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Capital Accumulation and State Growth in Mexico: A Panel Data Analysis

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Abstract

This paper studies the link between economic growth and state industrial capital stock accumulation using panel data techniques in the time period 1960-2012. The analysis is done in two moments: the age of national industrialization (1960-1982) and the structural reform era (1983-2012). The results point to a long-term relationship in both periods, but with a sign opposite of the expected sign in the latter, suggesting that the deceleration of industrial capital can explain the slowdown over the past three decades. This result is confirmed with the decline of manufacturing, as well as other economic indicators. The causality tests demonstrate two-way causality between the two variables, evincing a virtuous cycle between growth and accumulation.

Keywords: Industrialization; economic growth; capital accumulation; investment; panel data.

1. INTRODUCTION

In recent decades, Mexico underwent a sharp economic policy shift in the wake of the 1982 crisis. Between the nineteen-fifties and seventies, the country was an archetype of growth and financial stability. The primary macroeconomic variables were stable, the exchange rate to the dollar was fixed, convertibility held strong with no restrictions, inflation was moderate, and the gross domestic product (GDP) per capita climbed to high growth rates (Dornbusch and Werner, 1994). This period of stability drew to a close around the time of the 1973 oil crisis with burgeoning oil prices. High revenues from oil exports had left some breathing room in the fiscal budget, which meant policies became extremely expansive, the currency was overvalued, and public debt was on the rise. All of these events brought the financial system and the exchange rate to collapse, due to capital flight, pushing Mexico to bankruptcy in 1982, at which point it had to renegotiate its debt under the painful conditions imposed by its creditors.

Mexico not only paid high interest rates, but in order to borrow the money, was forced to enact a series of economic reforms to stabilize the economy (Dornbusch and Werner, 1994). Although the 1950-1970 growth strategy did generate some distortions (Mejía and Lucatero, 2011), there is more or less consensus as to the importance of capital accumulation as a source of growth during this time period (Elías, 1992; Santaella, 1998).

Since 1982, the key structural reforms were budgetary consolidation, trade openness, free-floating prices and rates in the public sector, and financial sector liberalization (Dornbusch and Werner, 1994). On the fiscal playing field, budgetary consolidation was the cornerstone of the reform and stabilization in Mexico. Major cuts to public spending, tax reforms to expand the tax base, and the privatization of public enterprises were just some of the measures involved in this adjustment. Privatization was a key objective of the public finance reforms (Dornbusch and Werner, 1994). To control the government deficit, some of these companies were sold off to businessmen and women, while others were simply shut down.

In the commercial realm tariff rates have gradually been brought down and reined in since the mid-nineteen-eighties. The initial tariff cut was greater for consumer goods, while intermediate and capital goods saw the liberalization gradually enter into force ever since the North American Free Trade Agreement (NAFTA) took effect in 1994. Governmental price liberalization was done to correct a supposed distortion in the price structure and bring about more efficient use of production factors.

Multiple studies have attempted to explore the growth slowdown in Mexico. Ros (2008) attributes the economic slowdown in large part to poor investment performance. The inability to invest with fixed capital would seem to be the underlying cause of the country's failure to achieve sustained growth since the structural reforms were implemented in 1982. Along these same lines, FitzGerald (2007) asserted that sustainable long-term economic growth depends on the capacity to raise physical and human capital accumulation rates, make optimal use of productive assets, and guarantee the population's access to them.

In any event, the outcome of the economic policies applied in the time period 1960-1981 and then 1982-2016 are vastly divergent. It could be argued that performance in these two time periods is the result of a strong relationship among domestic industrialization, fixed capital accumulation, rapid growth, and an industrial policy with a degree of state intervention.

This paper analyzes the role played by physical capital formation in economic growth (e.g., gGDP) via the fixed capital stock (e.g., gK) with state-level information for Mexico, using different panel data techniques. The text is structured as follows: the second section is a non-exhaustive review of pertinent literature. The third section lays out the theoretical framework and analyzes the growth trajectories, as well as investment in Mexico between 1960 and 2016. The fourth section introduces the econometric methodology used, and the main results. Finally, the conclusions point to several economic policy implications.

2. LITERATURE REVIEW

The hypotheses to explain the direction of causality between fixed capital and economic growth are multiple and substantially varied, so there is no consensus as to the direction of causality between them (Mehrara and Musai, 2013). One of the propositions wielded is that stronger investment can promote economic growth. This hypothesis is grounded theoretically in the Harrod (1939) and Domar (1946) "Keynesian" growth models, and contemporary models. By contrast, the original neoclassical models and their multiple current variations (Barro and Sala-i-Martin, 1995) only have marginal theoretical underpinnings. Not only because other "production factors" are now included, but rather because most of the fixed capital accumulation was supplanted by "technical progress," which according to its proponents, is either exogenously (Solow, 1956, 1957) or endogenously (Roemer, 1990; Grossman and Helpman, 1991) generated. In broad strokes, under this approach, economic investment policies that influence the growth and productivity level drive long-term growth. In theory, gross investment impacts growth, whether by raising the physical capital stock or promoting technology (Levine and Renelt, 1992; Plossner, 1992). The second hypothesis is that economic growth is the principal source of fixed capital stock formation. Nevertheless, the theoretical framework that would back the notion that these transmission mechanisms actually happen is unclear (Mehrara and Musai, 2013), and they are rather grounded in empirical data.

Some of the empirical studies that have shown a positive correlation between investment and economic growth include Tyler (1981), with evidence from a group of 55 developing countries, in which investment and exports are the top drivers of growth. The fastest-growing countries between 1960 and 1977 were t hose in which capital formation also grew the fastest. Tyler holds that this finding is unsurprising, as it furnishes empirical support for economic development theories that assign a key role to capital formation.

