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Domestic Market Integration and Regional Growth:

The Case of Mexico

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ABSTRACT: Per capita growth of the Mexican economy has lagged behind G20 peers in past decades with notable disparities between the north and south. In this paper, we build on the income convergence literature by examining the impact of domestic market integration on regional growth. To this end, we incorporate insights from the Law of One Price and construct a novel measure of the strength of domestic market integration from micro-level price data. We find that domestic market integration is strongly associated with regional growth and its spillovers, along with other structural factors such as human capital and infrastructure. Our result also indicates that neighboring states' income level and their integration into the national economy is positively correlated with a state's growth, suggesting cross-state spillover effects and regional clustering.

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Glossary

ADF Augmented Dickey-Fuller

LOOP Law of One Price

LLC Levin, Liu, and Chu

INEGI National Institute of Statistics and Geography

ENOE National Survey of Occupation and Employment

Banxico Banco de Mexico

CONAPO National Population Council

SNSP Secretariat of the National Public Security System

INPC *Índice Nacional de Precios al Consumidor*

Executive Summary

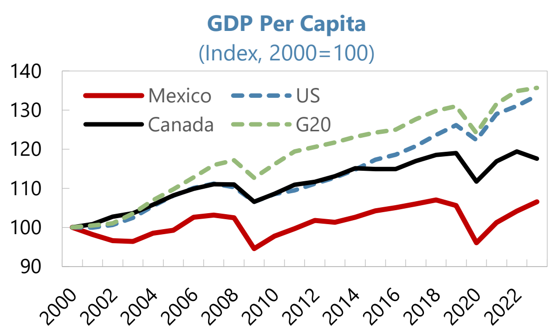
Per capita growth of the Mexican economy has lagged behind G20 peers in past decades with notable disparities between the North and the South. Drawing on the Law of One Price (LOOP) literature, we consider how regional market integration could affect regional growth. We do this by first estimating the half-lives of shocks to the differentials between state-level average prices and the national average-in effect—the strength of the LOOP at the state -level—and then using these estimates in a workhorse neoclassical conditional convergence model. We find that, while market integration has increased in most states over time, the degree of integration is divergent across states. Moreover, these patterns in integration are consistent with regional growth inequalities, with faster growing states more integrated into the national economy. Our analysis also reaffirms the importance of other structural factors for growth, most notably human and physical capital (measured by years of schooling and road infrastructure). In doing so, it reasserts the important role that high-quality government investment can play in boosting growth and tackling inequality in Mexico.

Going further to assess spillover effects using geospatial analysis, we find that the level of integration of a state's neighbors into the national economy, as well as their income level, is positively correlated with a state's growth. The result implies that there are positive spillover effects from high-growth states to their nearest neighbors. At the same time, the lack of nation-wide income convergence suggests that the spillovers are regionally clustered, in line with the observation that Mexican states experienced income divergence in the late 1990s after the introduction of NAFTA (Chiquiar, 2005; Fonseca, Llamosas-Rosas, and Rangel-Gonzalez, 2018; IMF, 2022). Finally, reflecting the insights from Rodrik (2013) and Rivadeneira (2024) that the sectoral composition of economies may be key to understanding convergence and that convergence may be achieved in the manufacturing sector if not at the aggregate level, we estimate our benchmark growth model on sectoral GDP and find no evidence for absolute convergence in either the secondary or tertiary sector. Nonetheless, our LOOP variable is statistically significant in the secondary sector. While further work is needed to understand the drivers of market integration, these results could be suggestive of deep path dependence in Mexico, with high-performing states more integrated with one another and increasingly pulling away from the rest of the country. Given the existing sizable income disparities across regions, the redistributive role that government could play is further underscored.

Introduction

Despite consistent economic stability underpinned by sound macroeconomic management, open trade policies, and close interlinkages with the U.S., per capita growth of the Mexican economy has lagged behind G20 peers in past decades (Figure 1). The low growth has persisted through the period of trade liberalization and integration of the Mexican economy to the global supply chain since the late 1990s, which brought robust export demand and significant FDI inflows to Mexico.

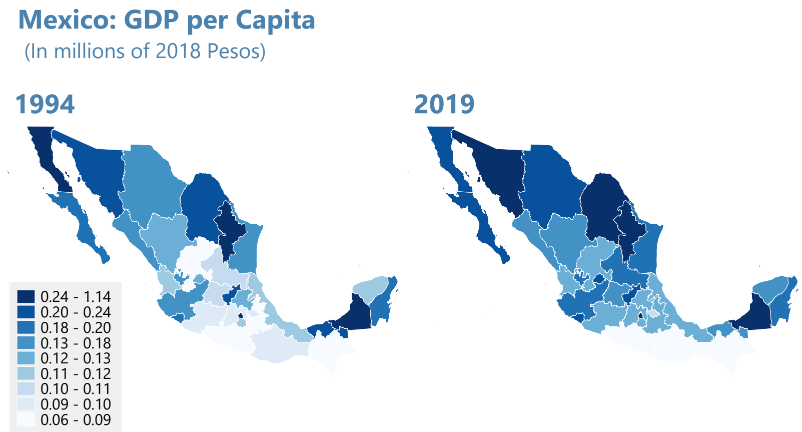
Figure 1. GDP Per Capita Developments



Sources: WEO, and IMF staff calculations.
Note: GDP as GDP PPP 2017 International Dollars per capita.

Moreover, analysis indicates that per capita income growth *within* the country is both regionally segmented and non-converging, suggesting that trade liberalization may not have generated large-scale positive spillovers for the whole economy (Chiquiar, 2005; IMF 2022). While northern states that share borders with the U.S. and several central states that benefitted from FDI have benefitted from the developments in manufacturing sectors, southern states' growth has stagnated (Figure 2). Structural factors, including weak governance, lack of safety, prevailing informality, weak infrastructure, and high cost of utilities, are often mentioned as growth impediments by firms operating in Mexico, though these factors are subject to notable regional variation (Misch and Saborowski, 2018, 2019, Verdugo-Yepes et al. 2015). With such variation in economic performance and structural factors across the country, taking a regional perspective on growth can provide important insights into the relative importance of different structural features of the economy. Furthermore, in light of the stark segmentation in economic performance, the extent to which economic growth in Mexico is characterized by 'convergence clubs'—subsets of the economies which may follow different growth paths depending on their initial states— is also an important one as these point to important non-linearities in the growth process that policymakers should pay heed to (Galor, 1996).

Figure 2. GDP Per Capita across Mexican States



Sources: INEGI, Banxico, and IMF staff calculations.
Note: Percentiles were calculated using 1994 GDP data.

Beyond considering how local conditions may have influenced *direct* gains from trade through FDI and increased external demand, the extent to which a lack of subnational integration has restrained economic spillovers from more to less successful regions—for example, through increased demand for domestic goods and trade between domestic firms —is also pertinent. As Mexico faces an abundance of new growth opportunities, including potential gains arising from the ongoing reshaping of global supply chains[1], understanding why some regions have prospered while others have stagnated could be key to designing policies that support inclusive growth. This paper seeks to add to the literature at this critical juncture.

In this paper, we examine the extent to which domestic markets are integrated across Mexican states, and how the market integration affects regional growth. To this end, we begin with the benchmark income convergence model of Barro and Sala-i-Martin (1991) and apply this to the Mexican states. Within this framework, we consider how structural factors, such as the availability of local infrastructure, access to education, and crime, have influenced growth in each state. As a contribution to the growth literature, we explicitly estimate the impact of market integration on regional growth. In doing so, we acknowledge the growth-enhancing features of market integration as documented in the welfare, innovation, and international trade literatures. These include allocative efficiency, competition-based innovation and improvements to productivity, and technological spillovers (see, for example Melitz, 2003; Pavcnik, 2002; and Blalock and Gertler, 2008). By seeking to account for these factors, we contend that these benefits to integration apply in a domestic setting as well as an international one and that, in a country with a large export sector such as Mexico, domestic market integration plays a mediating role for the transmission of the benefits of international trade from the export sector to the wider domestic economy.

To model domestic market integration, we follow the empirical literature on the Law of One Price (LOOP), which states that under perfect competition and frictionless trade, the price of tradable goods should converge between economies. As trade within a country can reasonably be expected to fulfill these criteria, failures and/or the weakness of the LOOP can be taken as a diagnosis of a lack of market integration within a country.[2] The first step in this approach is to test for the LOOP in Mexican states using the *Índice Nacional de Precios al*

[1] See Alfaro and Chor (2023), Wang and Hannan (2023), and Arizala, Mineyama, and Tuesta (forthcoming), for example.

[2] We remain agnostic about the underlying causes of the LOOP. However, the failures of LOOP may arise from factors already considered in the growth literature (such as transportation across regions) and those generally excluded (such as market structure).

