thus, Nayarit's San Blas Port on the Pacific can play a key role. However, the challenge is not only related to simply expanding transportation networks, but also improving its quality and coverage as well as investing in complementary infrastructure services, like the paper work to establish basic services, improve the capacity for logistics, trade administration, and security.[71]

[70] Disaggregated data on Nayarit's exports and imports by sectors and industries, even for current years is not available.

[71] For example, there are bottlenecks on some routes, specifically at the border crossing and around major urban centers.

Table 30: Comparison of trade openness levels of Aguascalientes vs. Nayarit

	Aguascalientes	Nayarit
Exports	2,161,809.00	41,644.00
Imports	2,292,681.00	14,909.00
State GDP	8,164,065.0	3,324,904.9
Trade openness	0.55	0.02

Source: Secretariat of Economy, 2007. Exports and Imports in thousand US 2002 current dollars and State GDP in thousand 2001 current dollars.

6.3.2 The impact of human capital in Aguascalientes and Guanajuato

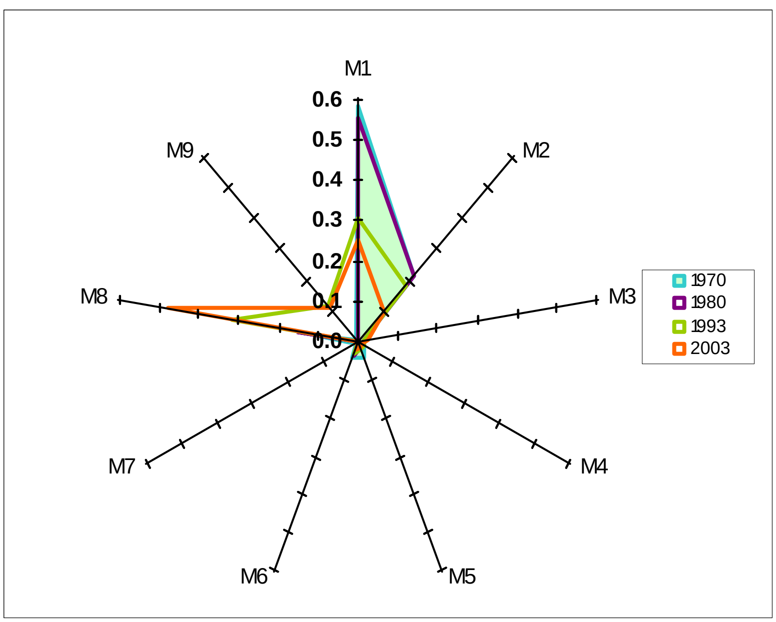
In this section I discuss the role of human capital in the development of Aguascalientes and Guanajuato. As will be explained below, the case studies provide some reasons why the results for education in the statistical analyses are often unclear. Human capital's role has not been as clear as infrastructure's in terms of the growth of industries in the different states.

As detailed in the previous section, Aguascalientes has experienced rapid manufacturing growth since the early 1980s, when the trade regime in Mexico changed. However, this growth can be divided into two phases. The first phase was characterized by an influx of firms attracted to various aspects of Aguascalientes. The second phase, after the country's economic crisis of the 1990s, was characterized by the modernization of these firms. As I discuss here, education seems to have been much more important in this second phase.

Aguascalientes's manufacturing growth in the early period of trade openness was driven by its attractiveness to firms. In addition to the availability of infrastructure discussed above, Gutierrez Castorena et al. (1999) argue that labor conditions were key in attracting and maintaining firms in Aguascalientes during the 1980s. Migration of labor to the state since the 1970s allowed the productive plants to keep growing without facing labor shortages. In addition, the state wage policy was quite beneficial to firms, keeping salaries low. This was possible, among other reasons, because the state lacked the tradition of independent unions, which made labor relations subdue their interests to the firms' interests. High levels of human capital are not in general discussed as a major factor for attracting firms during the industrial boom of the 1980s.

However, with the economic crisis of the 1990s and increasing exposure to international competition (particularly with NAFTA), firms in Aguascalientes saw the need to modernize and diversify. Although manufacturing industries like textiles had existed in Aguascalientes for a long time by the beginning of the 1980s, they were generally operating with more traditional productive methods. After the economic crisis in Mexico in the 1990s, according to Romo (2003), industrial plants underwent a modernization process that allowed them to keep growing. As shown in Figure 34, this modernization coincided with a change in the composition of the state's industry, as traditional manufacturing industries lost importance in the state's economy and more capital intensive industries gained importance. The largest loser was the food, beverage, and tobacco industries (M1) which went from contributing almost 60 percent of total state GDP in 1970 to 25 percent in 2003. Also, the textiles industry lost 11 percentage points from 21 to 10 percent. However, the metal, machinery, and equipment sector gained 38 percentage points (mainly due to production of auto and auto-parts industry, electronic components, and computer equipment) and the activities aggregated in other manufacturing industries (M9) gained 11 percentage points.

Figure 34: Manufacturing composition of Aguascalientes' GDP



Source: INEGI, National Accounts System. Numbers correspond to industries as detailed in Table 29.

As firms modernized, education rose to new prominence. Firms implemented different production and administrative systems, characterized by being more based on technology and as a consequence requiring higher skilled labor force. The common firm response was to implement training programs and to hire higher skilled labor (Gutierrez Castorena et al. 1999). This was especially true for the high tech industries that the state hosts, such as the electronics industry, which require more skilled workers like engineers and computer scientists (Mendoza Aguilar, 2006). In a special report on Aguascalientes, Mendoza Aguilar (2006) reports an interview with the director of Nissan in which the director states that the need for more skilled labor became so apparent for the industry that the state agreed to cover 30% of the training expenses of the new institute that the auto-plant established in 2000. In fact, this is just one example of how state industrial policies changed with the modernization of firms. According to Decuir (2005), during the period before 1986, the state government strategy for industrial promotion was limited to providing good infrastructure for urban and industrial sectors and its accompanying services (as discussed above). However, during the 1990s, the government put more emphasis on establishing external commercial links and creating institutions of education and research.

In sum, the increased competition that resulted from trade openness has led to an increased need for higher skilled labor in Aguascalientes, and firms and the state have implemented training programs as a result. Rather than being a factor that attracted industry to the state, the importance of human capital has been relevant for industries already in the state and in the context of competition resulting from trade openness.[72]

As mentioned above, the recent dynamism of the Aguascalientes economy has not in general been shared by the economy of Guanajuato. This is a marked change from the period prior to the 1980s, when they had fairly similar economic trajectories. Guanajuato and Aguascalientes have had similar development histories since their industrial development began in the colonial period. Guanajuato was one of the most important mining centers while Aguascalientes was close to a mining center and benefited from its growth. Like Aguascalientes, Guanajuato is located near major urban centers of the country and has had access to major transportation networks. As a result of the growth in the mining and agricultural industries, local activities like textiles (cotton and wool) and commerce flourished (again, similar to Aguascalientes). The two states even have had a

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[72] In the interviews with industry associations at the national level, there was a consistent perception that NAFTA and the new trade regime in general demanded new skills for the labor force. These new skills included specialized training in quality production, the need to speak English, administration, and specialization in areas such as exporting process and product quality design. In an interview, the Director of a national vocational training center (CONALEP) explained that they had modified their content in 1994 and emphasized the quality of education, which was certified according to international standards (ISA 9001). This change took place across the country, as part of a federal program of labor training. In addition, in 2005, two administrative professional programs were opened—accountancy and administration—because of the needs of industries. Therefore, there seems to be a rising demand for specific skills as firms start to export.

fairly similar industrial composition, as Figure 3 showed above. However, as discussed in this section, a major difference between them has always been their human capital level, and it is possible that this difference accounts for the disparity in their economic performance under an open trade regime.

As noted by Camacho Sandoval (2004), given its economic performance and the size of its economy (ranking 8th on its share of total GDP in 2004), Guanajuato's lag in its overall development level in social dimensions is somewhat surprising.[73] Figure 35 and Figure 36 compare the levels of human capital in Guanajuato, Aguascalientes, and the country as a whole—Guanajuato's levels have been low since 1940.[74] However, Guanajuato's industrialization prior to 1980 does not seem to have required higher levels, probably because of the industries which drove it. Before 1970 Guanajuato experienced the creation of industries related to the oil sector (like chemical and petrochemical industries) and the consolidation of the food processing and textiles industries.[75] Since 1970, the metal,

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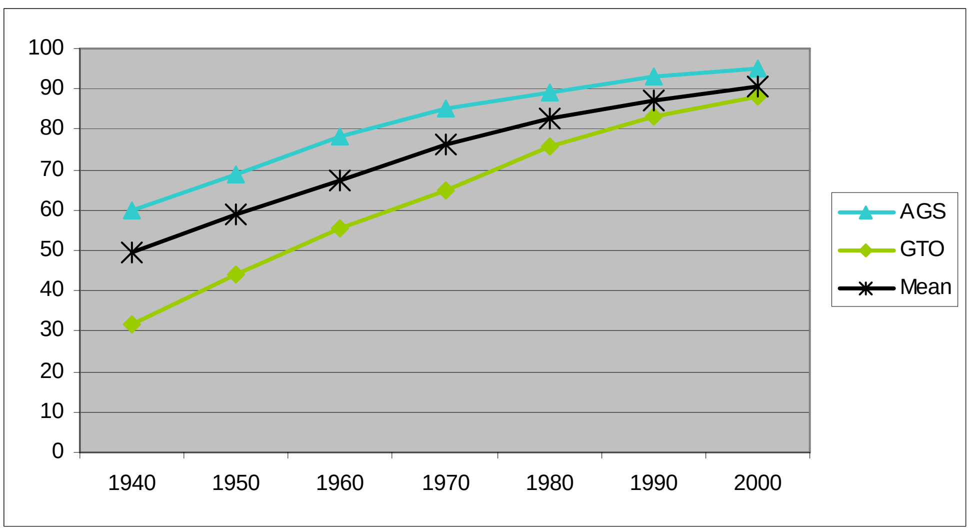
[73] Guanajuato houses a part of the industrial corridor that runs from Mexico City to Guadalajara, two main urban centers of the country.

[74] Of course human capital is not the only difference between Guanajuato and Aguascalientes. Other important differences include the size and availability of natural resources, and the size of the states. Guanajuato is a much larger state, with an area that represents 5.5 times the area of Aguascalientes and has population five times that of Aguascalientes in 2005 (4.8 share of total population of the country).

[75] In 1950 an oil refinery of the federal government company, Pemex, was established in Salamanca, one of the medium size cities of the state. In 1968, a thermoelectric plant was also established there,

machinery, and equipment industry has increased its share of Guanajuato's GDP by 37 percentage points (from 4 percent in 1970 to 40 percent in 2000), largely because of an increase in the production of automobiles and auto parts (reflected in Figure 37). This is the same trend that Aguascalientes experienced. Given the differences between Aguascalientes and Guanajuato in education, it does not seem that education was an important factor in these various industries.

Figure 35: Comparison of levels of literacy, Aguascalientes vs. Guanajuato



Source: INEGI, Population Censuses, various years.

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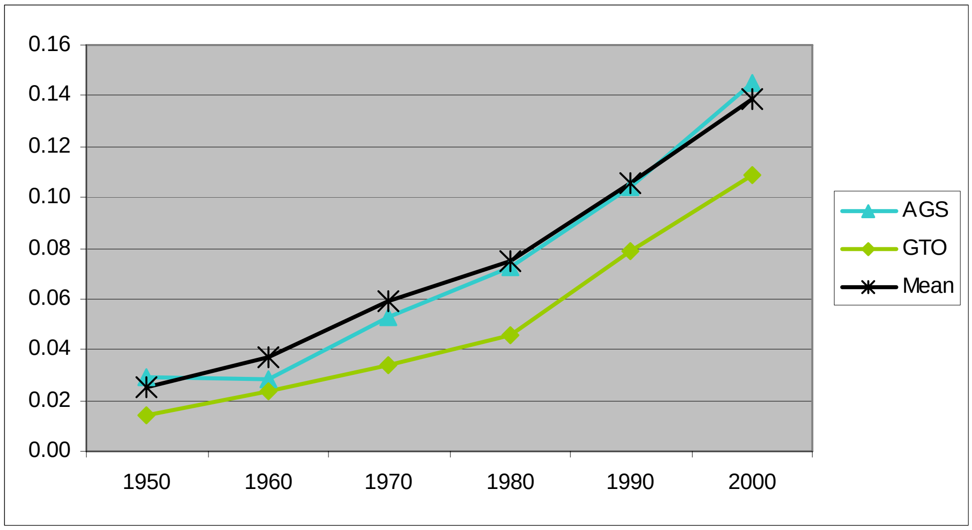
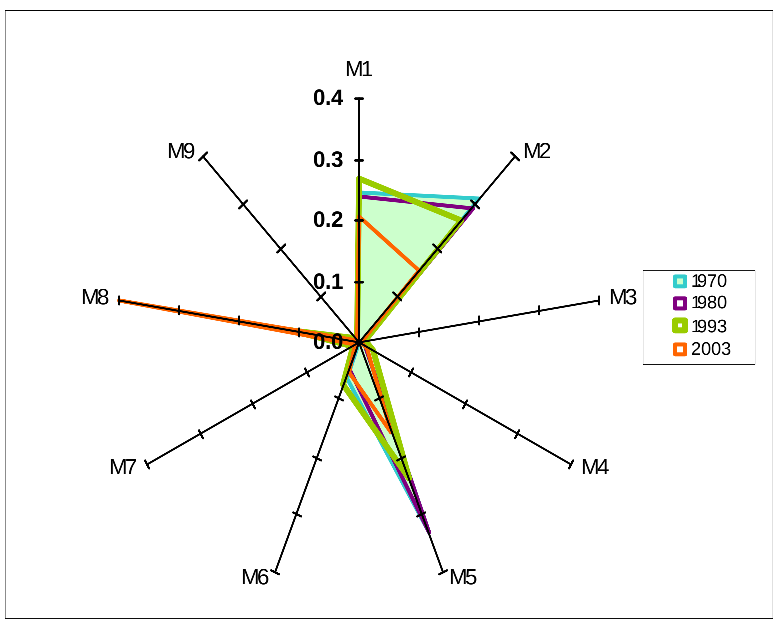
consolidating the new modern chemical and petrochemical industries in the state (Blanco, et. al. 2000).

Figure 36: Comparison of the share of technicians of total labor force, Aguascalientes vs. Guanajuato



Source: INEGI, Population Censuses, various years.

Figure 37: Manufacturing composition of Guanajuato's GDP

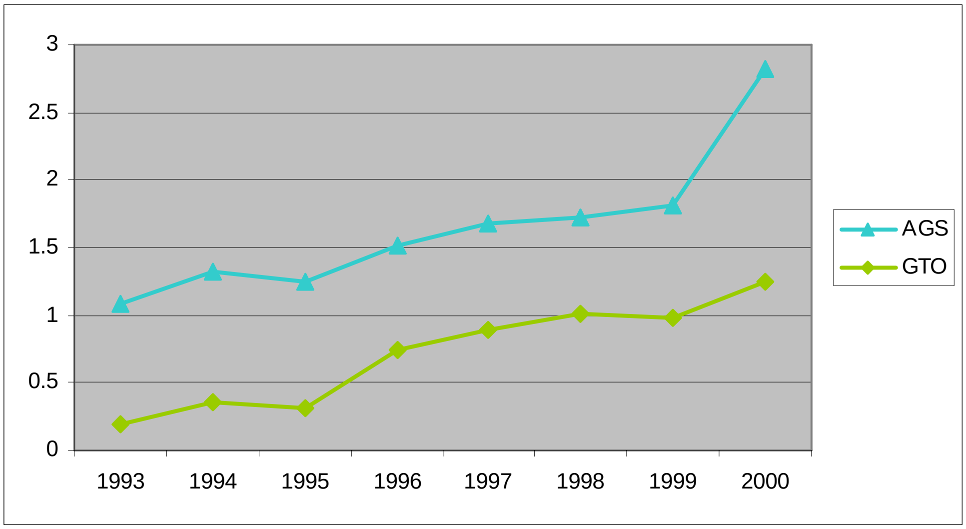


Source: INEGI, National Accounts System. Numbers correspond to industries as detailed in Table 29.