Bond *et al.* (2010) also deal with the matter of whether investment affects the long-term productivity growth rate. They report that diverse cross-section and panel data studies have found evidence that the coefficient for relative investment has a positive impact on the level of the product per worker in the "steady state." The cross-section studies include: Mankiw *et al.* (1992), Levine and Renelt (1992), De Long and Summers (1991 and 1993), and Barro and Sala-i-Martin (1995). Specifically, both Levine and Renelt (1992) and De Long and Summers (1991) found evidence that the investment rate is the most systematic and statistically significant driver explaining growth. The papers that have drawn on panel data methods include Islam (1995), Caselli *et al.* (1996), and Bond *et al.* (2001).

On the "Asian miracle" spectacular and the underlying sources of growth, we have Kim and Lau (1994) and Young (1992 and 1995). Through growth accounting and the neoclassical aggregate production function, these authors found that most of these countries' rapid growth can simply be explained by mounting capital accumulation. They furthermore conclude that total productivity (technical progress or TFP) was not an important factor. This pattern was also verified by Rada and Taylor (2006, pp. 9-12) in Southern Asia, China, Southeast Asia, and the Asian tigers, where the capital stock growth exceeded economic growth. Their industrial restructuring consisted of moving into more capital-intensive industries (and not of destroying their own national industry). While labor productivity grew rapidly, "capital productivity" declined, and while the farm sector saw its share of the pie decline, industry got a bigger piece (and services, to a lesser extent). Moreover, the Rada and Taylor study looked at 12 regional groups containing 57 developing countries and countries in transition. Comparing the GDP and capital stock growth rates between 1990 and 2004, they found a "clear positive relationship between the two growth rates across *all* of the regions." In the "semi-industrialized" region of Latin America (including Mexico), the slow growth of 3% is to be expected, given that fixed capital accumulation grew at only 3%, approximately.

3. GROWTH, INVESTMENT, ACCUMULATION, AND THEIR TRAJECTORIES IN MEXICO

The idea of a relationship between distribution, accumulation, and growth is as old as economic theory itself. It blossomed with classic theory, especially with Ricardo, and matured with Marxist theory. But while the obvious factor to the classicists, given their background (agriculture and manufacturing), was labor force demand wage fund, in addition, to Marx, with the capitalist institution of technical change (Mateo and Lima, 2012), the other relevant factor was the capital stock spent on physical means of production (with big industry). By contrast, Keynes turned his attention to final demand, in which fixed investment is fundamental. The omission of wages, however, is recovered in "post-Keynesianism," but as a residual (e.g., Kaldor). The theoretical basis for this work rests on the fundamental Harrod-Domar ratio:

$$g = \frac{I}{K} = \frac{s}{v} = \frac{S \cdot Y}{K \cdot Y}$$

In which *g* is the economic growth rate (*Y/Y*), *s* is the saving rate (*S/Y*) or investment rate (if we suppose that *S = I*), and *v* is the capital to product ratio (*K/Y*). This equation is a function in which economic growth is determined by the fixed capital stock accumulation or growth rate (*I/K=K/K*). Regardless of the assumptions associated with the behavior of *s* and *v,* growth depends solely on capital accumulation. However, in the fifth section, we also do a proof in the opposing causal direction. In this regard, at the "Harrod-Domar crossroads," the post-Keynesian posture revolved around changes in the propensity to save (*s*) as a key adjustment factor through the government's regulating economic policy; on their side, the neoclassicists concentrated on changes in the ratio *v* through "automatic" variations in the relative prices of the "production factors" (*K* and *L*) via the liberal free market mechanism. The former approach has tended to be sidelined, while the latter has flourished to the point that it is now the predominant viewpoint held in the economic sciences, despite its theoretical and empirical snags (Sylos, 1995; Felipe, 1999).

As such, if PIB_0 is the gross domestic product in the time period 0 and PIB_1 is the product in period 1, the rate $gPIB = \Delta PIB / PIB = (PIB_1 - PIB_0) / PIB_0$ measures economic growth. By contrast, to directly estimate the accumulation rate of *I/K,* we do not have the investment flow pertaining to the available stock of fixed capital, and the source of the latter only covers the "industrial sector." Nevertheless, the growth rate of this stock shall be used as a proxy: $gK = \Delta K_{ind} / K_{ind} = (K_1 - K_0) / K_0$.

The period 1960-1981 is part of an age known as "stabilizing development." Over these 22 years, the government pushed an economic "regulating" policy. The public sector supplemented—but did not replace—the private sector, although it did support several development policies under the objective of the *national interest* of industrializing the country with more capital-intensive sectors, applicable to all domestic industry, both public and private. The fiscal, monetary, trade, etc. policies were all lined up in that direction. To do so, the government *favored* the profitability of domestic private investment, *regulating* foreign investment and *supplementing* with public investment in strategic, risky, unprofitable, and social sectors.

The time period 1982-2016 is known as the age of "structural reforms." Over these 35 years, practically every reform ever dreamt up or known to man was experimented with in Mexico at some time, to some extent, or to some degree of intensity. The State imposed a liberal and mercantilist policy for economic activity, aiming to replace the public sector with the private sector to an unimaginable measure.