Consumidor (INPC) data generated by Instituto Nacional de Estadística y Geografia (henceforth INEGI) and which we access through Banco de Mexico (henceforth Banxico). This data provides monthly product-level price data covering 2009 to 2023 by city, state, and the type of store where the product was being sold. Exploiting the structure of the panel unit root test used to test for LOOP failures in the literature, we characterize a "LOOP parameter" which measures the half-life of shocks to price differentials between each state and a numeraire (in this case, the national average). Following the literature, we interpret these half-lives of regional price differences to be a measure of (the inverse of) market integration and include them as a conditioning variable in our convergence regression.

Our main results both reinforce previous findings and provide new insights into the mechanisms underpinning income (non-)convergence in Mexico. Consistent with the literature, we find that income convergence across the Mexican states has continued to fail to materialize, both in the immediate period after the North American Free Trade Agreement (NAFTA) and subsequently. We also confirm that key structural factors - including education and infrastructure - are persistently important determinants of state-level growth. However, the key contributions to the literature from our work arise from our analysis of the role of market integration and regional spillover effects, specifically:

- We find that the LOOP holds across the majority of Mexican states over the three time-periods—2009-14, 2015-19, and 2020-23—that we consider, with market integration generally increasing across the states over time. Our market integration variable, the LOOP parameter, is also statistically significant and of the expected sign in each of our main regression specifications. It is worth noting that the LOOP parameter remains significant with various control variables, suggesting that it captures an indispensable aspect of regional growth that is not well explained by other structural factors.
- In undertaking geospatial estimation of our benchmark growth model to better understand the role that geography and physical distance play in determining growth. We find that neighboring states' income level and their integration into the national economy is positively correlated with a state's growth. This result can be interpreted as evidence of cross-state spillover effects and regional clustering. However, given potential endogeneity issues (e.g., Durlauf et al., 2005), we do not make causal inferences and instead argue that our spatial analysis could be suggestive of a two-speed economy dominated by highly integrated high performers, which in-turn may reflect club convergence dynamics.[3]
- In estimating our benchmark growth model on sectoral GDP to examine sectoral convergence, in line with the intuition in Rodrik (2013), we find no evidence of conditional convergence in the secondary sector but find the LOOP parameter to be statistically significant. This may reflect the concentration of secondary sector activity in highly integrated, high-performing states.

Literature Review

Income convergence (or lack of convergence) is one of the crucial questions in macroeconomics. The standard neoclassical growth model suggests that economic growth starts at a fast pace and then gradually decelerates as the economy accumulates physical and human capital toward a desired level, implying that the income gap between the frontier and other economies should shrink over time. Technology diffusion from a more developed economy to a less developed one would boost convergence. The literature has tested this

[3] While the literature on the club convergence highlights the relevance of initial states that would bring economies into divergent growth paths, our empirical results suggest that the current status of market integration affects growth performance.

hypothesis in both cross-country data and regional data within a country (Barro and Sala-i-Martin, 1991). In terms of the regional convergence within a country, prior studies reported steady convergence in the US, Canada, Japan, and advanced European countries as the economies grew (Barro and Sala-i-Martin, 2003; Coulombe and Lee, 1995).

In testing income convergence, the literature has identified the importance of economies' structural characteristics in determining economic growth. In the context of cross-country analysis, no clear inverse relationship between income level and growth rates is observed in the past decades, suggesting a lack of income convergence. A prominent explanation is that the fundamental growth rate could differ depending on economies' characteristics, and thus the income gap should narrow in the course of development among economies with similar characteristics – the so-called 'conditional convergence'. These include educational attainment and life expectancy, that would determine human capital available in the economy, investment ratio of physical capital, and the rule of law, which would protect property rights and thus support investment, as well as indicators of macroeconomic stability such as inflation. Prior studies typically report income convergence across countries conditional on these characteristics and more recent literature has added the sectoral composition of the economy to this list of factors (Barro and Sala-i-Martin, 1991; Rodrik, 2013).

Market integration is an important structural factor for growth that has received comparatively less attention in the growth literature. The role of market integration in boosting aggregate productivity is well-established across a range of literature in economics. Broadly speaking, these gains can be attributed to the effects of increased competition and technological spillovers. Competitive markets have long been held as a key ingredient for allocative efficiency and the literature also cites the role that competition plays in economic growth through innovation. From the international trade literature, Melitz (2003) outlines how greater integration into competitive export markets increases firm productivity, including through the reallocation of resources to more productive activities. These mechanisms were also found to be at play amongst Chilean plants during a period of liberalization between 1970 and 1980 by Pavcnik (2002). Meanwhile, Aghion et al (2005) find that competitive product markets encourage innovation amongst frontier firms and Grossman and Helpman (1991) highlight the role that product improvements can play in economic growth. Additionally, Amiti and Khandelwal (2013) show how frictions to international trade integration (through tariffs) can discourage quality upgrading. The ability of integrated markets to facilitate the transmission of technological spillovers and know-how is well-evidenced in the international trade and FDI literature. For example, Blalock and Gertler (2008) find strong evidence of productivity-enhancing technology transfers between multinational firms and local suppliers whereas Madsen (2007) finds a robust relationship between TFP growth and trade when examining data covering 135 years for OECD countries. The beneficial dimensions of international trade integration apply when considering domestic market integration, with greater domestic competition also serving to boost productivity and open markets facilitating technological spillovers between domestic industry leaders and smaller firms. Moreover, where a country has a robust export sector, such as in Mexico, domestic market integration can be viewed as a mediating factor in the diffusion of the growth-enhancing aspects of international trade beyond the export sector to the domestic economy.

One method of assessing market integration in a country is to assess whether the Law of One Price (LOOP) holds. Originally formulated in the context of the international trade literature, the LOOP states that under perfect competition and frictionless trade, the price of non-tradable goods should converge between countries. While the typical focus of empirical analysis of the LOOP is the extent to which it holds across countries given trade frictions (see, for example, Frenkel, 1978; Frankel and Rose, 1996; Obstfeld and Rogoff, 2000; and Goldberg and Verboven, 2005), a notable literature exists examining price differences *within* countries. In a canonical paper, Parsley and Wei (1996) examine price data covering 51 different goods and services across 48 states in the US between 1971 and 1992 with the aim of establishing an upper bound for the rate of price convergence in the absence of trade frictions and currency fluctuations. The authors find that price gaps across US cities typically unwind within four to five quarters for tradable goods and fifteen quarters for services, with convergence rates faster for non-perishable items and larger initial price differentials but slower for far away locations. Additionally, the authors find transportation costs to account for a relatively small share of the slow convergence rates between countries. Meanwhile, subsequent papers have drawn a closer link between the strength of the LOOP within a country and domestic market integration. Fan and Wei (2006) estimate the rate of price convergence to determine the extent to which the transition from a centrally planned economy in China had led to market fragmentation. Assessing the strength of the LOOP using panel data consisting of 93 products in 36 cities between 1990 and 2003, the authors find that the speed of price convergence between cities during China's market transition was comparable with estimates found in the US, Canada, and Europe and positively related to the distance between cities. Undertaking a similar study for Canada, Li and Huang (2006) analyze the price indices for 42 Canadian provinces and find strong support for the LOOP. In contrast, using a panel dataset consisting of price indices covering 51 products and 11 regions in Brazil, Goes and Matheson (2015) find a slow rate of price convergence in Brazil relative to other countries, suggesting more limited domestic market integration.

Yet, an extension of the literature on convergence acknowledges possible non-linearities in growth dynamics that may yet be seen in the real world. Under the standard interpretation of conditional convergence, economies with similar structural features should converge to the same growth rate over a sufficiently long time-period irrespective of their initial conditions. However, Galor (1996) illustrates that the neoclassical growth model can be consistent with multiple stable steady state growth paths due to 'threshold effects' on the initial level of capital. In practical terms, this means that economies can have the same structural features but differences in initial conditions can result in convergence to different equilibria. Convergence should then hold between 'clubs' of economies that have both the same structural factors *and* similar enough initial conditions. Explanations for such threshold effects typically center on arguments for the capital accumulation path not being strictly concave, these include inequality in initial endowments and its impact on the savings rate (Galor, 1996) and externalities related to human capital investment (Azariadis and Drazen, 1990) amongst others. While support for club convergence has been found in the empirical literature (see, for example, Azariadis and Drazen, 1990 and Durlauf and Johnson, 1995), these approaches typically rely on *a priori* partitioning data according to initial conditions and then estimating convergence regressions. Results produced using this methodology could be sensitive to the choice of partitions and an alternative approach endogenizes the partitioning of the sample, though at the cost of specifying factors that may characterize the grouping (Corrado et al 2005; Bartkowska and Riedl, 2012). Nonetheless, a key insight from this literature is the extent to which entrenched inequalities–as specified by initial conditions–can dominate convergence mechanisms and result in divergent growth prospects despite a range of common structural features.