However, the fact that Aguascalientes has outperformed Guanajuato recently may be an indication that the role of human capital has increased with trade openness. In fact, when comparing the performance of manufacturing industries in both states, three trends are clear. The first is that the industries common to both states have generally performed better in Aguascalientes than Guanajuato since the 1980s.[76] This is especially true for the food processing, textiles, and wood and wood products industries (and also non-manufacturing industries like the utilities industry and all the service industries). The second trend is that the industries that only Guanajuato has, like the oil related industries (chemical, oil and plastics, mineral products) and the basic metallic industry, are growing slowly or not at all. Finally, the third trend is that Aguascalientes has been able to diversify recently into certain new industries (within the metal, machinery and equipment sector and into other manufacturing industries), much better than Guanajuato, as shown in Figure 38 and Figure 39.

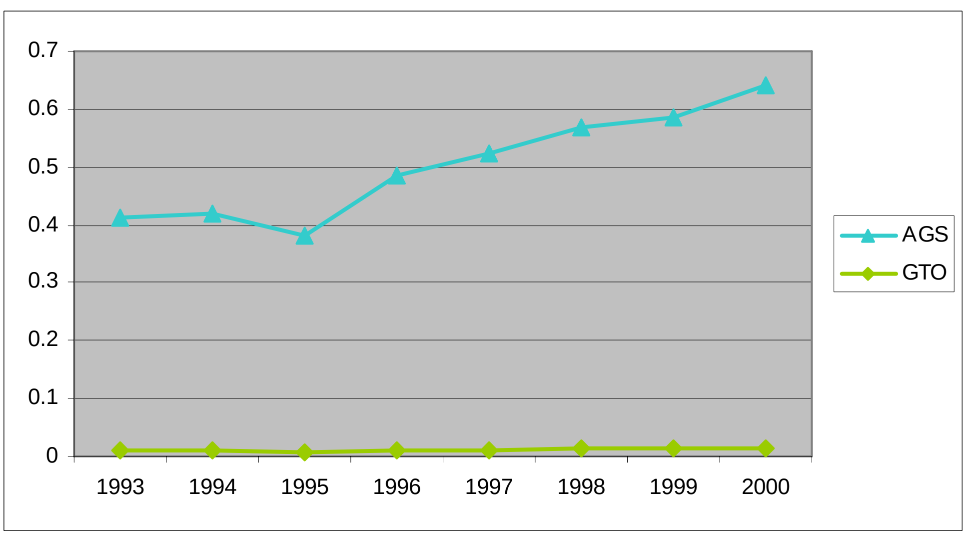
[76] The only exception is the paper, printing, and editing industry, in which both states are very similar in terms of levels and trend.

Figure 38: Evolution of per capita GDP of the metal, machinery and equipment industry, Aguascalientes vs. Guanajuato



Source: INEGI, National Accounts System.

Figure 39: Evolution of per capita GDP of other manufacturing industries, Aguascalientes vs. Guanajuato



Source: INEGI, National Accounts System.

The superior performance of Aguascalientes industries is also clear from a shift-share analysis for two periods of time: 1970-1985 and 1993-2000 reported in Table 31. Table 31 shows the three components of an output change registered in Aguascalientes and Guanajuato for the period 1993-2000. It is clear that the regional share of the change registered in most industries in Aguascalientes—i.e. the component of the change due to the performance of the state industry—is generally higher than that of Guanajuato, except for mining, mineral products and the basic metallic industry (in italics).

That education may be responsible for at least some of the difference in recent performance between these states has been understood by Guanajuato's government. In an interview, the secretary of economic development of the state emphasized that one of the obstacles for the state in terms of maintaining and attracting firms has been the lack of human capital, in particular the lack of a specialized and technical labor force. Thus, the state government is carrying on several projects geared toward closing this gap.[77] It is interesting to note, however, that while firms in Aguascalientes took the initiative to begin training their workers—and the state reacted to them—in Guanajuato firms have been slow to react to the changes that the trade openness regime has brought.

[77] One program is the Program for Labor Certification, which designs training programs according to the labor skill needs of particular firms. Another program is the Certification of Occupational Activities, which aims at guaranteeing the quality of the labor force in certain occupations.

Table 31: Decomposition of the change registered in sectors and manufacturing industries 1993-2000

	Aguascalientes			Guanajuato		
	National Share Change	Industry Mix Change	Regional Shift Change	National Share Change	Industry Mix Change	Regional Shift Change
Economic Sectors						
I. Agriculture, forestry and fishing	51.1	24.2	24.7	69.4	14.5	16.1
II. Mining	24.3	38.9	36.8	1.0	21.9	*77.1*
III. Manufacturing	22.5	0.6	77.0	72.8	17.0	10.2
IV. Construction	47.5	15.5	37.0	64.5	28.0	7.5
V. Electricity, gas and water	69.7	23.7	6.5	5.0	92.9	2.1
VI. Commerce, restaurant and hotel	76.5	12.0	11.5	56.2	35.5	8.3
VII. Transp., storing and comm.	36.8	26.8	36.4	26.6	59.1	14.3
VIII. Finan. & insurance, real estate	50.7	32.3	17.1	35.2	58.1	6.7
IX. Comm., social and pers. Services	49.2	14.0	36.8	73.9	17.2	8.9
Manufacturing Industries						
1. Food, beverage and tobacco	35.8	4.5	59.7	42.4	9.4	48.2
2. Textiles	12.1	5.6	82.3	55.8	11.5	32.7
3. Wood and wood products	26.5	6.5	67.0	21.0	49.5	29.4
4. Paper, printing and editing	11.7	1.5	86.8	5.4	28.2	66.4
5. Chemical, oil and plastics	70.6	13.0	16.3	60.6	25.8	13.6
6. Mineral non metallic products	50.3	23.9	25.8	35.9	29.2	*35.0*
7. Basic metallic industry	27.6	1.9	70.6	0.9	12.8	*86.3*
8. Metal, machinery and equipment	11.4	2.6	86.0	77.9	12.2	9.9
9. Other manufacturing industries	1.1	1.0	97.9	71.4	28.6	0.0

Source: Own calculation with data from INEGI, National Accounts System. Numbers refer to percentages.

Interviews and previous studies indicate that this slow reaction may be due to a highly insulated business culture that remains one of the major challenges of the state (Camacho Sandoval 2004, p. 160). One of the main characteristics of Guanajuato's economy is that it is composed of small, family-owned businesses of less than 15 workers. In fact, these "micro-firms" accounted for 99 percent of all firms, 80 percent of employment, and 50 percent of state GDP in 2004.[78] They are characterized by producing in small scale, being labor-intensive, using little or no technology, utilizing largely local inputs, generally lacking administrative and accounting systems, and being highly domestically focused (see for a comparison of trade openness between Guanajuato and Aguascalientes).[79] As such, it is probably not surprising that they have not invested much in training or hiring more educated workers. As Wolff (2006) found in his study of the relationship of education, wages, and inequality in the United States, "it is the introduction of new technologies rather than incremental improvement in existing technologies that increases the demand for skilled workers" (p. 58).

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[78] Data are from INEGI, Industrial Census 2004, cited in a government document of the Economic Development Secretary of Guanajuato.

[79] In fact, even though the city of León (the largest city in Guanajuato) hosts the largest cluster of the shoe and leather industry in the country, only five percent of their firms are linked to the international market. In other words, the economy of Guanajuato until recently (before the auto-industry boom of the most recent years) has been a highly local economy. The great majority of the economy remains geared to the domestic market. Thus, despite its economic potential in terms of transportation infrastructure and geographic location, its economy remains highly local. Camacho Sandoval (2004) argues that despite its proximity to important centers of the country, natural resources and rich history (Guanajuato is referred to as the cradle of the independence of 1810), the state is unfortunately lagging behind other states in terms of its industrial modernization as well as its economic links to international trade. In fact, one of the current efforts of the state government aims at increasing the state economy's links to international markets, as well as expanding its regional importance.

Table 32: Comparison of trade openness levels of Aguascalientes vs. Guanajuato

	Aguascalientes	Guanajuato
Exports	2,161,809.00	3,532,143.00
Imports	2,292,681.00	3,377,576.00
State GDP	8,164,065.0	18,182,677.49
Trade openness	0.55	0.38

Source: Secretariat of Economy, 2007. Exports and Imports in thousand US 2002 current dollars and State GDP in thousand 2001 current dollars.

In an interview, one of the advisors to the head of the agency for promotion of international trade (COFOCE) explained that one of the agency's main focuses has been changing the business culture prevalent in the state.[80] Because of the their long family traditions and success in the domestic market, very few firms in the state invest in innovation and development of marketable products—what predominates instead is tradition. They do not seem to realize that even if their products remain geared toward the domestic market, they increasingly need to be competitive internationally because competing imports are available in the domestic market.[81] Firms in Guanajuato generally do not employ professional level employees at the managerial level, even when there might be a supply of qualified labor in the state. Even at the blue-collar worker level, firms are not demanding qualified labor as much as the government would like to see, or instituting worker training programs. According to the advisor, the irony is that the few firms in the

[80] Interview with C.P. Gerardo Guapo, 2006, Feb 3.
[81] One of the examples the interviewee gave me during our conversation was that firms have been resistant to change their product lines. In general their products' designs are based on tradition rather than following market trends and the changing tastes of the market.

shoe and leather industry that have employed higher qualified labor have seen the value added of their products increase, as well as their exports.[82] Other observers consistently agree that the lack of higher levels of human capital in the state is an obstacle for the further expansion of exports.[83]

In sum, the evidence indicates that education is likely to have played a role in Guanajuato's worse performance in recent years than Aguascalientes, particularly as competitive pressures have increased as a result of trade openness. However, although Guanajuato's overall human capital levels are lower than those of Aguascalientes, the problem of Guanajuato is not necessarily its low level, but rather the predominant business culture that fails to see a value in higher skilled and educated workers, as well as investing in professional practices and advanced technological systems for production and business administration. Thus, although the need for more highly educated workers has become apparent to the state government, it is only slowly being accepted by the state's firms, and

[82] Two examples of this are Hispana and Grupo Court. However, as Martínez (2006) notes, the shoe and leather industry in Guanajuato operates in general under a family business structure that does not have mechanisms that allow them to capitalize their knowledge and therefore prevents them from innovating and from producing high quality products for exports. Even the production for the domestic market is losing market due to more competitive imports. Moreover, most of the firms do not know the process of exporting and the support programs that are available for small and medium size firms.

[83] Camacho Sandoval, 2004; Interview with Lic. Daniel Meléndez Sánchez, Director of Evaluation, Analysis and Strategy of the Secretariat of Sustainable Economic Development of Guanajuato, 2006, Feb 7; and interview with Lic. Hector López Santillana, Secretary of Sustainable Economic Development, 2006, Feb 8.

there seems to be a strong resistance to the change. The case study therefore not only indicates that Guanajuato's economy may continue to be at a disadvantage in future years, but also raises the important issue of business culture, which is often ignored in economic studies.

6.3.2 Alternative explanations

My case selection strategy, described above, specifically sought to keep constant some important alternative factors that might have driven economic performance in Aguascalientes, Guanajuato, and Nayarit (economic size, geographic location, etc.). However, as with any case study strategy, there are inevitably factors that vary between the states and could also have influenced the states' economic growth. While it is not possible to rule out the importance of these factors (at least without a larger statistical study), it is important at least to consider whether these differences might be so important as to make the endowments studied here irrelevant.

For example, one alternative explanation of the rapid transformation of the Aguascalientes economy has been the close personal relationship that the governor of Aguascalientes (Rodolfo Landeros) had with the President of the country (Miguel de la

Madrid) during the early part of the 1980s decade (Camacho Sandoval, 2002).[84] Although politics must have played a role in influencing the growth and modernization of Aguascalientes' industry and especially in the improvement of its infrastructure, one must be cautious in overestimating its importance. If politics were the primary factor, one would expect that other states with similar political connections would also have performed well. However, one counter-example to this is Guanajuato, where the former president of the country during 2000-2006, Vicente Fox, was governor during 1995-1999. Although Guanajuato was governed by the PAN—the political party of Fox—during Fox's presidency and thus probably benefited from a close relationship, the evidence shows that Guanajuato has not performed as well as Aguascalientes. Thus, although politics can constitute a major factor in the development of a state economy, it cannot be the decisive factor.

Another important factor that must have played an important role but also needs to be treated with caution is the traditional lack of independent unions in Aguascalientes. Although, weak unions and low labor costs have been associated with economic growth and with the location of economic activities, Aguascalientes' performance cannot be explained by this factor alone, as it has higher manufacturing average wages than Guanajuato and Nayarit. In general, many states in Mexico have lacked strong labor unions

[84] Their administrations correspond to 1980-1986 (Landeros) and 1982-1988 (de la Madrid). Their personal relationship dates from their work during the Presidency of José López Portillo, 1976-1982.

while also having among the lowest manufacturing average wages, like Chiapas, Zacatecas, and Yucatán. And in fact, the most unionized federal entity, historically and currently, is the Federal District, where the large majority of firms have of course always located, even after decentralization policies. Aguilar (1990), in his study of Mexico's decentralization program, found that most of the Mexico City's firms decentralizing under the programs' efforts actually tended to relocated near Mexico City. Moreover, a study of the automotive and auto parts industry in Mexico finds that low labor costs are not a significant factor in the localization of the industry, considering that the industry has consolidated in some of the states of the country with the highest labor costs (Unger y Chico, 2004). Therefore this argument cannot account for the difference in the economic performance of these states.

One alternative explanation to the low development of Nayarit is its low population density. In fact, Meyer (1997) notes that this low population density prevented the early exploitation of fertile land that was available for agricultural activities. Nayarit only relatively recently modernized its primary sector and started diversifying into other areas that could be exploited in the state, like livestock, fruit and vegetable crops, forestry, fishing, and tourism (IEPES, 1975). However, other states with low population density (such as Aguascalientes) have been able to attract workers to the state. Therefore the question is why Nayarit was not capable of doing this, and in fact why it lost field workers to bordering states, like Sinaloa and Sonora (states that, in fact, also have low population density but with dynamic agricultural sectors).[85] Thus, although low population density could be an important factor, it is clearly not a determining factor in state economic performance.

Another factor that could affect the economic performance across states is migration to the United States, and specifically the remittances sent back. Although in general one might expect that remittances impact the development of regions, especially for small rural areas where there has been substantial migration to the Unites States, the correlation between growth and level of income and remittances is low. For example, in 2004, the correlation is only 0.12 and 0.36 respectively.[86] Moreover, if remittances had played a determining factor in the development of states, then one would expect that Guanajuato, one of the principal origins of migrants to the United States (Durand, et al. 2001), would be doing better than Aguascalientes, a state with lower levels of migration to the USA. Therefore, although remittances might be an important factor for income at the individual level, they have not been a determining factor for states' development.

Another explanation for the underdevelopment of states in Mexico points to the existence of relatively sizeable indigenous groups, arguing that the lack of homogeneity in

[85] In fact a recent newspaper article discusses some of the problems that peasants from Nayarit have faced hen being recruited to work in Sonora. La Jornada, July, 7th, 2007.

[86] Data from INEGI.

the population can prevent economic growth due to social and ethnic fragmentation (see Alesina and Ferrara 2005 for a review). This argument would possibly explain why Nayarit, the most ethnically fragmented of the three states, has performed the worst. However, it should be noted that the indigenous region in Nayarit—the Huicot region—expands into Jalisco and Durango, which have performed better than Nayarit.[87] In fact, Jalisco has been one of the most successful states. This is not to deny the correlation that exists between indigenous populations and poverty in Mexico, as the indigenous groups in Mexico have been victims of systematic discrimination and constitute the most marginalized group of the society (Hall and Patrinos, 2005). However, it is clear that ethnic fragmentation does not necessarily have to hinder economic performance.

An important factor that worries the business community in Mexico and that has been a recent subject of study is the rising crime that has been observed in recent years.[88] However, looking at the crime rate for states (i.e. the number of criminal acts per 10, 000 people) in 2005, it is difficult to find a correlation between insecurity and economic development because many of the most developed states—like the states bordering the

[87] Aguayo Quezada, Sergio, 2007, p. 164. Sonora and Sinaloa have also performed well while having ethnic fragmentation.

[88] For example, in a newspaper article (Jornada, April 27, 2007) it is reported that the Mexican business community as well as the international investors in Mexico were alarmed by the increased waves of violence observed in the country. The study of Decuir (2005) includes insecurity as a measure of institutional factors that explain the different development levels across states in Mexico.

USA—have for a long time registered the highest crime rates of the country, mainly related to drug trafficking into the USA. Moreover, Nayarit has a slightly lower crime rate (11.5) than Aguascalientes (12), and Guanajuato's is higher (15.9)—if crime were a determining factor, it would be expected that Aguascalientes would have a lower growth rate than Nayarit, which is of course not true.[89] An argument also related to institutional factors is corruption. However, once again, it is difficult to find a correlation between state corruption levels and their economic development (as the richest state, the Federal District, has a high corruption level, according to the Transparency International's ICBG index).[90] In fact, the index of corruption for 2005 shows that Aguascalientes has a higher level of corruption than the other two cases. Other indices of corruption, (the EDGE indices) actually show that Nayarit and Aguascalientes had similar values in 2001, and Guanajuato a slightly higher corruption value.[91]

[89] Data are from Aguayo, 2007.

