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CONTRIBUTION OF FOREIGN DIRECT INVESTMENT TO MEXICO'S ECONOMIC GROWTH DURING THE NEOLIBERAL[1] PERIOD

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This paper analyses the impact of foreign direct investment on labor productivity for the period in which neoliberal policies were applied (1983-2018). It proposes a production function with labor and three types of capital: private national, foreign and government. From the production function in levels we derived a relationship concerning growth rates, and since the variables in levels are I(1) and co-integrated, a VEC model was used. Our estimate finds a long run joint positive causality for the three types of capital on labor productivity, but in the short run, the growth of foreign capital does not cause an increase in labor productivity. This is a critical issue, since Mexican economic policy, throughout its entire political regime, has been based on the assumption that foreign direct investment (FDI) is the primary source of growth of the Mexican economy.

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Keywords: Mexican Economy, Economic Growth, Foreign Direct Investment, FDI.

[1] "Neoliberalism, ideology and policy model that emphasizes the value of free market competition. Although there is considerable debate as to the defining features of neoliberal thought and practice, it is most commonly associated with laissez-faire economics. In particular, neoliberalism is often characterized in terms of its belief in sustained economic growth as the means to achieve human progress, its confidence in free markets as the most-efficient allocation of resources, its emphasis on minimal state intervention in economic and social affairs, and its commitment to the freedom of trade and capital." Encyclopedia Britannica. https://www.britannica.com/topic/neoliberalism

I. INTRODUCTION

Since the 1980s, foreign direct investment (FDI) flows have increased more than world production or world trade (Waldkirch 2008). For many developing countries, FDI has become an important, if not the most important source of external financing (UNCTAD, 2006). These increases can primarily be explained by a change in the policies being implemented by developing countries, with independent growth strategies being replaced by economic neoliberalism, which promotes free trade and FDI. In the framework of economic neoliberalism, FDI is considered beneficial, not only because it contributes capital and generates employment, but because, presumably, it drives economic growth by providing access to advanced technologies and technological spills (Borensztein et al., 1998 and De Mello, 1999).

Consequently, in recent decades, FDI has been given an increasing role as a determinant of national and international economic development processes. This role is not only due to the unprecedented expansion of the volume of international capital flows, but also because FDI is considered to have direct and indirect effects on economic development processes that affect efficiency and productivity in the receiving economies. The number of empirical studies that have sought to identify and quantify externalities related to FDI technology spills have increased. The results of early studies on this topic suggested that FDI generated positive external effects in receiving economies. However, later studies have contradicted those findings. Subsequent studies not only have indicated that such positive side effects are less frequent than previously thought, but also that the presence of FDI could actually lead to significant negative externalities. They also suggest that structural factors can neutralize, or accelerate, the development of these externalities.

Despite the high growth of FDI flows worldwide, they have mainly been directed towards developed countries, with primary exceptions being three developing ones: China, Brazil, and Mexico.

Since December 1, 1982, the Governments of Mexico have actively sought to attract FDI, first by relaxing their restrictions on FDI, and then in 1993, by making changes in the regulations of the Foreign Investment Act. After this, they sought a free trade agreement with the US that eventually led to NAFTA, the primary objective of which was to attract FDI, since tariffs had already been substantially reduced unilaterally from Mexico's entry into GATT in 1986. NAFTA gave investors confidence in the Government of Mexico's commitment to maintain and deepen the economic reforms undertaken in 1983, which led to significant FDI inflow. NAFTA facilitated the development in North America of a vertically integrated production network with a fragmentation of production processes; see Deardoff (2001) and Puyaa and Romero (2005).

This paper analyses the impact of foreign direct investment on labor productivity for the period 1983-2018. It starts with a production function that relates GDP to labor and three types of capital: private national, foreign and government (federal government only). From this function, an expression is derived for the productivity of labor, which is estimated by a VEC model (Vector Error Correction Model). Our estimate finds a positive and significant joint effect of domestic, foreign and government capital on labor productivity. However, in the short run the growth of foreign capital considered individually has no significant impact on the growth of labor productivity, and ultimately, none on its per capita income.

This work is structured as follows. Section II presents the evolution and relationship of labor productivity and per capita income in México, as well as the evolution of domestic, foreign and government capital during the 1983-2018 period. Section III discusses the validity of the hopes of Mexico´s government leaders related to expected beneficial effects of trade liberalization and inflows of FDI on economic growth. We examine the theoretical and empirical bases of those hopes and arguments and review the main literature related to growth and FDI. Section IV proposes a formal relationship between labor productivity and FDI. In Section V an empirical model is presented together with Mexican database sources using quarterly data for the period 1983-2018. It is shown that all the series are I (0), and the VAR is constructed (Vector Autoregressive Model) to obtain different lag criteria that serve to determine the optimal number of lags in the VEC model and that the series are cointegrated. In Section VI the VEC model is estimated focusing attention on a single equation and ensuring that this equation complies with standard OLS assumptions (the absence of autocorrelation and heteroscedasticity, and normal errors). In Section VII we test for a long and short run causality between the dependent and independent variables of the first equation and also perform a brief analysis of the impulse response and variance decomposition of the first equation of the VAR model. Section VIII interprets the results, and finally, Section IX offers our conclusions.