We refer to the manufacturing rate (GDPman/GDP) as an indicator of the degree of industrialization, because it is the most dynamic sector; it includes more fixed capital-intensive realms and produces several of them. With efforts to boost domestic manufacturing, the GDPman/GDP accumulated growth of 19.5% (from 14.1% to 16.8%) at an annual average rate of 0.9% between 1960 and 1981. By contrast, with the policy supporting the transnational *maquila* industry and trade, as well as own manufacturing imports of inputs and capital, it declined 6.6% (from 16.8% to 15.7%) with an annual negative rate of 0.2% between 1982 and 2016. The average elasticity gGDPman/gGDP tied to this pattern indicates that during the time of "stabilizing development," for each national percentage point change, the change in manufacturing was 1.132 points (7.8/6.9); by contrast, with the "structural reforms," the elasticity declined to 0.94 (2.1/2.2).

An industrial pattern is associated with an investment rate (GFCF/GDP, private and public), because it depends on the type of asset formation, as well as whether national saving mechanisms are regulated or liberalized. During the regulated development era, this percentage built up an increase of 49.6% (from 17.7 to 26.5%), with annual growth of 1.9%. Inversely, during the reform period when investment was curbed and national savings stabilized, there is a cumulative drop of -13.5% (from 26.5% to 22.9%), with growth clocking in at -0.02% per year (0.78%, for 1983-2016). Note that the 2016 GFCF/GDP rate has still not returned to the 2008 level, and is nearly equal to overall national achievement 42 years ago, from 1975.

Moreover, the capital to product ratio should slowly follow the rapid changes in the GFCF/GDP rate, because it measures net investment accumulated per product, pursuant to the wear and tear on the average lifetime of the asset structure. This (industrial) asset intensity had a cumulative increase of 73.4% at an annual rate of 2.7% with national industrialization; but between 1982 and 2013, these changes were, respectively, 70.3% and 1.7%. The SR/SD column indicates that the annual average variation in the K/GDP intensity induced by the reforms represents only 0.63 of a point for each percentage point driven by nationalist technification. Indeed, the reforms paralyzed technical change. Nevertheless, the K/GDP “census” ratio seems to show some bias. First, even admitting its slow change, the 1980 to 1988 jump does not reflect the severity of the crisis of the nineteen-eighties, which does come through in the GFCF/GDP ratio of national accounts; second, the 1995-2013 decline does not contain the slow GFCF/GDP recovery. This point shall be dealt with in the fourth section.

(SEE TABLE 1)

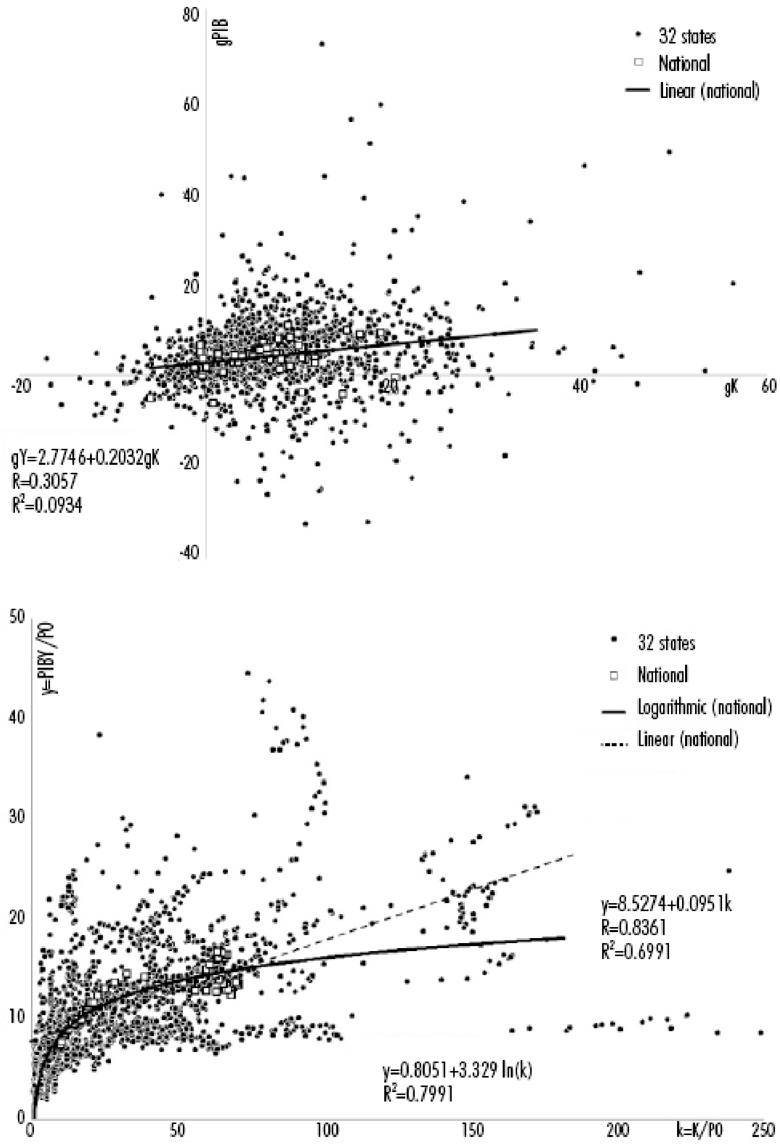
Specifically, the State’s different behavior is confirmed with its respective investment effort. Between 1960 and 1981 (state regulation), the public sector fixed investment rate (GFCFpub/GDP) rose 97.6% at an average rate of 3.3% per year;

between 1982 and 2016 (mercantile deregulation), it collapsed -61.6% with annual growth of -2.7%. In other words, while the nationalist State raised the public sector investment share from 5.4% to 10.7% of GDP, the State during the reform period cut back on investment from 10.7% to 3.4% of GDP. This reduction had a negative impact on the capital stock. First, because the public sector fixed capital stock was not renewed when the GFCFpub flow declined with the fiscal cutbacks tied to the reforms. Second, because much of the existing stock was liquidated when it was privatized, resold, or due to lack of repair. But the reformer State not only destroyed *productive* investment, but also, albeit to a lesser degree, cut back on the overall government's *current* social spending (health, education, etc.); this can be measured with all of the relative public spending (GP/GDP, including GFCFpub/GDP) (Rodríguez, Venegas, and Lima, 2013).