In the context of Mexico, regional growth disparities have been a longstanding feature of the Mexican economy. Among others, Chiquiar (2005) found that, using the data from 1970 to 2001, the trend of regional convergence was reverted after 1994 when the NAFTA started, suggesting the gain from trade liberalization was unevenly distributed across regions. Fonseca, Llamosas-Rosas, and Rangel-González (2018) reported a divergence pattern of regional income levels in an extended sample of 1994-2015. While their analysis indicated evidence of regional convergence after controlling for structural factors, they also found that convergence has weakened more recently.

Data and Stylized Facts

In estimating the strength of the LOOP in Mexico, we use *Índice Nacional de Precios al Consumidor* (INPC) microdata generated by INEGI, with access provided by Banxico's EconLab.[4] This confidential microdata covers product-level prices for non-food merchandise at a biweekly frequency for 299 products (87 non-food merchandise products) and 46 cities across all Mexican states for the years 2009 to 2023. Additional information in the dataset includes the type of store in which the product price was recorded. Consistent with the literature, we restrict our focus to non-food merchandise, i.e., tradable products[5].

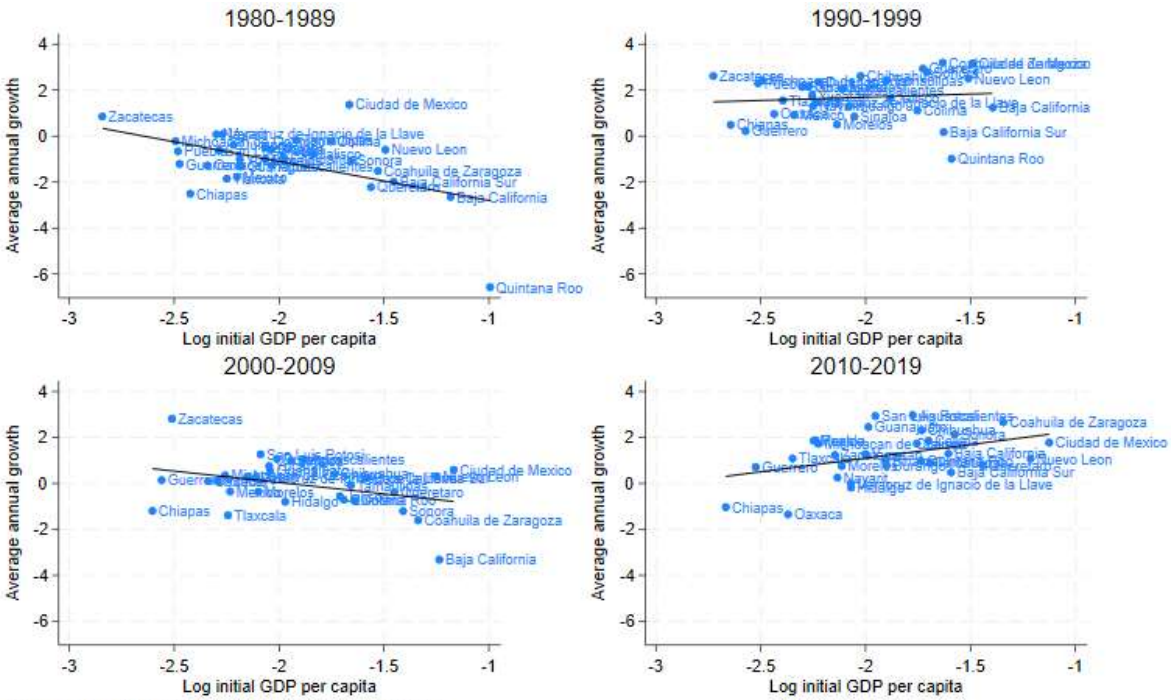
State-level GDP data at 2018 prices are obtained from the *Instituto Nacional de Estadística y Geografía* (INEGI). Per capita GDP is calculated with the population estimates by INEGI. Following previous studies, we exclude Campeche and Tabasco, where the oil industry is the main source of economic activity, and consequently the average per capita income is disproportionally high. Figure 3 displays the absolute convergence of per capita GDP across states. Consistent with previous studies, the β-convergence in Panel (A)—the relationship between the initial GDP level (x-axis) and subsequent growth (y-axis)— indicates a regional convergence in the 1980s, while the trend is reversed in the 1990s—the period including the start of NAFTA and the tequila crisis. The 2000s exhibit a slight tendency of convergence, though this possibly reflects the slowdown of the manufacturing sector following China's participation in WTO (2001) and the global financial crisis (2008-09). A divergence pattern started again after 2010. The σ-convergence in Panel (B)—cross-sectional variations in per capita GDP—confirms these observations with the adverse external events noted above corresponding to declines in the cross-sectional variation. Annex Figure 1 confirms that these convergences are resulted from more severe contractions of the states in the top quantile of per capita GDP. The current level of cross-sectional variation is close to the level in the mid-1980s. Overall, Mexican states do not display a clear tendency toward absolute income convergence in the past decades, and if any convergence was observed in specific time periods, it was mainly driven by the slowdown of top states, rather than higher growth of bottom states. That said, our main interest is in how structural factors, most notably the degree of market integration, affect regional growth and spillovers. The following sections describe methodologies and data to take into account these factors.

[4] The authors would like to thank Banco de Mexico's EconLab for facilitating access to the confidential *Índice Nacional de Precios al Consumidor* (INPC) Price microdata generated by INEGI. The data was accessed through the EconLab at Banco de Mexico. The EconLab collected and processed the data as part of its effort to promote evidence-based research and foster ties between Banco de Mexico's research staff and the academic community. Inquiries regarding the terms under which the data can be accessed should be directed to econlab@banxico.org.mx.

[5] Excluding goods from non-core inflation like agricultural and energy.

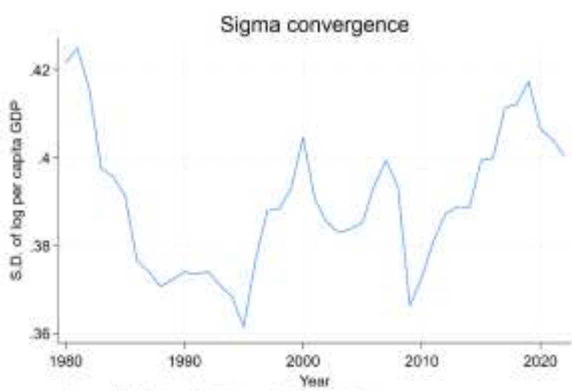
Figure 3. Absolute Convergence in GDP Per Capita across States[6]

(A) β convergence



Sources: INEGI, National Authorities, and IMF staff calculations.
Note: GDP at 2018 prices. Campeche and Tabasco are excluded.

(B) σ convergence



Sources: INEGI, National Authorities, and IMF staff calculations.
Note: GDP at 2018 prices. Campeche and Tabasco are excluded.

Control variables for structural factors are selected as below, which mostly follow Fonseca, Llamosas-Rosas, and Rangel-González (2018). First, we consider human and physical capital investment as fundamentals of

[6] Furceri (2005) found that a decreasing dispersion in of the GDP per capita lead to absolute convergence, and that positive speed of convergence will lead to a less unequal income distribution only if the speed is relatively high and the variance of the difference of per capita income at the beginning and at the end of the period is small enough. It means that $\sigma - convergence$ is only a sufficient (but not necessary) condition for the existence of $\beta - convergence$.

$$sign(\beta) = sign\left[\sigma_t^2 - \sigma_{t+\tau}^2 + var\left(log(GDP_t) - log(GDP_{t+\tau})\right)\right]$$

growth in the spirit of Mankiw et al. (1992). Specifically, we use (i) the average years of schooling among the population of 15 years or older as a measure of human capital, and (ii) the length of paved road per square kilometers to proxy infrastructure, which would be the basis of private investment as well. Second, we consider investment through foreign direct investment (FDI) by using (iii) a dummy variable for the Bajío area (Aguascalientes, Guanajuato, Querétaro, San Luis Potosí, and Zacatecas), which show a high concentration of auto industries and receive sizable FDI in these sectors.[7] Lastly, we include (iv) a crime indicator of the number of homicides per population.[8] Crime could be key constraints for business activities and investments in the context of Mexico. In addition, while de jure policy institutions, which are often used in a cross-country convergence analysis, are expected to be less divergent across states within a country, the intensity of crime could reflect the compliance to laws and implementation of policies. The data for indicators (i), (ii), and (iv) are obtained from INEGI.

