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# Regional Convergence, Road Infrastructure, and Industrial Diversity in Mexico

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**ABSTRACT**

This paper presents a convergence analysis of productivity growth in the manufacturing sector in Mexico using regional data from the National Economic Census 1999 and 2004. The absolute convergence analysis indicates that regional productivity growth follows a slow convergence trajectory. However, a conditional convergence analysis indicates that current productivity gaps can be directly attributed to divergences in the industrial profile of the regional economy as well as to differences in infrastructure endowments. The results of the paper suggest that the productivity gaps which originated from the liberalisation reforms of the 1980s and 1990s will be exhausted in 25 years approximately. The innovation of this paper is the extension of a convergence analysis to the industrial sector. The use of regional data improves the details of the analysis and allows the identification of growth patterns that had not been previously identified. Finally, it applies innovative metrics to model the industrial profile of a region and the value of transport infrastructure.

**KEYWORDS**

Road infrastructure, Growth, Manufacturing, Mexico, NAFTA, International trade, Border infrastructure, Convergence

**JEL codes**

014, 018, 019

## 1 INTRODUCTION

The North American Free Trade Agreement (NAFTA), signed in 1994, was the peak of a liberalisation reform in the Mexican economy, which started in the mid 1980s and dramatically transformed the country. In the first five years after the NAFTA took effect – between 1995 and 2000– Mexico underwent an average growth rate of 7.8 percent, fostered by an incredible growth of its export sector. However, the development process that NAFTA triggered was far from even across Mexican regions. Between 1995 and 2000 the border states[1] experienced a growth rate of seven percent, considerably higher than that experienced by the southern states[2], where the growth rate was on average three percent. This behaviour generated a geographic polarisation of the Mexican economy, which had and still has consequences on the social and demographic development of the country as a whole.

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1 Baja California, Chihuahua, Coahuila, Nuevo Leon, Sonora, and Tamaulipas.
2 Chiapas, Guerrero, and Oaxaca.

In order to investigate the roots of this process this paper presents a convergence analysis of productivity in the manufacturing sector, using regional data from the National Economic Census (NEC) 1999 and 2004. The analysis attempts to investigate whether productivity is converging or diverging in growths rates or levels across regions in Mexico for this sector. We estimate an absolute and a conditional convergence model using four different econometric approaches, including a spatial autocorrelation model.

The most important result of the analysis is that manufacturing productivity follows a slow conditional convergence trajectory. There are two main factors for this long-run productivity convergence. The first one is a change in the industrial profile of industrially specialised regions to a more diverse composition. The second factor is that the productivity gains originally generated by the 1980s and 1990s liberalisation reforms will be eventually exhausted in the long term.

In particular, our analysis identifies industrial specialisation and accessibility to international markets as significant determinants in a conditional convergence model. This implies that the present gaps in manufacturing productivity can be directly associated to differences in industrial profiles at regional level as well as divergences on accessibility endowments. Finally, the analysis suggests that road infrastructure does generate positive spillovers on productivity as long as it is complementary to the liberalisation reforms. These results highlight the importance of infrastructure policy as a tool for achieving an even development process at regional level.

## 2 LITERATURE REVIEW

One of the most important predictions of neo-classical economic growth theory is convergence. This concept implies that if two economies have the same technology, and their economic agents have the same preferences, the initially poorer economy will grow faster in per capita terms.

Barro and Sala-i-Martin (1992) propose a simple empirical framework to test the validity of this prediction. Starting from a standard neo-classical growth model, the authors derive the expression presented in Equation 1.

**Equation 1**

$$\log\left(\frac{y_{i,t+T}}{y_{i,t}}\right) = \alpha - \frac{1-e^{-\beta T}}{T}\log(y_{i,t}) + \varepsilon_{i,t+T}$$

In Equation 1, $y_{i,t}$ is the initial per capita income for economy $i$, $y_{i,t+T}$ is per capita income when $T$ years have elapsed, $\varepsilon_{i,t+T}$ is a random variable, and $\alpha$ is a constant. In this expression, $\beta$ is the speed of convergence to a long-run steady state common to all the economies. A positive value for this parameter implies absolute convergence, and a negative value suggests that the per capita income diverges across different economies.

Barro and Sala-i-Martin (1992) applied this framework to the analysis of historic USA data at state level, finding strong evidence of income convergence. However, when the analysis is extended to an international context it is not possible to get the same result. This puzzle has been tackled with the introduction of conditional convergence. The idea is that the intrinsic parameters that determine the long-run steady state of per capita income –*ie* technology and preferences- vary across different economies. Therefore, conditional convergence predicts that income per capita will converge given these parameters. In practice, economies that exhibit similar characteristics are expected to converge in their income levels. In fact, this is the case for the developed countries in the Organisation for Economic Cooperation and Development (Barro and Sala-i-Martin 1992).

