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Regional Convergence and Trade Liberalization under Weak State Capacity: Evidence from Mexico

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Abstract

Long-term regional convergence hypothesis is examined for 32 Mexican states in a regional growth model with poverty traps using a new dataset on regional income inequality for the period 1940-2011. Although zero-growth poverty trap hypothesis is rejected for 28 out of 32 states, the evidence confirms β-convergence and σ-convergence for the period 1940-1980 and indicates the breakup of convergence in post-1980 period. The break in the convergence process is attributed to trade liberalization carried out under weak state capacity and clientelistic patronage environment without independent and effective regulators. The widening of regional inequality is characterized by an increase in growth in high-income U.S.-border states and no such increase in poorer states that cannot converge to the frontier under such conditions. When long-term convergence relationship is conditioned on unobserved long-run effects, the speed of convergence for pre-1980 period is around 2% per year and diminishes with the estimation horizon. Sensitivity analysis based on income-specific quantile regressions emphasizes substantial heterogeneity in the speed of convergence across states.

JEL classification: missing

Keywords: β-convergence, σ-convergence, panel-data econometrics, economic growth, poverty traps, regional inequality

1. Introduction

The importance of strong capacity of the state in enforcing contracts and providing the key public goods such as rule of law and education for economic development is well-recognized (Besley and Persson 2010, Cárdenas 2010, Knutsen 2013, Acemoglu et. al. 2015, Dinecco 2017, Johnson and Koyama 2017). At the same time, there is strong evidence and consensus in the literature that regions within countries tend to experience conditional convergence of per capita income at the rate of about 2 percent per year (Gennaioli et. al. 2014, Ganong and Shoag 2017). The notion of regional convergence has gained its momentum and attracted considerable attention in recent years and this is especially true for developing countries such as Mexico (Díaz-Dapena et. al. 2019).

The failure of poor regions to sustain high growth rates over time can intensify the vicious cycle of poverty trap by widening the regional per capita income gap. With respect to regional convergence, the literature emphasizes two distinct concepts of convergence (Barro and Sala-i-Martin, 2004). When initially poor regions grow faster

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over time than initially rich regions, the process is characterized by β-convergence. Even though poor regions can sustain higher growth compared to rich counterparts, a substantial dispersion in the distribution of per capita income can persist over time. When dispersion of per capita income across regions falls over time, the process is characterized by σ-convergence. Therefore, the presence of β-convergence is a necessary but insufficient condition for σ-convergence. A growing body of empirical research has presented multiple attempts to disentangle regional income disparities within single countries.[1] The evidence of both types of regional convergence has been confirmed for a growing number of countries starting from late 19th century onwards with the main emphasis on post-war period.[2]

This paper presents an attempt to analyze the long-term patterns of regional convergence and divergence for a panel of 32 Mexican states for the period 1940-2010.[3] Compared to existing literature, we focus on long-term dynamics of per capita income distribution and paths of regional growth. To this end, a new regional dataset on real per capita GDP is constructed for the Mexican states using purchasing power parities and regional GDP deflator based on the historical intertemporal regional distribution of regional GDP per capita from a seminal contribution by Germán-Soto (2005).

A simple model of convergence and poverty traps is constructed and tested on the reconstructed historical time-series for Mexican states. The evidence, based on decennial cycles, suggests that before the onset of 1980s, Mexican states and regions exhibit a strong and robust unconditional (absolute) output per capita convergence with no evidence of self-perpetuating poverty traps. The estimated convergence coefficient is robust to long-term unobserved state-specific effects and technology shocks over time with significant decline of regional income inequality. After the economic reforms carried out by De La Madrid and Salinas de Goltari administrations starting in early

[1] See Dobson et. al. (2006) for an excellent overview of cross-regional convergence studies from within-country perspective. In addition, Young et. al. (2008) demonstrated the presence of β-convergence and absence of σ-convergence using U.S. country-level data

[2] The evidence of cross-regional convergence has been confirmed for U.S. states (Barro and Sala-i-Martin, 1992a), Canadian provinces (Coulombe and Lee, 1995), Swedish counties (Persson, 1997), Irish provinces (O'Leary, 2003), Greece (Petrakos and Saratsis, 2000), Spain (De La Fuente, 2002; Villaverde, 2005) and Argentina (Utrera and Koroch, 1998). On the contrary, Cashin and Sahay (1995) confirmed β-convergence for post-WW2 Indian states but found no evidence of σ-convergence.

[3] Due to the change in the methodology in regional accounts, the analysis is not pushed beyond the final year of our investigation (i.e. 2011).

1980s, Mexican regional convergence came to a halt with little evidence of absolute and conditional per capita output convergence since initially rich regions sustained higher growth compared initially poor counterparts. The absence of (un)conditional convergence in post-1980 period is further substantiated by rising regional Kuznets ratio and Gini coefficient since regional dispersion of per capita income rose substantially between US border and non-border regions. The evidence from within-regional estimated sigma coefficient uncovers significant divergence, driven by widening per capita income gap among Southern states compared to the rest of the country. Our sensitivity analysis underlines the absence of convergence and shows that the share of states exhibiting per capita income convergence declined markedly in post-1980 period. Our evidence on estimated regional growth disparities remains robust after the convergence coefficient is conditioned on spatial and intertemporal heterogeneity. These findings indeed suggest that Mexico's postwar regional growth pattern has created both "winners" and "losers" despite indicative evidence of regional convergence until 1980s.

The paper contributes to the growing literature on regional income convergence in developing countries by providing a large dataset to exploit long-run patterns of economic growth across Mexican states with unobserved heterogeneity and deploying a plausible panel-data model of regional income convergence in the long-term perspective. The rest of the paper is organized as follows. Section 2 reviews the regional convergence response to trade liberalization in the context of weak state capacity. In Section 3, stylized facts from the literature on regional inequality and growth in Mexico are discussed. Section 4 presents a simple model of poverty traps where β- and σ-convergence are discussed in more detail. In Section 5, the data and methodology are presented. Section 6 discusses the results. Section 7 proceeds with robustness checks. Section 7 concludes.

2. Trade liberalization under weak state capacity: the Mexican case

In the 1980s, Mexico embarked on the path of ambitious economic policy reforms that overhauled the previous inward-looking policies emphasizing import substitution and state-led industrialization. The key pillars of market-oriented economic policies of De la Madrid government administration in the period 1982-1988 included the encouragement of foreign direct investment, widespread privatization of state-run industries and a substantial tariff reduction. In January 1986, Mexico signed GATT agreement and embraced trade liberalization. Numerous scholars agree that trade liberalization is associated with higher rates of growth (Krueger 1998, Greenaway et. al. 2002, Cavalcanti Ferreira and Luiz Rossi 2003, Dollar and Kraay 2003, Winters 2004, Foster 2008). The general thrust of these studies is that trade liberalization fosters the economic specialization, improves productivity growth and reinforces both allocative and dynamic efficiency although the latter does not come automatically (Dijkstra 2000).

One of the neglected facets of trade liberalization concerns the strength and weakness of state capacity. In particular, the notion that free markets function well of property rights are well defined and impartially enforced has become widely accepted (Demsetz 1964, Furubotn and Pejovich 1972, Leblang 1996, Besley and Ghatak 2010, Galiani and Schargrodsky 2011). Since gaining independence from Spain in the early 19th century, Mexico's institutional environment has been characterized by the distorted and unequal access to the rule of law. Kuchar (2016) provides several historical narratives and substantial evidence in support of the argument that the economic policies of trade liberalization and privatization of the De la Madrid administration were decidedly illiberal and further strengthened the directorship (i.e. rectoria) and control of the Mexican government over the economic activity. In particular, the privatization of the 1980s and 1990s culminated in a de facto protection and shielding of large state-funded corporations that went bust by 1970s. Haber et. al. (2008) show that trade liberalization in the 1980s did not produce the boom in investment trade and economic growth because Mexico changed its policies but did not fully liberalize its economy by maintaining a tax system that evolved under decades of the authoritarian rules. This implies that the macroeconomic stabilization policies along with the trade liberalization were carried out in the context of fragile state capacity under weak rule of law. Although the commitment of de la Madrid administration to macroeconomic stabilization had been undisputed, the stabilization policies were undermined by several constitutional reforms that promulgated state-led economic planning and government intervention in the particular economic sectors such as energy and telecommunications with exclusive public control.

Furthermore, some scholars argue that the absence of the institutional environment that embeds the disregard of the rule of law is one of the chief causes of Mexico's underdevelopment (Katz 2014). Ill-defined property rights and the absence of an accessible low-cost enforcement of contracts for a significant fraction of the Mexican population coupled with the culture of rent-seeking, inefficient judiciary and costly bankruptcy law decidedly hinder economic transactions and restrain the financial development which feeds into lower total factor productivity and decreased economic growth. For instance, Ugalde (2014) argues that the economic reforms such as trade liberalization by the government administrations of de la Madrid and de Gotari were implemented without challenging the existing patronage framework. When the patronage networks hold substantial de facto economic power, the economic reforms that take place with the clientelistic patronage framework without effective and independent regulatory agencies, the deregulation, trade liberalization and privatization tend to benefit the existing business elites instead of the market in general. This implies that the economic reforms render the existing business and political elites entrenched insiders and further fuel the demand for political clientelism and the cooptation between both elites. Diaz Cayeros (2019) outlines the defining characteristics of the Mexican political and economic equilibrium of patronage framework that maintains the status quo bias such as the failure of land reform in facilitating asset formation among poor peasants, limited role of the stock market in firm-level capital formation, clientelistic regulatory framework that favors the dominance of a small number of powerful interest groups such as monopolistic firms and trade unions, and oil rents as a political survival tool of the ruling coalition.

The question that remains unanswered is how trade liberalization affects regional development in the presence of notoriously weak state capacity and clientelistic patronage networks. The most critical question to ask is whether poorer Mexican states can converge to the per capita income frontier of the richer states under such conditions. To this end, we reconstruct per capita income levels for the Mexican states for the period 1940-2011 building on several existing estimates, and measure the speed of convergence over time. Consistent with our theoretical expectations, we show that the reforms carried out by the de la Madrid (1982-1988) and Salinas de Gotari (1988-1994) administration without fundamental changes to the patronage pact are associated with a marked increase in the regional inequality. Our estimates imply that trade liberalization policies carried out by both administrations broke the cycle of decreasing regional inequality that began to unfold in late 1950s. Our findings thus indicate that distorted institutional environment that enables the clientelistic networks of business and political elites to flourish through patronage pacts most likely hinders the ability of the poorer states to catch-up with the frontier.

Several caveats should be stated. First, as our analysis adopts the standard Solow growth model to study the speed of regional convergence over time for Mexican states, the assumption of free flow of labor and capital is implicit in our analysis. Such assumption may be questionable given that business activity in Mexico is subject to pervasive corruption, violence and institutional environment that is skewed towards status quo. In the light of this caveat, the analysis herein should be viewed as exploratory, and not as a conclusive quantification of the regional convergence speed. And second, our measures of per capita income for Mexican states does not consider the income generated in the economic activities that have been declared illegal given the obvious data limitation. It should be noted that some of the most efficient firms in Mexico operate in the illegal zone and often provide widespread public services in parallel with the state and federal government, or even substituting the function of both. As emphasized by Zaid (2009), many economic activities in Mexico are not accounted for by authorities given the presence of widespread informality and illegal economic activities.