[90] The ICBG index (Index of Corruption and Good Government) was produced by Transparency International Mexico (2005) through a random national survey of 13, 790 households. It refers to the perceived corruption in public services by users.

[91] The EDGE indices (Governance and Business Development Survey 2001) are based on a survey of 3,985 firms located in Mexico conducted by the Center for Strategic Studies. They measure the perception of firms of the existing corruption between government and private firms in 2001 (Center for Strategic Studies, 2001).

6.4 Conclusion

This chapter aims at illuminating the relationship between infrastructure and human capital to the growth of states and their role as trade openness increases in the country. The comparison between the contrasting development experiences of Aguascalientes and Nayarit is a clear example of a cumulative causation effect emerging from infrastructure, in the sense that early access to transportation networks—due mainly to a strategic geographic location—gave Aguascalientes an advantage in the development of economic activities. In contrast, Nayarit has historically been at a disadvantage since it had relatively late access to the railway network and has remained a low endowed state in terms of infrastructure, as discussed above. This has made the industrialization of the state difficult, as it remains highly dependent upon primary sector activities. Moreover, Aguascalientes continues to do better than Nayarit, and the evidence indicates that this trend is likely to continue, as trade openness increases. During a time of increase linkages of markets, not only for the efficient distribution of final products to other markets but also for the transportation of inputs for production, infrastructure networks play a key role for the development of regions. Furthermore, the case study analysis indicates that the success of Aguascalientes in the rapid transformation of its economy depended not only in the provision of infrastructure, but in the provision of the range of services that go hand in hand with infrastructure availability, such as the substantial reduction of red tape in registering land property and the contracting of services such as water connection and electricity and the availability of telecommunications infrastructure.

The comparison of Aguascalientes and Guanajuato point at how two states with similar historical development—both states located in the center of the country have had access to major transportation networks—have also had different development experiences, specially during recent period. Guanajuato' industrial performance has not only been surpassed by Aguascalientes', but also, the latter has been able to expand into new industries. The evidence from the analysis indicates that the role of human capital has been crucial in the recent industrial growth of Aguascalientes and specifically in the maintenance of its competitiveness. Meanwhile, although the role of human capital has started to take relevance in some business circles in Guanajuato, the predominance of a traditional way of doing business has prevented firms to value skilled labor and professionalize their operations. This has resulted in the limited innovation of their products and consequently limited access of higher value markets, domestically and internationally. Although the different interviews with government officials indicated that this attitude is slowly changing in Guanajuato, perhaps the decline in their performance will force them to adopt new business practices.

7. Conclusion

Fourteen years after the enactment of NAFTA and various other measures to free their trade regime, the promised results for most Mexicans have yet to be realized. For example, economic performance indicators for the country before trade openness were much higher than afterwards: average annual per capita income grew by approximately 4 percent from 1960-1980 and at 0.8 percent since then. This is substantially lower than the growth experienced by Mexico's partners in NAFTA.[92] Moreover, average aggregate output by sector grew faster prior to trade openness, as shown in Table 33.

This poor economic performance has occurred together with a widening of Mexico's historically high levels of regional inequality. As discussed in Chapter 2, Mexico has been an unequal country since 1940—both regionally and along other dimensions—but this inequality seems to have diminished over the period leading up to 1980. After 1980, this trend reversed, and Mexico's spatial pattern of inequality—with the poorest states in the south and the richest states in the center and north—has been solidified.

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[92] Average annual per capita income growth in Canada and the USA during 1960-1980 was 2.8 and 2.4 percent respectively; and from 1980 to 2003 was 1.7 and 1.9 percent respectively. Data from World Bank, 2005.

Table 33: Average annual growth rate of output by sector and manufacturing industry

Economic sectors	*1970-75*	*1975-80*	*1980-85*	*1985-88*	*1993-98*	*1998-03*
Agriculture, forestry and fishing	5.1	2.0	2.4	-8.7	1.8	2.1
Mining	9.5	25.1	-6.8	-15.8	2.9	1.4
Manufacturing	6.5	7.6	1.0	1.0	5.2	1.0
Construction	9.2	9.4	-7.1	-6.6	0.7	1.7
Electricity, gas and water	1.5	9.9	-0.1	5.9	3.6	4.5
Commerce, restaurant and hotel	6.2	6.4	4.3	-4.8	2.0	3.0
Transp., storing and comm.	10.1	10.6	1.1	0.3	5.4	5.3
FIRE	3.3	4.2	-0.4	-2.1	2.7	4.3
Community, social and personal services	9.5	9.3	-0.7	-6.4	1.2	1.0
Average Aggregate Output	6.8	9.4	-0.7	-4.1	2.8	2.7
Manufacturing industries	*1970-75*	*1975-80*	*1980-85*	*1985-88*	*1993-98*	*1998-03*
Food, beverage and tobacco	7.3	3.8	2.5	-0.8	3.2	2.7
Textiles	5.5	6.2	-2.2	-2.3	4.6	-2.7
Wood and wood products	4.9	12.2	0.5	-0.7	2.3	-2.0
Paper, printing and editing	4.5	8.9	3.0	4.0	2.8	0.0
Chemical, oil and plastics	6.3	8.7	-2.0	8.6	4.3	0.6
Mineral non metallic products	5.7	7.8	6.0	0.4	2.1	1.6
Basic metallic industry	6.9	9.1	-0.3	7.0	8.3	0.3
Metal, machinery and equipment	6.5	10.6	0.2	-0.8	8.8	1.0
Other manufacturing industries	11.2	12.2	-0.1	-4.0	4.5	1.3
Average Manufacturing	6.5	8.8	0.8	1.3	4.5	0.3

Source: Own calculations with data from INEGI, National Accounts System.

This trend is disturbing, as scholars have argued that understanding regional inequality is important not only because it reflects the overall level of income inequality in a country, but also because of its political and social implications (Kanbur, Venables, and

Guanghuan, 2005; Murshed and Gates, 2005). In fact, regional inequality in Mexico is already having effects beyond the economic realm. In the controversial 2006 presidential election, many analysts described Mexican society as deeply fractionalized over the two main candidates (from the left- and right-wing parties). In some quarters the election was cast as a contest between the south vs. the north of the country (Figure 40 shows the election results by state). Furthermore, the most recent and significant social unrest has taken place in Chiapas, Guerrero, and Oaxaca (Trejo, 2004; Meyer, 2007 and 2006), the three states that form the core of the cluster of low values through the 1940-2000 period, as described in Chapter 2. Thus, the magnitude and persistence of regional inequality in Mexico may be a growing source of political instability for the country.

In addition to those practical concerns, Mexico's widening inequality contradicts much of mainstream economic theory, which argues that that increased economic openness should reduce spatial inequalities (Krugman, 1996, 1991a). Contrary to the expectation of Krugman and Livas (1996), the location of economic activities after trade reform did not significantly change the pattern that had existed prior to the reform. That is, economic activities (domestic and international) have tended to locate in those areas with higher levels of infrastructure, and consequently the pattern of regional inequality has been maintained and even strengthened. This dissertation has attempted to understand this theoretical puzzle.

Figure 40: 2006 Presidential election results by state

Source: Federal Electoral Institute, 2007, p. 67. Blue indicates states where the PAN (right-wing party) won; Yellow indicates states where the left-wing party (PRD) won.

7.1 The argument revisited

The research reported here has focused on the impact of trade reform on regional inequality and the mechanisms through which the relationship takes place. Specifically, the dissertation has investigated the extent to which the existing differences across states in terms of income, infrastructure, and human capital have exacerbated regional inequality in Mexico as trade openness has increased. In this sense, the goal of the dissertation has been to investigate the extent to which local conditions and factors mediate the effect of global forces like trade openness on regional inequality. This idea was captured in three distinct hypotheses.

Hypothesis I was that poorer states will grow faster than richer ones as trade openness increases, based on Krugman's core-periphery model and Krugman and Livas Elizondo's model (1996). The second hypothesis was that states better endowed with infrastructure will grow faster than those with less infrastructure endowments, as trade openness increases (Mansori, 2003). Finally, the third hypothesis was that states with higher levels of human capital will tend to grow faster than those with lower levels of it as trade openness increases (Nelson and Phelps, 1966; Benhabib and Spiegel 1994). The third chapter presented a theoretical model of growth that incorporated the three hypotheses, thus enabling them to compete against each other.

I tested the hypotheses using a combination of statistical analysis and case studies. Chapter four presented the statistical tests at the state level. The dependent variable was growth in state per capita gross domestic product for all states over the period 1940-2000. The findings reported in Chapter four indicate that although regions remain significantly different in terms of their levels of income, there has been a pattern of convergence across regions; however, this convergence pattern has been diminished by trade openness, as the coefficient of Hypothesis I is positive and significant (i.e., richer regions tend to grow faster as trade openness increases). Similarly, unequal infrastructure endowments across states have helped to maintain and even increase inequality in the context of trade openness, as the coefficient of Hypothesis II is positive and significant.

The findings also show, however, that the role of human capital plays an opposite role—that is, states with higher levels of education tend to grow *slower* than states with lower levels of education in the context of a more open trade regime. As discussed in Chapter four, the result for the human capital variable is contrary to most theoretical expectations (including mine), but it is surprisingly common in the literature and remains a puzzle. One potential explanation of this finding in the context of Mexico is that increased levels of education did not translate into higher growth because the economic structure did not require high levels of human capital—that is, the economy was mainly based on low-skilled labor activities. This argument is especially relevant for the earlier part of the period of study and is consistent with the arguments of Krueger and Lindhal (2001) and Lewis (1964).

Despite this finding, however, the overall effect of opening up to trade has been to increase regional inequality in Mexico. Lesser endowed states—that is, poorer states with less infrastructure and less education—have tended to perform worse in the context of trade openness than better endowed states. That is, the "education effect"—by which trade has tended to reduce regional inequalities—has been outweighed by the "income effect" and the “infrastructure effect” which have served to increase regional inequalities. Thus, my findings indicate that although regional inequality in Mexico has been present for a long time, the latest increase is related to the trade reform the country has undergone since the mid 1980s.

In Chapter five the same model and hypotheses were tested again, but this time at a more disaggregated level. The aim of the chapter was to identify different patterns across economic sectors, based on the idea that it is possible that each economic sector is affected differently by trade openness. If that is true, it would have different policy implications. For example, if the negative effect of trade on GDP per capita growth in the analysis of Chapter four was driven by its effect on the primary sector, that would be less important now that the primary sector makes up much less of the Mexican economy. Moreover, if each sector were affected differently by trade openness, it would have important consequences at the regional level because economic sectors are unevenly distributed across states, as shown in Chapter five.

I show that the results are fairly consistent across sectors. There is a general income convergence trend across sectors; however, the findings for Hypothesis I show that trade openness has tended to slow the convergence trend in the primary sector. Furthermore, the results show that states with higher levels of infrastructure have tended to grow faster in the context of trade openness than those with less.

Finally, the results for Hypothesis III are, as in Chapter four, contrary to expectation and indicate that states with lower levels of education tend to do better than those with higher levels in the context of trade openness. Although there are, as at the state level, simultaneous counteracting effects of trade in each sector, the overall effect of trade openness on state income growth in the three sectors has been negative. In addition, it has been *more* negative for less endowed states, thus tending to increase regional inequality in the net.

The case studies discussed in Chapter Six provided further evidence regarding the hypotheses studied in this dissertation, particularly the extent to which infrastructure and education have affected economic growth in the context of trade openness. The case studies provide "real world" examples of the effects of infrastructure and education, and they also indicated slightly different conclusions than the statistical results in earlier chapters.

The comparison between Aguascalientes (high levels of infrastructure) and Nayarit (low levels of infrastructure) indicated a strong relationship between infrastructure and growth. In the case of Aguascalientes, early access to transportation networks gave the state an advantage that carried over into the transformation of the economy from an agricultural to a manufacturing orientation. Moreover, the state continues to provide infrastructure-related services to maintain its industry and keep attracting industries. In contrast, Nayarit has historically been at a disadvantage since it gained relatively late access to the railway network and has remained a low-endowment state in terms of infrastructure. This has made the industrialization of the state difficult, as it remains highly dependent upon primary sector activities. The contrasting experiences of Aguascalientes and Nayarit therefore provides evidence of the cumulative causation effect of infrastructure underlying Hypothesis II, in the sense that states with high levels of infrastructure have done better and continue to do better than those lagging behind. Moreover, as trade openness has increased in the country, the role of infrastructure has become even more of a key factor in the development of regions. The evidence from the case studies points to the fact that in order for Mexico to take advantage of the new trade regime, the availability of infrastructure needs to be upgraded, as industries face constant pressure to remain competitive and the costs and timing of distribution are key factors.

In terms of the role of human capital, whereas the statistical results in early chapters reported a negative relationship between education levels and economic growth, the case studies indicated some positive effects. These positive effects seemed to be most prominent, however, in the context of trade openness. Prior to trade barriers falling, the difference in the education levels of Aguascalientes and Guanajuato seems to have had little to no effect. Factors like infrastructure, geography, and labor conditions in the states seem to have been most important during this time. However, Aguascalientes' superior performance in the last two decades—and particularly its ability to expand into new industries—seems to indicate that education's role has increased. The case study analysis shows a consistent perception that NAFTA, and the new trade regime in general, demanded new skills for the labor force. Those new skills included specialized training in quality production, the need to speak English, administration, and specialization in areas such as exporting processes and product quality design. Unfortunately, however, it seems that some business cultures—as in Guanajuato—have been slow to adjust to this new environment.

Overall, the case studies suggest that education's importance might be quite different in closed versus open economies. Moreover, the comparison between Aguascalientes and Guanajuato points to the need to incorporate the idea that business culture and tradition can prevent the utilization of human capital in the production process and therefore attenuate education's effect on growth. Specifically, the evidence from Guanajuato indicated that the predominant tendency until very recently has been to underestimate the value of human capital.

7.2 Planning and Policy Implications

There are important planning and policy consequences from the different findings of the study. The different analyses indicated that there are local conditions and factors that gain more relevance as trade openness increases and thus play an important role in the development that occurs across regions. Thus, economic development plans and policies should focus on targeting those factors in order to address regional inequality. In particular, this dissertation can inform plans and policies regarding two specific factors: infrastructure provision and education.

This study has indicated that the substantial historical differences in terms of infrastructure endowments across states in Mexico have served to maintain regional inequality, a tendency that has been exacerbated since the country's trade reform. One of the evident obstacles for lagging regions in Mexico is the relatively low availability of infrastructure. The statistical analyses showed that as Mexico has become more connected to international markets, the states with better infrastructure have been more capable of reaping the benefits of trade.

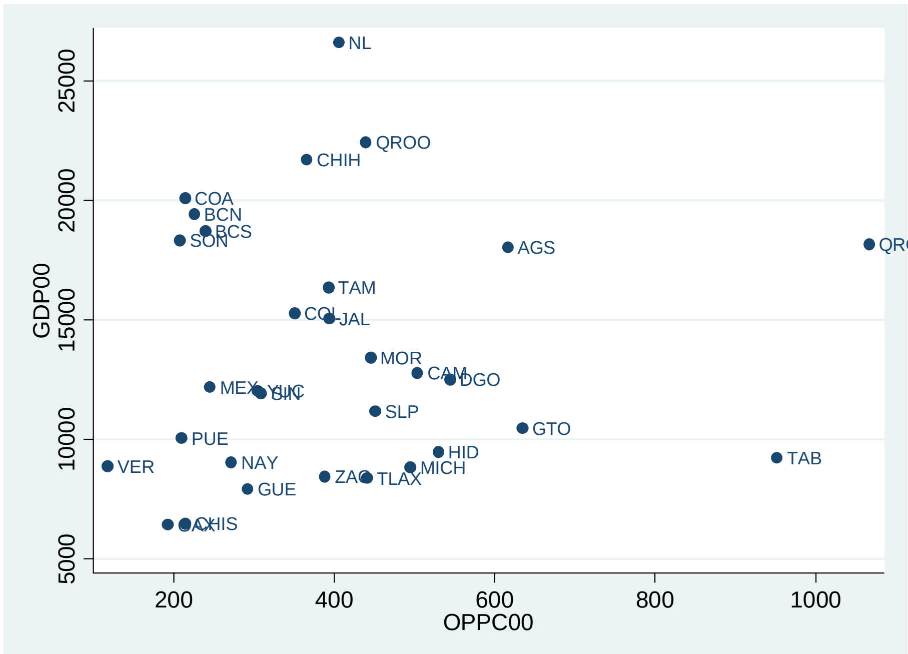
The (seemingly obvious) idea that relatively equal access to general infrastructure is necessary for the dispersion of economic activities and thus the reduction of regional inequality has been part of the discussion surrounding NAFTA. In fact, an architect of the agreement during the Clinton administration, Bradford DeLong, was recently quoted in *The*

New York Times as saying that Mexico's inequality across regions in terms of infrastructure and human capital was ignored when NAFTA and its "alluring" promises were conceived and enacted (Uchitelle, 2007). It seems likely that NAFTA would have provided more (and more equal) benefits to Mexico if it had been combined with a series of complementary policies. As Rodrik (2001) notes, one major problem with trade openness in Mexico (and in many other countries) is that it was implemented as if trade openness is in itself a development strategy. He argues that trade policy needs to be complemented with industrial, development, and institutional policies in order for the benefits of open trade to be realized (Rodrik, 2001 and 1999).