As a robustness check, we use additional variables that compose (v) the number of car thefts per population, (vi) the length of railways per square kilometers, (vii) telephone usage per population, (viii) the number of ATMs per population, (ix) the number of gas stations per population, which, and (x) FDI per population, deflated by the state CPI. Indicator (v) is collected by *Secretariado Ejecutivo del Sistema Nacional de Seguridad Pública*, indicators (vi)-(ix) are by the INEGI Statistical Yearbook, and indicator (x) is taken from the Ministry of Economy (*Secretaría de Economía*). When all these additional variables are included in the regression, most of the baseline indicators (i)-(iv) remain significant, suggesting that these constitute a sort of a stable core of the determinants of regional growth. For sectoral analysis, we use GDP for the secondary and tertiary sectors compiled by INEGI, while we omit the primary sector for the small share in the economy. Per worker GDP (labor productivity) is calculated by dividing sectoral GDP by the number of employments taken from the *Encuesta Nacional de Ocupación y Empleo* (ENOE) administered by INEGI. In the regression analysis, we focus on the period of 2010-2019 with the start year corresponding to the availability of the INPC price data and the end year set to exclude the disruptions due to the COVID-19 pandemic. Table 1 reports summary statistics, which confirms substantive variations of these structural variables across states.

[7] Though Fonseca, Llamosas-Rosas, and Rangel-González (2018) also used FDI as a percent of GDP, the variable has an unintended sign in our sample period when included in the regression along with other control variables, which may capture the contraction of manufacturing-intensive states after the global financial crisis, and thus we omit it in the baseline analysis. We confirm in a robustness check that the inclusion of FDI in the regression does not alter our main results.

[8] Homicides are the deaths classified as aggressions (homicides) considering the codes X85-Y09 from the National Health System, collected by INEGI.

Table 1. Summary Statistics

	N	Mean	SD	p10	p90
GDP per capita (millions of pesos)	300	.17	0.07	0.1	0.26
GDP per capita growth rate (percent)	300	1.21	2.69	-2	4.2
Primary sector (percent of GDP)	300	4.39	2.73	1.09	8.14
Secondary sector (percent of GDP)	300	32.31	10.50	18.93	44.04
Tertiary sector (percent of GDP)	300	58.03	10.58	46.22	70.98
Homicides (per 1k population)	300	0.12	0.16	0	0.27
Car theft (per 1k population)	300	1.4	1.19	.29	2.69
Average years of schooling	300	9.07	0.89	7.78	10.04
Railway tracks (km per 100 square km)	300	3.06	4.40	.23	5.57
Paved roads (km per 100 square km)	300	14.61	17.93	3.77	25.2
Telephone (per 100 pop)	180	15.65	8.35	9.43	21.81
ATMs (per 1k pop)	300	0.38	0.18	0.19	0.66
Gas stations (per 1k pop)	300	0.11	0.06	0.05	0.16

Notes: Observations are pooled for the period of 2010-2019. The data for telephone usage is available until 2015. Campeche and Tabasco are excluded.

Methodology

As estimates of the strength of domestic market integration are and input into our growth convergence model, we begin by testing the LOOP across the Mexican states. Following the extensive empirical literature on the topic, the LOOP is tested by assessing whether regional price deviations are stationary in panel data characterized by product *m*, region *i*, and time *t*.[9] Underlying this approach is the notion that for the LOOP to hold, price differentials should be broadly stable and disturbances should dissipate quickly. Although a range of hypothesis tests can be constructed to test for unit roots in panel data, almost all build on the Augmented Dickey-Fuller (ADF) unit root test at the individual panel level:

$$\Delta p^{*}_{imt} = (\rho_{im} - 1)p^{*}_{imt-1} + \sum_{k=1}^{K_{im}} \lambda_{im}\Delta p^{*}_{imt-k} + \varepsilon_{imt} \quad (1)$$

where $p^{*}_{imt} = \log\left(\frac{p_{imt}}{\bar{p}_{mt}}\right)$ is the log price differential between product *m* in state *i* at time *t* and the price of *m* in a chosen reference region at *t*, $\bar{p}_{imt}$, and ε_{imt} is a stationary independent and identically distributed (IID) error term.

When $\hat{\rho}_{im} = 0$, the log price differential of product *m* in state *i* is non-stationary--meaning that shocks to prices have permanent impacts and that convergence to a stable price differential cannot therefore be confirmed, resulting in a failure of the LOOP. However, individual panel-level ADF tests typically exhibit low statistical power and panel unit root tests seek to address this problem by exploiting the properties of panel data to increase the power of unit root testing (Pesaran, 2015). In doing so, this class of tests construct test statistics and hypothesis tests that aggregate across panels, typically under the strong assumption that panels are cross-sectionally independent, though this can be relaxed under different specifications.

[9] See Parsley and Wei (1996), Fan and Wei (2006), and Li and Huang (2006) for pivotal contributions to the literature.

In this paper, we utilize the Levin, Lin, and Chu (LLC) panel unit root test developed in Levin, Lin, and Chu (2002). The standard LLC test proceeds in three stages. First, separate ADF tests as in (1) above are run on each individual panel and orthogonalized residuals are estimated to remove the impact of any serial correlation in the dependent variable and the main regressor, p^*_{imt} in the above. Second, the ratios of long-run to short-run standard deviations are then calculated for each individual panel as they will be used to adjust the pooled t-statistic calculated in the last step as it does not have a standard normal limiting distribution once a constant and/or time trend are added. Finally, a pooled regression is run on the orthogonalized residuals calculated in the first step to give an estimate of the coefficient on the variable of interest (p^*_{imt} in the above) that is unaffected by serial correlation and the ratios from the second step are used to adjust the test statistic on this parameter to ensure that it has asymptotically normal limiting distribution.[10] Crucially, the coefficient in the pooled regression in the last step of the LLC test is restricted to be the same across panels in the null hypothesis of panel non-stationarity. As such, the presence of a unit root in even one of the panels can result in a failure to reject the null hypothesis of non-stationarity. In LOOP tests in the literature—where panels are determined by product, region, and time—this corresponds to imposing the same coefficient across all regions *i* for a given product *m*.

In the context of our analysis, we restrict our focus to tradeable products, in line with the standard LOOP literature, take Mexican states to be our unit for regions, and designate the simple nationwide average price of the relevant good to be our reference price. Log price differentials are therefore calculated for each product in each state relative to the nationwide average price. Furthermore, to control for local price heterogeneity—for example, due to local crime levels or the effect of local Balassa-Samuelson effects on demand—we also run specifications of the LLC test where we include a time-invariant constant.[11] As our object of interest is an overall assessment of market integration by state, rather than the integration of specific product markets, we depart from the literature by running the LLC test across products and time for each state *i*. As such, we impose the same coefficient for all *m* products for a given state *i*. Taken altogether, we estimate the following in applying the LLC test:

$$\Delta p^*_{imt} = \alpha_{im} + (\rho_{im} - 1)p^*_{imt-1} + \sum_{k=1}^{K_{im}} \lambda_{im} \Delta p^*_{imt-k} + \varepsilon_{imt} \quad \text{for i = j, m = k, and all t} \quad (2)$$

$$\widehat{\varepsilon_{imt}} = \Delta p^*_{imt} - \sum_{k=1}^{K_{im}} \widehat{\lambda_{im}} \Delta p^*_{imt-k} - \widehat{\alpha_{im}} \quad \text{for i = j, m = k, and all t} \quad (3)$$

$$\widetilde{v_{imt}} = p^*_{imt-1} - \sum_{k=1}^{K_{im}} \widetilde{\lambda_{im}} \Delta p^*_{imt-k} - \widetilde{\alpha_{im}} \quad \text{for i = j, m = k, and all t} \quad (4)$$

$$\widehat{\varepsilon_{imt}} = \delta_i \widetilde{v_{imt-1}} + \theta_{imt} \quad \text{for i = j, all m and t} \quad (5)$$

where (2) is the product market and state ADF test, (3) and (4) are the auxiliary regressions that generate the orthogonalized residuals, and (5) is the pooled regression of orthogonalized residuals that provides our test statistic using estimates of δ, which can be interpreted as the coefficient measuring the average impact of a change in a disturbance to the average (across product markets) log price differential in region *i = j* in *t-1* on the

[10] Readers are referred to Levin, Lin, and Chu (2002) and Pesaran (2015) for a fuller discussion of the methodology and theory underpinning the test.