3. Regional inequality and economic growth in Mexico

In Mexico, substantial regional income inequality is a stylized fact. Per capita income differences between highly developed and relatively prosperous regions such as Nuevo Leon in the North and underdeveloped regions such as Chiapas and Oaxaca in the South correspond to the per capita income difference between Switzerland and Colombia[4] which nonetheless highlights the persistent of income per capita gaps from within-country perspective. Mallick and Carayannis (2006) argue that convergence in less developed countries is mainly hampered by the absence of well-developed transportation infrastructure. Using the Mexican data on state-level per capita income,

[4] The figures are based on 2005 Geary-Khamis international dollar

their results highlight a strong regional convergence compared to the U.S. as a result of the manufacturing productivity. However, the analysis neglects the regional income differences and instead focuses on the aggregate perspective. In this respect, Chiguiar (2005) further examines Mexico's growth performance before and after the entry into North American Free Trade Agreement (NAFTA) and found that diverging pattern of regional per capita income was not reversed with NAFTA. The results highlighted that winners from the reforms in the aftermath of Mexico's debt crisis were those states initially endowed higher levels of physical and human capital in the proximity of the U.S. border compared to the Southern states which exhibited the greatest deficiencies in human capital and physical infrastructure.

Considering the effect of trade liberalization on regional inequality in Mexico, Sanchez-Reaza and Rodriguez-Pose (2002) attribute widening regional inequalities to the shift from import substitution policies to GATT[5] by 1986. Four different samples were employed to control for possible data bias as a result of the inclusion of oil-rich and maquiladora-based states. The evidence advocates an unequivocal association between NAFTA-based trade integration and regional income inequality. While pre-trade integration period is associated with cross-regional convergence, post-trade liberalization period is associated with per capita output divergence regardless of the type of analysis.

In a similar vein, Juan-Ramon and Rivera Batiz (1996) examine Mexico's postwar regional growth episodes and find evidence of real GDP per capita convergence across Mexican states for the period 1970-1985 and the evidence of divergence in the period 1985-1993. The results hold across states and regions whereas growth performance of poor states has been characterized as more erratic than the growth performance of richer states in relation to its group. Although the analysis of postwar regional growth performance uncovers the shift in the regional distribution of income, the existing literature has underscored heterogeneity bias which renders the estimated convergence coefficients inconsistent.

A comprehensive approach to disentangle the key causality mechanisms behind Mexico's heterogeneous growth performance was undertaken by Rodriguez-Oreggia (2005). His results showed that Mexico's economic history has been characterized by regional economic polarization between industrialized North and underdeveloped

[5] General Agreement on Trade and Tariffs

South. Income differences between North and South further widened during episodes of economic crisis and trade liberalization. The empirical evidence from the attempt to identify the determinants of regional convergence suggests that Northern Mexican states moved from pre-liberalization falling-behind position to the winning position in the aftermath of trade liberalization given its proximity to the U.S. border. Moreover, Southern states moved from pre-liberalization catch-up phase to the loser position. The results also advocate a crucial role of human capital investment behind widening regional disparities across Mexico. Hanson (2010) further discussed the impact of macroeconomic and structural reforms on Mexico's economic growth. His conclusions suggest that despite aggressive reforms, trade liberalization and fiscal discipline, Mexico's growth performance was disappointing, triggered by the poorly functioning credit markets, supply-side distortions of non-tradable factor inputs and substantial incentives for informality, which created a sizeable drag on economic growth.

Several attempts to uncover the sources of regional income disparities across Mexico aimed at providing a broader discussion of regional economic development outcomes across Mexican states. Garcia-Verdu (2005) examined distributional dynamics of per capita GDP, adult literacy and infant mortality between Mexican regions for the period 1940-2000 and tested the convergence hypothesis. Given external shapes of regional income distribution, the results showed that despite the convergence to common adult literacy rate, Mexican states failed to converge both in terms of per capita income distribution and infant mortality. In addition, Rodriguez-Oreggia and Rodriguez-Pose (2004) highlight the inefficiency in the allocation of public investment funds since the Mexican debt crisis as the underlying factor in determining Mexico's regional income distribution. Since no evidence on the growth-enhancing effect of public investment funds across Mexican states has been found, the most likely explanation of such an effect is the embedded pork-barrel politics which contributed significantly to the lowering of economic impact of public investment on state-level economic growth. Moreover, Looney and Frederiksen (1981) emphasized the differential impact of infrastructural investment in Mexico using the Cobb-Douglas production function approach. The preliminary evidence suggests that the impact of infrastructure indeed differs across regions depending on the type of the investment and type of recipient region. The results advocate that economic overhead capital has its greatest impact on growth in intermediate regions while social overhead capital has had its greatest impact on growth in lagging regions. In addition, a direct causality test suggests that investment precedes income.

The stylized facts on Mexico's regional economic growth episodes highlight both β-convergence and β-divergence. The shift into regional economic divergence is typically associated with the accession to NAFTA and the subsequent trade liberalization which largely benefitted states in a close proximity to the U.S. border whilst resulting in slow-growth dynamics in non-border regions, especially in Southern part of the country. An attempt by Esquivel (1999) to estimate the speed of convergence across Mexican states in a long-term historical perspective presents both the description and analysis of the underlying characteristics of the cross-state convergence process. The results suggest 1.2% per year rate of β-convergence which is both low and insufficient to reduce marked regional disparities in the distribution of per capita income. The decomposition of the sample also suggest that β-convergence mostly occurred in the sub-period 1940-1960 when regional economies converged rapidly to the common frontier whereas in the sub-period 1960-1995, regional convergence came to a halt and started to revert itself which is consistent with earlier and subsequent literature on Mexico's regional economic growth and heterogeneous convergence pattern (Carrion-i-Silvestre and German-Soto, 2007; 2009).[6] Additional inquiries to uncover the key sources of Mexican regional income disparities emphasize structural weaknesses (Rodriguez-Oreggia, 2011), differences in health improvements (Mayer, 2011), interaction between foreign direct investment and benefits of agglomeration (Jordaan and Rodriguez-Oreggia, 2012), fiscal federalism and good governance (Carega and Weingast, 2003).

A specific inquiry by Lopez-Alonso and Porras-Condey (2003) seeks to explain the regional growth pattern and inequality across Mexico by exploiting the historical variation in biological living standards between Mexican states in the period 1870-1950 from military physical stature data and passport records. Despite the industrialization

[6] For instance, Quah (1996) studied per capita income distributions across European regions and confirmed that regional income distribution fluctuate over time leading to convergence, stratification and continuously increasing inequality. Moreover, the evidence highlights the relevance and importance nation-state factors, macroeconomic variables and physical geography spillovers in explaining changing shapes of regional income distribution. In addition, the results confirmed that geographic factors matter more than national ones in accounting for the variation in regional income inequality.

and rapid growth, only modest improvements occurred in adult height, health and nutritional status of Mexican population. The evidence infers considerable social differences since Mexican upper-class recorded markedly taller stature than the working class and indigenous population while the gap increased prior to the revolution, resulting in the economic growth with systematic inequality.

4. Convergence and poverty traps: production function approach

4.1. The environment

Suppose the economy consists of the continuum of regional agents, $i = 1,2, \ldots N$ where each agent forms a space, denoted by $i \in N$. Each agent has the access to simple Cobb-Douglass production function to produce the final good in the economy:

$$Y = F(K, L, A) \tag{1}$$

where Y is the total amount of production, K is the capital stock and L is the size of the labor force. The parameter A represents the level of technology and the baseline differences in productivity between regional agents. The production function with two-factor model $F: \mathbb{R}^{J+2} \rightarrow \mathbb{R}$ satisfies the Euler theorem. The function is differentiable in $K \in \mathbb{R}$ and $L \in \mathbb{R}$ with partial derivatives denoted F_K and F_L, it is m-th degree homogeneous in K and L which immediately implies that $mF(K, L) = F_K(K, L) + F_L(K, L)$ for each $K \in \mathbb{R}$ and $L \in \mathbb{R}$.

4.2. Poverty traps

Regional convergence in per capita output can fail if agents are trapped in the steady state with low values of per capita output and capital stock which reinforces poverty trap in a sense of continually low per capita output. The poverty trap can persist even if the regional agents break it out while the economy has a tendency to return to the low steady-state equilibrium. To gauge the persistence of poverty traps, assume that the economy consists of two sectors. First, traditional sector (T) has access to low-productivity technology and second, the modern sector (M) has access to high-productivity technology.[7]

$$Y_T = A_{i,t}^T \cdot K_{i,t}^\alpha L_{i,t}^{1-\alpha} \tag{2}$$

$$Y_M = A_{i,t}^M \cdot K_{i,t}^\alpha L_{i,t}^{1-\alpha} \tag{3}$$

To exploit the advantages of better technology, regional agents have to pay the initial cost every moment in time to cover the expenditure such as public infrastructure and legal system to protect the intellectual property rights from the better type of technology. The cost is financed by an exogenous tax rate, $\tau > 0$. The cost is proportional to the labor force and is given by $\tau \cdot L$ which implies that tax rate is levied on each worker. Given the steady-state equilibrium for capital stock per effective unit of labor and the constant returns to scale, Cobb-Douglas production functions can be written:

$$Y_T = A_{i,t}^T \cdot k_{i,t}^\alpha \tag{4}$$

$$Y_M = A_{i,t}^M \cdot k_{i,t}^\alpha - \tau \tag{5}$$

The key implication from two-sector structure is that the adoption of modern technology is hampered by the cost of maintaining high-productivity technology which disallows the escape from poverty trap. If the government pays the cost up-front, the agents will switch towards modern technology whereas the agents will keep the traditional (i.e. primitive) technology if the cost is not paid. A sensible social planner with growth-enhancing policy has to pay the cost only if the shift to modern technology leads to rising per capita output at existing capital stock per worker. The shift to modern technology is desired if capital per worker exceeds a critical threshold:

[7] See Galor and Ryder (1989) for a discussion of non-constant savings rates in the neoclassical growth model.

$$k^* = \left(\frac{\tau}{Y_M - Y_T}\right)^{1/\alpha} \tag{6}$$

where the critical threshold rises with the setup cost (tax) parameter τ and falls with the difference in the productivity parameters, $Y_M - Y_T$. For a fixed productivity level in the traditional sector, greater the productivity advantage from modern technology leads to the lower capital per worker threshold at which high-productivity technology can be adopted. Therefore, the government pays the cost of setting up and maintaining modern technology if $k \geq k^*$ and does not pay the cost if $k < k^*$. If $k < k^*$, the economy will maintain the production function with low-productivity technology whereas if $k \geq k^*$the economy will switch to high-productivity modern technology.

4.3. Convergence

When agents escape the poverty trap by adopting modern technology and sustain high growth rates, the income gap between the poor and rich agents declines. In a neoclassical growth model, β-convergence occurs when initially poor agents in the regional income distribution grow faster over time than initially rich agents. We consider a simple model of β-convergence originally proposed by Barro and Sala-i-Martin (2004):

$$\ln(y_{i,t} - y_{i,t-k}) = \alpha_{i,t} - (1 - e^{-\beta}) \cdot \ln(y_{i,t-k}) + u_{i,t} \tag{7}$$

where y denotes output per capita for i-th agent at time t, yi,t-k is the level of initial income per capita in the base year, denoted by k. The parameter β represents the speed of convergence between the agents across regions. When $\beta > 0$, initially rich agents grow at a faster rate than initially poor agents, leading to divergence of per capita output whereas if $\beta < 0$, regional agents converge since initially poor agents grow faster over time than initially rich agents. Parameter α captures the baseline productivity differences, $\alpha_{i,t} = g_i + (1 - e^{-\beta}) \cdot [\ln(y_i^*) + g_{i,t-1}]$ where *g* denotes the growth of technology over time and y* represents the long-run steady-state output per capita for each regional agent. The stochastic component u captures systemic shocks affecting the long-term growth performance and is assumed to be independently distributed with zero mean and constant variance, $u_{i,t} \sim i.i.d(0, \sigma^2)$.