Some of the authors that have analysed convergences for the Mexican case are Chiquiar (2004), Equivel (1999), Equivel and Mesmacher (2002), Garcia-Verdu (2002), Juan-Ramon and Rivera-Batiz (1996), Mallick and Carayannnis (1994), Messmacher (2000), Rodríguez-

Oreggia (2001), Rodriguez-Pose and Sanchez-Reza (2002a), and Rodriguez-Pose and Sanchez-Reza (2002b). These studies have shown that, in general terms, per capita income seemed to converge across states until the mid 1980s, when this pattern was broken.

The divergences in the geographical distribution of income the literature has identified may be directly associated with trade liberalisation (Rodriguez-Pose and Sanchez-Reza 2002b). In the mid 1980s the Mexican economy started a deep structural transformation, driven by a change in international trade policy. It started precisely in 1986, when the country entered into the General Agreement on Tariffs and Trade (GATT) and culminated in 1994, with the signature of the NAFTA. Some of the research that has analysed growth patterns after the mid 1990s has shown that after NAFTA the convergence process was never restored. In fact, there is robust evidence showing that trade liberalisation and membership of NAFTA is connected to a greater geographic polarisation.

Immediately after Mexico entered into the NAFTA the domestic economy experienced an outstanding boost of its export sector. For example, between 1993 and 2000, the share of non-oil exports in the gross domestic product increased from 13 to 38 percent (INEGI 2008). This improvement was driven by the export-oriented manufacturing sector. However, the distribution of these improvements was not even across the country. In fact, the empirical literature shows that the states that are closer to the USA market have experienced greater benefits from the structural changes in comparison to the states in the south (Rodriguez-Pose and Sanchez-Reza 2002a).

An illustration of this point is one of the most successful export programmes in Mexico: the *maquila* industry. This programme gives tax exceptions to intermediate goods imported from the USA and Canada, which are also the main destinations of the *maquila* industry exports. The gross product of the *maquila* sector in 2003 represented 59 percent of the total manufacturing product in the country and up to 99 percent of the product was exported

(INEGI 2008). The importance of the *maquila* industry in Mexican exports, its weight in manufactures' product, and the peculiarities of its spatial distribution suggest that the polarisation of income levels has been driven by an asymmetric growth of the manufacturing sector.

Physical proximity to international markets is only part of the explanation of the uneven process of growth. Infrastructure endowments, human capital, and the industrial composition of the economy have been identified as some of the key variables that explain the divergences in growth rates across Mexico. For example, the empirical literature has shown that the states that had sufficient availability of communications and transport infrastructure, an important presence of large firms with export capabilities, and a relatively well educated labour force, have been more likely to take advantage of the liberalisation reforms that started in the mid 1980s (Chiquiar 2004). Moreover, within a country, the differences in the institutional framework are not as significant as at international level, given that a country shares these features as a whole political unit. This is an additional argument that supports the hypothesis that the differences in socio-economic determinants, rather than the divergences in institutions, are the cause of the interregional gaps in income levels.

## 3 REGIONAL CONVERGENCE IN THE MANUFACTURING SECTOR

The analysis presented in this paper applies the methodology of the convergence literature to the analysis of the recent evolution of the manufacturing sector in Mexico. We use data from the NEC in 1999 and 2004 to study the growth pattern of the productivity, measured as the gross value added per worker during this period. The objective is to verify whether the present regional productivity gaps across the country are widening or closing. The dataset is the most updated information on production in the manufacturing sector in the country at local level. It covers a period that has not been analysed previously at this geographic level.

Following the limited availability of data, the existing literature has relied on the analysis of state economies. The state-level approach has an important limitation because it cannot analyse in detail any kind of intra-state divergences. This can be particularly troublesome in the analysis of conditional convergences. The geographic scale effects of variables such as infrastructure might be limited to a local context and not apply to the whole state. Under this scenario, if the weight of a region in a state is not large enough to be captured by aggregate state data, an analysis might underestimate the real effects of infrastructure.