[11] Although we opt to include these further controls, our focus on tradeable goods should greatly restrict the scope for price heterogeneity due to local conditions. This is in-line with the literature. We also run specifications including a time trend to control for price drift over time, though we do not use this as our main specification due to concerns over over-parameterization.

change in the average (across product markets) log price differential in region *i* = *j* at *t*. Meanwhile, ε_{imt} and θ_{imt} in (1) and (5), respectively, are standard IID error terms.[12]

The corresponding LLC null hypothesis of a panel unit root is then:

$$H_0: \delta_{i1} = \cdots = \delta_{iM} = \delta_i = 0 \text{ for state } i = j \text{ and all } M \text{ products} \tag{6}$$

From our estimate of δ_i, we can then calculate the average half-life of a disturbance to price differentials between state *i* = *j* and the nationwide average as $L_i = -\ln(2)/\ln(1 + |\hat{\delta_i}|)$. As we expect the strength of the LOOP to vary over time due to structural economic developments and reforms, we estimate L_I for each state over sub-periods. These sub-periods are consistent with the structural data used in our growth convergence model and the time-variation in the LOOP parameter L makes it a suitable explanatory variable in the growth regressions.

Turning to our growth convergence model, the regional income convergence is estimated by a regression in the spirit of Barro and Sala-i-Martin (1991):

$$\Delta y_{it'} = \alpha \log y_{it'-1} + X_{it'-1}\beta + \epsilon_{it'} \tag{7}$$

where we use the t' subscript to denote that the 5-year time intervals in our growth regression and data differ from the monthly time intervals in the LOOP estimations, $g_{it'}$ is the growth rate of state *i* at time *t'*, $y_{it'-1}$ is the income level and $X_{it'-1}$ is a vector of structural factors (including the LOOP parameter $L_{it'}$). The specification does not include state fixed effects given the upward bias to the convergence parameter arising from a panel structure with small sample in the time-series dimension (Arellano and Bond, 1991; Barro 2015).

The regional spillover is estimated in the spirit of the spatial externality model:

$$\Delta y_{it'} = \alpha \log y_{it'-1} + (\gamma_0 + \gamma_1 L_{it-1})y_{-it'} + X_{it'-1}\beta + \epsilon_{it'} \tag{8}$$

where $y_{-it'}$ is the average of the initial per capita GDP in the three nearest neighbors for state *i*. γ_0 captures the baseline degree of spillover, whereas γ_1 gauges the extent to which the LOOP parameter hampers or facilitates the spillover.

Results

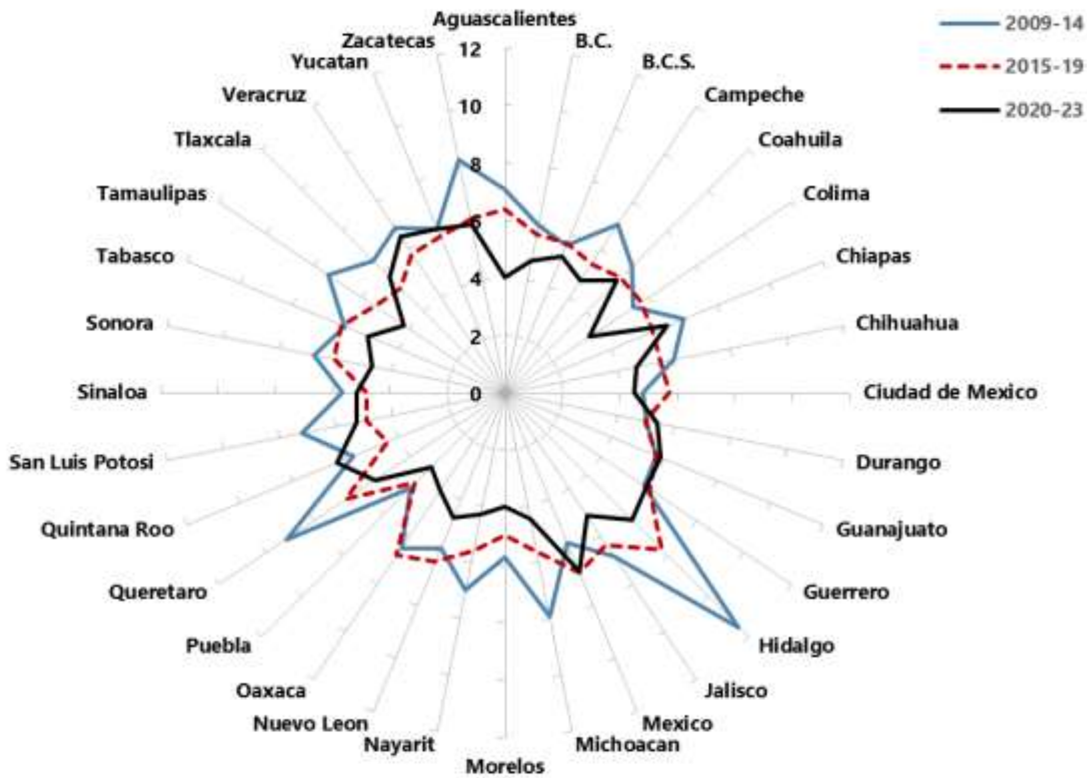
Running our preferred specification of the LOOP test as in (2) above, we find that the LOOP holds in all states in Mexico in two of the three time periods for which we have the INPC data - in the 2015-19 period, we find that LOOP holds in all but 10 states. Additionally, we find that market integration, as measured by the half-lives of shocks to the average price differential, increased over time. In 2009-14, the median half-life of shocks to the average price differential across states was 6.2 months and the standard deviation was 1.3 months. In 2015-

[12] As our main objective is to generate a variable measuring the strength of market integration consistent with the LOOP, we present the key regressions underpinning the LLC test but not the construction of the test statistic. Readers are referred to Levin, Lin, and Chu (2002) for further details on the construction of the test statistic.

19, the median fell to 5.7 months and the standard deviation to 0.7 months while 2020-23 saw the former fall to 5.1 months and the latter increase slightly to 0.9 months. These estimates are slightly longer than those for Canada (4.72 months on average; Li and Huang, 2006) and China (2.35 months on average; Fan and Wei, 2006) while shorter compared to the case of Brazil (14-16 months; Goes and Matheson, 2015). Nonetheless, the LOOP parameter is highly heterogeneous across both states and time, and this can be seen in Figure 4 below. In particular, only two states–Hidalgo and Zacatecas, both of which are in the center of the country–have LOOP parameters that are in the third quartile of the distribution in all three of the time periods that we consider. Although we present point estimates for individual states, care should be taken when drawing inferences and a better understanding of the conditions in each state over these periods is required before drawing any robust conclusions on the dynamics of price integration and its drivers. Indeed, closer inspection of the circumstances of individual states highlights the complexity of factors at play. For example, while the state of Hidalgo's proximity to Mexico City might suggest that prices should be more integrated due to the economic weight of the latter, the former's relatively low level of urbanization and large rural population (OECD, 2019) may have presented logistical and transport issues that outweighed this channel and so increased the magnitude of the LOOP parameter.
The failure of LOOP in ten states in 2015-19, in particular, highlights the sensitivity of the LOOP parameter to a range of factors and the role that policy can play. A key driver of this failure is likely to have been the Mexican government's decision to liberalize gasoline prices in December 2016. The reform process was a piecemeal one, with Baja California and Sonora the first states to have regulated prices reformed in March 2017, followed by Chihuahua, Coahuila, Nuevo León, and Tamaulipas in June, and Baja California Sur, Sinaloa, and Durango in October. Prices were then liberalized in the remaining states by December 2017. The effect of this gradual implementation was to create price-differentials between regions, potentially affecting the logistical costs of non-food merchandise and disrupting relative prices. This could be seen in inflation prints for 2017, where – contrary to historical trends - the North of the country temporarily posted the highest inflation rate amongst the regions in (Banxico, 2018).

Table 2 reports pairwise correlations of our main variables. The LOOP parameter is negatively correlated with GDP per capita and the average years of schooling in a statistically significant manner at least at the 10 percent level. The correlation with paved roads is negative but not significant, implying that the LOOP parameter gauges a broader degree of market integration than the quality of physical infrastructure. For instance, higher GDP per capita could reflect the market size of each state, and international or nation-wide firms may prefer to operate in these regions, facilitating market integration. Another potential determinant of the LOOP parameter is that exporting firms might be more likely to locate in states with higher income or a higher education level. These states could experience common shocks arising from external demand, for example, U.S. business cycles. While these potential scenarios suggest caution around causal interpretations of the LOOP parameter, it how strongly correlated market integration is with regional growth vis-à-vis other structural factors is an important empirical question, which is examined below.

Figure 4. LOOP Parameter Estimates by State, Months



Source: INPC data, Authors' estimates
Notes: While we find that the LOOP holds in all states in the periods 2009-14 and 2020-23, it fails in ten states in the period 2015-19.