For example, the importance of infrastructure availability in the context of trade openness was clearly illustrated by the comparison of Aguascalientes and Nayarit in Chapter Six, as Aguascalientes has been able to capture a share of economic activities and transform its economy in a relatively short period of time, while Nayarit continues to lag behind. Moreover, the case study showed that there has been a significant difference between the two states in terms of levels of infrastructure, in particular access to major transportation networks. Thus, Nayarit officials continue to focus special attention to the need to upgrade the state's transportation networks in order to be able to transport their agricultural products to other markets and import inputs for production (like fertilizers, oil and cement) as well as allow the development of the tourist industry in the south of the state. However, the case studies show also that it is not only the availability of infrastructure that is important but also the services that complement it. In two World Bank (2006 and 2007) studies on the ease of doing business in Mexico, Aguascalientes ranks as the best place for business due to factors like the low amount of paperwork needed to register property, establish basic services like connections to the electricity and water network.

Thus, although infrastructure improvement in Mexico might seem an obvious policy to address regional inequality, it is not reflected in the way federal spending in infrastructure across states is distributed. According to Díaz Cayeros (1995) richer states received more federal funding per capita than poorer states in 1990. I have replicated his analysis for 2000 and the same trend appears, as shown in Figure 41.

Figure 41: Federal spending by states per capita in infrastructure vs. level of per capita income



Source: Own calculation with data from INEGI, SIMBAD, 2007. Horizontal axis is federal per capita spending on infrastructure by state and vertical axis is the level of GDP per capita.

The evidence indicates the clear need to increase the availability of infrastructure in lagging regions on the one hand, while also complementing that effort with policies aimed at improving the services mentioned above.

The planning and policy implications associated with the findings with respect to human capital are not as straightforward. On the one hand, the results from the statistical studies are contrary to expectations, showing that less educated states do better than more educated states in the context of trade openness. On the other hand, the case studies provide evidence of the relevance of human capital for production as trade openness has increased in Mexico. New skills have been required, both to serve emerging industries and because of the nature of business in an open economy. For example, companies need new administrative, logistics, and marketing skills related to the increased linkanges to international markets. However, one factor that became clear from the case studies is that the general attitude and culture of the business sector is a key factor for the functioning of the economy. The comparison between Aguascalientes and Guanajuato showed evidence of a variation of business culture in these two states: while in Aguascalientes the business sector has adjusted to the open trade regime and made efforts to achieve the new skills for the workforce it requires, in Guanajuato the business sector has been reluctant to adjust to the new system. This has had important implications for the role that human capital plays in production and growth in Guanajuato since the value of education has not generally been perceived as a priority for achieving competitiveness, as discussed in Chapter Six.

Policies to address this business reluctance have been implemented in Guanajuato. The goal is to make businesses more sensitive to the changes in the economy, i.e. to encourage them to think about competing in international markets, even if they do not intend to export. In this way, the businesses should become even more competitive in the international market. However, the general response from firms has been slow.

Another program related to exposing firms to professional employees has been implemented in other states. In Mexico, a requirement of obtaining a bachelor's degree is six months of social service to government agencies, organizations, associations, or firms. This service is like an internship or professional practicum, but generally it is unpaid or poorly compensated. Until recently, micro- and small firms have not been receivers of this service. However, but a program of the University of Baja California Norte and Nayarit established links between students in the business and administrative areas and micro- and small firms that generally lack professional skills. According to an evaluation of the program (Ramírez Urquidi, et al. 2002), the firms have benefited by being exposed to these professional skills and have subsequently improved some of their productive processes. This program could be implemented in Guanajuato, especially among firms that are the most reluctant to adjust trade related trends. This program would allow them to receive the benefits without incurring large costs, which in an initial stage could be eye-opening for them.

7.3 Future Research

The present study has important implications for three bodies of literature. First, it contributes to the large literature on regional inequality (Perroux, 1955; Myrdal 1957; Kaldor 1981 and more recently Krugman 1991a, 1991b) and regional convergence (Barro and Sala-I-Martin, 1995; De la Fuente, 1995), by testing various hypotheses against one another and providing a more detailed understanding of the mechanisms through which trade affects economic performance at the regional level. Second, it advances the broad literature on the impact of trade openness on developing countries. Many studies have looked at the relationship between trade and economic development at the cross-national level (Rodrik and Rodriguez, 2000; Frankel and Romer, 1999) as well as at the effect of trade reform on different socio-economic groups within countries (Rodrik, 1995; Burtless, 1995). However, the question of how trade reform affects regional inequality within a country is a newer area of research, and to my knowledge no other study evaluates competing hypotheses concurrently as this one does. Finally, this dissertation contributes indirectly to research that looks at the relationship between development and levels of education and infrastructure (Barro, 1991; Pritchet, 2001; Van de Walle 2003). Like the literature on trade, existing work has largely used cross-national statistical approached. This project provides a way to study these dynamics in a more controlled setting (at the sub-national level) and provide a more nuanced understanding about how these endowments interact with global economic forces.

A research agenda that can extend the current research would address the following issues:

- Does the effect of education on growth depend on the level of development? This study has indicated that the statistical results with regard to education may be worth revisiting in future research. As discussed in previous chapters, there are some hypotheses about why the negative relationship between education levels and economic growth continues to appear in statistical studies. These hypotheses include the possibility that education is of poor quality in developing countries, and the possibility posed by Krueger and Lindhal (2001) that education affects growth differently depending on levels of education and economic structure. The case studies in Chapter six were not chosen in a way that could shed light on the hypothesis posed by Krueger and Lindhal (2001), but future studies might usefully explore this possibility of a non-constant effect of education at different levels of development.

- What are the different strategies implemented by regions to improve infrastructure and human capital and how effective have they been? This dissertation provides the starting steps in the identification of mechanisms that exacerbate inequality. A logical next step is the evaluation of ameliorative strategies. Various analyses have started to do that mainly in the European Union (Puga, 2002, Dall' erba and Le Gallo, 2003) where regional policies are highly prominent. However, in many developing countries the evaluation of policies and programs that aim at addressing regional inequalities need to be evaluated in order to improve them. Moreover, more research is needed on the differences across regions in terms of business practices, traditions, and general business culture that affect the perceived importance of education in the production process.

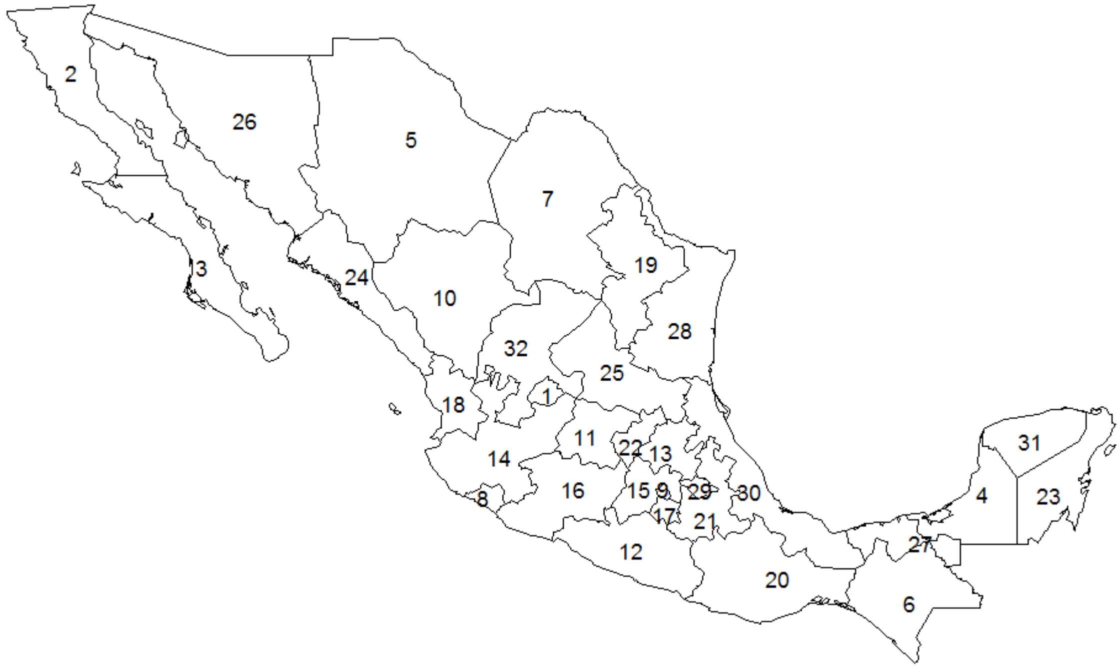
- What is the relationship between spatial inequality in economic activities—across regions, states, counties, etc, within countries—and individuals socioeconomic inequality? The literature on regional inequality—particularly with regard to trade's impact on it—has overwhelmingly focused on the spatial distribution of economic activities, especially in terms of employment and where firms locate. However, much remains unknown about the linkages between such economic activities and indicators of socioeconomic inequality, such as health, poverty, and education. If one considers economic activities as "means" to the end of those development goals, it is crucially important that we understand whether concentration of activities necessarily leads to socioeconomic inequality across regions. Might the concentration of economic activities in fact simply lead to better economic growth in the country, from which everyone might benefit? Understanding these linkages would give even more importance to the above debates about economic openness and its effect on the concentration of economic activity.

- To what extent is the concentrating dynamic observed at the national level replicated within states? Infrastructure and human capital are not distributed evenly within states, just as they are not distributed evenly within the country. We might therefore expect to see rising inequality within states during periods of trade openness. This is intrinsically related to the question of whether regions that are relatively less successful in linking themselves to international markets might grow less but be more equitable (Unger and Chico, 2004; Young, et al. 1994). Underlying this question is the broader, more fundamental issue of what constitutes a successful region. That is, is it more desirable, based on fairness, for a fast growing region to have balanced development internally?

Understanding the above questions will allow the economic development planning and policy field to be better equipped to inform development policy in regions and states, as well as to provide guidelines on the role of the state in a "globalized" world.

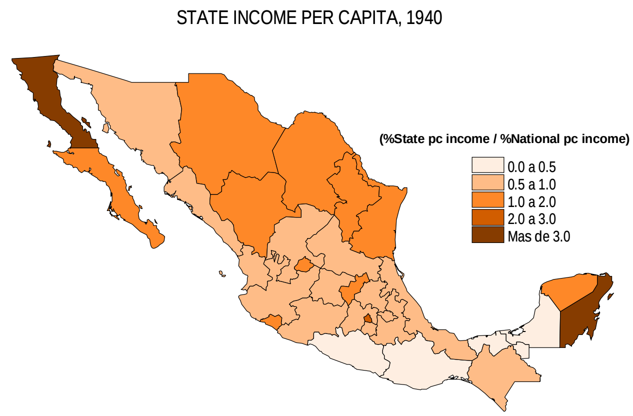
APPENDICES

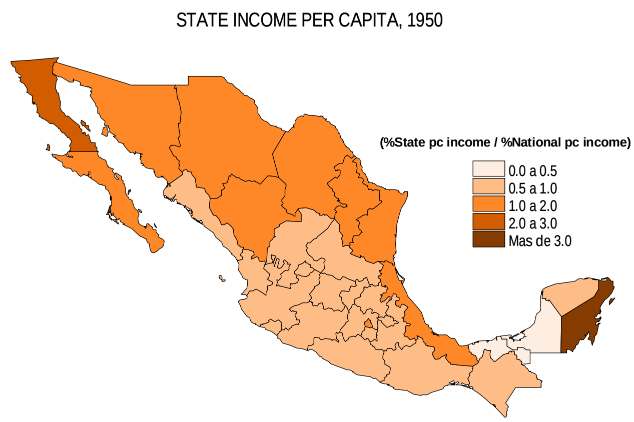
Appendix 1: List of Mexican States

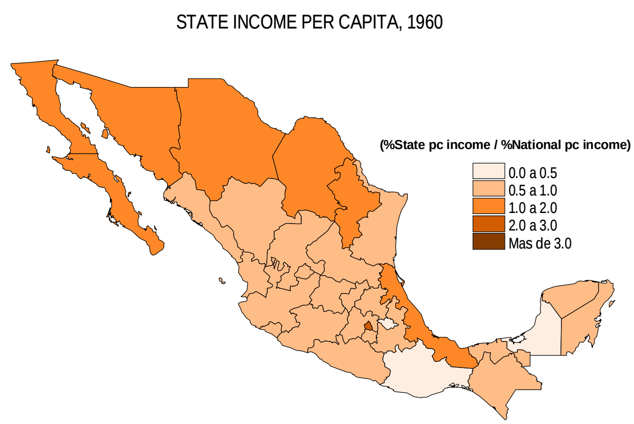


Code	*State*	*Code*	*State*
01	Aguascalientes	17	Morelos
02	Baja California Norte	18	Nayarit
03	Baja California Sur	19	Nuevo León
04	Campeche	20	Oaxaca
05	Chihuahua	21	Puebla
06	Chiapas	22	Querétaro
07	Coahuila	23	Quintana Roo
08	Colima	24	Sinaloa
09	Distrito Federal	25	San Luis Potosí
10	Durango	26	Sonora
11	Guanajuato	27	Tabasco
12	Guerrero	28	Tamaulipas
13	Hidalgo	29	Tlaxcala
14	Jalisco	30	Veracruz
15	México	31	Yucatán
16	Michoacán	32	Zacatecas

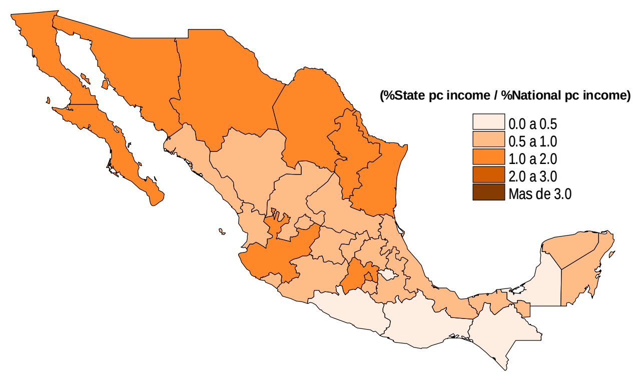
Appendix 2: State per capita income relative to the national per capita income, 1940-2000