The NEC provides an exceptional opportunity to analyse growth patterns at local level given that it presents information on production at municipal level. However, the direct analysis of municipal data might not be as useful for the study of conditional convergence because of the potential interaction between a municipality and neighbouring locations. In this case, the industrial composition of a region might be a more relevant piece of information. A middle point to tackle this geographic scale trade-off is the use of regional data. We use the NEC to build-up a dataset on manufacturing production at regional level following the regionalisation proposed by Bassols-Batalla (1993, 2002).

### 3.1 Absolute Regional Convergence

Absolute convergence is analysed using four different econometric models. The first one estimates the non-linear model presented in Equation 1 under a non-linear least squares regression (NLLS). This model assumes the error term $\varepsilon$ is independent from the explanatory variables.

It is worth noting that Equation 1 is intrinsically a linear model. A linear version of this model, as presented in Equation 2, would estimate $\alpha$ and $\beta$ such that it would be possible to recover the original values of the parameters of the non-linear model.

**Equation 2**

$$\log\left(\frac{y_{i,1}}{y_{i,0}}\right) = \alpha - \beta \log(y_{i,0}) + \varepsilon_{i,1}$$

The NLLS model assumes that the variance of the error term is constant for all the observations. This could be a restrictive assumption because the number of industrial activities in a particular location varies considerably from region to region. Therefore, we could expect the variance of the model to depend on the relative size of the region. To investigate this possibility we also estimate the model using robust maximum likelihood (ML). This is our second model, which considers a Huber-White estimator of variance. The linear model was also estimated using robust ordinary least squares (OLS). This is our third model. The results are presented for comparison purposes.

Finally, the fourth model considers a spatial autoregressive (SAR) error term. A concern in empirical research dealing with small-scale geographic data is the possibility of spatially correlated errors. This possibility arises when the error term is not independent from the errors of the neighbouring observations. In particular, we consider a case where the magnitude of the dependence of the spatially-lagged residuals decays as a function of an impedance measure among the observations. This relationship is described in the SAR model presented in Equation 3.

**Equation 3**

$$\varepsilon_{i,t} = \rho \mathbf{W} \varepsilon_{i,t} + u_{i,t}$$

In this expression, $\varepsilon_{i,t}$ and $u_{i,t}$ are independent and identically distributed random variables. **W** is a spatial weighting matrix of known constants with rank equal to number of observations, and $\rho$ is a spatial autoregressive parameter. The elements of **W** are assumed to be the inverse of an impedance measure $d_{i,j}$ that, for this exercise, is defined as the minimum time required to travel between any two regions $i$ and $j$.

Travel times and optimal routes (defined as the route that minimises travel times between any two points $i$ and $j$) were estimated using a Geography Information System North American Road Model, as presented in Duran-Fernandez (2014). Equation 4 presents the formula used to estimate the elements of the spatial weighting matrix **W**. The matrix was row-normalised multiplying each row by a constant $C_j$ such that the sum of $w_{i,j}$ across $j$ is equal to 1.

**Equation 4** $$w_{i,j} = \left(d_{i,jl}\right)^{-1} C_j$$

The SAR error term model is estimated using a generalised moment estimation for the autoregressive parameter (GMSAR) proposed by Kelejian and Prucha (1999). With this methodology, the autoregressive parameter $\rho$ and the variance of $u_{i,t}$ are estimated through a generalised moments estimation, which is based on the residuals of the first-stage OLS regression of Equation 2. The estimated parameters are used to perform a spatial Cochrane-Orcutt transformation of the original model. Finally, the transformed model is used to obtain feasible generalised least squares (FGLS) estimates of the parameters $\alpha$ and $\beta$. Kelejian and Prucha (2004) present a method to estimate the variance of the autoregressive parameter $\rho$. This parameter follows a normal distribution, which allows us to test its significance.

Table 1 presents the results of the estimation of the four models. All the coefficients present a positive sign and are statistically significant at one percent level.[3] The value of the estimated coefficient is robust across the four models. The implicit non-linear $\beta$ of the ML and OLS models is the same as in the NLLS model. The estimation of this parameter under the GMSAR model is also very similar. The estimated value of the autoregressive parameter $\rho$ in the GMSAR model is -0.55, and it is statistically significant at one percent level. Therefore, it is not possible to reject the hypothesis of spatially lagged error terms.

[3] By construction, a positive sign implies convergence because the models are estimating the value of $-\beta$.

The results show that for the period under study (1999 to 2004), manufacturing productivity experienced sharper improvements in the regions that were relatively less productive. Under a convergence framework, this implies that interregional gaps on this variable tend to decrease. According to these results, the estimated half-life of the interregional gaps is 25.7 years. This value can be interpreted as the time that it would take to reduce the present gaps by a half.