Table 2. Correlation of LOOP Parameter and Other Variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) LOOP parameter	1					
(2) GDP per capita	-0.10*	1				
(3) GDP per capita growth	0.03	0.15***	1			
(4) Homicides	-0.06	0.02	0.03	1		
(5) Years of schooling	-0.22***	0.79***	0.06	0.05	1	
(6) Paved roads	-0.09	-0.23***	-0.05	0.10*	-0.18***	1

Source: INPC data, INEGI, World Bank, and authors' estimates.
Notes: Observations are pooled for the period of 2010-2019. Campeche and Tabasco are excluded

Table 3 below presents the results of our main specifications. The dependent variable across all specifications is the 5-year average of state-level per capita GDP growth rate. The growth rate is taken average to remove short-run fluctuations with the assumption that structural factors would be associated with longer-run growth. The regression is conducted using the panel generalized least squares (GLS) method, correcting for heteroskedasticity across states. Column (1) presents the results of the absolute convergence regression while column (2) presents the results of a conditional convergence regression, excluding the LOOP parameter and after the elimination procedure for structural variables outlined above. Whereas column (1) finds no support for absolute convergence consistent with the scatter plot in Figure 3 (bottom-right panel), column (2) provides weak support for conditional convergence, with the average years of schooling, paved road, and the *Bajio*[13] dummy being positive and statistically significant. The result confirms the previous studies' finding of the relevance of education and infrastructure for regional growth (e.g., Chiquiar, 2005; Fonseca, Llamosas-Rosas, and Rangel-González, 2018).

Once the LOOP parameter is included in the regression in column (3), the coefficient is statistically significant and of the expected sign, though it should be noted that data availability means that the regressions are estimated over a smaller sample period. The estimated coefficient indicates that a one-month increase in the half-life of a shock to the average product price differential is associated with a decrease in the 5-year average growth rate of 0.24 percent. In addition, the convergence (i.e., the coefficient of lagged GDP per capita) becomes statistically significant (though at the 10 percent level) whereas other structural variables remain significant at the 1 percent level. This suggests that the LOOP parameter captures a dimension of regional growth that is not captured by other structural variables.

To assess spillover effects between states, we introduce variables controlling for the average initial GDP per capita of the nearest-three neighboring states as well as the average LOOP parameter for the nearest three neighbors in columns (4) and (5). In doing so, we utilize a spatial externalities methodology with a Generalized Least Squares estimator (see Annex 2 for more details). Controlling for spillover effects between neighboring states with our spatial initial GDP variable, we find that the support for conditional convergence between states disappears as the coefficient on initial GDP becomes insignificant. However, the coefficient on the nearest-neighbors initial GDP variable is positive, relatively large, and significant, providing strong evidence of regional growth clustering in Mexico and thus lending support to the notion of club convergence. In both columns (4) and (5), the headline LOOP parameter remains statistically significant and of the expected sign while nearest-neighbor LOOP parameter is of the expected sign and statistically significant at the 10 percent level. By indicating that the level of integration of a state's neighbors into the national economy is positively correlated with a state's growth, this result can be interpreted as evidence of cross-state spillover effects and regional clustering. In turn, this adds further support to the possibility that growth in Mexico may be characterized by club convergence dynamics.

[13] Bajío is a dummy variable that takes the value of one for the following states: Querétaro, Michoacán de Ocampo, Guanajuato, Aguascalientes and Jalisco. These states show a high concentration of auto industries and receive sizable FDI in these sectors. The Bajío dummy captures disproportional growth effects arising from these states' characteristics.

Table 3. Main Results

VARIABLES	(1)	(2)	(3)	(4)	(5)
Ln(GDP Per Capita)	0.713***	-0.693	-0.819*	-0.172	-0.393
	(0.227)	(0.452)	(0.455)	(0.371)	(0.402)
LOOP Parameter			-0.241**	-0.242***	-0.238***
			(0.097)	(0.073)	(0.070)
Homicide Rate		0.007	0.002	-1.925*	-1.711
		(0.143)	(0.148)	(1.079)	(1.072)
Years of Schooling		1.056***	1.059***	0.558***	0.641***
		(0.210)	(0.205)	(0.153)	(0.163)
Paved Road		0.270*	0.222*	1.547**	1.408**
		(0.141)	(0.130)	(0.742)	(0.689)
Bajio		1.349***	1.648***	1.460***	1.641***
		(0.313)	(0.292)	(0.265)	(0.298)
Nearest Neighbours Avg.				1.217***	1.249***
ln(GDP per capita)				(0.299)	(0.284)
Nearest Neighbours Avg.					-0.232*
LOOP Parameter					(0.138)
Observations	60	60	60	60	60
Number of States	30	30	30	30	30
State FE	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: INPC data, INEGI, and authors' estimates.
Notes: The sample period is 2010-2019 with the 5-year intervals for the dependent variable being the average per capita GDP growth rate in 2010-2014 and 2015-2019 and corresponding independent variables being those of 2009 and 2014, respectively. The start year of the sample corresponds to the availability of the INPC price data, whereas the end year is set to exclude the disruptions due to the COVID-19 pandemic. Campeche and Tabasco are excluded, leaving 30 states in the sample. Homicide rate, years of schooling, and paved road are standardized. Campeche and Tabasco are excluded.

Table 4 reports the results of robustness checks. We examine a full set of control variables in columns (1)-(2); replace the dependent variable with each year's growth rate in columns (3)-(4) and 10-year average growth rate in columns (5)-(6); and use non-oil GDP for all states for each year, instead of excluding oil-rich states of Campeche and Tabasco, in columns (7)-(8). Across these specifications, the LOOP parameter remains statistically significant at the 1 percent or 5 percent levels.[14] For instance, the result is robust in the "horse race" regression in columns (1)-(2), supporting the view that the market integration captures different aspects of structural impediments to growth from other indicators.

[14] In columns (1) and (2), a few control variables (car theft, railway, ATM, and FDI) have unintended sign, though most are significantly insignificant. This may capture correlation between these structural factors and income level. For instance, high-income states could attract more FDI, while these states may display lower growth if convergence holds.

Table 4. Robustness Check

VARIABLES	(1) More Controls	(2)	(3) 1-Year Growth	(4)	(5) 10-Year Growth	(6)	(7) Non-oil GDP Growth	(8)
Ln(GDP Per Capita)	-0.495	0.045	-0.528	-0.614	-0.819**	-0.492	-0.339	-0.409
	(0.816)	(0.791)	(0.456)	(0.455)	(0.380)	(0.342)	(0.463)	(0.460)
LOOP Parameter		-0.280***		-0.195**		-0.219***		-0.219**
		(0.084)		(0.098)		(0.057)		(0.096)
Homicide Rate	-0.127	-0.120	0.003	-0.001	-0.080	-0.012	0.008	-0.001
	(0.149)	(0.140)	(0.093)	(0.095)	(0.111)	(0.142)	(0.093)	(0.094)
Car Theft	0.110	0.110						
	(0.106)	(0.109)						
Years of Schooling	1.173***	1.225***	0.739***	0.702***	1.142***	0.958***	0.668**	0.604**
	(0.194)	(0.191)	(0.265)	(0.265)	(0.180)	(0.146)	(0.269)	(0.270)
Railway	-0.428**	-0.337*						
	(0.185)	(0.181)						
Paved Road	0.492***	0.455***	-0.040	-0.071	0.237*	0.272**	-0.034	-0.069
	(0.147)	(0.147)	(0.094)	(0.093)	(0.126)	(0.107)	(0.093)	(0.092)
Telephone	0.424***	0.271**						
	(0.142)	(0.117)						
ATM	-0.191	-0.355**						
	(0.146)	(0.147)						
Gas Station	0.130	0.141						
	(0.317)	(0.319)						
Bajio	1.452***	1.660***	1.379***	1.514***	1.331***	1.545***	1.404***	1.544***
	(0.348)	(0.313)	(0.320)	(0.315)	(0.152)	(0.108)	(0.324)	(0.320)
Ln(FDI per capita)	-0.299*	-0.327**						
	(0.181)	(0.166)						
Observations	59	59	300	300	30	30	320	320
Number of States	30	30	30	30	30	30	32	32
State FE	No	No	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: INPC data, INEGI, and authors' estimates.
Notes: In columns (1) and (2), control variables (from homicide rate to FDI) are standardized. In columns (3)-(4) and (5)-(6), the dependent variable is per capita GDP growth rate in each year and 10-year average, respectively, and all dependent variables are lagged by one year. In columns (7)-(8), the dependent variable is per capita GDP growth rate in each year. The sample period is 2010-2019. In columns (1)-(6), Campeche and Tabasco are excluded, whereas they are included in columns (7)-(8).