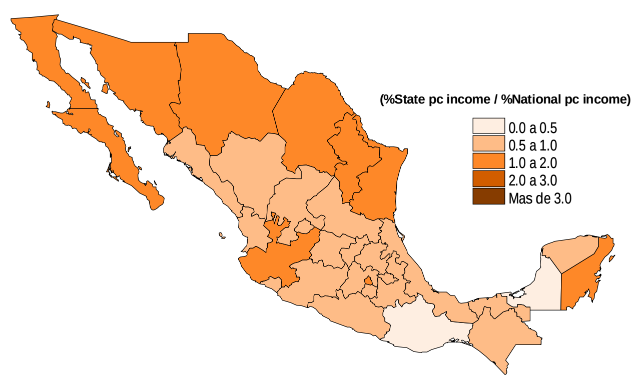




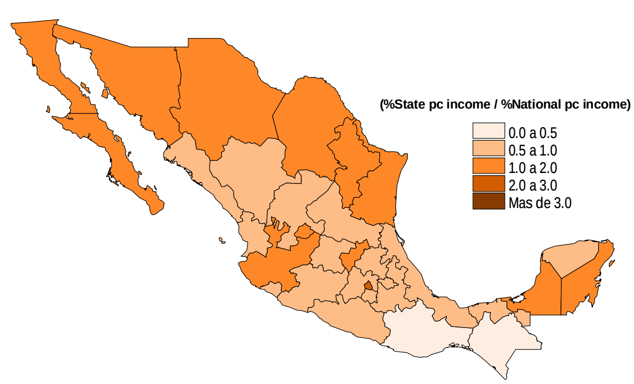
STATE INCOME PER CAPITA, 1970



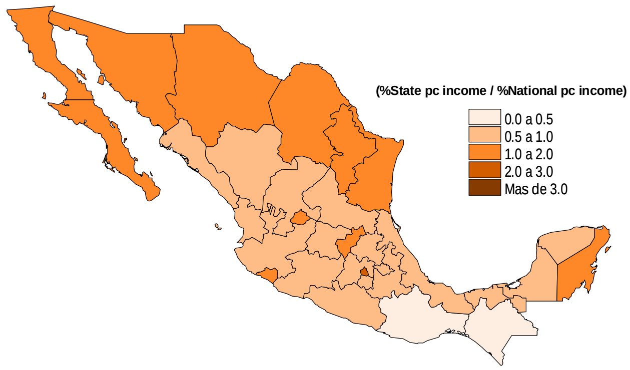
STATE INCOME PER CAPITA, 1980



STATE INCOME PER CAPITA, 1990

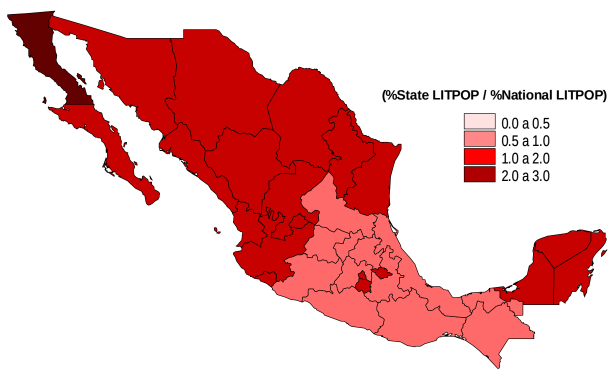


STATE INCOME PER CAPITA, 2000

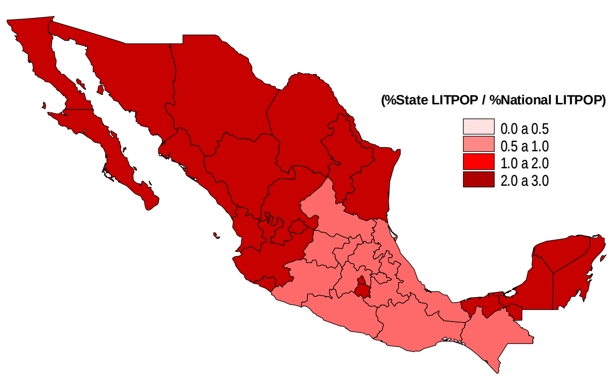


Appendix 3: Percentage of literate population by state 1940-2000

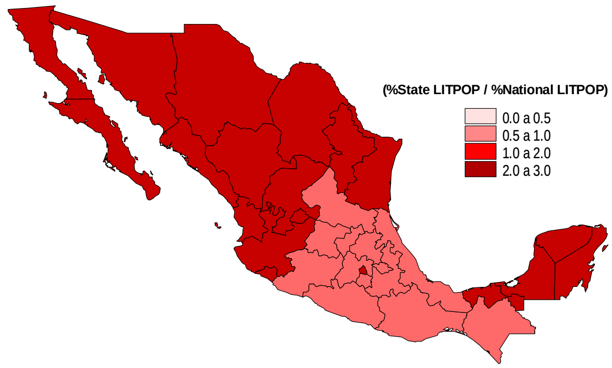
PERCENTAGE OF LITERATE POPULATION BY STATE, 1940



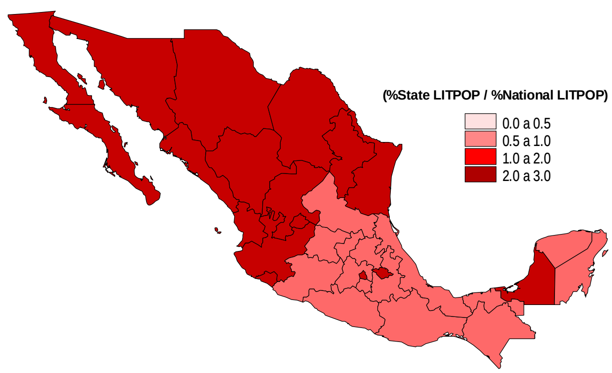
PERCENTAGE OF LITERATE POPULATION BY STATE, 1950



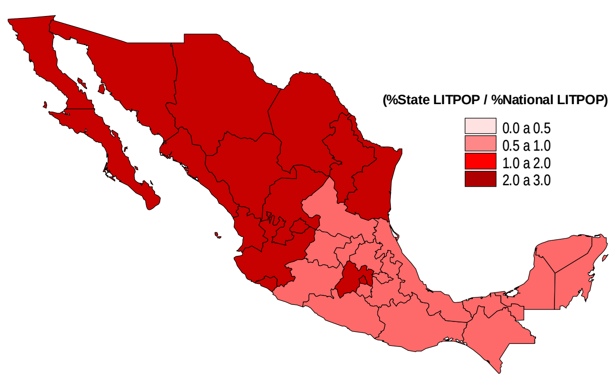
PERCENTAGE OF LITERATE POPULATION BY STATE, 1960



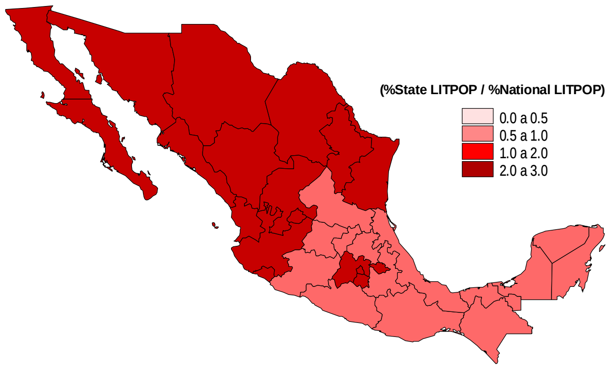
PERCENTAGE OF LITERATE POPULATION BY STATE, 1970



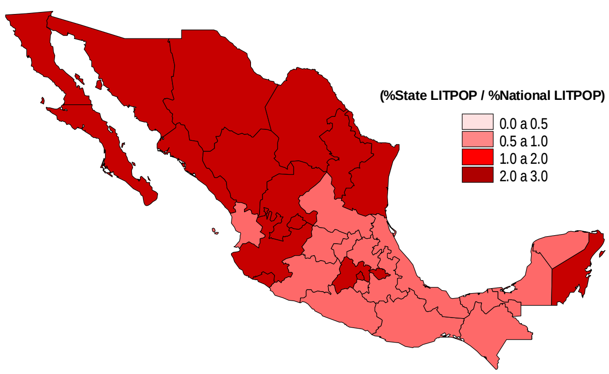
PERCENTAGE OF LITERATE POPULATION BY STATE, 1980



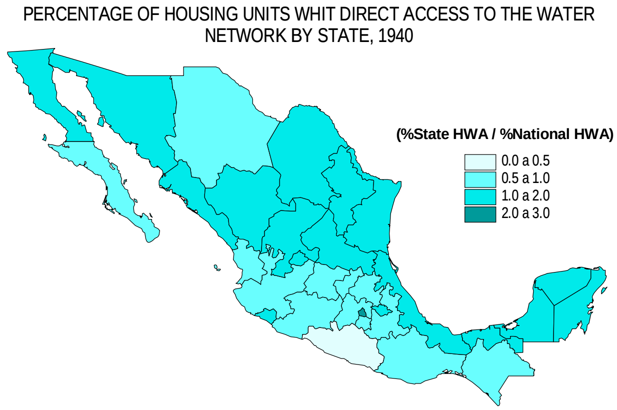
PERCENTAGE OF LITERATE POPULATION BY STATE, 1990

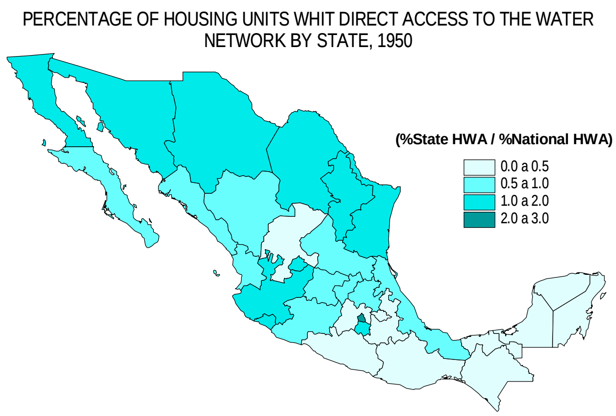


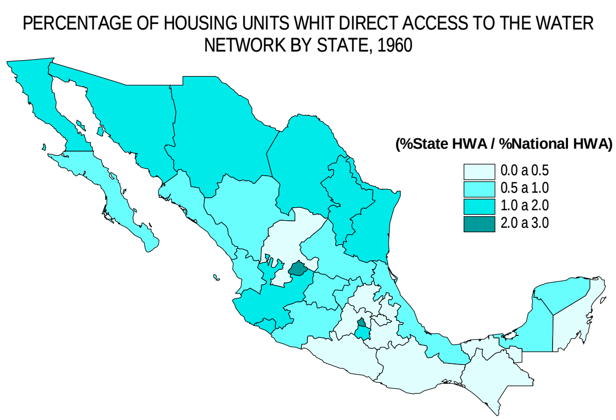
PERCENTAGE OF LITERATE POPULATION BY STATE, 2000



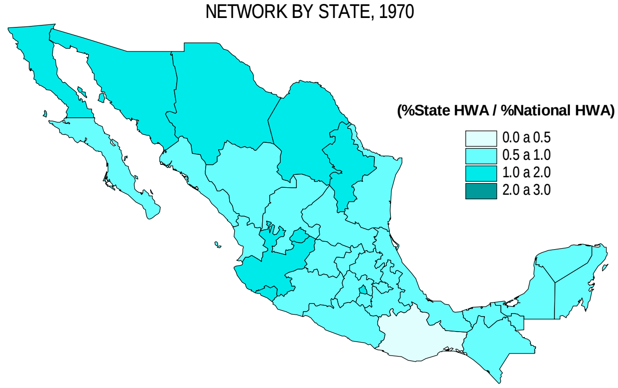
Appendix 4: Share of housing units with direct access to the water network 1940-2000



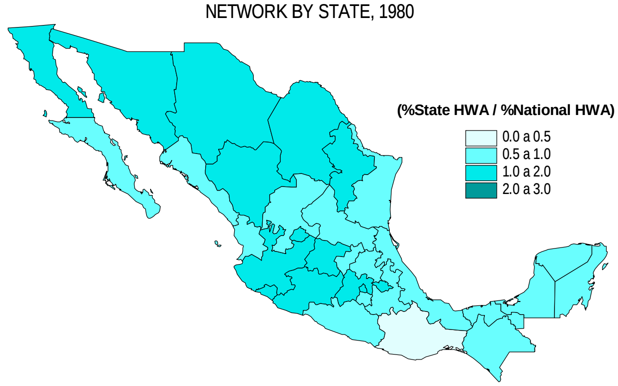




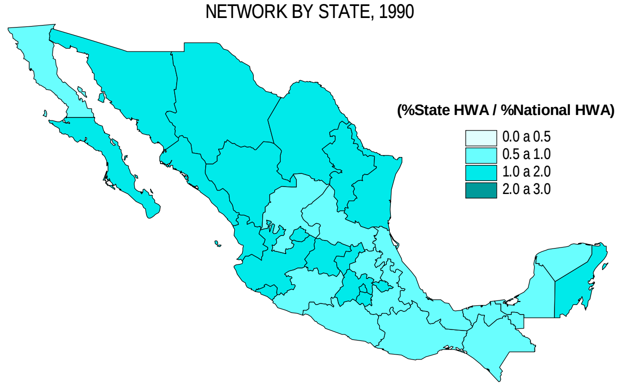
PERCENTAGE OF HOUSING UNITS WHIT DIRECT ACCESS TO THE WATER NETWORK BY STATE, 1970



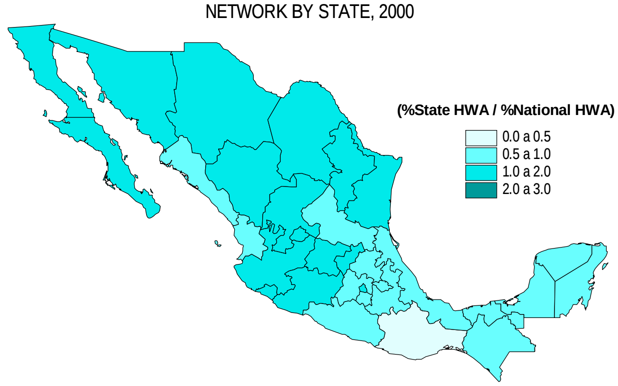
PERCENTAGE OF HOUSING UNITS WHIT DIRECT ACCESS TO THE WATER NETWORK BY STATE, 1980



PERCENTAGE OF HOUSING UNITS WHIT DIRECT ACCESS TO THE WATER NETWORK BY STATE, 1990



PERCENTAGE OF HOUSING UNITS WHIT DIRECT ACCESS TO THE WATER NETWORK BY STATE, 2000



Appendix 5: State road density relative to national road density, 1940-2000

RELATIVE STATE ROAD DENSITY, 1940

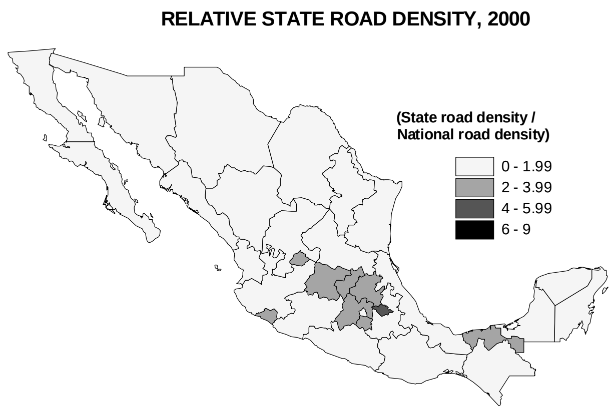
RELATIVE STATE ROAD DENSITY, 1950

RELATIVE STATE ROAD DENSITY, 1960

RELATIVE STATE ROAD DENSITY, 1970

RELATIVE STATE ROAD DENSITY, 1980

RELATIVE STATE ROAD DENSITY, 1990



Appendix 6: State share of labor employed in the primary sector, 1940-2000

STATE SHARE OF LABOR EMPLOYED IN THE PRIMARY SECTOR, 1940

STATE SHARE OF LABOR EMPLOYED IN THE PRIMARY SECTOR, 1950

STATE SHARE OF LABOR EMPLOYED IN THE PRIMARY SECTOR, 1960

STATE SHARE OF LABOR EMPLOYED IN THE PRIMARY SECTOR, 1970

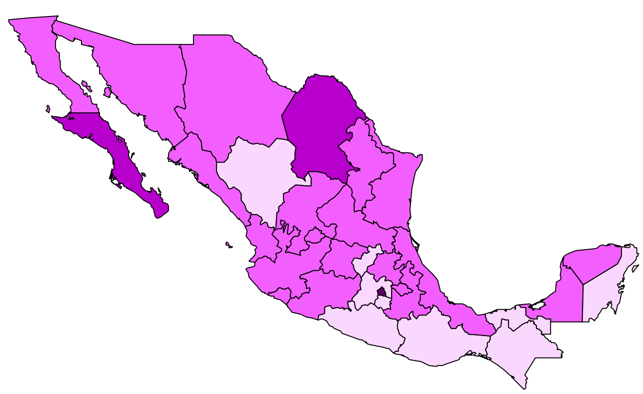
STATE SHARE OF LABOR EMPLOYED IN THE PRIMARY SECTOR, 1980

STATE SHARE OF LABOR EMPLOYED IN THE PRIMARY SECTOR, 1990

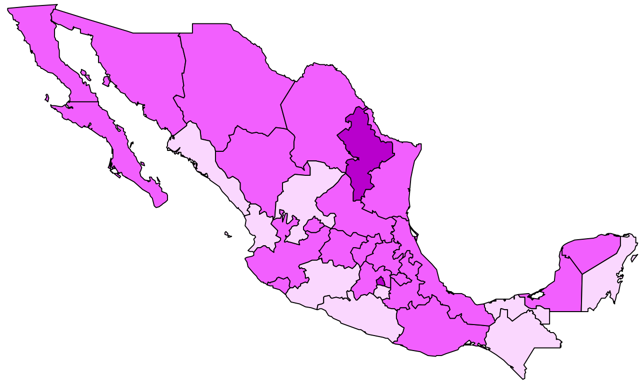
STATE SHARE OF LABOR EMPLOYED IN THE PRIMARY SECTOR, 2000