## 3.2 Conditional Regional Convergence

The positive convergence of manufacturing productivity presented in the last section suggests that on average, existing gaps during the period 1999-2004 have been closing up. Nevertheless, this result does not rule out the possibility of finding local divergences of this variable, conditional on certain socioeconomic factors. This possibility is illustrated in Figure 1. In this diagram, there are two types of economies (**U** and **L**) and each of them converges to their own equilibrium (also denoted **U** and **L**). However, the gap between **U** and **L** is closing up in time, and in the limit both types will converge to a long-run equilibrium, denoted **A**.

In order to investigate this mechanism, we estimate a conditional version of the convergence model. Following the results from the growth literature, the **U** and **L** economies can be assumed to exhibit differences in their growth determinants (Barro and Sala-i-Martin 1992), such as in their infrastructure endowments, industrial profiles and stock of human capital. The conditional convergence model incorporates metrics of these variables to analyse their impact on productivity growth rates during the period of analysis.

Transport infrastructure has been identified as one of the determinants that explain divergences in Mexico's growth pattern. In the present paper, we use the domestic, international, and regional attraction-accessibility measures (AM) to approximate the value of the road infrastructure in Mexico. We also use a network curvature index to control for the geometry and quality of the roads at regional level.

The AM used in this exercise measures the market potential of a region as a function of their road infrastructure endowment and the interregional spatial distribution of economic activity. The measure captures special characteristics of road infrastructure such as the structure of a road system, and its level of service. This approach allows us to identify separate measures for domestic, international and regional market potential, which are the basis for the estimation of the three AM used in the analysis.

Equation 5 shows the functional form of the AM used in this paper, where $p_j$ is population in location $j$, $d_{i,j}$ is travel time between locations $i$ and $j$, and $\theta$ is a parameter that can be interpreted as the elasticity of the market potential with respect to impedance.[4] In the domestic index $i$ and $j$ represent any two regions in Mexico. In the international index $i$ and $j$ represent regions in Mexico and the USA respectively. Finally, the regional index is the average accessibility for all the urban settlements in a particular region.[5] In addition to the accessibility indexes, the conditional convergence analysis includes a *network curvature index* as a control for the quality of the roads at local level. This variable is defined as the ratio between the length of the optimal routes between $i$ and $j$ in a region and the linear distance between them. This index is a measurement of road quality in any region under the assumption that higher quality roads will tend to trace direct linear paths.

**Equation 5**

$$A_i = \sum_j \frac{p_j}{d_{i,j}^{\theta}}$$

The industrial profile of an economy can be modelled using the Shannon Entropy Index ($H$). Heip (1974) shows that $H$ can be decomposed in two components: a richness ($S$) component and an evenness ($E$) component, as presented in Equation 6. In an economic context, $S$

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[4] The population data is from INEGI (2000a). The value of the impedance parameter is 0.73, following the estimates of Duran-Fernandez and Santos (2014). Finally, travel times are estimated using the GIS North American Road Model introduced in Duran-Fernandez (2014).

[5] Mexican regions follow the regionalisation proposed by Bassols-Batalla (1993, 2002). The regions in the USA are defined by the Bureau of Economic Analysis in Johnson and Kort (2004). The geographic information of urban settlements is defined in INEGI (2000b).

models the *industrial range* of an economy and $E$ models the *industrial evenness*. The *industrial range* can be measured as the number of industrial activities carried out in a particular location and the *industrial evenness* can be measured as the degree of specialisation of an economy. An independent measure for $E$ can be obtained from Equation 6, in terms of $H$ and $S$. This measure is known as the *Heip Evenness Index* ($E$), and the higher its value, the less the degree of specialisation of a region.[6]

**Equation 6** $$H = \ln(S) + \ln(E)$$

The conditional convergence model incorporates the two components of industrial diversity in order to measure separately the impacts of industrial diversification and of industrial specialisation on convergence rates. These variables are expected to capture the effects that different industrial profiles have on aggregate growth. Finally, human capital is measured using average schooling for each region. The estimation is based on municipal schooling rates from the 2000 population census.

The conditional converge analysis re-estimates the four original non-linear and linear models presented in Equations 2 and 3. They include as additional explanatory variables the four infrastructure variables (domestic, international and regional accessibility as well as the curvature index), industrial diversity (S and E), and human capital. The specification of this linear model is presented in Equation 7, where $x_i$ are the additional controls and $\gamma$ is a parameter. The non-linear model also assumes a linear specification for the controls.