How does the above affect social development? Directly. And that is because, pursuant to the Harrod-Domar relationship, we know that the product per capita depends on the capital per capital bound up in savings and technology among the population. Figure 1 (bottom) shows the spread of this ratio (GDP/PO vs. K/PO) both state- and nationwide. For the nation and the entire time period 1960-2013, we find a good linear (r) correlation of 83.6% and a determination (r^2) of 69.91%. The ratio improves with a logarithmic regression (r^2=79.91%). This means an initially strong relationship that dissipates post-1981. Breaking it out against the 1981 crisis, the first period (1960-1981) matches up with the time of nationalistic industrialization (r=96.5%, r^2=93%), and the latter (1982-2013) with the deindustrialization entailed by the reform period (r=8.5%, r^2=0.72%). Accordingly, the ratio between stronger social development and higher industrial capital per capita is robust during the age of stabilizing development, but not for the reform period. In this regard, the five states displaying the highest correlation were: State of Mexico, Jalisco, Puebla, Quintana Roo, and Campeche; those with the latest correlations were: Tabasco, Michoacán, Baja California Sur, Norte, and Sonora.

Figure 1 (top) moreover shows the state spread between growth and accumulation (gGDP vs. gK), which we will examine below. Throughout the entire period, there is a lower correlation and determination (r=30.6%, r^2=9.34%). The ratio improves during the nationalist State (r=43.3%, r^2=18.73%) but not for the reform period (r=-14.8%, r^2=2.18%). As a result, according to Table 1, it is salient to note that the rapid economic and manufacturing growth during nationalism (gGDP=6.9% and GDPman=7.8%) are on average tied to the faster growth of accumulation (gK=9.6%). Likewise, the slow growth in the reform period (gGDP=2.2% and GDPman=2.1%) is related to lower accumulation (gK=3.9%). This result matches up with Lima (2005), who estimated the gross domestic fixed capital stock for the non-residential private sector (Cf^) with data from the national accounts and the perpetual inventory method (PIM).

Figure 1. State Spread of Growth vs. Accumulation (gGDP vs. gK)
and Product per Capita vs. Capital per Capita (GDP/PO vs. K/PO),
1960-2013



Source: Created by the authors with data from Germán-Soto, V., 2005, 2008, and 2015 <https://works.bepress.com/vicente_german_soto/>

To wrap it up, it emerges that social development (GDP/PO, Table 1) grew at an annual average speed of 3.8% during the stabilizing development time and at 0.6% in the reform period. That is to say, social welfare in the latter period only amounted to 17% (SR/SD) of the achievement in the former period. Likewise, it appears that low economic growth during this same period represents 32% of what it was in the latter (6.9/2.2), given that the structural reforms are tied to five severe crises that have cropped up over the past 35 years. Thus, the *stronger economic growth* and social development Mexico attained during the age of national industrialization from 1960 to 1981 is correlated with a *higher accumulation rate* and industrial capital per capita, which is in turn associated with a burgeoning manufacturing rate, a high saving and overall investment rate, rising technical intensity of capital, a progressive public fixed investment rate, and progressive rate of public spending. With that said, the *weaker growth* and development that afflicted Mexico during the reform and stabilization period of 1982-2016 is related to *lower accumulation* and capital per capita rates; which is in turn bound to a declining manufacturing rate, a low saving and overall investment rate, slow capital intensity, a falling fixed public investment rate, and decreasing relative public spending.

4. METHODOLOGY AND DATA

4.1 The Data

The series used in the analysis are the fixed capital stock (K) for the industrial sector (mining, manufacturing and electricity, gas, and water) and the product of the entire economy (GDP) for the 32 states of the Republic of Mexico in the time period 1960-2012, in prices from 1993. The data were taken from Germán-Soto (2005 and 2008), and their extent, quality, and review depend on the author. But, the *K* series could be biased. The Germán-Soto method (2008) consisted of deriving by regression the average age of the capital with data on gross fixed investment and employment to later estimate the stock of capital with the PIM. The bias could come from the data source, which is the five-year economic censuses conducted between 1960 and 2003. It is known that these censuses have inter-census comparability biases because (according to the census), some classes or sectors are simply not covered, new ones are added, or they are changed pursuant to the classifier. A non-readjusted historical series that normalizes the criteria to their original levels by census to compare them could contain biases. Moreover, since 2004, Germán-Soto has estimated K using the industrial GDP growth rates by state. We proceeded despite these limitations.