To better understand the mechanisms that may be at play, we run additional specifications in Table 5, which reflect the insights from Rodrik (2013) and Rivadeneira (2024) that the sectoral composition of economies may be key to understanding convergence and that convergence may be achieved in the manufacturing sector even when it is not supported at the aggregate level. Specifically, we estimate our benchmark growth model on sectoral GDP and find that neither the secondary nor tertiary sector displays absolute convergence in a statistically significant manner in columns (1) and (4). However, the secondary sector suggests a tendency of convergence, i.e., a negative coefficient of the initial GDP, as opposed to diverging patterns in the tertiary sector and overall GDP, broadly in line with the literature. The LOOP parameter has a significant effect on growth in the secondary sector (column (3)), while it does not in the tertiary sector (column (6)). This result is intuitive as market integration presumably facilitates goods trade, which would adjust demand and supply across regions and allow for technology diffusion as well, driving growth in the secondary sector, particularly in manufacturing. To the extent that cross-state differences in manufacturing and tertiary sector activity may be correlated with the differences in initial conditions that would determine club convergence dynamics, the lack of evidence for conditional convergence at the sectoral level is surprising. However, it should be noted that these specifications still aggregate over multiple growth equilibria as they the underlying sample is not partitioned by initial conditions. As such, the lack of support for sectoral conditional convergence may be consistent with club convergence dynamics.[15] Repeating our spatial analysis for both the secondary sector (columns (4) and (5)) and the tertiary sector (columns (9) and (10)), we find that the coefficient on nearest neighbors' GDP is insignificant for both sectors, suggesting limited spillover effects and clustering. While the spatial LOOP parameter is statistically insignificant for the secondary sector (column (5)), suggesting that a spatial model may not be suitable for a sectoral approach, it is significant at the 10 percent level for the tertiary sector and has a positive sign. While further investigation would be needed to better understand the mechanisms behind this result, one possibility is that states whose nearest neighbors are less integrated into the national economy-and hence are likely to be poorer-may see positive labor supply effects for the services sector due to migration from their neighbors.

[15] Bernard and Durlauf (1993) show that the behavior of statistical tests of convergence where multiple equilibria exist depends on whether the data is cross-sectional or time-series, the initial conditions in the data, and the precise null and alternative hypotheses used in the test.

Table 5. Sectoral GDP

VARIABLES	(1)	(2)	(3) Secondary Sector	(4)	(5)
Ln(Sectoral GDP Per Employment)	-0.562	-1.202	-0.907	-0.998	-0.797
	(0.390)	(0.934)	(0.892)	(0.891)	(0.878)
LOOP Parameter			-0.489*	-0.455*	-0.429
			(0.269)	(0.269)	(0.267)
Homicide Rate		0.828	0.842	0.827	0.746
		(0.570)	(0.549)	(0.547)	(0.543)
Years of Schooling		0.961	1.008*	0.953	0.866
		(0.632)	(0.611)	(0.612)	(0.610)
Paved Road		0.584	0.584	0.700	0.673
		(0.501)	(0.499)	(0.516)	(0.515)
Bajio		1.249*	1.804**	1.655**	2.283***
		(0.758)	(0.747)	(0.761)	(0.879)
Nearest Neighbours Avg.				1.202	1.434
In(Sectoral GDP per Employment)				(1.314)	(1.310)
Nearest Neighbour Avg.					-0.923
LOOP Parameter					(0.650)
Observations	60	60	60	60	60
Number of States	30	30	30	30	30
State FE	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes

VARIABLES	(6)	(7)	(8) Tertiary Sector	(9)	(10)
Ln(Sectoral GDP Per Employment)	0.541	-1.438	-1.218	-1.153	-0.742
	(0.558)	(0.874)	(0.904)	(0.936)	(0.986)
LOOP Parameter			0.120	0.118	0.116
			(0.107)	(0.108)	(0.104)
Homicide Rate		0.240	0.212	0.215	0.255
		(0.172)	(0.172)	(0.172)	(0.165)
Years of Schooling		0.940***	0.925***	0.921***	0.802***
		(0.260)	(0.259)	(0.259)	(0.271)
Paved Road		0.059	0.011	0.022	0.119
		(0.240)	(0.243)	(0.246)	(0.239)
Bajio		0.473**	0.414*	0.386	0.115
		(0.212)	(0.214)	(0.238)	(0.261)
Nearest Neighbours Avg.				0.190	0.074
In(Sectoral GDP per Employment)				(0.707)	(0.654)
Nearest Neighbour Avg.					0.437*
LOOP Parameter					(0.235)
Observations	60	60	60	60	60
Number of States	30	30	30	30	30
State FE	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: INPC data, INEGI, and author estimates.
Notes: The dependent variable is the 5-year average of sectoral GDP growth per employment for each of secondary and tertiary sectors. The sample period is 2010-2019. Campeche and Tabasco are excluded.

Conclusion

In this paper, we have examined the impact of domestic market integration on regional growth and its spillovers in Mexico. To this end, we gauge the strength of domestic market integration as the speed of price convergence across regions, drawing on the insights from the Law of One Price literature and using micro-level price data. We find that domestic market integration has increased over time, but less integrated markets are associated with lower regional growth. Our empirical results confirm the relevance of other structural factors for growth - such as education and infrastructure – in-line with the existing literature. However, they also indicate that domestic market integration remains relevant even after controlling for these factors. In addition, we find no evidence for growth spillovers across regions when we consider segmented regional markets. Altogether, this would seem to add empirical support to our contention that market integration is important for growth through mechanisms such as competition and technology diffusion and, in the presence of a large export sector, may also be key for the transmission of the benefits of international trade to the wider economy.

In this context, consideration of the role of government in this process becomes pertinent. Government could seek to support market integration through physical and human capital investment and by ensuring market structure through regulation and competition policy to enhance regional growth. Investments needed to boost lagging regions may require central government to finance this investment through effective intra-regional redistribution.

Nonetheless, given possible endogeneity in our estimation procedure and the notable segmentation of economic performance in Mexico along interrelated geographical, sectoral, and human and physical capital lines, our results may also be reflective of club convergence dynamics whereby initially high-performing states are themselves highly integrated and have become even more integrated over time, further boosting their economic performance. In such a case, economic performance in Mexico would then be characterized by a two-speed economy consisting of high performers and then the rest, which would also explain the lack of overall income convergence across states. Transforming the low-growth states into the club of high performers is crucial and may require policy supports. In particular, policies facilitating physical and human capital investment may be necessary to push lagging regions beyond capital accumulation thresholds that theory suggests keep them on a low equilibrium growth.

We conclude the paper with potential areas of future research. First, it would be worth exploring the determinants of market integration. While we remain agnostic about the drivers, one could conjecture that the lack of market integration may be associated with physical or technological constraints (such as transportation across regions and availability of ICT), but could also be rooted from institutional settings, including market structure and competition policies. Second, rigorous analysis of causality would further develop our understanding on the issue, and we believe that our evidence of the association between market integration and growth based on regional data would be complementary. Thirdly, the extent to which Mexico economic performance can be characterized by club convergence dynamics merits investigation.

Annex I. Additional Figures and Tables

Figure A1.1. Mean Growth Rate by Income Quartile

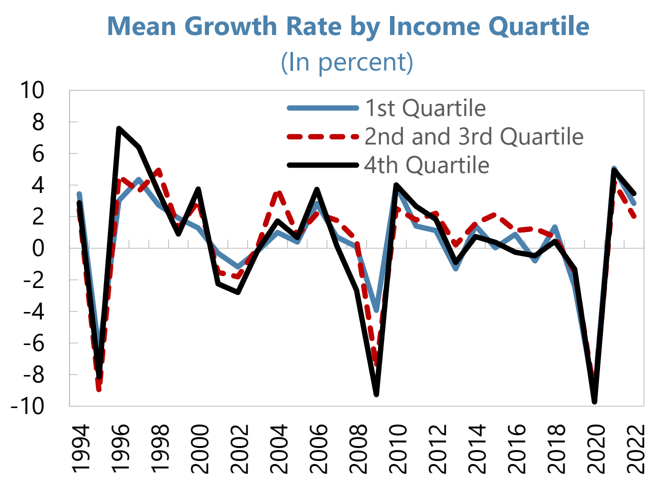
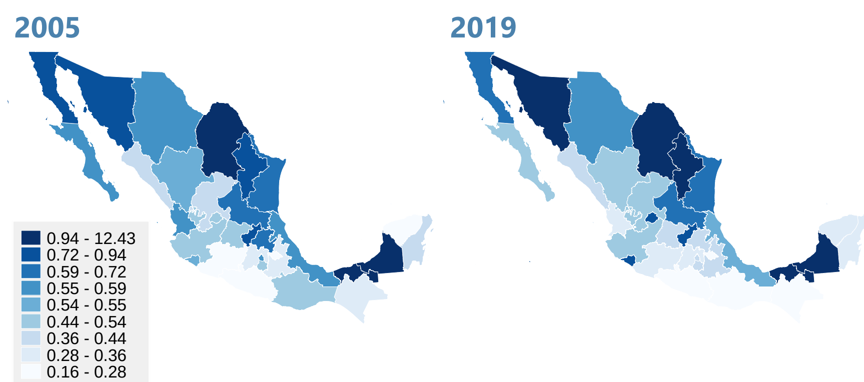