**Equation 7** $$\log\left(\frac{y_{i,1}}{y_{i,0}}\right) = \alpha - \beta \log(y_{i,0}) + \sum_i \gamma x_{i,1} + \varepsilon_{i,1}$$

[6] The Shannon Entropy Index can be estimated as $H_i = \Sigma_i \pi_{i,j} \ln(\pi_{i,j})$, where $\pi_{i,j}$ is the ratio of production of the $j^{th}$ industrial activity with respect to the total. Following Heip's decomposition, presented in Equation 6, the *Heip Evenness Index* can be estimated as $E_i = S_i \exp(H_i)$, where $S_i$ is the industrial range measured as the number of industrial activities carried out in location $i$.

Table 2 presents the results of the estimation of the conditional models. The results show that the convergence parameter is positive and statistically significant under the four specifications. The implied half-life of the conditional gaps in manufacturing productivity is 8.45. Following the stylised facts illustrated by Figure 1, this would be the time for a given economy to reduce the productivity gap with respect to the short-run equilibrium (**U** or **L**) by a half. On the other hand, the half-life of the gap with respect to the long-run equilibrium (**A**) would be the one reflected by the absolute convergence model: 25.72 years. The results of the convergence model help to characterise the variables that determine the short-run convergence to a type **U** or **L** equilibrium.

The coefficient of industrial evenness suggests that manufacturing productivity growth is on average larger for specialised economies. This effect is identified by the four econometric specifications. The industrial range has a positive coefficient; however, it is not statistically significant. Due to the fact that *H* is equal to the sum of these variables, the result indicates that growth responds negatively to overall industrial diversity.

The infrastructure metrics –domestic and international accessibility- present a positive sign, indicating that regions with higher market potential tend to exhibit higher productivity growth rates. International accessibility is statistically significant for all the models, a characteristic that is not shared by domestic accessibility.

Regional accessibility and network curvature present a positive and a negative coefficient respectively; however, the coefficients are not significant for any of the models, except for the coefficient of network curvature in the ML model, which is negative and significant. Nevertheless, a joint significance test indicates that both parameters are jointly significant with a confidence level of ten percent ($\chi^2_2$=4.91). This result would suggest that the growth rate of manufacturing productivity in regions with highly interconnected local markets and good road quality is higher. Finally, schooling is positive under the four models but it is not statistically significant.

The results of all the models show that productivity growth rates of specialised regions that are well connected to international markets are in general higher. However, the joint significance tests suggest that local transport infrastructure has a positive effect on the short-run equilibrium productivity growth rate.

The autoregressive parameter $\rho$ of the GMSAR model is -0.87 and statistically significant at one percent level, suggesting that the error term follows a SAR process. Under this hypothesis, transport infrastructure has a secondary effect on the growth rate of manufacturing productivity because it serves as a medium for the diffusion of the spatially lagged growth disturbances.

Having said that, the SAR hypothesis cannot be unambiguously accepted. A crucial assumption of the GMSAR estimation is the homoskedascity of the non-spatial component $u_{i,t}$ in Equation 3. If this assumption is violated the distribution of $\rho$ does not necessarily follow the one presented in Kelejian and Prucha (2004) and the GMSAR estimation does not prove the presence of a SAR process. The differences between the estimated variance of the robust and the GMSAR coefficients suggest that this might be the case. Unfortunately, neither the ML nor the OLS models generate minimum variance estimators. Therefore, it is not possible to formally test via a Hausman Specification Test which estimation is more likely to be correct. Given this uncertainty, the robustness of the estimations across the models is very valuable because the results do not seem to be sensitive to the econometric specification.

## 4 DISCUSSION AND FINAL REMARKS

In this paper, the origins of regional divergences in income per capita have been traced back to the liberalisation reforms of the 1980s and 1990s (Rodriguez-Pose and Sanchez-Reza 2002b). This analysis suggests that the productivity gains attributed to trade liberalisation in the manufacturing sector have been higher for specialised regions as well as for those with high infrastructure endowments. Nevertheless, they will be eventually exhausted in the long term.

Mexico's geography strongly supports this claim. Figures 2 and 3 maps international accessibility and industrial evenness at regional level in Mexico. The figures show that the regions with the highest international accessibility are largely clustered in the northern part of Mexico. This spatial distribution might be the direct cause of the "*border state effect"* identified in Chiquiar (2004).