Appendix 7: State share of labor employed in the secondary sector, 1940-2000

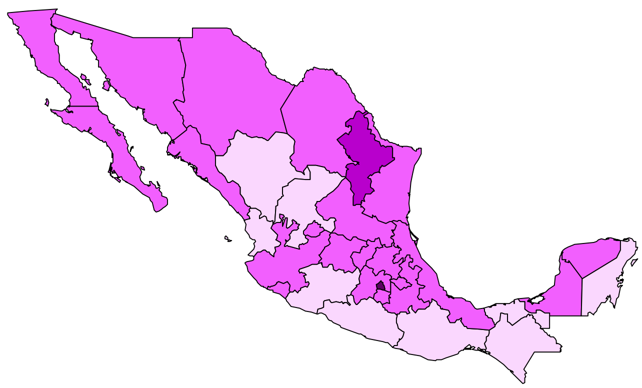
STATE SHARE OF LABOR EMPLOYED IN THE SECONDARY SECTOR, 1940



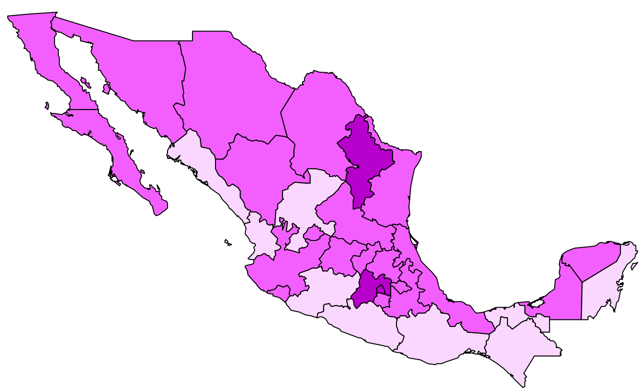
STATE SHARE OF LABOR EMPLOYED IN THE SECONDARY SECTOR, 1950



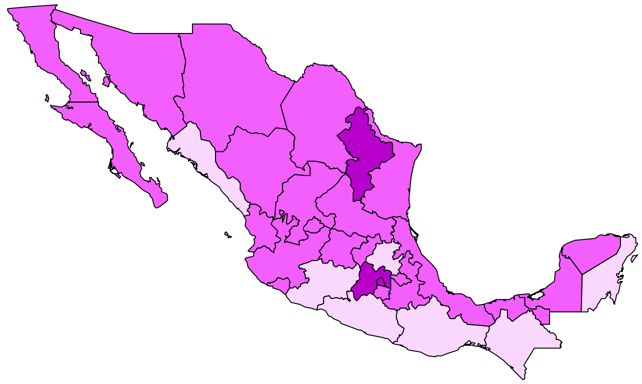
STATE SHARE OF LABOR EMPLOYED IN THE SECONDARY SECTOR, 1960



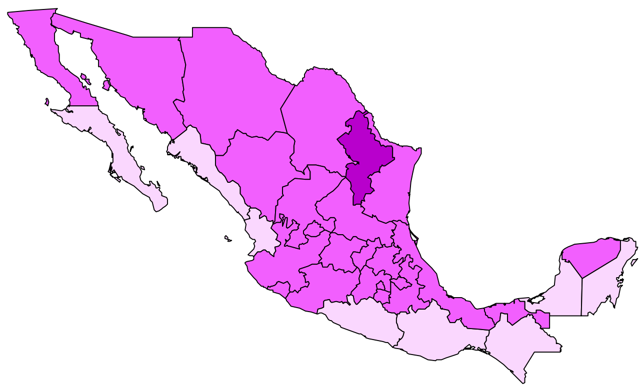
STATE SHARE OF LABOR EMPLOYED IN THE SECONDARY SECTOR, 1970



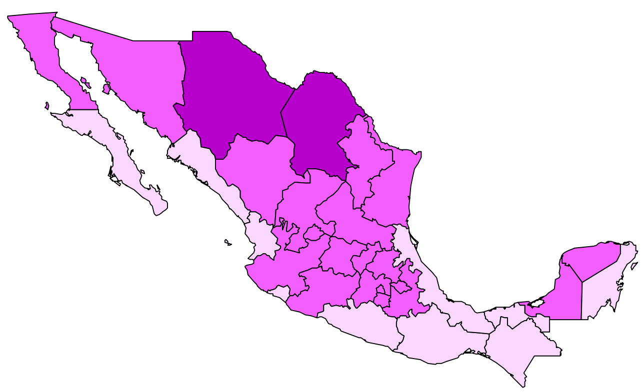
STATE SHARE OF LABOR EMPLOYED IN THE SECONDARY SECTOR, 1980



STATE SHARE OF LABOR EMPLOYED IN THE SECONDARY SECTOR, 1990



STATE SHARE OF LABOR EMPLOYED IN THE SECONDARY SECTOR, 2000

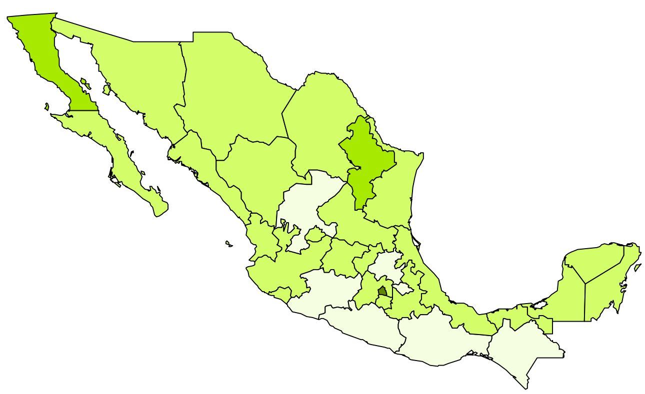


Appendix 8: State share of labor employed in the tertiary sector, 1940-2000

STATE SHARE OF LABOR EMPLOYED IN THE TERTIARY SECTOR, 1940

STATE SHARE OF LABOR EMPLOYED IN THE TERTIARY SECTOR, 1950

STATE SHARE OF LABOR EMPLOYED IN THE TERTIARY SECTOR, 1960



STATE SHARE OF LABOR EMPLOYED IN THE TERTIARY SECTOR, 1970

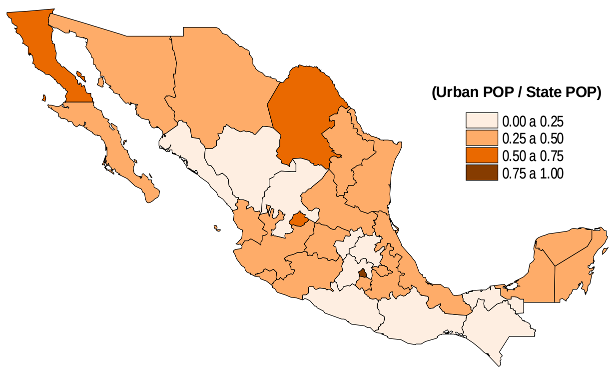
STATE SHARE OF LABOR EMPLOYED IN THE TERTIARY SECTOR, 1980

STATE SHARE OF LABOR EMPLOYED IN THE TERTIARY SECTOR, 1990

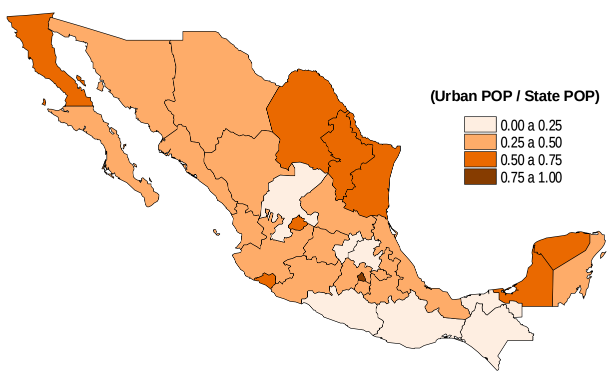
STATE SHARE OF LABOR EMPLOYED IN THE TERTIARY SECTOR, 2000

Appendix 9: States urban population 1930, 1950, 1970, 1990 and 2000

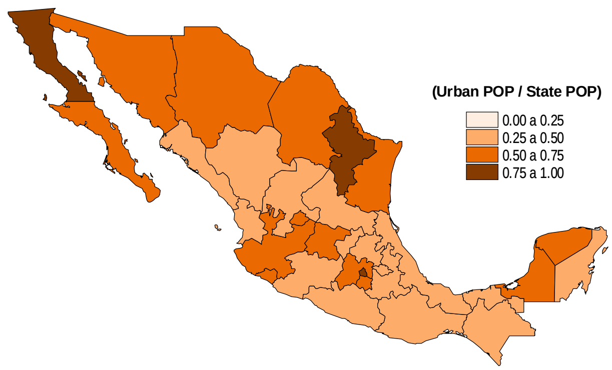
STATE URBAN POPULATION, 1930



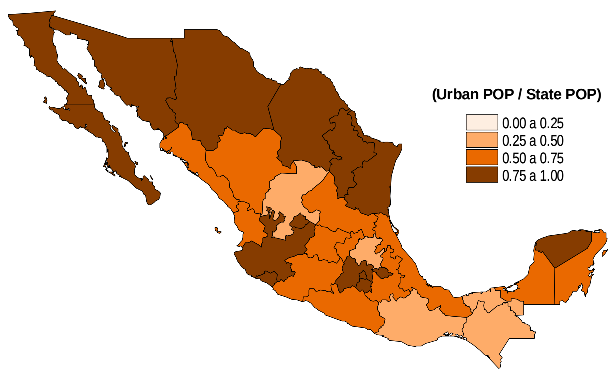
STATE URBAN POPULATION, 1950



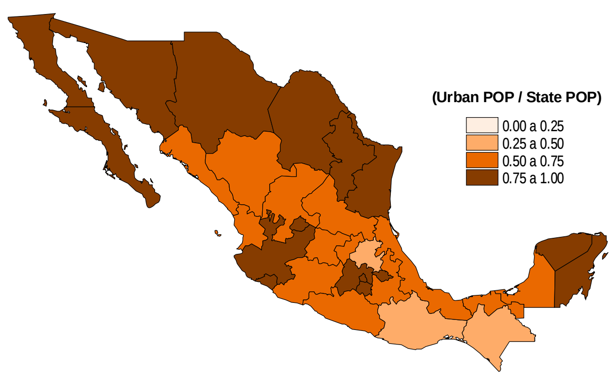
STATE URBAN POPULATION, 1970



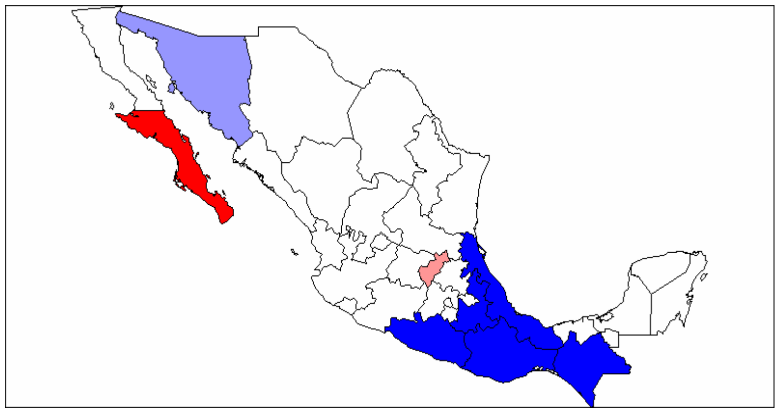
STATE URBAN POPULATION, 1990

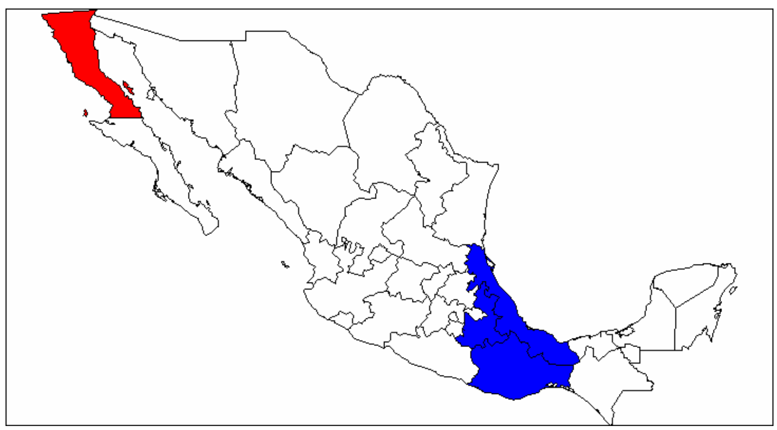


STATE URBAN POPULATION, 2000

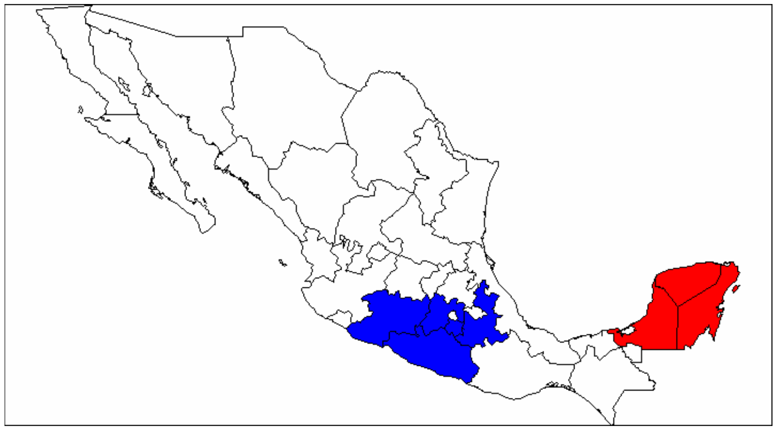


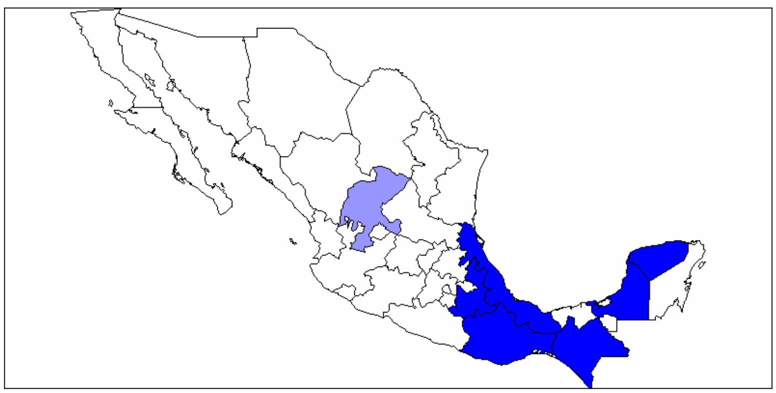
Appendix 10: Cluster Maps of Local Indicators of Spatial Autocorrelation for state per capita income 1940, 1970 and 2000

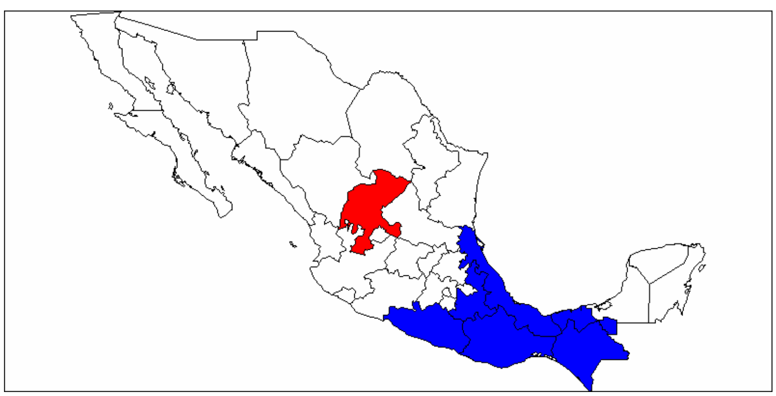




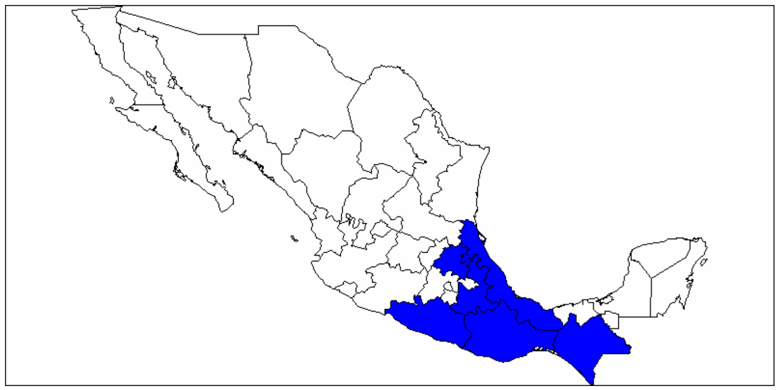
Appendix 11: Cluster Maps of Local Indicators of Spatial Autocorrelation for share of housing units with direct access to the water network 1940, 1970 and 2000