Even though the income per capita gap between the rich and poor regions can narrow if the latter sustain higher growth rate over time than the former, substantial inequality in the distribution of per capita output can exist between agents. Therefore, σ-convergence indicates a more equal distribution of output per capita between agents over time whereas σ-divergence indicates a greater dispersion of output per capita from the mean value over time. Assume that a cross-regional variance of per capita output (σ_t^2) evolves through a non-linear difference equation:

$$\sigma_t^2 = e^{-2\beta} \cdot \sigma_{t-1}^2 + \sigma_{u,t}^2 \tag{8}$$

where β is the convergence coefficient, σ_{t-1}^2 is the lagged variance of per capita output, capture the persistence of regional income inequality and σ_u^2 is the residual variance capturing random disturbances to the dispersion of per capita output. When the stochastic disturbance is constant over time, $\sigma_{u,t}^2 = \sigma_u^2$, the solution to the first-order difference equation is given by:

$$\sigma_t^2 = \frac{\sigma_u^2}{1-e^{-2\beta}} + \left(\sigma_0^2 - \frac{\sigma_u^2}{1-e^{-2\beta}}\right) \cdot e^{-2\beta} \tag{9}$$

where σ_0^2 is the variance of per capita output in the initial year. The solution implies that σ_t^2 monotonically approaches its steady state value, given by $\sigma^2 = \sigma_u^2/1 - e^{-2\beta}$ which rises with σ_u^2 but declines with β-convergence coefficient. Over time, σ_t^2 declines if the initial dispersion of per capita output, σ_0^2, is above the steady-state value of σ_t^2 which implies that a negative *β* coefficient indicates convergence but does not necessarily imply a falling dispersion (σ_t^2) over time. Therefore, *β*-convergence is a necessary but insufficient condition for *σ*-convergence.

5. Data and methods

5.1. Data

The data on regional distribution of income in Mexico is considered at the state level. The real GDP per capita time series is constructed for a panel of 32 Mexican states for the period 1940-2011. For the period 1940-1991, time-series on real GDP is considered from the regression-based GDP reconstruction by German-Soto (2005). The approach is based on using a common national GDP deflator to construct inflation-adjusted (real) GDP. The 1940-1991 series is linked to the PPP-adjusted real GDP series by OECD (2013) in 1992 as benchmark year to create a continuous long-term time series for each Mexican state following the approach originally proposed by Maddison (2007). The reconstructed time-series is adjusted for inflation using national GDP deflator in 2005 as base year and converted to Geary-Khamis international dollar to allow for direct international comparison on both regional and cross-national basis. Compared to earlier attempts to reconstruct regional income distribution in Mexico, our approach is based on updating the base year for GDP deflator and pushing it back to early 1940s to construct a common time-series and observe the patterns of cross-regional economic growth in a long-term perspective.

In Table 1, key descriptive statistics is presented for the real GDP per capita (in natural log) for the set of 32 Mexican states for the period 1940-2011. State-level real GDP per capita is aggregated onto the regional basis to account for possible large-scale spatial heterogeneity in the behavior of economic growth over time. The set of Mexican states is grouped into five distinct regions: (i) North, (ii) Central, (iii) West, (iv) East and (v) South. The total size of the aggregate sample amounts to 2,304 observations distributed among five Mexican regions. Key parameters in Table 1 uncover a persistent heterogeneity in reconstructed per capita income levels across Mexican states and regions. A notable disparity in per capita income is evident between higher income levels in Northern states in the proximity of U.S. border and lower levels in the rest of the country. A notable feature of the regional growth pattern is a remarkable degree of heterogeneity in per capita income path over time.

Table 1: Descriptive Statistics for Real GDP Per Capita (2005 $G-K, Natural log) by State and Region

	Obs	Mean	Overall StD	Min	Max
Base Sample	2,304	8.436	0.875	5.865	11.691
North	**648**	**8.779**	**0.683**	**6.252**	**10.082**
Baja California Norte	72	9.197	0.249	8.820	9.603
Baja California Sur	72	8.368	1.144	6.252	9.905
Chihuahua	72	8.903	0.453	7.817	9.593
Coahuila	72	8.921	0.538	7.917	9.754
Durango	72	8.291	0.667	7.401	9.303
Nuevo Leon	72	9.167	0.598	8.005	10.082
Sinaloa	72	8.494	0.472	7.477	9.267
Sonora	72	8.842	0.545	7.596	9.565
Tamualipas	72	8.831	0.445	8.130	9.621
Central	**576**	**8.386**	**0.898**	**6.373**	**10.220**
Aguascalientes	72	8.524	0.786	7.203	9.484
Federal District	72	9.549	0.415	8.928	10.220
Guanajuato	72	8.058	0.825	6.609	9.246
Mexico	72	8.305	0.833	6.601	9.133
Morelos	72	8.348	0.637	7.216	9.129
Queretaro	72	8.317	0.951	6.864	9.605
San Luis Potosi	72	8.155	0.702	6.891	9.263
Zacatecas	72	7.779	0.790	6.373	9.085
West	**288**	**8.305**	**0.718**	**6.562**	**9.424**
Colima	72	8.520	0.664	7.539	9.399
Jalisco	72	8.532	0.734	7.097	9.424
Michoacan	72	7.941	0.738	6.562	9.043
Nayarit	72	8.227	0.566	7.080	9.060
East	**288**	**8.136**	**0.711**	**6.535**	**9.142**
Hidalgo	72	7.879	0.829	6.535	9.142
Puebla	72	8.241	0.587	7.275	9.026
Tlaxcala	72	7.879	0.778	6.640	8.785
Veracruz	72	8.545	0.302	7.565	9.077
South	**504**	**8.300**	**1.081**	**5.865**	**11.691**
Campeche	72	9.750	0.795	8.713	11.691
Chiapas	72	7.841	0.721	6.512	8.913
Guerrero	72	7.930	0.688	6.426	8.783
Oaxaca	72	7.671	0.760	5.936	8.719
Quintana Roo	72	7.995	1.373	5.865	9.682
Tabasco	72	8.445	0.984	6.908	10.132
Yucatan	72	8.466	0.448	7.778	9.192

Notes: table reports mean level of the natural log of real per capita GDP in 2005 $G-K over time and the key descriptive parameters.

Persistent intertemporal heterogeneity is especially evident in Southern Mexican sub-sample where the states with the largest standard deviation in per capita income (Quintana Roo, Tabasco, Campeche) have been characterized by natural resource discoveries and oil production related to the activities of PEMEX, Mexico's state-owned petroleum producer. Oil production and related fiscal revenue seem to characterize the pattern of economic growth in oil-abundant Mexican South consistent with occasional growth spurts followed by subsequent reversals of per capita income path compared to the rest of the country.[8]

In Table 2, growth rates of real per capita GDP are estimated from changes in levels expressed in natural log and presented across states and regions for the period 1941-2011. Average growth rates vary significantly not only across states but also within specific regions. For instance, despite the highest level of per capita income, growth rates in Northern Mexico varied from 0.6% in Baja California Norte and 1.8% in Tamaulipas to 2.9% in Nuevo Leon and 4.4% in Baja California Sur. In addition, Northern sub-sample also consists of two non-border states, Durango and Sinaloa. Although the former experienced a turbulent growth path over time, the latter which seems to have sustained relatively stable and non-recurring growth rates since the highest detected growth collapse is estimated at 3% on the annual basis which represents the lowest growth shortfall across the sample.

A similar spatial pattern is evident in Mexican poor states in the South where states such as Campeche and Tabasco managed to achieve both growth collapses preceded by spectacular growth rates. The most spectacular growth shortfall is evident in oil-rich state Campeche. Nonetheless, its path of per capita income over time is characterized by periods of persistently slow growth occasionally interrupted by the immediate effects of oil exploration and production related to PEMEX activities which raised the per capita income artificially and were followed by significant growth shortfalls when the immediate effects of oil production and exploration disappeared.

[8] See Reyes-Loya and Blanco (2008) and Breglia (2013) for further discussion of oil-related natural resource curse within Mexico over time.

Table 2: Descriptive Statistics for Real GDP Per Capita Growth Rate (in %) by State and Region

	Obs	Mean	Overall StD	Min	Max
Base Sample	2,272	.028	.092	-.604	1.470
North	**639**	**.024**	**.099**	**-.548**	**.860**
Baja California Norte	71	.006	.067	-.180	.182
Baja California Sur	71	.044	.231	-.548	.860
Chihuahua	71	.021	.050	-.117	.192
Coahuila	71	.025	.081	-.161	.281
Durango	71	.022	.085	-.159	.413
Nuevo Leon	71	.029	.063	-.156	.242
Sinaloa	71	.024	.035	-.039	.202
Sonora	71	.027	.087	-.231	.272
Tamualipas	71	.018	.047	-.177	.214
Central	**568**	**.030**	**.069**	**-.223**	**.394**
Aguascalientes	71	.024	.054	-.075	.153
Federal District	71	.017	.041	-.089	.086
Guanajuato	71	.037	.078	-.176	.332
Mexico	71	.034	.052	-.108	.155
Morelos	71	.026	.056	-.126	.222
Queretaro	71	.029	.075	-.108	.255
San Luis Potosi	71	.033	.073	-.140	.313
Zacatecas	71	.038	.102	-.223	.394
West	**284**	**.029**	**.052**	**-.112**	**.306**
Colima	71	.023	.056	-.112	.155
Jalisco	71	.032	.045	-.091	.175
Michoacan	71	.034	.055	-.066	.306
Nayarit	71	.027	.050	-.104	.156
East	**284**	**.023**	**.068**	**-.222**	**.311**
Hidalgo	71	.034	.084	-.178	.311
Puebla	71	.010	.075	-.222	.173
Tlaxcala	71	.029	.060	-.089	.208
Veracruz	71	.020	.045	-.062	.214
South	**497**	**.034**	**.129**	**-.604**	**1.470**
Campeche	71	.027	.239	-.604	1.470
Chiapas	71	.029	.066	-.083	.285
Guerrero	71	.032	.038	-.059	.146
Oaxaca	71	.038	.054	-.101	.163
Quintana Roo	71	.048	.177	-.283	.503
Tabasco	71	.043	.136	-.266	.797
Yucatan	71	.019	.033	-.078	.117

Notes: the table reports mean annual change in real GDP per capita (in natural log) and key descriptive parameters.

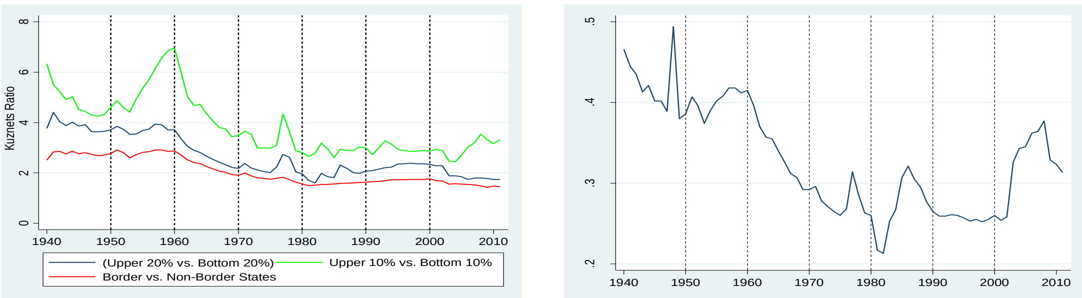
Compared to the episodes of substantial within-region growth disparities in Northern and Southern Mexico, the estimated growth rates in Central, West and East subsample are indicative of relatively stable growth pattern over time. In East Mexican sub-sample, low average growth rates of real GDP per capita are present in states such as Puebla and Tlaxcala, comprising 6% of Mexican population and 41% of the population in East Mexican sub-sample, where per capita income rose by less than 2% and its respective growth rates are the lowest among the set of non-border Mexican states.