Higher accessibility has a direct effect on productivity as long as it is reflected in lower transport costs. The impact of international accessibility on growth can follow different channels. First, if production exhibits increasing returns to scale with respect to accessibility, this will be reflected in a higher growth equilibrium level for high accessibility regions. Second, if accessibility lowers transaction costs, this will have an indirect impact on productivity growth rates. For instance, private investment could be attracted to high accessibility regions. Indeed, there is small but positive linear correlation (0.11) between international accessibility and the growth of private capital. Finally, if higher accessibility is associated to better technological diffusion, this will have a direct impact on productivity growth rates.

Table 3 compares the regional averages of the components of industrial diversity for 1999 and 2004. It shows that during that period average industrial diversity increased, pushed by a decrease in industrial evenness, and that the industrial range experienced a mild reduction. On average, each region lost 3.8 industrial activities during the period 1999-2004. During this period, the Mexican economy was characterised by two phenomena. On the one hand, the country experienced a remarkable macroeconomic stability characterised by low inflation, low interest rates, and stable exchange rates. On the other hand, after 2001 the economic growth rate decreased, especially in comparison to the growth rate of the late 1990s, and this trend continued until 2008. Therefore, the results of this analysis can be attributed to long term trends rather than short term peculiarities of the period studied here (1999-2004).

The increase of industrial evenness indicates that the regional industrial sectors are becoming less specialised, implying that non-dominant activities have been growing at higher rates. An interesting feature of this behaviour is that the average evenness seems to converge. Table 4 presents a robust ML convergence regression for this variable. This result indicates that the reduction in the degree of specialisation has been higher for the more specialised regions. The estimation predicts a half-life of the interregional evenness gaps of 13.4 years. These figures, and the negative effect on growth associated to industrial evenness, strongly suggest that the manufacturing productivity in specialised regions is catching-up with that in diversified regions.

The most important implication of this mechanism is that it can explain the absolute convergence patterns of manufacturing productivity. Due to the fact that industrial evenness is converging to a unique level, this movement has an effect on the long-term equilibrium. Recalling the stylised diagram of Figure 1, industrial evenness would be one of the variables that pull together the trajectories of **U** and **L.**

The spatial distribution of industrial evenness, presented in Figure 2, highlights another interesting feature. The most specialised regions are located in central and southern Mexico. This suggests that the aforementioned convergence mechanism is geographically concentrated in the south and not in the north of the country. In fact, this variable is negatively correlated with international accessibility. Therefore, the positive effect of industrial specialisation cannot be unambiguously associated to trade-liberalisation. The forces behind the convergence of industrial evenness could include the development of an export-oriented industry far beyond the border states and/or the growth of the domestic markets. Unfortunately, the data does not allow any further analysis in this direction.

These findings show that interregional productivity gaps in the manufacturing sector can be partially attributed to changes in the regional industrial profile. Due to the fact that the estimated half-life of the interregional industrial evenness gap is shorter than the half-life of the productivity gaps, there must be other factors hindering a faster convergence for this variable. The most obvious candidate, as pointed out by Rodriguez-Pose and Sanchez-Reza (2002b), is trade liberalisation. This point is illustrated on Figure 4. This graph presents domestic productivity for the manufacturing sector as well as for the export-oriented *maquila* industry. The historic behaviour of these variables shows that after the signature of the NAFTA, the productivity in the export-oriented sector grew at considerably higher rates in comparison to the rest of the manufacturing sector. However, since 2003 this process has reverted and productivity is converging again to the national average.

The results of this study show that higher infrastructure endowments generated positive spillovers on productivity growth rates in the period 1999-2004, which was a period characterised by the development of the international markets. This suggests that trade liberalisation and accessibility to international markets have been complementary to each other. However, the results indicate that in approximately 26 years, these gains would halve.

Policy makers in Mexico have linked the origin of this behaviour to the lack of structural reforms (Secretary of Finance, SHCP 2001) as well as to the poor development of infrastructure systems (President's Office, PdR 2007). Among the structural reforms that have been proposed, we find the liberalisation of labour, the liberalisation of the energy sector, and the implementation of a more efficient tax system. If infrastructure investment is complementary to these reforms, as it seemed to be case for the trade reforms of the 1990s, infrastructure policy will play a crucial role in the future development of the country. In particular, the allocation of transport infrastructure investments and the subsequent modification of the accessibility landscape could be used as an instrument to achieve a more even regional economic development in Mexico.