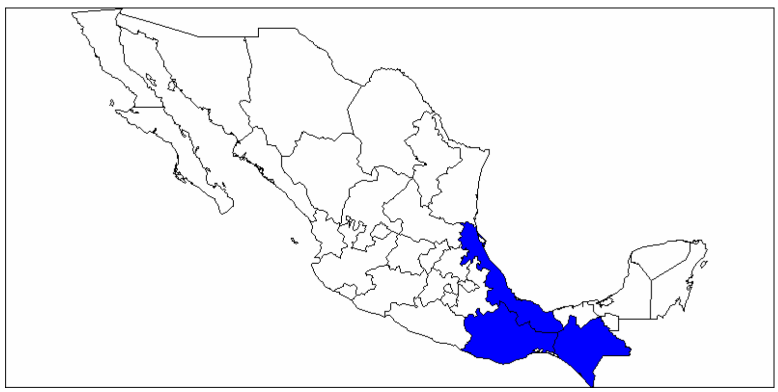




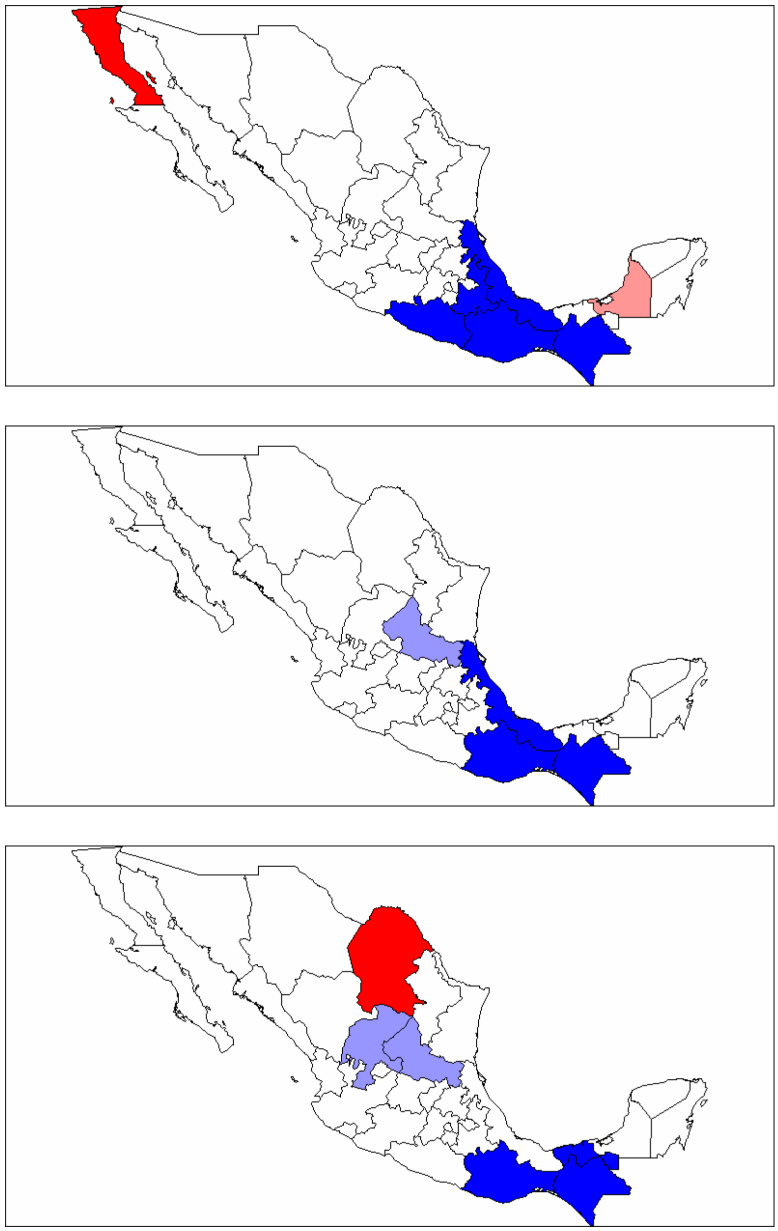


Appendix 12: Cluster Maps of Local Indicators of Spatial Autocorrelation for state share of urban population 1930, 1970 and 2000

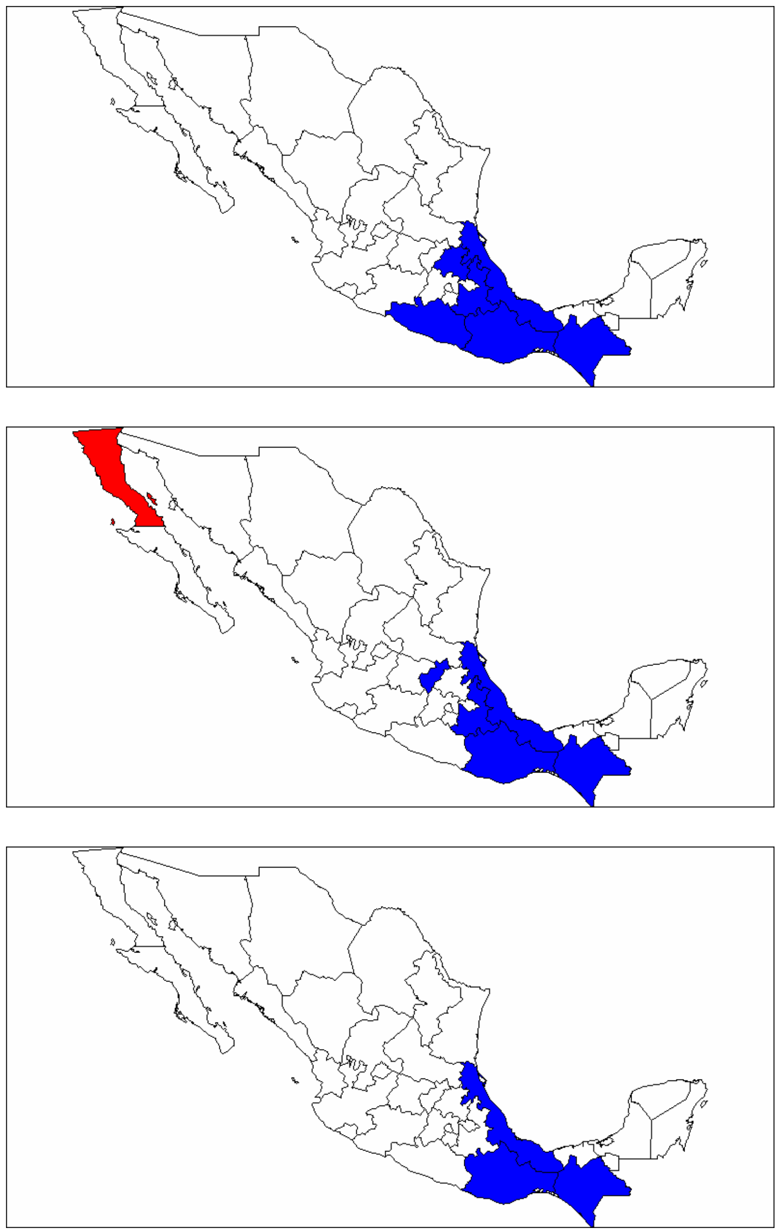




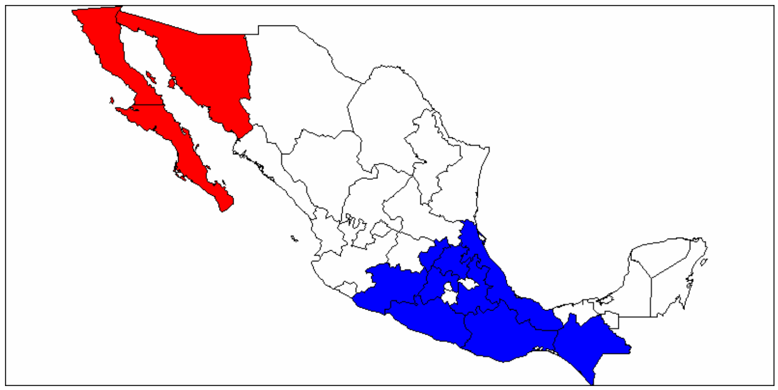
Appendix 13: Cluster Maps of Local Indicators of Spatial Autocorrelation for labor employed in secondary sector 1940, 1970 and 2000

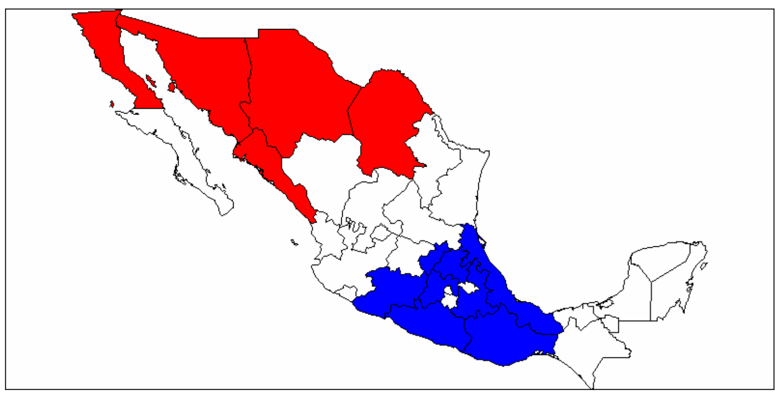


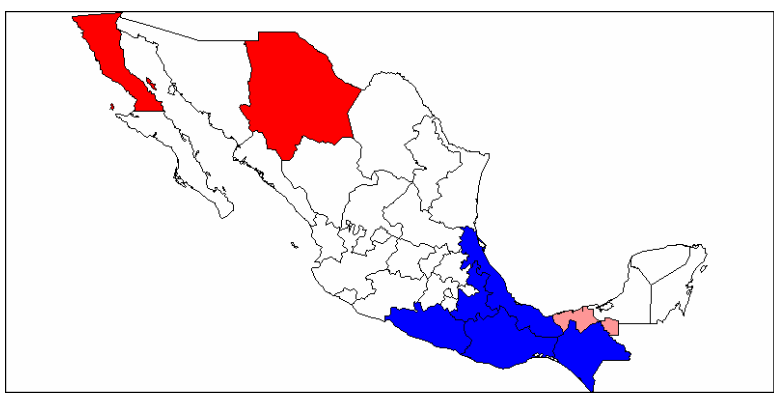
Appendix 14: Cluster Maps of Local Indicators of Spatial Autocorrelation for labor employed in tertiary sector 1940, 1970 and 2000



Appendix 15: Cluster Maps of Local Indicators of Spatial Autocorrelation for state literacy rate 1940, 1970 and 2000







Appendix 16: Cluster Maps of Local Indicators of Spatial Autocorrelation for labor employed in primary sector 1940, 1970 and 2000

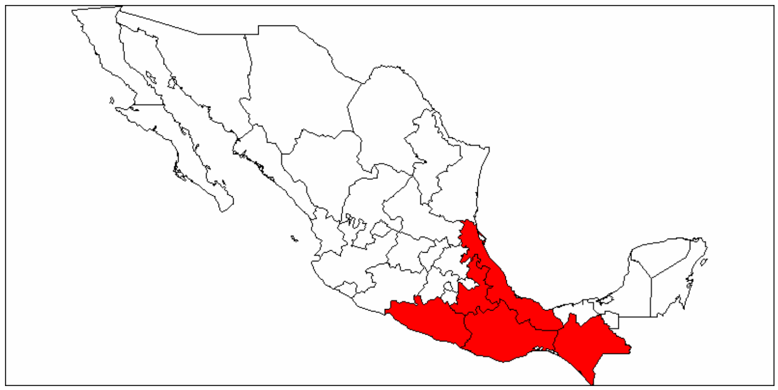
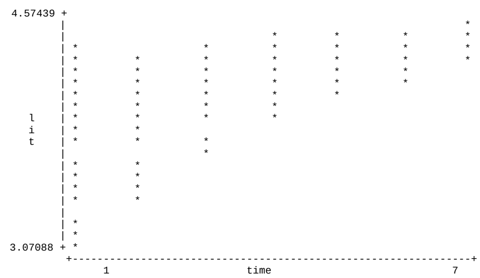
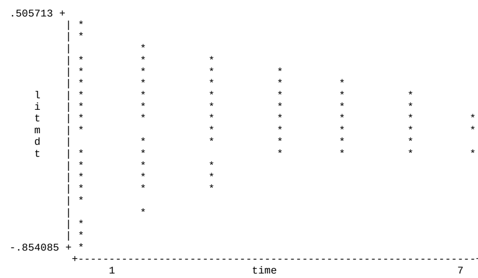


Table 34: Comparison of time trend of different variables

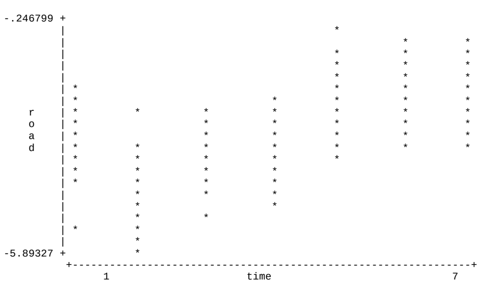
Literacy



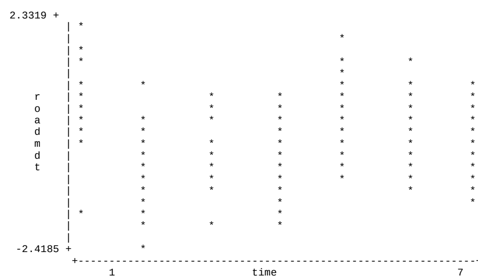
Literacy de-trended



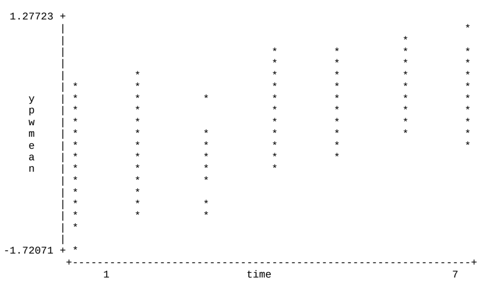
Highway density



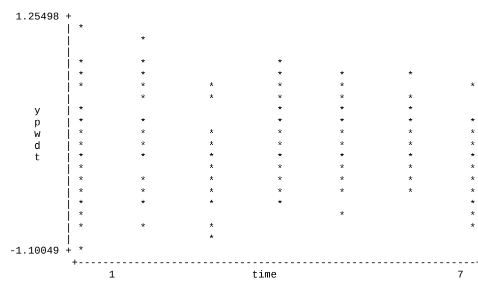
Highway density de-trended



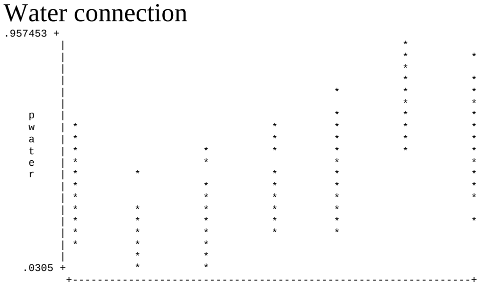
Per worker income



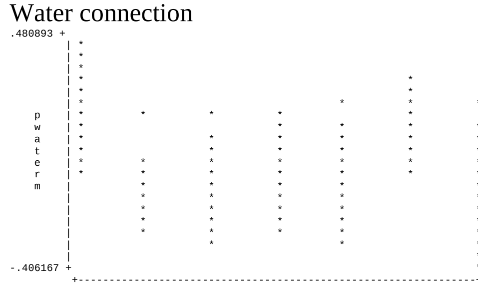
Per worker income de-trended



Water connection



Water connection



Appendix 18: Autocorrelation function of the residuals

Table 35: Autocorrelation function of the residuals at various lags

Cross product of residuals and lags	ACF Highway density	ACF Water connection
First lag	0.59	0.69
Second lag	0.63	0.67
Third lag	0.59	0.64
Fourth lag	0.42	0.58
Fifth lag	0.28	0.39
Fifth lag	0.28	0.39

The unit lag is a decade

Appendix 19: Hausman Test

The Hausman test reported here shows that the coefficients estimated by the two models (fixed and random effects) are different, as we reject the null that the difference in coefficients is not systematic. Under the null hypothesis that the unit effects and the rest of the variables are not correlated, both coefficients (b for the fixed effects and B for the random effects estimation) are consistent, but those estimated by random effects are more efficient. Under the alternative hypothesis, that the unit effects are not zero, the fixed effects estimators are consistent, but the random effects ones are not. This test is based on the assumption that if the variance due to unit specific effects is not equal to zero (i.e. it is not a constant), then the coefficients estimated by both models should be the same (Greene, 2003). Thus, the results of this test suggest the need for a model that accounts for unit specific effects. More importantly, as stated in the main text (p.89), the option of choosing a fixed-effects specification is based on theoretical assumptions rather on empirical tests.