However, the growth of PPP-adjusted per capita GDP seems to have been characterized by persistent instability over time. The intertemporal variation in growth rates indicates substantial differences in the levels of real GDP per capita across states further amplified by high degree of regional inequality. Key descriptive parameters suggest that the inherent feature of regional income disparities in Mexico is the instability rather than low growth. In fact, descriptive statistics for state-level per capita income and its growth rate suggests that while Mexican states seem to have been capable of achieving high growth, the states failed to establish a stable growth pattern to improve its path of per capita income over time. Zero-growth behavior is not confined to non-border states in less developed East and South Mexico but also to border states such as Baja California Norte and Tamaulipas which experienced persistently slow per capita income growth path over time.

In Figure 1, a closer look at regional per capita income disparities is presented for 32 Mexican states. Two measures of regional income are considered to examine spatial and intertemporal heterogeneity across states in more detail: (a) Kuznets ratio based on the distributional income ratios and (b) Gini coefficient based on the regional inequality in income per capita distribution. Gini coefficient is a standardized measure of inequality and measures the extent to which per capita income within the economy deviates from the perfectly equal distribution. The coefficient ranges from 0, representing full equality, to 1, representing full income inequality. For Kuznets Ratio, three distinct ratios are calculated. First, a ratio of average income per capita in upper 20% of per capita income distribution and income per capita in bottom 20% of the distribution is examined over time. Similarly, the ratio of average per capita income in the upper 10% and the bottom 10% of the distribution is examined over time. In both respects, upper and bottom tails of the distribution are considered on the annual basis to assess whether the income and per capita gap between the rich states and poor states declined over time. The evidence indicates that the gap between upper and lower 20% of the distribution steadily decreased in the postwar period, indicating a regional convergence. After 1980s, the reversal of the pattern is observed since the ratio either increased slightly or remained constant. Similar evidence is implicated by the income per capita gap between upper and lower 10% of the distribution where declining regional inequality across Mexican states was evident for pre-1980 period whereas no such evidence exists for post-1980 period. In addition, the income gap between U.S-border states and non-border states kept declining until early 1980s and came to a subsequent halt in post-1980 period.

Figure 1: Regional income per capita inequality in Mexico, 1940-2010

(a) Kuznets Ratios (b) Gini Coefficient



The behavior of regional inequality between Mexican states is further examined by regional Gini coefficient. The intertemporal pattern of Gini coefficient confirms the indicative evidence from the Kuznets ratios. Inequality in the distribution of regional income per capita declined strongly in the postwar period in spite of occasional and short-lived setbacks. Between 1940 and 1981, regional Gini coefficient more than halved from 0.46 to 0.21, indicating robust decreases in regional per capita income disparities. After 1981, a narrowing income per capita gap across Mexican states stopped, precluding the continuity of regional convergence, since the estimated regional Gini coefficient rose from 0.21 in 1982 to 0.32 by 2010. The changing shape of regional per capita income inequality between Mexican states indicates the reversal in the pattern of regional inequality and a U-shaped behavior of inequality over time.

5.2. Empirical model

To examine whether Mexican states exhibit per capita income convergence in the long-run perspective, we estimate the basic long-term cross-regional growth specification:

$$\hat{g}_{i,t} = \alpha + \beta \ln y_{i,0} + X'_{i,t}\delta + \xi_{i,t} \tag{10}$$

where $\hat{g}_{i,t}$ denotes the average change in the natural log of real per capita GDP for country i at time t, capturing long-term rate of economic growth. The primary coefficient of interest is β which represents the speed of regional convergence across states given the level of per capita output in the baseline year, denoted by $y_{i,0}$. When $\beta < 0$, states with lower initial level of per capita output exhibit higher average growth over time compared to initially richer states, confirming regional convergence. If $\beta > 0$, initially richer states sustain higher growth over time than initially poorer states, indicating regional divergence of per capita income. The vector X captures long-term unobserved spatial and intertemporal effects held fixed. These effects capture fixed state-level (spatial) heterogeneity and common technology shocks over time affecting the average growth rate and are essential in examining whether the states exhibit conditional convergence over time. When the underlying convergence coefficient is conditioned on these state-fixed and time-fixed effects and when $\beta < 0$, conditional long-term regional convergence is confirmed compared to the unconditional convergence without fixed effects. The term α represents the constant term and the term ξ captures short-term cyclical components and stochastic disturbances affecting the average growth rate in state i at time t.

Decomposing the vector of fixed effects into spatial and intertemporal component to capture time-invariant state-specific effects and common technology shocks over time yields:

$$\hat{g}_{i,t} = \alpha + \beta \ln y_{i,t=0} + \sum_{i=1}^{n} D_i \boldsymbol{\varphi}_i + \sum_{t=1}^{T} \tau_t \boldsymbol{\theta}_t + \xi_{i,t} \tag{11}$$

where D is a state dummy capturing unobserved spatial effects and φ is the set of coefficients measuring the magnitude and significance of spatial heterogeneity with respect to average growth rate. The variable τ is a time dummy, denoting the common technology shocks at time t, affecting the average growth rate and θ denotes the set of coefficients measuring the contribution of time-fixed effects to the average growth rate over time. Collecting right-hand-side terms in Eq. (11) yields:

$$\hat{g}_{i,t} = \alpha + \beta \ln y_{i,t=0} + \mu_i + \pi_t + \xi_{i,t} \tag{12}$$

where the term μ_i captures the contribution of spatial (state-fixed) effects to the average growth whereas the term π_t represents the common technology shocks over time. By definition, the growth rate of per capita GDP (in natural log) is a first-order derivative of per capita output with respect to time:

$$g_{i,t} = \frac{d\ln y_{i,t}}{dt} \tag{13}$$

The existence of poverty traps depends chiefly on the observed behavior of economic growth over time with respect to its underlying magnitude and long-term pattern. The existence of poverty trap is confirmed when $g_{i,t} = \frac{d\ln y_{i,t}}{dt} = 0$ which implies zero average growth. A more rigorous evidence of poverty trap is established when the evidence is indicative of negative average growth over time. $g_{i,t} = \frac{d\ln y_{i,t}}{dt} < 0$. Essentially, the significance of the estimated growth parameter over time is crucial in uncovering the intertemporal growth pattern across states since the zero growth equilibrium is the main characteristic of the poverty trap in the sense of inability to improve the long-term path of per capita income.

6. Results

In Table 3, long-term poverty trap hypothesis is tested on the aggregate level, regional level and state level. A simple long-term zero growth dynamics from the real per capita GDP series is tested against the alternative non-zero growth hypothesis. In addition to mean and standard errors, the table presents the significance level of estimated mean growth rate and the 95% confidence interval to check for possible indices of possible zero-growth equilibrium across states and regions. No evidence of nation-wide poverty trap and zero-growth equilibrium is found since both mean growth rates, its upper and lower bound is outside the zero range. However, the evidence uncovers considerable differences across states and regions. Although the Northern Mexico as whole does not seem to exhibit zero-growth behavior over time, substantial evidence of zero-growth behavior is confirmed for the states Baja California Norte and Baja California Sur situated in a close proximity to the U.S border. In both instances, the estimated long-run growth parameter is not statistically significant even at 10% level which further substantiates zero-growth pattern over time. Interestingly, Baja California Norte experienced the third highest per capita by the beginning of the estimation period in 1940 and yet the evidence suggests that in spite of initial affluence, the long-term path of per capita income was nonetheless characterized by zero-growth equilibrium. Instances of zero-growth pattern in other states in the border region are not confirmed although states such as Tamaulipas, Durango and Coahuilla have, at best, experienced weak growth rates as indicated by the lower bounds of long-run growth parameter which is estimated close to zero level. In non-border states, the heterogeneity of long-run growth parameter is substantial. In Central Mexico, the estimated growth parameters are highly significant across states with no evidence found to confirm the zero-growth pattern in the long-term perspective. Substantial confidence intervals advocate considerable dispersion in long-term growth rates which indicates that states have proven capable of achieving both weak growth and rapid accelerations. Similar evidence is found in West Mexican sub-sample where the estimated long-run growth parameters do not indicate the episodes of zero-growth behavior. In East Mexican sub-sample, zero-growth pattern is evident in the state Puebla since the growth parameter is not statistically different from zero. In South Mexican sub-sample, zero-growth hypothesis is not rejected for oil-rich state Campeche whose long-run growth parameter is highly heterogeneous indicated by wide confidence intervals. Hypothetical zero-growth steady state is rejected for poorer states such as Chiapas, Guerrero and Oaxaca as well as for the rest of the region although weak zero-growth episode is detected in the state Quintana Roo which is characterized by the lower bound of the confidence interval. The evidence from testing long-term zero-growth hypothesis is indicative of substantial heterogeneity across Mexican space, characterized by growth spurts and subsequently weak growth. Although the direct evidence of poverty traps is rather weak, the estimated long-run growth parameters are indicative of the persistence of slow growth.

Table 3: Testing Long-Term Poverty Trap Across Mexican States

	Obs	Mean	Std. Error	Zero-Growth Hypothesis Pr(|T|>|t|)	95% Confidence Interval Lower Bound	Upper Bound
Base Sample	2,200	.028	.001	0.000	.024	.032
North	**648**	**.024**	**.003**	**0.000**	**.016**	**.032**
Baja California Norte	71	.006	.007	0.408	-.009	.022
Baja California Sur	71	.044	.027	0.105	-.009	.099
Chihuahua	71	.021	.005	0.000	.010	.033
Coahuila	71	.025	.009	0.008	.006	.045
Durango	71	.022	.010	0.030	.002	.042
Nuevo Leon	71	.029	.007	0.000	.014	.044
Sinaloa	71	.024	.004	0.000	.016	.033
Sonora	71	.027	.010	0.009	.006	.048
Tamaulipas	71	.018	.005	0.001	.007	.029
Central	**567**	**.030**	**.002**	**0.000**	**.024**	**.035**
Aguascalientes	71	.024	.006	0.000	.012	.037
Federal District	71	.017	.004	0.000	.008	.027
Guanajuato	71	.037	.009	0.000	.018	.055
Mexico	71	.034	.066	0.000	.022	.046
Morelos	71	.026	.006	0.000	.013	.040
Queretaro	71	.029	.009	0.001	.011	.047
San Luis Potosi	71	.033	.008	0.000	.016	.050
Zacatecas	71	.038	.012	0.000	.013	.062
West	**288**	**.029**	**.003**	**0.000**	**.023**	**.035**
Colima	71	.023	.006	0.000	.010	.036
Jalisco	71	.032	.005	0.000	.022	.046
Michoacan	71	.034	.006	0.000	.021	.047
Nayarit	71	.027	.006	0.000	.015	.039
East	**288**	**.023**	**.004**	**0.000**	**.015**	**.031**
Hidalgo	71	.034	.010	0.001	.014	.054
Puebla	71	.010	.008	0.228	-.006	.028
Tlaxcala	71	.029	.007	0.000	.015	.043
Veracruz	71	.020	.005	0.000	.010	.031
South	**504**	**.034**	**.005**	**0.000**	**.022**	**.045**
Campeche	71	.027	.028	0.337	-.029	.084
Chiapas	71	.029	.007	0.000	.013	.045
Guerrero	71	.032	.004	0.000	.023	.041
Oaxaca	71	.038	.006	0.000	.025	.051
Quintana Roo	71	.048	.021	0.025	.006	.090
Tabasco	71	.043	.016	0.008	.011	.076
Yucatan	71	.019	.003	0.000	.012	.027

Notes: the tables reports mean changes in natural log of real per capita GDP across the estimation horizon and presents a test of poverty trap for a set of Mexican States based on state-level mean comparison to the hypothetical zero growth steady-state. Long-run growth parameter, its standard error, p-value for zero-growth hypothesis, lower bound and upper bound of 95% confidence interval are reported.