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## Table 1 Absolute Convergence Analysis

*(Standard Errors in Parenthesis)*

| | NLLS | ML | OLS | GMSAR |
|---|---|---|---|---|
| $-\beta$ | 0.1347 * | 0.1260 * | 0.1260 * | 0.1251 * |
| | *(0.0488)* | *(0.0475)* | *(0.0477)* | *(0.0018)* |
| Constant | 0.7699 * | 0.7699 * | 0.7699 * | 0.7684 * |
| | *(0.1982)* | *(0.2202)* | *(0.2210)* | *(0.0382)* |
| $R^2$ | 0.0545 | 0.0616 | 0.0616 | 0.0615 |
| N | 135 | 135 | 135 | 135 |

Significance level *1% ** 5% *** 10%
Source: Own calculations

## Table 2 Conditional Convergence Analysis

*(Standard Errors in Parenthesis)*

| | NLLS | ML | OLS | GMSAR |
|---|---|---|---|---|
| $-\beta$ | 0.4099 * | 0.3363 * | 0.3363 * | 0.3354 * |
| | *(0.0842)* | *(0.0621)* | *(0.0641)* | *(0.0030)* |
| **Controls** | | | | |
| Industrial Diversity | | | | |
| Industrial Range | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| | *(0.0008)* | *(0.0008)* | *(0.0008)* | *(0.0000)* /1 |
| Industrial Evenness | -1.8632 * | -1.8632 * | -1.8632 * | -1.9484 * |
| | *(0.3745)* | *(0.3502)* | *(0.3614)* | *(0.1401)* |
| Accessibility | | | | |
| Domestic | 0.0005 | 0.0005 | 0.0005 | 0.0003 |
| | *(0.0020)* | *(0.0020)* | *(0.0021)* | *(0.0000)* /1 |
| International | 0.0083 *** | 0.0083 *** | 0.0083 *** | 0.0079 ** |
| | *(0.0048)* | *(0.0043)* | *(0.0044)* | *(0.0000)* /1 |
| Regional | 0.0019 | 0.0019 | 0.0019 | 0.0021 |
| | *(0.0026)* | *(0.0018)* | *(0.0019)* | *(0.0000)* /1 |
| Other | | | | |
| Network curvature | -0.2038 | -0.2038 *** | -0.2038 | -0.1937 |
| | *(0.1312)* | *(0.1218)* | *(0.1257)* | *(0.0167)* |
| Schooling | 0.0446 | 0.0446 | 0.0446 | 0.0409 |
| | *(0.0429)* | *(0.0434)* | *(0.0448)* | *(0.0017)* |
| Constant | 1.6051 * | 1.6051 * | 1.6051 * | 1.6499 * |
| | *(0.4810)* | *(0.4811)* | *(0.4963)* | *(0.1951)* |
| $R^2$ | 0.2518 | 0.2971 | 0.2971 | 0.2963 |
| N | 133 | 133 | 133 | 133 |

Significance level *1% ** 5% *** 10%
Source: Own calculations
/1 The Standard Error is less than 10E-5. Industrial Evenness: 6.92E-7; Domestic Accessibility: 2.60E-6; International Accessibility 1.65 E-5; Regional Accessibility: 6.71 E-6

Table 3 Industrial Diversity and Components
*(Standard Errors in Parenthesis)*

| | 1999 | 2004 | □□(2004-1999) |
|---|---|---|---|
| H | 2.40 | 2.43 | 0.03 |
| | *(0.85)* | *(0.81)* | |
| lnS | 4.40 | 4.36 | -0.05 |
| | *(0.68)* | *(0.77)* | |
| lnE | -1.98 | -1.96 | 0.02 |
| | *(0.61)* | *(0.62)* | |

Source: Own calculations based on the NEC 1999 and 2004

Table 4 Absolute Convergence for Industrial Evenness
*(Standard Errors in Parenthesis)*

| | □ lnE | |
|---|---|---|
| $lnE_{1999}$ | -0.29 | * |
| | *(0.11)* | |
| Constant | -0.56 | * |
| | *(0.20)* | |
| N | 135 | |