4.2 The Harvey, Leybourne, and Taylor (2013)

Unit Root Test

To determine the order of integration of the variables under study, we carried out the unit root test in the presence of non-frequent changes, in structural trends of single-variable time series when the break dates are unknown, as recently suggested by Harvey *et al.* (2013). This procedure is robust in the presence or lack of a unit root test in the underlying error process and avoids the "problem of the circular test" that frequently arises in empirical applications among tests on the parameters of the trend function and unit root tests. As such, no *a priori* information on the order of integration of the time series is required. The single-variable model can be described via:

$$
\begin{aligned}
y_t &= \mu_0 + \beta_0 + \sum_{i=1}^{m} \mu_i DU_{it} + \sum_{i=1}^{m} \beta_i DT_{it} + u_t \\
u_t &= \alpha u_{t-1} + v_t
\end{aligned} \tag{1}
$$

Where $DU_{it} = 1(t > T_i)$ and $DT_{it} = (t - T_i)1(t > T_i)$ are dummies that reveal the changes in the level and the trend in the series for $i = 1, ..., m$, where *m* is the number of breaks and 1(.) the indicator function. The maximum number of breaks on the test is equal to *m* = 2 (Harvey *et al.,* 2013).

4.3 The Westerlund (2007) and Westerlund and Edgerton (2008)

Panel Cointegration Test with Structural Breaks

Two panel cointegration tests with structural breaks, developed by Westerlund (2006) and Westerlund and Edgerton (2008) were used, respectively. First, Westerlund proposed an LM test for the null hypothesis of cointegration, which permits multiple structural breaks, both in the level and the trend, for a cointegrated panel regression. According to that, first, the following model is estimated:

$$
y_{i,t} = \alpha_{ij} + \beta_i X_{i,t} + e_{i,t}, \quad j = 1, ..., M_{i+1} \tag{2}
$$

Where $e_{i,t} = r_{i,t} + \mu_{i,t}$ y $r_{i,t} = r_{i,t-1} + \phi_i \mu_{i,t}$, β_i is a specific slope for each unit assumed constant over time, and α_{ij} is a specific intercept, also for each unit, subject to M_i structural breaks. The null hypothesis is formulated such that the units on the panel are cointegrated, while the alternative establishes that at least for one unit, there is no cointegration. Westerlund and Edgerton (2008) propose two versions of the test, which derive from the LM unit root test, for the null hypothesis of no cointegration, whose test statistics are *Z(M)* and $z_j(N)$; additional details regarding their derivation can be found in Westerlund and Edgerton (2008).

4.4 The Dumitrescu and Hurlin (2012)

Panel Heterogeneous Non-Causality Test

Dumitrescu and Hurlin (2012) developed a test in order to analyze the null hypothesis of Granger non-causality for panel data. The test is posited on the following: if *x* and *y* are two stationary variables observed for *N* individuals in *T* periods, for each individual *i* = 1, 2, ..., *N* at time *t* = 1, 2, ..., *T,* the following linear VAR model is considered:

$$
y_{it} = \alpha_i + \sum_{k=1}^{k} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{k} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \tag{3}
$$

With $K \in N^*$ and $\beta_i = (\beta_i^{(1)},...,\beta_i^{(K)})'$. For simplicity, the individual effects α_i are assumed to be fixed over time. Likewise, the assumption is made that the order of lags *K* is identical for all panel units and that it is balanced.

Dumitrescu and Hurlin (2012) propose testing the non-causality hypothesis between *x* and *y*:

$$H_0 : \beta_i = 0 \quad \forall \ i = 1,...,N \tag{4}$$

Where $\beta_i = (\beta_i^{(1)},...,\beta_i^{(p)})'$. Under the alternative hypothesis, there is causality from *x* to *y* in at least one unit:

$$H_1 : \beta_i = 0 \ \ \forall \, i = 1,..., N_1 \ \ \beta_i \neq 0 \ \ \forall \, i = N_1 + 1, \ N_1 + 2,..., N \tag{5}$$

The statistic for the panel is obtained as the average of the cross-sections of the individual Wald statistics (Herrerias *et al.,* 2013). Dumitrescu and Hurlin (2012) show that this statistic converges toward a normal distribution under the hypothesis of non-causality, when *T* tends to infinity first and later when *N* grows indefinitely. It is also possible to construct a standardized statistic $Z_{N,T}^{HNC}$.

4.5 Estimating the Cointegrated Panels

There is ample literature enabling an estimate of the cointegrating vectors for cointegrated panels (Kao and Chiang, 2000; Pedroni, 1999, 2001, and 2004; Pesaran *et al.,* 1999). The estimation method for cointegrated panels that we use is from Mark and Sul (2003).

5. EMPIRICAL RESULTS

Table 2 shows the results of the Harvey *et al.* (2013) test with one and two structural breaks for the capital stock (K) series and the product (GDP) series from the 32 states of the Mexican Republic between 1960 and 2012. Only in four states was the null unit root hypothesis rejected in K when the test was specified with one break and in three states when the test was done with two breaks. In the case of GDP, the hypothesis of the unit root was only rejected in three states with one break and in two with two breaks. There is therefore evidence that the majority of the series comprising the K and GDP panels possess a unit root.

Table 2. Result of the Harvey, Leybourne, and Taylor (2013) Unit Root Tests with Structural Breaks for the Stock of Industrial Capital and GDP by State in Mexico, 1960-2012