In Table 4, unconditional β-convergence model is estimated based on (1.25) without conditional variables for 10-year intervals. The evidence advocates the presence of unconditional convergence until 1980s with an occasional interruption in the 1950-1960 period. The speed of unconditional convergence is estimated between 2.7% and 3.1% per year. However, the results advocate the break of regional convergence by the beginning of 1980s since the estimated unconditional convergence coefficient remains statistically insignificant for the entire post-1980 period. The structural break in the regional convergence is further confirmed by the diminishing share of variance of per capita income over time. For early postwar period, initial per capita income differences account for 13% to 20% of the growth differential between the initially poor and rich states. In post-1980 period, the significance of initial per capita income at the beginning of each 10-year interval drops to almost zero, indicating the halt of regional convergence. In Figure 2, unconditional β-convergence is depicted graphically at 10-year intervals based on the estimated model specification in Table 4.

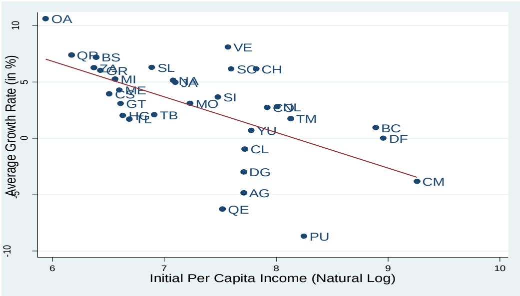
Table 4: 10-Year Estimated Unconditional β-Convergence

	(1) 1940-1950	**(2) 1950-1960**	**(3) 1960-1970**	**(4) 1970-1980**	**(5) 1980-1990**	**(6) 1990-2000**	**(7) 2000-2010**
lnYi,0	-.031*** (.006)	.008 (.007)	-.032*** (.003)	-.027*** (.007)	-.017 (.012)	-.006 (.012)	-.010 (.014)
Constant Term	.254*** (.043)	-.043 (.061)	.313*** (.030)	.277*** (.064)	.163 (.107)	.069 (.113)	.121 (.126)
Observations	320	352	352	352	352	352	352
F-Test (Prob>F)	24.98 (0.000)	1.08 (0.307)	71.42 (0.000)	13.67 (0.000)	1.93 (0.175)	0.24 (0.627)	0.55 (0.463)
R2	0.1378	0.0097	0.2013	0.0150	0.0033	0.0033	0.0019

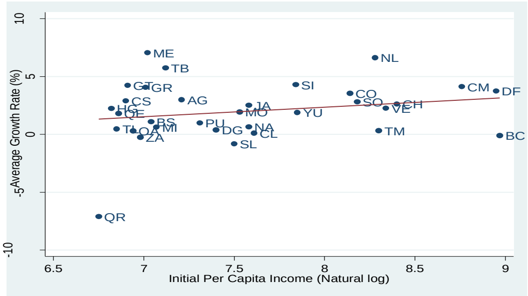
Notes: the table reports 10-year estimated unconditional β-convergence model for a set of 32 Mexican states. Dependent variable is the growth rate of real per capita GDP (in natural log). Standard errors are adjusted into 32 state clusters to correct for possible heteroskedasticity and serially correlated stochastic disturbances and denoted in the parentheses. Asterisks denote statistically significant β-coefficient at 1% (***), 5% (**) and 10% (*).

Figure 2: 10-Year Cycle of Regional Beta Convergence Across Mexican States

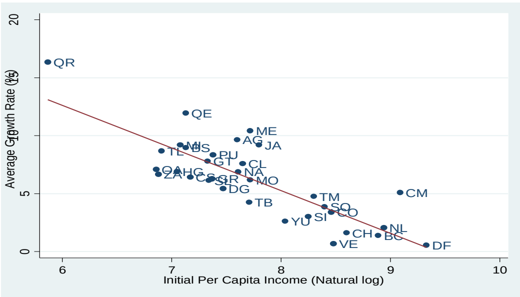
(a) 1940-1950



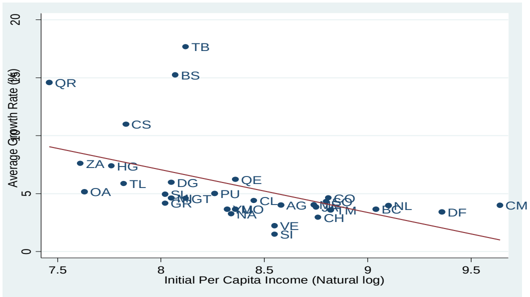
(b) 1950-1960



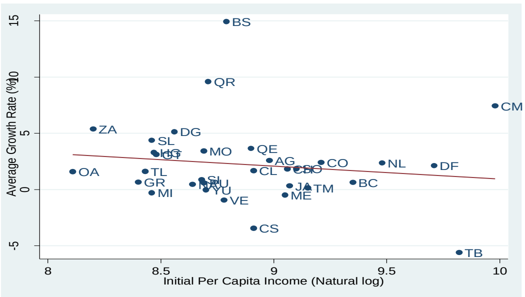
(c) 1960-1970



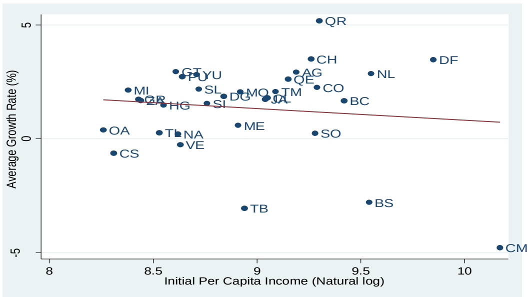
(d) 1970-1980



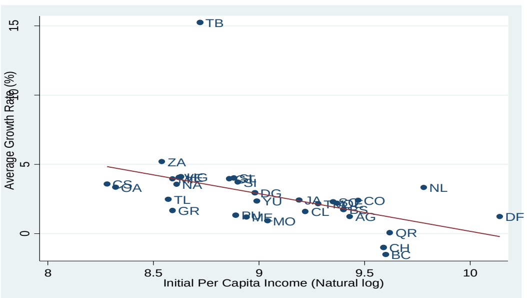
(e) 1980-1990



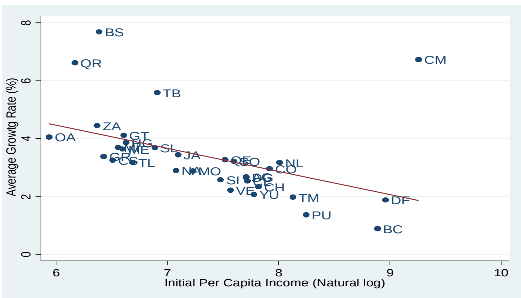
(f) 1990-2000



(g) 2000-2010 (Campeche excluded)



(h) 1940-2010



In Table 5, unconditional β-convergence model is estimated based on (1.21) without conditional variables for 20-year intervals to capture the long-term trends in regional income disparities across Mexican states. The evidence consistently demonstrates the presence of long-term regional convergence in the postwar period. Until 1980, per capita income gap between rich and poor states declined at a rate between 1.1% and 2.6% per year whereas the narrowing of income difference stopped in the post-1980 period where the evidence does not seem to support the long-term convergence hypothesis. The pattern evident across 20-year cycle indicates a substantially heterogeneity in the regional convergence since income gaps decreased at differing rates across the estimation periods. The speed of regional convergence slowed down substantially and almost halved in the period 1960-1980. By the start of 1990s, the coefficient on initial income level is statistically insignificant, highlighting the break of the postwar regional convergence across Mexico since poorer states failed to bridge the gap between richer areas of the country. In Figure 3, 20-year regional convergence cycles are presented graphically for 32 Mexican states.

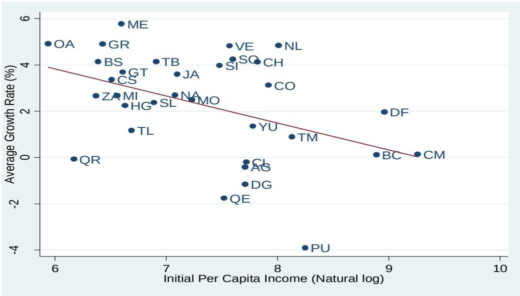
Table 5: 20-Year Estimated Unconditional β-Convergence

	(1) 1940-1960	**(2) 1950-1970**	**(3) 1960-1980**	**(4) 1970-1990**	**(5) 1980-2000**	**(6) 1990-2010**
lnYi,0	-.011** (.004)	-.015*** (.003)	-.026*** (.003)	-.015** (.006)	-.014* (.008)	-.007 (.005)
Constant Term	.106*** (.031)	.155*** (.027)	.261*** (.029)	.159*** (.052)	.138*** (.071)	.079* (.045)
Observations	640	672	672	672	672	651
F-Test (Prob>F)	7.15 (0.011)	18.80 (0.000)	50.77 (0.000)	6.57 (0.000)	3.02 (0.092)	1.85 (0.184)
R2	0.0235	0.0289	0.0493	0.0041	0.0039	0.0019

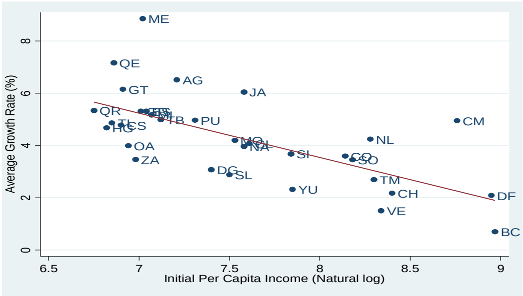
Notes: the table reports 20-year estimated unconditional β-convergence model for a set of 32 Mexican states. Dependent variable is the growth rate of real per capita GDP (in natural log). Standard errors are adjusted into 32 state clusters to correct for possible heteroskedasticity and serially correlated stochastic disturbances and denoted in the parentheses. Asterisks denote statistically significant β-coefficient at 1% (***), 5% (**) and 10% (*).