Table 36: Hausman test on the appropriateness of fixed effects vs. random effects specification

	Coefficients		(b-B)	Square root (diag(V_b-V_B))
	(b) fixed	(B)	Difference	S.E.
Hypothesis 1: Trade openness * per worker income	0.005	0.005	0.000	0.000
Hypothesis 2: Trade openness * highway density	0.442	0.257	0.185	0.034
Hypothesis 3: Trade openness * human capital	-0.006	-0.003	-0.003	0.001
Trade openness	-0.080	-0.080	0.000	0.006
Per worker income	-0.014	-0.004	-0.009	0.002
Highway density	-0.208	-0.249	0.041	0.170
Human capital	-0.014	0.001	-0.014	0.004
Domestic diffusion	0.00001	0.0002	-0.0002	0.0003
Growth of labor	-25.358	16.392	-41.750	17.611
Level of capital	0.267	0.123	0.144	0.059
Spatial lag	0.035	0.114	-0.078	0.053
chi2 (8) =	26.43			
Prob>chi2 =	0.0009			
Hypothesis 1: Trade openness * per worker income	0.0038	0.0047	-0.0009	0.0002
Hypothesis 2: Trade openness * water connection	0.6000	0.4029	0.1972	0.0387
Hypothesis 3: Trade openness * human capital	-0.0109	-0.0077	-0.0032	0.0005
Trade openness	-0.2272	-0.1905	-0.0367	0.0114
Per worker income	-0.0175	-0.0064	-0.0111	0.0021
Water connection	0.9533	0.6996	0.2537	0.0857
Human capital	-0.0178	-0.0052	-0.0126	0.0037
Domestic diffusion	-0.0002	0.0000	-0.0002	0.0003
Growth of labor	-14.265	13.682	-27.947	17.247
Level of capital	0.1068	0.0468	0.0600	0.0592
Spatial lag	-0.0963	0.0155	-0.1118	0.0491
chi2 (7) =	30.65			
Prob>chi2 =	0.0001			

Appendix 20: Variables descriptive statistics

Table 37: Data descriptive statistics

Concept	Variation	Mean	St. Dev.	Min	Max
Dependent variable					
Growth of state GDP per	overall	0.20	0.25	-1.09	0.88
capita	between		0.06	0.04	0.31
	within		0.24	-0.98	0.81
Independent variables					
Hypothesis 1:	overall	-3.23	29.79	-108.81	196.89
Trade openness * per	between		6.76	-14.69	18.96
worker income	within		29.04	-105.22	174.71
Hypothesis 2:	overall	0.02	0.24	-0.68	1.83
Trade openness * highway	between		0.08	-0.08	0.26
density	within		0.23	-0.63	1.58
Hypothesis 3:	overall	-2.86	16.45	-72.81	33.46
Trade openness * human	between		6.22	-13.13	10.87
capital	within		15.26	-79.17	24.30
Trade openness	overall	-2.5E-08	1.95	-1.66	4.27
	between		0	-2.55E-08	-2.5E-08
	within		1.95	-1.66	4.27
Per worker income level	overall	8.70E-08	13.44	-25.48	46.52
	between		11.48	-16.35	29.22
	within		7.24	-22.12	22.29
Highway density	overall	-7.0E-10	0.10	-0.16	0.64
	between		0.08	-0.08	0.27
	within		0.07	-0.25	0.37
Water connection	overall	1.25E-09	0.18	-0.41	0.48
	between		0.10	-0.20	0.21
	within		0.15	-0.25	0.51
Endogenous human capital	overall	-7.0E-08	11.79	-30.77	31.66
	between		10.76	-20.98	16.18
	within		5.14	-14.39	15.50
Domestic diffusion term	overall	5.18E-07	61.09	-113.97	236.60
	between		46.69	-78.80	109.13
	within		40.13	-167.32	127.48
Capital	overall	-6.6E-12	0.0015	-0.0048	0.0040
	between		0.0013	-0.0035	0.0027
	within		0.0008	-0.0020	0.0026
Growth of workforce	overall	0.31	0.20	-0.17	1.15
	between		0.11	0.14	0.66
	within		0.17	-0.11	0.81
Spatial lag	overall	0.22	0.19	-0.16	0.72
	between		0.07	0.04	0.45
	within		0.18	-0.17	0.62

Appendix 21: Correlation among independent variables

Table 38: Correlation among independent variables

	Hyp1	Hyp2: highway	Hyp2: water	Hyp3	Trade	Income	Highway	Water	Literacy	Domestic diffusion	Labor growth	Capital	Spatial
Hyp1	1												
Hyp2: highway	-0.2451	1											
Hyp2: water	0.4527	0.2384	1										
Hyp3	0.6277	-0.1279	0.3897	1									
Trade	0.1461	-0.1176	0.28	0.0681	1								
Income	-0.5226	0.0342	-0.1864	-0.4578	0.0934	1							
Highway	0.0405	-0.0968	-0.1223	0.0884	0.2019	-0.1986	1						
Water	-0.1323	-0.1372	-0.3865	-0.2016	0.5524	0.4218	0.2528	1					
Literacy	-0.4291	0.0888	-0.2426	-0.8544	-0.0318	0.6121	-0.0913	0.3206	1				
Domestic diffusion	0.4108	-0.067	0.0186	0.2012	-0.0032	-0.7234	0.1846	-0.1253	-0.2921	1			
Labor growth	-0.2983	0.1516	-0.0052	-0.2327	-0.0205	0.3767	-0.0196	0.2015	0.244	-0.1536	1		
Capital	-0.2034	0.1075	-0.086	-0.1466	-0.0316	0.2123	-0.044	0.1135	0.1448	-0.2342	0.0665	1	
Spatial	0.0929	0.0602	-0.1847	0.1237	-0.5104	-0.249	-0.1198	-0.181	-0.1763	0.0715	0.0556	0.0954	1

Appendix 22: Summary statistics by economic sector

Concept	Variation	Mean	St. Dev.	Min	Max
Growth of state GDP per capita	overall	0.020	0.053	-0.195	0.201
primary sector	between		0.015	-0.028	0.037
	within		0.051	-0.197	0.184
Growth of state GDP per capita	overall	0.013	0.100	-0.668	0.721
secondary sector	between		0.013	-0.014	0.047
	within		0.099	-0.702	0.686
Growth of state GDP per capita	overall	0.019	0.056	-0.175	0.211
tertiary sector	between		0.010	0.003	0.050
	within		0.055	-0.176	0.207
Hypothesis 1:	overall	-175.521	1144.391	-5613.926	2766.414
Trade openness * per worker	between		441.955	-1565.610	788.992
income, primary	within		1058.143	-4356.062	2414.346
Hypothesis 1:	overall	-220.205	1246.995	-4661.650	9961.298
Trade openness * per worker	between		342.527	-807.024	884.370
income, secondary	within		1200.372	-4739.037	8856.723
Hypothesis 1:	overall	-270.622	883.627	-2884.522	2163.247
Trade openness * per worker	between		210.743	-648.814	276.459
income, tertiary	within		858.839	-2974.349	1967.335
Hypothesis 2:	overall	6.937	305.946	-745.080	3217.085
Trade openness * highway	between		115.097	-96.549	537.980
density	within		284.112	-1060.896	2686.043
Hypothesis 2:	overall	13.582	359.510	-1843.308	857.681
Trade openness * water	between		68.412	-119.118	111.869
connection	within		353.122	-1726.976	792.303
Hypothesis 3:	overall	-3608.760	18179.360	-75437.380	38934.220
Trade openness * literacy	between		7178.954	-17181.900	10535.020
	within		16744.150	-89293.480	29522.520
Trade openness	overall	0.000	1940.096	-1885.048	4047.099
	between		0.000	0.000	0.000
	within		1940.096	-1885.048	4047.099
Per worker income level	overall	0.000	0.567	-1.387	1.522
primary sector	between		0.407	-0.736	0.783
	within		0.401	-1.575	1.335
Per worker income level	overall	0.000	0.761	-6.502	1.825
secondary sector	between		0.438	-1.249	0.760
	within		0.627	-5.252	1.809
Per worker income level tertiary	overall	0.000	0.489	-1.412	1.280
sector	between		0.263	-0.486	0.589
	within		0.415	-1.250	1.163
Highway density	overall	0.000	0.148	-0.184	1.666
	between		0.103	-0.089	0.437
	within		0.107	-0.421	1.228
Water connection	overall	0.000	0.175	-0.455	0.468
	between		0.106	-0.205	0.218
	within		0.140	-0.260	0.509
Endogenous human capital	overall	0.000	11.627	-32.707	29.721
	between		9.738	-20.154	15.229
	within		6.555	-22.029	23.703
Spatial lag, primary	overall	0.019	0.045	-0.156	0.173
	between		0.017	-0.021	0.062
					0.156
	within		0.042	-0.116	

Spatial lag, secondary	overall	0.018	0.051	-0.176	0.244
	between		0.012	-0.009	0.045
	within		0.049	-0.154	0.266
Spatial lag, tertiary	overall	0.020	0.059	-0.095	0.293
	between		0.014	0.003	0.066
	within		0.057	-0.141	0.248

Appendix 23: Comparison of results for the tertiary sector

Table 39: Comparison of the results for the tertiary sector

Fixed effects model vs. the first order autocorrelation model for the difference of natural log of per worker GDP, 1940-2000				
	Regression using highway density		**Regression using water connection**	
	Normal	***AR-1***	***Normal***	***AR-1***
Hypothesis 1: Trade openness * pw income	0.00001 (0.00001)	0.00001 (0.00001)	0.00001 (0.00001)	0.00001 (0.00001)
Hypothesis 2: Trade openness * infrastructure	-0.00003** (0.00002)	0.00003 (0.00002)	0.00006** (0.00002)	0.00005** (0.00003)
Hypothesis 3: Trade openness * human capital	-0.00000 (0.00000)	-0.0000001 (0.0000003)	-0.00000** (0.00000)	-0.0000008 (0.0000005)
Trade openness	-0.00001*** (0.00000)	-0.00001*** (0.00000)	-0.00001*** (0.00000)	-0.00001** (0.00001)
Per worker income	-0.04411*** (0.01165)	-0.03446*** (0.01431)	-0.04914*** (0.01127)	-0.03747*** (0.01418)
General infrastructure	-0.07111** (0.03294)	0.06487 (0.04366)	0.05394 (0.03597)	0.00202 (0.07224)
Endogenous human capital	-0.00113* (0.00061)	0.00053 (0.00085)	0.00007 (0.00071)	-0.00051 (0.00092)
Spatial lag variable	0.49186*** (0.05513)	0.53400*** (0.06128)	0.46850*** (0.05829)	0.50945*** (0.06497)
N =	192	160	192	160
T =	32	32	32	32
Within R^2 =	0.69	0.71	0.70	0.71
Between R^2 =	0.06	0.00	0.11	0.02
Overall R^2 =	0.65	0.67	0.64	0.65

Appendix 24: Comparison of results across sectors

Table 40: Comparison of results across economic sectors

Fixed effects regressions of per capita income growth, 1940-2000							
		Highway density			**Water connection**		
Concept	**Measurement**	**Primary Sector**	**Secondary Sector**	**Tertiary Sector**	**Primary Sector**	**Secondary Sector**	**Tertiary Sector**
Hypothesis 1: Trade openness * pw income	$r(\ln O_{t-1} \ln y_{it-1})$	0.00001* (0.00001)	0.000001 (0.00001)	0.00001 (0.00001)	0.00001 (0.00001)	0.000000 (0.00001)	0.00001 (0.00001)
Hypothesis 2: Trade openness * infrastructure	$q(\ln O_{t-1} I_{it-1})$	0.00004** (0.00002)	0.00004 (0.00003)	0.00003 (0.00002)	0.00001** (0.00000)	0.00017*** (0.00004)	0.00005** (0.00003)
Hypothesis 3: Trade openness * human capital	$n(\ln O_{t-1} \ln h_{it-1})$	-0.00000 (0.00000)	0.000001 (0.000001)	-0.0000001*** (0.0000003)	-0.00000* (0.00000)	0.0000002** (0.000001)	-0.0000008 (0.0000005)
Trade openness	$s(\ln O_{t-1})$	-0.00001** (0.00000)	-0.00001*** (0.000004)	-0.00001*** (0.00000)	-0.00001*** (0.00000)	-0.00003*** (0.00001)	-0.00001** (0.00001)
Per worker income	$z(\ln y_{it-1})$	-0.04379*** (0.00953)	-0.12008*** (0.01277)	-0.03446*** (0.01431)	-0.05063*** (0.00958)	-0.11386*** (0.01220)	-0.03747*** (0.01418)
General infrastructure	$p(I_{it-1})$	-0.07629** (0.03668)	-0.08928 (0.06008)	0.06487 (0.04366)	-0.01676** (0.00826)	0.24786*** (0.06608)	0.00202 (0.07224)
Endogenous human capital	$(g-m)(\ln h_{it-1})$	-0.00049 (0.00072)	0.00394*** (0.00110)	0.00053 (0.00085)	-0.00097 (0.00074)	0.00092 (0.00131)	-0.00051 (0.00092)
Spatial lag variable	$\rho(Wy)$	0.30771*** (0.07467)	0.22269** (0.10744)	0.53400*** (0.06128)	0.36852*** (0.06994)	0.10184 (0.10804)	0.50945*** (0.06497)
	Within R^2=	0.45	0.66	0.71	0.45	0.67	0.71
	Between R^2=	0.02	0.16	0.00	0.00	0.28	0.02
	Overall R^2=	0.30	0.52	0.67	0.24	0.54	0.65

Appendix 25: List of Interviews

Industry Associations and national agencies

- Lic. Arturo Cobian, General Director, CANAFEM (National Chamber of Producers of Metallic Containers) January 10, 2006.
- Dr. Juan Pablo Llamas, CANIFARMA (National Chamber of Pharmaceutical Enterprises) January 13, 2006.
- Ing. Alfredo López Machorro (National Association of Producers of Plastic) January 13, 2006.
- Claudia Ávila Connelly, General Director, AMPIP (Mexican Association of Private Industrial Parks) January 20, 2006.
- Dr. Reyes Suárez del Ángel, Vice-president, CNEC (National Chamber of Consulting Firms) March 16, 2006.
- Lic. Xochitl Hernández Lara, Sub-director of technical training, CONALEP (National College of Professional Technical Education) March 16, 2006.

Academics

- Dr. Ismael Aguilar, Technological Institute of Monterrey. Various phone conversations and email exchanges.
- Dr. Maria-Luisa Decuir Viruez, Kent University.

State officials and state industry associations

- Lic. Carolina Berumen, Coparmex Aguascalientes (Confederation of Business Owners) January 30, 2006.
- Jorge Ayala Gil, Chief of the Statistics Department of the Secretariat of Economic Development Aguascalientes, January 31, 2006.
- C.P. Gerado Guapo, Advisor to COFOCE, Guanajuato (Commission for the promotion of International Trade) February 3, 2006.
- Lic. Héctor López Santillana, Secretary of the Secretariat of Sustainable Development, Guanajuato, February 8, 2006.
- Lic. Daniel Meléndez Sánchez, Director of the Department of Analysis, Evaluation and Strategy, Secretariat of Sustainable Development, Guanajuato, February 7, 2006. Follow up via email.
- Ing. Armando García Jiménez, Secretary, Secretariat of Rural Development, Nayarit, February 16, 2006.
- Benjamin Gutierrez Gallo, Ex-Secretary of Economic Development, Nayarit, various email exchanges and phone conversations.

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