	K		*GDP*	
	MDF_1	MDF_2	MDF_1	MDF_2
Aguascalientes	-2.883	-4.116	-2.354	-3.250
Baja California Norte	-2.835	-4.028	-4.188*	-4.348
Baja California Sur	-1.995	-2.927	-3.955*	-4.144
Campeche	-2.686	-5.662*	-2.117	-2.956
Coahuila	-2.847	-3.215	-3.565	-4.610*
Colima	-2.830	-3.140	-2.450	-3.497
Chiapas	-5.330*	-5.967*	-2.447	-2.907
Chihuahua	-3.409	-4.053	-3.921*	-4.071
Distrito Federal	-2.366	-3.231	-2.833	-2.972
Durango	-4.080*	-4.318	-3.179	-3.936
Guanajuato	-3.312	-3.487	-3.249	-4.112
Guerrero	-2.583	-3.496	-3.064	-3.844
Hidalgo	-2.530	-3.101	-2.783	-4.161
Jalisco	-2.691	-3.098	-2.471	-3.211
México	-2.330	-2.792	-2.116	-2.885
Michoacán	-3.279	-3.862	-2.802	-3.833
Morelos	-3.338	-4.063	-3.004	-3.699
Nayarit	-3.740	-3.896	-1.704	-3.210
Nuevo León	-2.428	-2.636	-3.019	-4.122
Oaxaca	-4.549	-5.010	-2.224	-3.751
Puebla	-2.320	-3.089	-2.691	-3.284
Querétaro	-3.459	-4.061	-3.079	-3.894
Quintana Roo	-4.279*	-4.602*	-3.087	-3.666
San Luis Potosí	-3.209	-4.067	-3.046	-3.893
Sinaloa	-3.475	-3.580	-1.767	-4.189
Sonora	-3.061	-3.648	-3.428	-4.169
Tabasco	-3.270	-4.298	-1.483	-3.536
Tamaulipas	-2.907	-3.835	-1.903	-4.188
Tlaxcala	-3.070	-3.135	-2.209	-3.864
Veracruz	-4.030*	-4.475	-2.116	-4.801*
Yucatán	-3.326	-4.119	-2.123	-3.801
Zacatecas	-2.555	-3.617	-2.883	-3.733

Note: *Denotes rejection at 5%. The critical values for each test are -3.85 and -4.85 at 5% significance, respectively.

Source: Created by the authors.

Once the evidence for the unit root was found in the series for both panels, the next step was to inspect whether the two panels were cointegrated. Aiming to check whether the series comprising the K and state GDP panels maintain a long-term relationship, the Westerlund and Edgerton (2008) (see results in Table 3) panel cointegration test was performed.

As can be seen in Table 3, although the panel cointegration tests did use structural breaks, it is not possible to reject the null hypothesis of no cointegration among the variables in question, under any specification (no breaks, level shift, and regime shift) for the sample encompassing the entire period. On the contrary, this hypothesis was rejected in the first period into which the sample was divided (1960-1982), which matches up with the age of national industrialization, when the test was specified without change and with change of regime. It turns out that in the latter specification, the majority of the breaks happened in 1980. During the second time period for the sample (1983-2012), the reform era, it was only possible to reject the null hypothesis of no cointegration among the K and state GDP panel series when the test was specified without breaks with both test statistics. Accordingly, no long-term relationship between the K and GDP variables was found throughout the period studied, but there was indeed evidence of cointegration during the time periods into which the data were divided. Due to these results, both the estimates for the cointegrated panels and the panel causality tests employed in the rest of the analysis were carried out by periods: the national industrialization era (1960-1982) and the structural reform era (1983-2012).

Table 3. Results of the Westerlund and Edgerton (2008)
Panel Cointegration Tests with and without Structural Breaks

	Total Sample			*1960-1982*			*1983-2012*		
	No shift	*Level shift*	*Regime shift*	*No shift*	*Level shift*	*Regime shift*	*No shift*	*Level shift*	*Regime shift*
$Z_{\tau}(N)$	0.256	-0.528	4.258	-3.848	4.699	-5.087	-6.962	1.510	2.106
	[0.601]	[0.299]	[1.000]	[0.001]	[1.000]	[0.000]	[0.000]	[0.934]	[0.982]
$Z_{\phi}(N)$	2.769	1.291	4.112	-0.201	2.994	-2.836	-3.488	2.695	1.279
	[0.997]	[0.902]	[1.000]	[0.421]	[0.999]	[0.002]	[0.000]	[0.996]	[0.900]

Source: Created by the authors

The results of the estimates for cointegrated panels using the Mark and Sul (2003) method are summarized in Table 4. In both periods, the choice was made to do the test incorporating just one constant, one lag, and one forward. As is evident, the results of the estimates suggest that the capital stock has an influence on the GDP, at both the individual and overall levels, resulting positive and significant for nearly all of the states in the first period and even in various cases very close to or greater than the unit. By contrast, the results from the second time period show at the individual level for some states, the parameter that measures the incidence of capital stock (*k*) on GDP (*y*) turned out to be negative, further from the unit, and in some cases, not even statistically significant.

Table 4. Individual and Panel Estimates for $y_{it} = \alpha_i + \beta_i k_{it} + u_{it}$ with a constant