Figure 3: 20-Year Regional Beta Convergence Across Mexican States

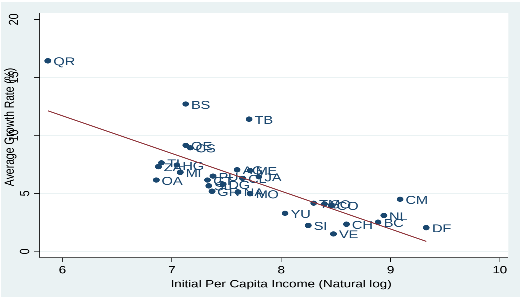
(a) 1940-1960



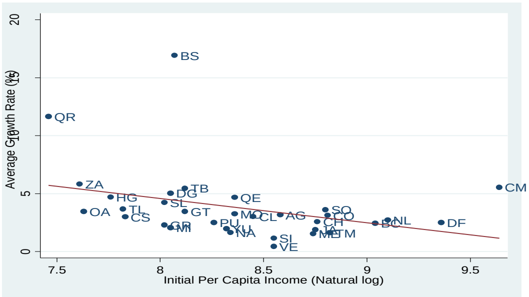
(b) 1950-1970



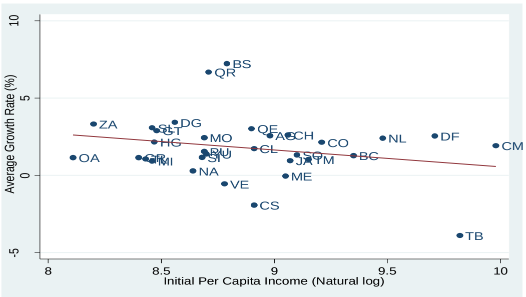
(c) 1960-1980



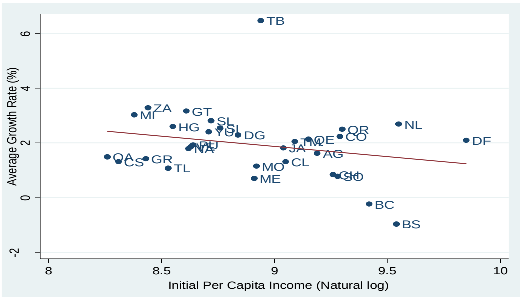
(d) 1970-1990



(e) 1980-2000



(f) 1990-2010 (Campeche excluded)



In Table 6, unconditional β-convergence model is estimated without conditional variables for 30-year intervals to extend 10-year and 20-year convergence model and capture the long-term effects of initial income differences. Compared to the earlier results, 30-year cycles of regional convergence are characterized by substantially smaller rate of regional convergence ranging from 1.1% to 2% in the long-term perspective. For post-1980 period, the absence of regional convergence is confirmed since the coefficient on initial income per capita is almost zero and statistically insignificant. Over time, initial income position accounted for smaller share of cross-regional long-term growth variance, decreasing from 4.1% in the 1940-1970 period to almost zero in 1980-2010 period, reaffirming the remarkable stop of regional convergence in the post-1980 period which kept income differences between high-income U.S-border region and rest of the country intact.

Table 6: 30-Year Estimated Unconditional β-Convergence

	(1) 1940-1970	(2) 1950-1980	(3) 1960-1990	(4) 1970-2000	(5) 1980-2010
lnYi,0	-.015*** (.001)	-.017*** (.002)	-.020*** (.004)	-.011** (.004)	-.001 (.005)
Constant Term	.151*** (.030)	.176*** (.020)	.195*** (.031)	.120*** (.039)	.027 (.052)
Observations	960	992	992	992	992
F-Test (Prob>F)	74.13 (0.000)	42.27 (0.000)	25.00 (0.000)	6.27 (0.017)	0.04 (0.083)
R2	0.0418	0.0196	0.0198	0.0031	0.0000

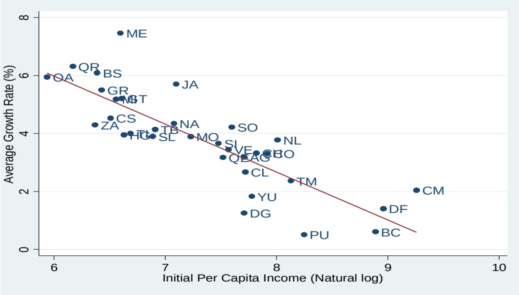
Notes: the table reports 30-year estimated unconditional β-convergence model for a set of 32 Mexican states. Dependent variable is the growth rate of real per capita GDP (in natural log). Standard errors are adjusted into 32 state clusters to correct for possible heteroskedasticity and serially correlated stochastic disturbances and denoted in the parentheses. Asterisks denote statistically significant β-coefficient at 1% (***), 5% (**) and 10% (*).

In Figure 4, 30-year regional convergence cycles are presented graphically for 32 Mexican states. The relevance of initial per capita income differences can be readily observed for the large part of the postwar period in which initially poorer states sustained higher average growth than initially richer states which amplified the unconditional convergence across the country. However, the origins of convergence break-up can be seen by tracing the slope of the unconditional β-convergence curve over time. Whereas the downward slope of the curve is evident in the long-term perspective from the years 1940, 1950 and 1960 onwards, the slope is diminished substantially for the period 1970-2010. In the post-1980 period, the evidence is wholly consistent with earlier results on the cycles of convergence since long-term convergence process was reversed. From 1980 onwards, states with initially higher per capita income achieved consistently higher growth rates compared to the states with initially lower per capita income. A possibility for a sudden reversal of convergence in divergence could be traced back to the oil effect in natural resource-rich state Campeche which experienced sequential growth spurts as a result of oil exploration and production boom. Therefore, a separate β-convergence model is estimated with and without Campeche to control for possible effects of oil on regional divergence. Surprisingly, the exclusion of Campeche from the regional convergence sample does not alter the baseline effect. In fact, excluding Campeche from the sample results in a statistically significant regional divergence in post-1980 period when 30-year perspective is considered.

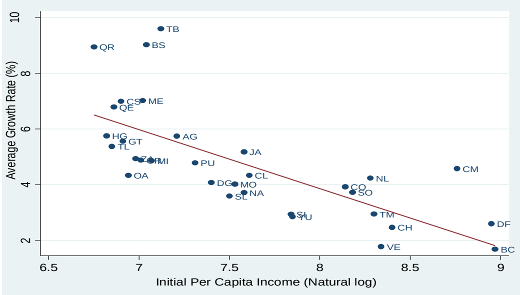
The evidence so far suggest that Mexican states exhibited unconditional regional convergence in the early postwar period and failed to narrow income per capita differences further in the post-1980 period. During the convergence years, the speed of regional convergence is estimated between 1.1% and 2%. Despite the marked reduction in regional income disparities, substantial income per capita differences remained in place given widespread regional income inequality across Mexican states. However, the evidence is hinged upon the assumption of complete long-term growth specification whereas other relevant growth determinants and structural factors are not taken into account. In other words, the estimated speed of regional convergence is unconditional on growth determinants, structural factors and additional control variables. Conditional variables and controls are difficult to observe in long-term growth relationship compared to short-term growth specifications. In equations (1.22) and (1.23), fixed-effects were introduced to address the unobserved effects affecting the long-term growth performance of Mexican states. State-fixed effects refer to the unobserved state-specific characteristics not directly controlled in the model such as initial endowment differences, effect of location, schooling rates, physical capital, demographic structure and state-level government policy.

Figure 4: 30-Year Regional Beta Convergence Across Mexican States

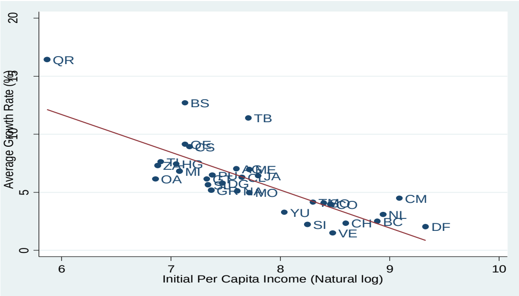
(a) 1940-1970



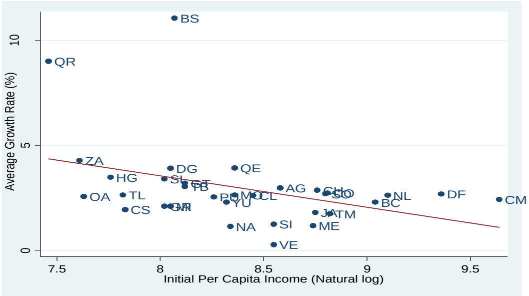
(b) 1950-1980



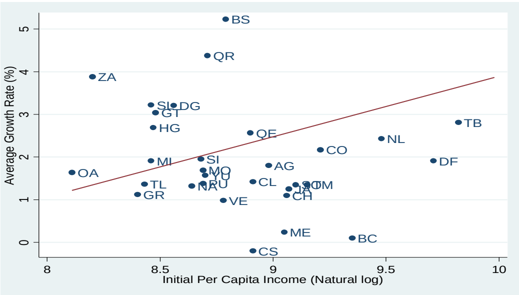
(c) 1960-1990



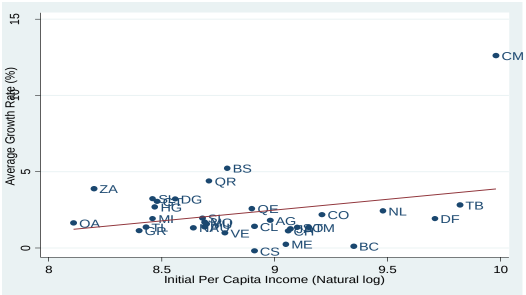
(d) 1970-2000



(e) 1980-2010 (without Campeche)



(f) 1980-2010 (with Campeche)



Whereas state-fixed effects capture cross-state heterogeneity in unobserved growth determinants, time-fixed effects capture common technology shocks over time, affecting the long-term rate of economic growth across Mexican states. Time-fixed effects are essential to estimate the underlying conditional convergence model consistently since it allows us to control for both internal and external effects of technology on the cross-state growth performance. The failure to control for unobserved effects inevitably results in omitted variable bias and triggers the inconsistency of the estimated conditional β-convergence coefficient in a regional perspective.

In Table 7, conditional long-term β-convergence model is estimated with state-fixed effects and time-fixed effects as conditioning variables. In Panel A, base sample is considered where the overall observations for 32 Mexican states are pooled into common sample using different decades as a start of the initial period to gauge the effect of initial income differences on economic growth. In column (1), the regional convergence model is estimated starting in 1940. The result suggests that once unobserved state-level and time effects are controlled for, β-convergence coefficient drops to 0.5% per year, advocating a slow speed of regional income convergence compared to a relatively strong unconditional effects. Even though the convergence coefficient is significant at 1%, the estimated speed of convergence is slow, indicating a gradually slow process of narrowing income differences from the year 1940 onwards. The β-coefficient remains marginally significant only until 1960 as initial year. In post-1960 period, there is no evidence of conditional convergence in the aggregate perspective. In columns 1-6, the contribution of state-fixed and time-fixed effects is jointly significant whereas in column 7, only time-fixed effects withstand the joint significance, suggesting that over time the effect of technology shocks largely benefited initially richer states. In Panel B, 10-year cycles of conditional regional convergence are estimated. The evidence is consistent with the observed pattern of unconditional convergence. In the early postwar period, Mexican states experienced a robust conditional convergence as indicated by the negative and significant β-coefficient. The process of regional convergence was sustained until the onset of 1980s. The remarkable feature of the Mexican regional development pattern is the diminishing speed of regional convergence.