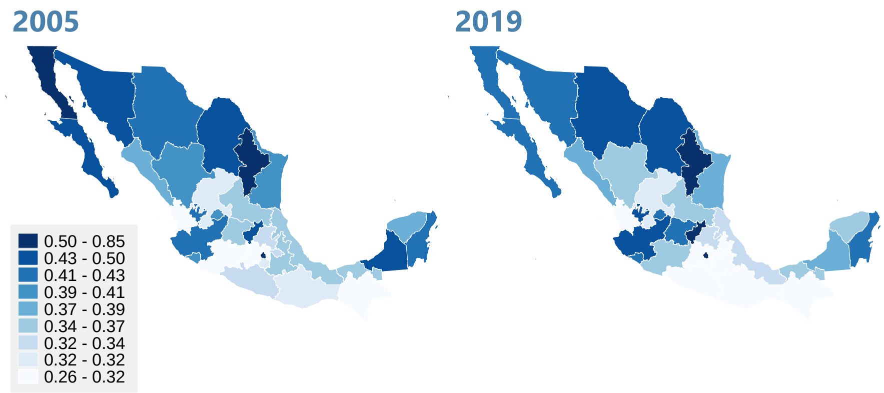
Figure A1.2. Sectoral GDP Per Capita across Mexican States

A) Secondary Sector GDP per Capita



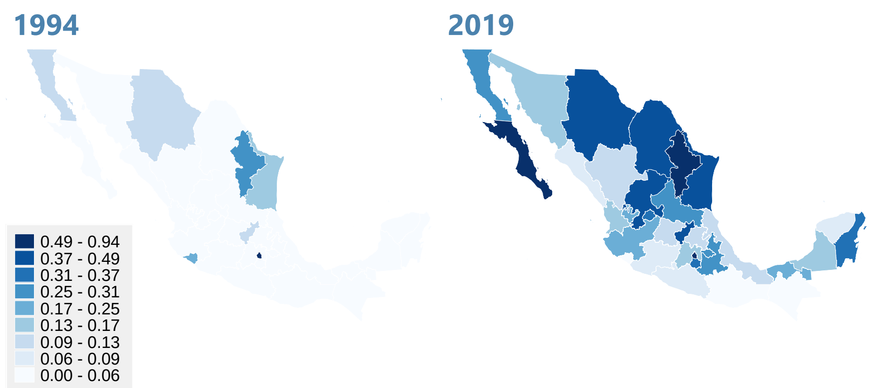
Sources: INEGI, Banxico, and IMF staff calculations.
Note: Percentiles were calculated using 2005 Secondary Sector GDP data. Millions of Pesos at 2018 prices.

B) Tertiary Sector GDP per Capita



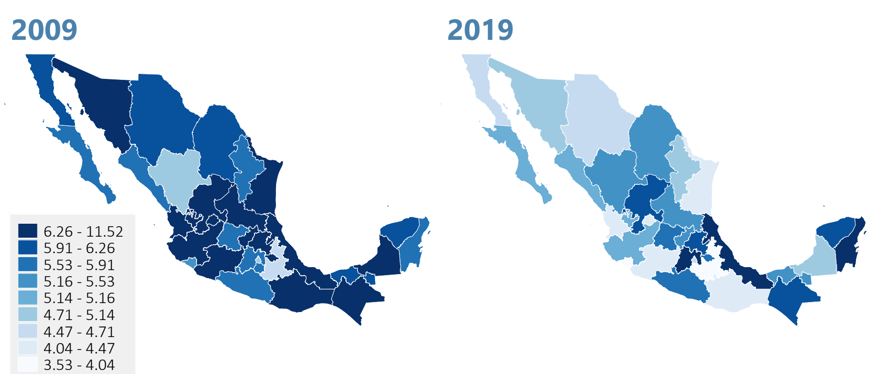
Sources: INEGI, Banxico, and IMF staff calculations.
Note: Percentiles were calculated using 2005 Tertiary Sector GDP data. Millions of Pesos at 2018 prices.

Figure A1.3. FDI per Capita Across States



Sources: INEGI, Banxico, and IMF staff calculations.
Note: Percentiles were calculated using 2019 FDI data. FDI in thousands of USD.

Figure A1.4. Loop Parameter Across States



Sources: INEGI, Banxico, and IMF staff calculations.
Note: Percentiles were calculated using 2019 the Loop Parameter data. Data in months.

Table A1.1. Growth Rate Correlations Across Decades

	1980-1989	1990-1999	2000-2009	2010-2019
Whole Sample				
Growth1980-1989	1.00			
Growth1990-1999	0.59	1.00		
Growth 2000-2009	0.48	0.22	1.00	
Growth 2010-2019	0.10	0.48	0.12	1.00
Rich State Group				
Growth1980-1989	1.00			
Growth1990-1999	0.81	1.00		
Growth 2000-2009	0.35	0.12	1.00	
Growth 2010-2019	0.39	0.60	-0.16	1.00

Notes: Whole sample 30 states. Rich group is 9 states. Campeche and Tabasco are excluded. GDP at 2018 prices.

Table A1.2. Growth Rate Correlations Across Decades

Secondary Sector GDP per Capita

	2000-2009	2010-2019
Whole Sample		
Growth 2000-2009	1.00	
Growth 2010-2019	-0.01	1.00
Rich State Group		
Growth 2000-2009	1.00	
Growth 2010-2019	-0.45	1.00

Tertiary Sector GDP per Capita

	2000-2009	2010-2019
Whole Sample		
Growth 2000-2009	1.00	
Growth 2010-2019	-0.03	1.00
Rich State Group		
Growth 2000-2009	1.00	
Growth 2010-2019	0.05	1.00

Notes: Whole sample 30 states. Rich group is 9 states. Campeche and Tabasco are excluded. Rich states based on GDP per capita at 2018 prices.

Table A1.3. Disparities in GDP per Capita

State	R1994	R2019
Aguascalientes	2.4	3.5
Baja California	4.4	3.7
Baja California Sur	3.4	3.6
Campeche	20.2	9.5
Coahuila de Zaragoza	3.7	4.8
Colima	3.2	3.5
Chiapas	1.3	1.0
Chihuahua	2.5	3.6
Ciudad de México	4.7	6.2
Durango	2.1	2.7
Guanajuato	2.0	2.8
Guerrero	1.4	1.4
Hidalgo	2.3	2.1
Jalisco	2.8	3.3
México	1.7	2.0
Michoacán de Ocampo	1.6	2.1
Morelos	2.1	2.1
Nayarit	2.1	2.0
Nuevo León	4.3	5.2
Oaxaca	1.7	1.4
Puebla	1.5	2.0
Querétaro	3.5	4.0
Quintana Roo	3.4	3.2
San Luis Potosí	2.0	3.0
Sinaloa	2.4	2.7
Sonora	3.6	4.2
Tabasco	3.8	3.0
Tamaulipas	2.8	3.3
Tlaxcala	1.7	1.7
Veracruz de Ignacio de la Llave	2.1	2.0
Yucatán	2.0	2.5
Zacatecas	1.3	2.0

Note: R is GDP per capita as a fraction of the Mexican GDP per capita.
GDP at 2018 prices.

Annex II. Application of the Spatial Externalities (SLX) Model

In the presence of spatial externalities, a region's GDP growth can be decomposed into contributions from its neighbors. In order to undertake this decomposition, it is important to define the Neighbor Matrix, *W*. The matrix *W* used in our model follows the three nearest neighbors based on the geographic centroid of each state. The matrix is row standardized (each row sum is equal to one) and has zeros on its main diagonal (no state is its own neighbor). When *W* is pre-multiplied by a variable, WX represents the average value of that variable for the neighboring states.

Figure A2.1: Definition of W: 3 nearest neighbors (excluding Tabasco and Campeche).

Source: INEGI, Authors' calculations.

It is well-known that the effect of an independent variable can have spillover effects, meaning its impacts may extend beyond administrative borders into neighboring states. We propose that the GDP growth of state *i* is partly determined by the value of the half-life LOOP parameter (as well as the initial level of GDP) of neighboring region *j*. This relationship can be expressed as: $y = \alpha + X\beta + WX\theta + \varepsilon$, where WX represents the average LOOP parameter (and/or the initial level of GDP) of neighboring regions for each state i. This gives the Spatial Lag of X model (SLX). In this specific case of spatial models (SLX), Ordinary Least Squares (OLS) can be used for estimation. The coefficient β measures the direct effect of the variable on the growth of state *i*, while θ captures the spillover effects (indirect effects) from neighboring regions on the growth of state *i.*

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