	1960-1982		1983-2012	
	$\widehat{\beta}_i$	e.e.	$\widehat{\beta}_i$	e.e.
Aguascalientes	0.9661	0.0455	0.8000	0.2575
Baja California Norte	0.8912	0.0598	0.5746	0.0390
Baja California Sur	0.9452	0.1688	0.5167	0.3316
Campeche	0.8113	0.4701	-0.9632	0.1449
Coahuila	0.3972	0.0619	1.4325	0.4928
Colima	0.4558	0.0308	0.7175	0.0649
Chiapas	0.7236	0.0412	0.1196	0.0630
Chihuahua	0.7732	0.0288	1.0461	0.3340
Distrito Federal	0.6128	0.0448	-0.0219	0.1564
Durango	1.0842	0.4272	-0.0528	0.2607
Guanajuato	0.8103	0.0626	0.5653	0.0871
Guerrero	1.1151	0.0749	0.2007	0.0191
Hidalgo	0.4865	0.0797	0.3140	0.0483
Jalisco	0.7277	0.0465	-0.7566	0.5640
México	1.1111	0.0146	-0.3358	0.2564
Michoacán	1.8093	0.2769	-0.1970	0.0400
Morelos	0.6733	0.0530	0.5494	0.1864
Nayarit	0.5087	0.0492	0.0508	0.0248
Nuevo León	0.7092	0.1008	0.3911	0.2683
Oaxaca	0.8196	0.0686	0.3504	0.0718
Puebla	0.6486	0.1123	0.6914	0.1962
Querétaro	0.7104	0.0263	0.9634	0.2301
Quintana Roo	0.7685	0.0792	1.3389	0.4393
San Luis Potosí	0.4259	0.0356	1.0049	0.2839
Sinaloa	0.8827	0.0468	0.3893	0.0536
Sonora	1.6676	0.1138	0.3196	0.1955
Tabasco	0.5043	0.0661	-1.2098	0.4302
Tamaulipas	0.8938	0.3045	0.6081	0.0948
Tlaxcala	0.8480	0.4667	-0.6950	0.1141
Veracruz	0.5284	0.0296	-0.1547	0.0381
Yucatán	1.2203	0.0829	0.9688	0.1733
Zacatecas	1.0030	1.4515	0.2623	0.1679
Panel	0.6574	0.0339	0.4472	0.0421
Panel[a]	0.5752	0.0460	0.2110	0.0871

Notes: Estimates made with one lag and one forward in the model. [a] Controls for common time effects.

Source: Created by the authors.

Another noteworthy result emerges when comparing the magnitude of the coefficients estimated for each state between the two time periods, because only seven of the 32 states recorded a higher coefficient in the second period than in the first period. These states were: Coahuila, Colima, Chihuahua, Puebla, Querétaro, Quintana Roo, and San Luis Potosí; the rest of the states saw the magnitude of the incidence of capital stock on state GDP decline. The foregoing is moreover confirmed for the aggregate coefficient estimated, because the magnitude of the coefficients for the panel overall is higher in the first period than in the second, even under the specification controlling for the common effects of time on the estimate.

Finally, Tables 5, 6, 7, and 8 report the results of the Granger non-causality tests (Dumitrescu and Hurlin, 2012) with up to three lags (both individual and panel) applied to the first differences in capital stock and GDP for both periods being analyzed. As observed in these tables, the null hypothesis of Granger non-causality is rejected—among the first differences for both variables in both periods—for the overall panel. With that, we find evidence that the variables of the industrial capital stock (K) and the product (GDP) are simultaneously determined, spurring a virtuous cycle between them. Perhaps the main implication of these results is that they suggest the need to drive fixed capital accumulation in the industrial sector, which can be done via a return to the industrial policy of developing fixed capital formation in this sector.

Table 5. Result of the Granger Causality Test in Heterogeneous Panel Data Models Applied to Differences in the Capital Stock and GDP by Mexican State, 1960-1982
(H_0: Granger homogenous non-causality for $\Delta k \rightarrow \Delta y$)

	1 lag		*2 lags*		*3 lags*	
	Wald statistic	*P-value*	*Wald statistic*	*P-value*	*Wald statistic*	*P-value*
$W_{N,T}^{Hnc}$	2.6358		11.1026		12.5307	
$\overline{Z}_{N,T}^{Hnc}$	6.5430	[0.0000]	51.4919	[0.0000]	66.0309	[0.0000]
$\tilde{Z}_{N,T}^{Hnc}$	4.9598	[0.0000]	19.2835	[0.0000]	15.0507	[0.0000]

Source: Created by the authors.

Table 6. Result of the Granger Causality Test in Heterogeneous Panel Data Models Applied to Differences in the Capital Stock and GDP by Mexican State, 1960-1982
(H_0: Granger homogenous non-causality for $\Delta y \rightarrow \Delta k$)

	1 lag		*2 lags*		*3 lags*	
	Wald statistic	*P-value*	*Wald statistic*	*P-value*	*Wald statistic*	*P-value*
$W_{N,T}^{Hnc}$	2.5764		4.0225		4.3786	
$\overline{Z}_{N,T}^{Hnc}$	6.3055	[0.0000]	11.4409	[0.0000]	9.5516	[0.0000]
$\tilde{Z}_{N,T}^{Hnc}$	4.7658	[0.0000]	3.8319	[0.0001]	1.5220	[0.1280]

Source: Created by the authors.

Table 7. Result of the Granger Causality Test in Heterogeneous Panel Data Models Applied to Differences in the Capital Stock and GDP by Mexican State, 1983-2012

(H_0: Granger homogenous non-causality for $\Delta k \rightarrow \Delta y$)

	1 Lag		2 Lags		3 Lags	
	Wald statistic	P-value	Wald statistic	P-value	Wald statistic	P-value
$W_{N,T}^{Hnc}$	0.5064		3.5872		5.9071	
$\overline{Z}_{N,T}^{Hnc}$	-1.9745	[0.0483]	8.9785	[0.0000]	20.1409	[0.0000]
$\tilde{Z}_{N,T}^{Hnc}$	-1.9982	[0.0457]	3.3705	[0.0008]	4.9180	[0.0000]

Source: Created by the authors.

Table 8. Result of the Granger Causality Test in Heterogeneous Panel Data Models Applied to Differences in the Capital Stock and GDP by Mexican State, 1983-2012

(H_0: Granger homogenous non-causality for $\Delta y \rightarrow \Delta k$)

	1 Lag		2 Lags		3 Lags	
	Wald statistic	P-value	Wald statistic	P-value	Wald statistic	P-value
$W_{N,T}^{Hnc}$	2.1071		7.7456		6.7054	
$\overline{Z}_{N,T}^{Hnc}$	4.4285	[0.0000]	32.5020	[0.0000]	25.6715	[0.0000]
$\tilde{Z}_{N,T}^{Hnc}$	3.5780	[0.0003]	13.2880	[0.0000]	6.4157	[0.1280]

Source: Created by the authors.