Table 7: Estimated Beta Convergence Across Mexican States with Unobserved Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Base Sample **Initial Year**	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**
lnYi,0	-.005*** (.001)	-.003 (.003)	-.006* (.003)	-.002 (.003)	-.0005 (.005)	.001 (.005)	.006 (.031)
Constant Term	.060*** (.017)	.083*** (.028)	.109*** (.025)	.065** (.028)	.073 (.045)	.187*** (.033)	-.039 (.277)
F-Test on Joint Significance of State-Fixed Effects (Prob>F)	21.96 (0.000)	14.81 (0.000)	34.11 (0.000)	27.78 (0.000)	20.47 (0.000)	10.36 (0.000)	1.54 (0.229)
F-Test on Joint Significance of Time-Fixed Effects (Prob>F)	423.30 (0.000)	430.69 (0.000)	2454.02 (0.000)	221.52 (0.000)	2027.46 (0.000)	60.23 (0.000)	36.34 (0.000)
N	2,272	1,984	1,664	1,344	1,024	704	384
R2	0.1716	0.1829	0.1926	0.1645	0.1855	0.3272	0.3430
Panel B: 10-Year Regional Convergence Dynamics **Estimation Sub-Period**	**1940-1950**	**1950-1960**	**1960-1970**	**1970-1980**	**1980-1990**	**1990-2000**	**2000-2010**
lnYi,0	-.031*** (.005)	.018*** (.001)	-.022*** (.007)	-.010*** (.002)	.008 (.010)	-.022 (.018)	.011 (.037)
Constant Term	.264*** (.039)	-.129*** (.012)	.209*** (.062)	.148*** (.026)	.017 (.104)	.232 (.155)	-.081 (.324)
F-Test on Joint Significance of State-Fixed Effects (Prob>F)	114.32 (0.000)	2891.37 (0.000)	2.00 (0.152)	132.52 (0.000)	444.11 (0.000)	23.83 (0.000)	1.16 (0.327)
F-Test on Joint Significance of Time-Fixed Effects (Prob>F)	37.37 (0.000)	255.13 (0.000)	1177.34 (0.000)	38.09 (0.000)	40.97 (0.000)	40.16 (0.000)	13.03 (0.000)
N	320	352	352	352	352	352	352
R2	0.3777	0.2337	0.5283	0.1203	0.0856	0.4862	0.3438
Panel C: 20-Year Regional Convergence Dynamics **Estimation Sub-Period**	**1940-1960**	**1950-1970**	**1960-1980**	**1970-1990**	**1980-2000**	**1990-2010**	
lnYi,0	-.008** (.003)	-.005 (.005)	-.015*** (.003)	-.004 (.004)	-.008 (.007)	.003 (.005)	
Constant Term	.064*** (.022)	.050 (.045)	.184*** (.026)	.106** (.049)	.094 (.079)	-.021 (.052)	
F-Test on Joint Significance of State-Fixed Effects (Prob>F)	62.46 (0.000)	6.09 (0.005)	72.20 (0.000)	46.96 (0.000)	13.65 (0.000)	21.98 (0.000)	
F-Test on Joint Significance of Time-Fixed Effects (Prob>F)	1082.51 (0.000)	2146.49 (0.000)	1678.29 (0.000)	78.39 (0.000)	52.14 (0.000)	54.97 (0.000)	
N	640	672	672	672	672	672	
R2	0.1686	0.3161	0.1724	0.0902	0.1217	0.3245	
Panel D: 30-Year Regional Convergence Dynamics **Estimation Sub-Period**	**1940-1970**	**1950-1980**	**1960-1990**	**1970-2000**	**1980-2010**		
lnYi,0	-.012*** (.001)	-.006** (.003)	-.009*** (.002)	-.008* (.004)	.004 (.007)		
Constant Term	.178*** (.019)	.073*** (.024)	.077*** (.021)	.103*** (.035)	.037 (.067)		
F-Test on Joint Significance of State-Fixed Effects (Prob>F)	56.09 (0.000)	20.60 (0.000)	91.67 (0.000)	67.92 (0.000)	4.27 (0.023)		
F-Test on Joint Significance of Time-Fixed Effects (Prob>F)	8864.03 (0.000)	6105.75 (0.000)	19989.23 (0.000)	856.13 (0.000)	507.25 (0.000)		
N	960	992	992	992	992		
R2	0.2280	0.1603	0.1369	0.1152	0.1826		

Notes: table reports estimated β-convergence model conditional on unobserved spatial and intertemporal effects. Standard errors are adjusted into 32 state cluster to correct possible heteroskedastic distribution of error variance and serially correlated stochastic disturbances, and denoted in the parentheses. Asterisks denote statistically significant β-coefficient at 10% (*), 5% (**) and 1% (***), respectively.

In early postwar decades, the speed of regional convergence decreased from 3.1% to 1.1% on the annual basis after controlling for state-fixed effects and time-fixed effects. In post-1980 period, the evidence advocates the break-up of conditional regional convergence which seems to have been driven by technology shocks, benefitting initially richer states and yielding higher growth rates compared to the poorer states who seemed to have proven incapable of adopting better technology to boost the growth performance. In Panel C, the evidence advocates the break-up of regional convergence by the start of 1970s despite the robust conditional convergence in earlier decades, estimated between 0.5% and 1% on the annual basis. Although the evidence is indicative of narrowing income disparities across Mexican states, the achieved conditional convergence rate is low and insufficient to bridge persistent income per capita gap between the rich and poor states.

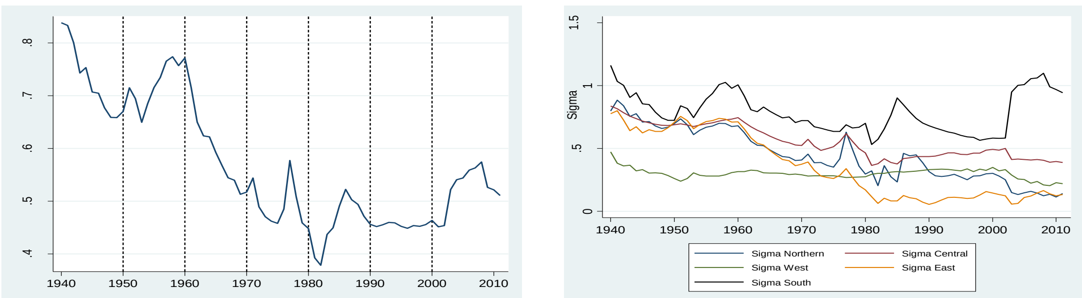
In Panel C, the baseline 30-year cycle of regional convergence is extended by augmenting the long-run growth model with state-fixed and time-fixed effects. The results uncover a slow process of regional convergence conditional on unobserved effects. In the first 30-year cycles (1940-1970), the estimated rate of conditional convergence (1.2% per year) is statistically significant but its magnitude is low, leading to persistent regional income differences across states in a long-term perspective. Moreover, the evidence highlights a diminished rate of conditional convergence in subsequent 30-year cycles, dipping below 1% on the annual basis. In post-1980, the evidence confirms the absence of conditional regional convergence across states since the underlying β-coefficient is non-negative and statistically insignificant.

Key implications from our results support the view according which postwar income disparities across states declined considerably with and without state-fixed effects and time-fixed effects as conditioning variables in the long-run convergence model. The estimated convergence model confers strong evidence against both conditional and unconditional convergence in the post-1980 period when Mexico experienced debt crisis and the onset of North American trade integration in the subsequent periods. Although the results emphasize two distinct and substantially different episodes of economic across states, it remains unclear from β-convergence model whether the distributional structure of regional income differences changed over time.

In Figure 5, the estimated sigma convergence coefficient is plotted for 32 Mexican states in the period 1940-2011. Panel (a) features the estimated sigma parameter - standard deviation of the log of real per capita GDP from the national mean. The parameter captures the dispersion of per capita income and captures the extent to which the inequality in the distribution of per capita income changed over time. Falling dispersion in per capita income across states over time indicates σ-convergence and narrowing income gap between richer and poorer states over time. The evidence from Mexico indicates a heterogeneous pattern of σ-convergence. In the postwar period, per capita income dispersion kept declining after a short-lived rise in 1950-1960 period. After 1960, distributional per capita income disparities across states decreased at a robust rate until early 1980s. After early 1980s, the dispersion in per capita income increased persistently in spite of occasional setbacks in the period 1990-2000. The evidence readily advocates the onset of σ-divergence between Mexican states in early 1980s, indicating the rise in the dispersion of per capita income. The roots of the post-1980 σ-divergence can be traced to the disparities in growth rates between U.S-border states and non-border states. After the Mexican debt crisis in 1980s and the admission to NAFTA, Northern states improved economic growth considerably compared to the rest of the country which experienced lower growth. Trade liberalization can be considered a key structural factor behind the σ-divergence since the removal of trade barriers led to the increasing agglomeration of economic activity alongside the U.S. border, increasing returns to scale which triggered rising rates of economic growth compared non-border states. Another factor behind σ-divergence in post-1980 period is the endowment effect resulting from oil exploration and production in Southern Mexican state Campeche.

Figure 5: Sigma Convergence Across Mexican States and Regions, 1940-2011

(a) Base Sample (b) Regional Blocks



These effects are perceivable in Panel (b) which presents the estimated standard deviation of real per capita GDP from the national mean for five Mexican regions.

Falling dispersion, indicating by decreasing σ parameter is evident until 1980s for Northern Mexico, Eastern Mexico and Central Mexico. The evidence from Western Mexico and Southern Mexico differs considerably from the rest of the country. The former experienced little σ-convergence from early 1940s onward given persistent income dispersion between richer and poorer states within the region. The latter experienced a moderate rate of σ-convergence until 1980s with occasional reversals evident in 1950-1960 period. After 1980, Southern Mexican states experienced narrowing income differences compared to the rest of the country where the evidence readily demonstrates the break of σ-convergence within the region. However, after 2000, the regional reversal in the σ-convergence trend is evident as a result of the oil production effect in oil-rich Campeche. Increases in oil production and exploration raised income disparities within Southern Mexico to a remarkably, leaving poor states such as Chiapas, Oaxaca and Guerrero behind Campeche and the rest of the region. The effect corresponds with the sudden and rapid oil-related growth in Campeche.

7. Robustness checks

The ultimate question concerns the robustness of the estimated convergence relationship across Mexican states and regions. The evidence from the estimated model specification advocates persistent postwar convergence across states while the process of both β-convergence and σ-convergence stopped in post-1980 period. The estimated coefficients are based on simple least-square regression with clustered standard errors to ensure heteroskedasticity-robust inference from the estimated parameter on initial per capita income, allowing for possible serially correlated stochastic disturbances.

The robustness of estimated parameters is based on extending the baseline model specification to quantile regression originally proposed by Koenker (2005) to assess the sensitivity of the results. The empirical distribution is broken down into q number of quantiles to estimate quantile-specific conditional expectation function, allowing for differential effect of initial per capita income on the average growth rate since low-income states may exhibit a tendency to achieve a higher growth compared to high-income states. There are several advantages of the quantile regression. First, when the distribution of the stochastic disturbances in non-normal, OLS estimator is inefficient despite the adjustment for heteroskedasticity and serial correlation. And second, quantile regression parameters are invariant to monotonic transformations and relatively straightforward to translate results back to the mean dependent variable whereas this is not possible under conditional mean expectation function.

In our framework, an empirical distribution is constructed by grouping Mexican states into ten income quantiles on the annual basis to observe income-specific effects of initial per capita income on average growth in *β*-convergence model. Let $Q_q(g|X)$ denote conditional quantile expectation function for the average growth where q represents specific quantile with a mass normalized to one, $q \in (0,1)$. The conditional expectation function splits the Mexican states into q proportions below and $1-q$ proportions above the quantile so that $F(y_q) = q$ and$y_q = F^{-1}(q)$.

For a quantile *q*, quantile regression estimator is used to minimize the objective function:

$$Q(\beta_q) = \sum_{i:y_i \geq \alpha+\beta \ln y_{i,t=0}+X'_{i,t}\eta}^{N} \sum_{t=1}^{T} q\left|g_{i,t} - \alpha + \beta \ln y_{i,t=0} + X'_{i,t}\eta_q\right| + \sum_{i:y_i \leq \alpha+\beta \ln y_{i,t=0}+X'_{i}\eta}^{N} \sum_{t=1}^{T} (1-q)\left|g_{i,t} - \alpha + \beta \ln y_{i,t=0} + X'_{i,t}\eta_q\right| \quad (14)$$

which is non-differentiable and estimated via simplex method to yield a solution in a finite number of iterations. Quantile regression estimator is assumed to be asymptotically normally distributed. In addition, 10,000 sub-sample replications of (14) are performed to establish robust inference of quantile-specific parameter on initial per capita income. Bootstrapping technique allows us to retain the crucial assumption on independent distribution of stochastic disturbances while forgoing the assumption of identical distribution of stochastic disturbance which yields standard errors equivalent to the robust and clustered standard errors.