Source: Own calculations

Figure 1 Convergence Trajectory

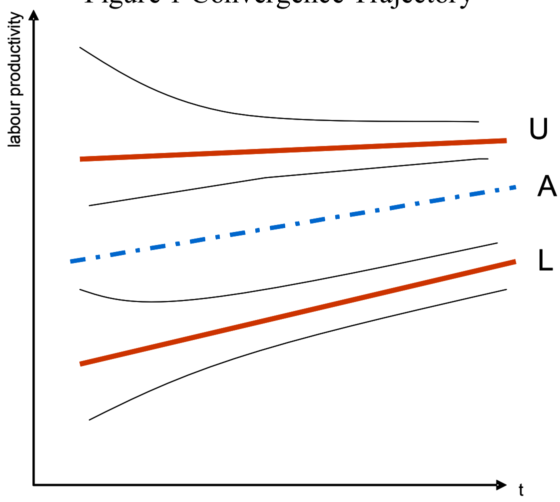
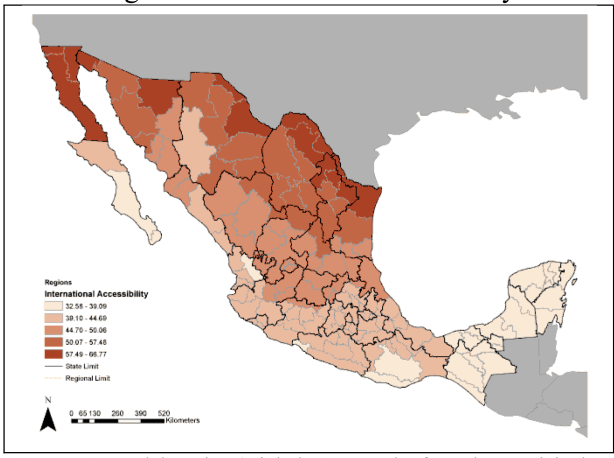
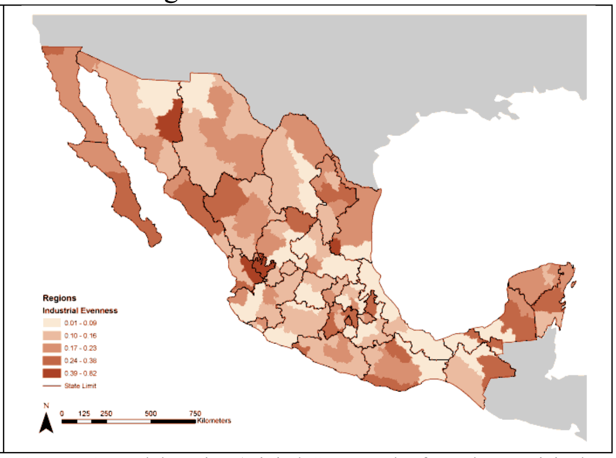


Figure 2 International Accessibility




Source: Own elaboration (Digital Cartography from the Municipal Geo-statistical Framework and the Topographic Digital Dataset, INEGI)

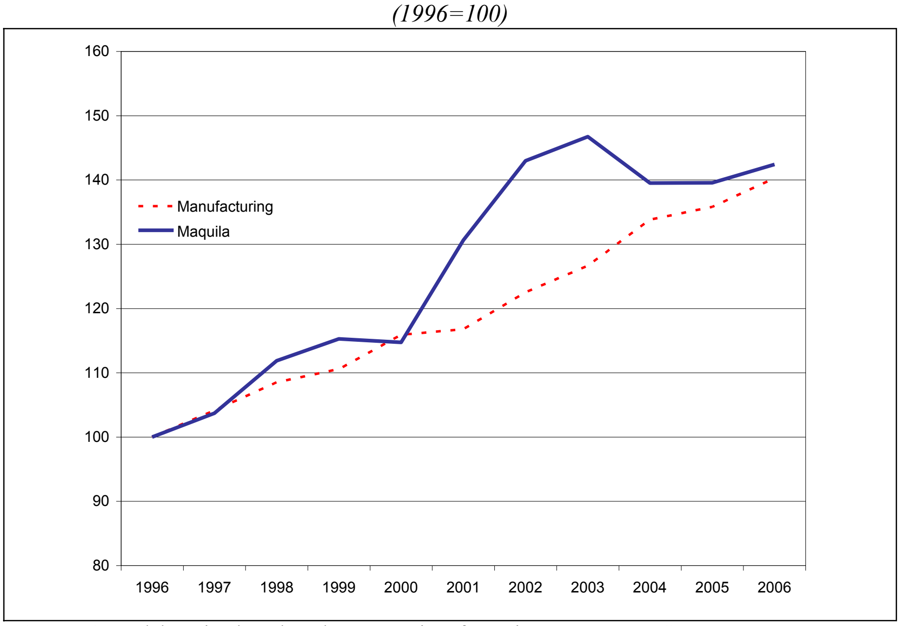
Figure 3 Industrial Evenness




Source: Own elaboration (Digital Cartography from the Municipal Geo-statistical Framework and the Topographic Digital Dataset, INEGI)

Figure 4 Productivity Index. Average Product of Labour in the Manufacturing and *Maquila* Industry

*(1996=100)*




Source: Own elaboration based on the Economic Information Dataset, INEGI