6. CONCLUSIONS

This study involved a descriptive analysis and an econometric application of the Harrod-Domar relationship, which associates economic growth with capital accumulation. In particular, fixed capital accumulation in the industrial sector by state and its relationship to the state product was studied, as in order to understand the stagnation of the last three decades of structural reform, it was necessary to relate this era to the profound national deindustrialization that these sorts of policies brought on. In this regard, history has shown that mature national industrialization, not to mention the manufacturing industry as the motor, is essential both to elevating labor productivity and to attaining the economic growth of a successful nation (Hirschman, 1958; Kaldor, 1966; Atesoglu, 1993), and in order to generate social development, enable wage raises, mitigate inequalities, and reduce poverty.

This secret to success was borne out by the era of national developmentalism, laying the groundwork for Mexican industrialization that produced average growth of 6.9% (higher than the global average). Nevertheless, the neoliberalism of the "structural reforms" ruined the incipient industrialization, at a labor and human cost that for nationalism represents more growth with inequality, and entailed greater inequality with the reforms, and now stagnation for over 35 years (Jaimes and Matamoros, 2017, pp. 13, 14, and 25). Undoubtedly, the two industrial policies are worlds apart (Calderón and Sánchez, 2012; Moreno-Brid, 2013; Trejo, 2017; Tijerina, 2018). Specifically, the new liberal State asserted that NAFTA was "our industrial policy" (Johnson, 1998, p. 137), or that in reality, "the best industrial policy was no industrial policy" (Moreno-Brid, 2013) (by promoting only transnational *maquila,* foreign trade, international financing, and foreign investment). During the era of "stabilizing development," the State actively wielded public regulatory policies and pursued the national interest, relatively speaking. On the contrary, in the second time period, the State abandoned national interests in the name of industrialization.

Subsequently, analyzing the relationship between state-level GDP and the state-level industrial capital stock, using panel data techniques, it turns out that the two variables do have a unit root, and that the panel cointegration test with and without structural breaks reveals a long-term relationship in the two time periods analyzed: 1960-1982 (national industrialization) and 1983-2012 (structural reforms). The cointegrated panels therefore showed—both individually and for the panel as a whole—a positive and significant relationship between rapid growth and fixed capital accumulation during the nationalist industrialization age. By contrast, during the deindustrialization and structural reforms, that relationship was less positive (or negative) and less significant, between slow economic growth and accumulation. Nevertheless, this latter anomalous result may be due to a possible bias in the Germán-Soto (2008) estimates of the capital stock in the latter period. In short, although to a different temporal extent, industrial accumulation and growth are related.

This result matches up with the trajectories in the third section. Rapid social development (GDP/PO) of 3.8% and average economic growth of 6.9% (gGDP) during the era of nationalist industrialization (1960-1981) were correlate with burgeoning fixed industrial capital accumulation of 9.6% (gK) and rising capital per capita (K/PO). In comparison, the slow development of 0.6% and economic growth of 2.2% during the deindustrialization of the reform and stabilization period (1982-2016) are connected with slow industrial capital accumulation of 3.9% and weak capital per capita. This is related to a manufacturing rate (GDPman/GDP), which, in the former period, garnered growth of 19.5%, but plummeted -6.6% in the reform era. Moreover, in terms of average growth, manufactures rose (gGDPman), respectively, 7.8% a year against 2.1%. In other words, the reforms impeded the incipient domestic manufacturing industry.

These different investment patterns meant, in terms of the growth of the industrial capital technical intensity (K/GDP), respectively, an increase of 2.7% per year compared to 1.7%. Finally, these divergent investment and technical progress patterns are underpinned by, in part, the State's vastly different role as a public investor. Thus, the regulator State that supported national industrialization generated a public sector fixed investment rate (GFCFpub/GDP) that rose from 5.4% to 10.7% of GDP between 1960 and 1981. In that time period, Mexico grew 6.9%. Nevertheless, the State that expressly set out in its programs to reduce the share of public investment because it "distorted" the market brought the share down from 10.7% to 3.4% of GDP between 1982 and 2016. As a result, Mexico grew 2.2% a year in the second time period.

Furthermore, in the fifth section, the Granger non-causality tests revealed—both individually and for the panel as a whole—a two-way causal relationship in both time periods. This feedback between the variables in turn suggests a virtuous cycle between growth and accumulation.

In conclusion, there is a strong relationship between national industrialization, fixed capital accumulation, rapid growth, and industrial policy with a certain degree of regulation or state intervention. These stylized facts have tended to be forgotten or sidelined. Even so, they constitute in large part the successful policy that both China and the Asian Tigers have implemented at present, and which Mexico had until 1981. Essentially, industrial policy with state support is back again, even though it never really went away (Rodrik, 2010). This has been recognized by several economists and by several successful economies, and, more recently, by several international bodies (Rodrik, 2008; Hausmann, Rodrik, and Sobel, 2008).

In this regard, Rodrik (2010) claims that the true question is not *whether* an industrial policy should be applied but rather *how.* Rodrik sets out three principles: *1*) first, a climate of collaboration between the government and the private sector must be fostered; *2*) government incentives must be temporary and results-based; *3*) any industrial policy must be designed to serve society as a whole, and not the bureaucrats who administer it or the companies on the receiving end of the economic or other benefits.

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