In Table 8, the estimated model specification of β-convergence from quantile regression is presented for ten income thresholds to check for the stability of the baseline coefficients and assess income-specific speed of β-convergence across Mexican states. The coefficient indicates the rate at which states at particular income threshold convergence to the top 10% income frontier in the empirical distribution. Panel E exhibits the long-term convergence relationship for the period 1940-2010. The estimated β convergence coefficient is stable across all income thresholds although the estimated speed of convergence in the bottom 10% of the distribution is substantially above the average level. A notable feature of the quantile regression estimate of β-convergence coefficient is the low speed of convergence across all income thresholds, estimated below 1% per year which confirms earlier results.

In Panel F, the period 1950-2010 is considered to re-estimate the long-term convergence relationship. The evidence demonstrates significant disparities in the speed of β-convergence across states. For bottom 30% of the empirical distribution, little evidence of convergence to the high-income frontier is found. Quantile coefficients uncover persistent disparities since upper 70% of the empirical distribution converged to the common frontier at significantly higher rate than bottom 70% of the distribution. Moreover, the evidence indicates almost complete absence of β-convergence in bottom 20% of the distribution which is consistent with the fixed-effects estimates in Table 7.

Similar evidence is found in Panel G which presents the quantile β-convergence regression for the period 1960-2011. Substantial income disparities between bottom 20% and top of the empirical distribution remain intact. The results suggest that higher income quantiles above the median level exhibited considerably higher rate of β-convergence, exceeding 1% per annual basis whereas states in the 90th percentile of the distribution experienced 2.5% convergence rate per year. Sensitivity analysis of the convergence coefficient is consistent with low speed of convergence estimated in Table 7.

In Panel H, the quantile β-convergence regression is featured for the period 1970-2011. Compared to earlier pre-1970 specification, the results indicate the absence of convergence at each particular section of the empirical distribution. Although the re-estimated coefficient is negative, it is both small and statistically insignificant which highlights the persistence of income inequality across states. The only exception to this pattern is the coefficient for 60th percentile of the distribution which exhibits only marginal significance with respect to the effect of initial income level on average growth. Sensitivity analysis of the baseline β-convergence is consistent with earlier evidence from Table 7 which suggests the non-existence of both unconditional and conditional convergence over time. On the contrary, the sensitivity analysis for the period 1980-2011 in Panel I confirms the evidence of β-convergence for the bottom 30% of per capita income distribution. Quantile-specific convergence coefficient is surprisingly large, exceeding 5% for the bottom 10% of the distribution, 3.6% for the bottom 20% of the distribution and 1.8% for the bottom 30% of the overall distribution.

Table 8: Estimated Beta Convergence Model by Income Thresholds

	(1) 10%	**(2) 20%**	**(3) 30%**	**(4) 40%**	**(5) 50%**	**(6) 60%**	**(7) 70%**	**(8) 80%**	**(9) 90%**
Panel E: Base Year: 1940									
lnYi,0	-.010** (.004)	-.007*** (.002)	-.008*** (.001)	-.006*** (.001)	-.008*** (.001)	-.007*** (.001)	-.009*** (.001)	-.009*** (.002)	-.009* (.004)
Observations	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272
Pseudo R2	0.0049	0.0038	0.0048	0.0044	0.0057	0.0048	0.0070	0.0054	0.0048
Panel F: Base Year: 1950									
lnYi,0	-.003 (.007)	-.003 (.003)	-.004* (.002)	-.005*** (.002)	-.008*** (.002)	-.009*** (.002)	-.011*** (.002)	-.013*** (.003)	-.019*** (.006)
Observations	1,984	1,984	1,984	1,984	1,984	1,984	1,984	1,984	1,984
Pseudo R2	0.0003	0.0005	0.0011	0.0027	0.0038	0.0041	0.0076	0.0083	0.0014
Panel G: Base Year: 1960									
lnYi,0	-.002 (.007)	-.002 (.003)	-.004* (.002)	-.005*** (.002)	-.011*** (.001)	-.013*** (.002)	-.013*** (.002)	-.018*** (.003)	-.025*** (.007)
Observations	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664	1,664
Pseudo R2	0.0002	0.0002	0.0014	0.0033	0.0072	0.0084	0.0146	0.0147	0.0183
Panel H: Base Year: 1970									
lnYi,0	-.009 (.012)	-.002 (.006)	-.007 (.004)	-.004 (.003)	-.003 (.002)	-.006* (.003)	-.003 (.003)	-.007 (.005)	-.028 (.017)
Observations	1,344	1,344	1,344	1,344	1,344	1,344	1,344	1,344	1,344
Pseudo R2	0.0018	0.0002	0.0006	0.0004	0.0003	0.0001	0.0005	0.0014	0.0082
Panel I: Base Year: 1980									
lnYi,0	-.051*** (.012)	-.036*** (.009)	-.018*** (.005)	-.006* (.003)	-.003 (.003)	.0007 (.004)	.002 (.004)	.006 (.005)	.016 (.012)
Observations	1,024	1,024	1,024	1,024	1,024	1,024	1,024	1,024	1,024
Pseudo R2	0.0454	0.0130	0.0052	0.0016	0.0003	0.0000	0.0001	0.0008	0.0041
Panel J: Base Year: 1990									
lnYi,0	-.033*** (.011)	-.014* (.007)	-.008 (.005)	-.001 (.004)	.000 (.004)	.0007 (.004)	.0002 (.003)	.002 (.005)	.002 (.008)
Observations	704	704	704	704	704	704	704	704	704
Pseudo R2	0.0247	0.0051	0.0016	0.0000	0.0000	0.0000	0.0000	0.0003	0.0002
Panel K: Base Year: 2000									
lnYi,0	-.013 (.015)	-.015 (.010)	-.012* (.007)	-.012** (.005)	-.009 (.006)	-.010** (.005)	-.007 (.006)	-.015* (.007)	-.021 (.027)
Observations	384	384	384	384	384	384	384	384	384
Pseudo R2	0.0035	0.0061	0.0044	0.0048	0.0035	0.0048	0.0024	0.0064	0.0055

Notes: table reports quantile regressions of average growth rate on initial per capita GDP for 32 Mexico states across ten quantiles. Standard errors are based on empirical sampling distribution using non-parametric bootstrap resampling method as a first-order asymptotic approximation of the theoretical distribution function. Standard errors are smoothed across 10,000 quantile-specific sub-sample replications using Monte-Carlo simulation method for original empirical distribution function and reported in the parentheses. Acceleration method is used to correct sample coefficients, sample variance, t-statistics and p-values corresponding to the statistical significant of the estimated quantile regression coefficients. p-values are adjusted for asymptotic bias in empirical distribution function using Bollen-Stine empirical sampling estimator. Asterisks denote statistically significant quantile regression coefficients at 1% (***), 5% (**) and 1% (*).

For upper parts of the cross-state per capita income distribution above 30% threshold, no evidence of β-convergence is confirmed. Strong evidence of the long-term convergence is confirmed in Panel J which exhibits the relationship in the period 1990-2011. The convergence relationship is significant only for the bottom 20% of the empirical distribution, confirming narrowing income differences between rich and poor states at 3.3% annual rate for the bottom 10% and 1.4% annual rate for the bottom 20% of the distribution. Similar to earlier sensitivity checks, no evidence of convergence is confirmed for middle and upper part of the distribution. Finally, in Panel K, the stability of β-convergence coefficient is assessed for the period 2000-2011. The evidence reaffirms earlier findings from Table 7, highlighting the breakup of regional convergence in the respective period. Some evidence of convergence is reconfirmed for upper 40% and 60% of the empirical distribution and marginally significant convergence coefficient is found at 30th percentile and 80th percentile which further advocates the halt of state-level convergence process in post-1980 period compared to pre-1980 period when Mexican states exhibited a robust convergence. However, the rate and speed of convergence seems to have been too small to further narrow the income differential between rich and poor states across Mexico.

8. Conclusion

The paper has presented the framework for long-term heterogeneous convergence and poverty trap using the empirical distribution of real GDP per capita across 32 Mexican states in the period 1940-2011. In the empirical framework, β-convergence and σ-convergence are employed to examine if per capita income gap and its dispersion between initially rich and poor states narrowed over time. A model of poverty trap is developed in the neoclassical growth framework. The model emphasizes that poverty trap can arise when poor regions suffer from the inability to adopt modern high-productivity technology given the inherent inability to switch from the unproductive traditional sector to the productive modern sector.

A new dataset on the within-country per capita income distribution over time is developed for 32 Mexican states based on the seminal contribution of German-Soto (2005). Historical estimates of real per capita GDP from the period 1940-1992 are linked to the contemporary post-1990 time-series from OECD (2013). Real per capita GDP series is reconstructed by updating GDP deflator to 2005 base year and using national purchasing power parity to derive internationally comparable real GDP per capita series which allows us to observe long-term regional growth patterns across Mexico.

The evidence uncovers substantial heterogeneity in the long-term income convergence across Mexican states. Although long-term poverty trap hypothesis is rejected for the majority of Mexican states, indices of persistently low growth are confirmed in border state Baja California Norte even though states at the U.S. border exhibited consistently higher per capita income compared to the rest of Mexico. Furthermore, poverty trap hypothesis is not rejected in the state of Puebla and oil-rich state of Campeche which experienced repeated growth spurts followed by subsequent growth collapses. For the postwar period, strong evidence of β-convergence and σ-convergence is confirmed. However, the convergence process came to a halt in the post-1980 period since increasing income inequality across states seems to have been driven by the trade liberalization policies implemented in the presence of weak state capacity without altering the patronage pact. The resulting political and economic equilibrium in response to the economic reforms carried out by the government administrations of de la Madrid (1982-1988) and Salinas de Gotari (1988-1994) failed to foment fundamental changes to the patronage pact. By promulgating the entrenched insiders among the existing business and political elites, the liberalization benefited the existing owners and their clientele instead of the market in general which increased the demand for corruption further. We argue that this led into a marked increase in the regional inequality since poorer Mexican states could not catch-up the frontier under such conditions. Our estimates imply that trade liberalization policies carried out by both administrations broke the cycle of decreasing regional inequality that began in late 1950s. Our findings emphasize that distorted institutional environment that enables the clientelistic networks of business and political elites to flourish through patronage pacts most hinders the ability of the poorer states to catch-up with the frontier which holds important and long-lasting implications for growth and regional inequality.

Furthermore, conditional β-convergence is confirmed using state-fixed effects and time-fixed effects as conditioning variables. These variables capture unobserved growth determinants over the long-term horizon such as human capital investment, physical capital accumulation, demographic structure, government policy, institutional differences, resource endowments and technology shocks. Once these fixed effects are controlled for, the results demonstrate low rate of β-convergence in the long-term perspective which contributed to the persistent of regional income inequality across Mexican states over time. In the sensitivity analysis, quantile regressions are employed to check for both the stability of the baseline parameters and the differential income-specific rate of convergence. The robustness checks further confirm the reversal of convergence in the post-1980 period when initially high-income states sustained higher growth and pulled ahead of initially poorer states.

This paper contributes to the growing literature on the long-term effects of within-country inequality and economic growth by constructing a new dataset on Mexican regional per capita income distribution to study long-term state-level patterns of economic growth over time. Future research should examine key structural characteristics behind the substantial income differences and economic growth within Mexico to further the understanding and significance of within-country income inequality.

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