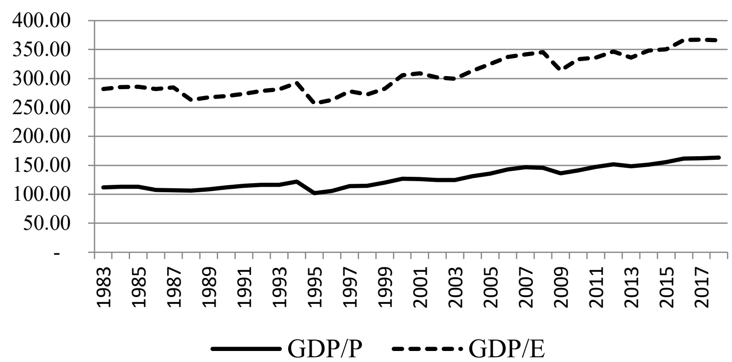
II. LABOR PRODUCTIVITY AND PER CÁPITA GDP

Labor productivity is determinant for per capita income. Per capita income is the best indicator for economists and historians of a country's standard of living.[2] Per capita *GDP* (*GDP/P*) can be broken down into average labor productivity (*GDP/E*), the rate of participation of the population in the workforce in (*L/P*), and the employment rate (*E/L*). Where *GDP*: gross domestic product; *P*: population; *L*: labor force; and *E*: employment. This is:

$$\frac{GDP}{P} \equiv \left(\frac{GDP}{E}\right)\left(\frac{L}{P}\right)\left(\frac{E}{L}\right) \tag{II.1}$$

This identification shows that the observed variations in per capita *GDP* respond to factors related to productivity, socioeconomic trends and level of economic activity. Graph II.1 presents the behavior of per capita *GDP* and the average product per worker during the period 1983-2018.

Graph II. 1
GDP per capita and GDP per worker: 1983-2018
(thousands of pesos of 2015)



Source: Own calculations with several years of data from the Anexo Estadístico. Informe Presidencial, Presidencia de la República.

The growth rate of per capita GDP can be expressed as the sum of the growth rate of average labor productivity, the growth rate of population participation in employment and the growth rate of the employment rate.[3]

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[2] "It is the product per capital, and not the total one, which provides the economist and historian with the best (if imperfect) indication of production and thus, of the state of an economy." Coatsworth (1990). Page 25.

[3] Equation II.2 is obtained taking logarithms to the Identity II.1 and deriving them with respect to time.

$$\left(\frac{GDP}{P}\right)^0 = \left(\frac{GDP}{E}\right)^0 + \left(\frac{L}{P}\right)^0 + \left(\frac{E}{L}\right)^0 \quad \text{(II.2)}$$

Where superscript °, indicates growth rates. Table II. 1 shows the growth rates of (*GDP/P*), (*GDP/E*), (*L/P*) and (*E/L*) for the period (1983-2018).

Table II. 1
Annual Average Growth Rates

	1983-2018
GDP	2.66%
P: Population	1.59%
L: Employment	1.91%
GDP/L	0.75%
GDP/P	1.07%
L/P	0.33%

Source: The data used to calculate the rates were obtained from the Bank of Mexico (SIE) and INEGI (BIE).

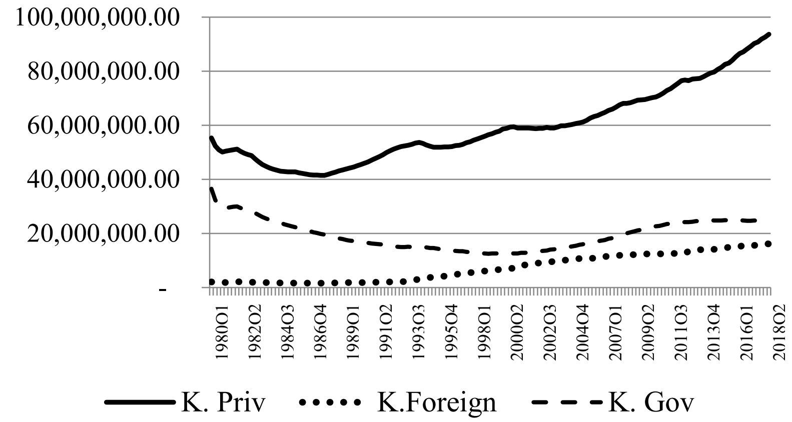
During the period 1983-2018 per capita GDP grew at a rate of 1.07%, labor productivity growth was 0.75% with the difference being caused by an increase in the rate of participation of the population in the labor force of 0.34%. From these results, we can conclude that during these 35 years the growth in average labor productivity was minimal.

It is, therefore, essential to investigate the determinants of the productivity of labor because this mainly determines per capita income, the leading indicator of the standard of living in the country. In principle, the growth of labor productivity in a country depends on technological innovation and the growth rate of human and physical capital in the economy and of the externalities that are generated in its productive processes.

Graph II.2 presents the evolution of real capital for the period 1983-2018: private national (excluding foreign capital), government, and foreign. A decline in government investment was observed during the period 1983-2001, which had an impact on the impasse in government capital during those years. From 1983 to 1987 a fall in the national private capital can be observed, followed by a notable recovery. Concerning foreign capital, a continuous increase was found throughout the period, although a slowdown has occurred since 2001 when China entered as a full member of the World Trade Organization (WTO)[4] and became more attractive than México for foreign direct investment.

[4] China joined the WTO on 11 of December, 2001.
ttps://www.wto.org/spanish/thewto_s/countries_s/china_s.htm

Graph II.2
CAPITAL STOCKS, 1983-2018
(millions of pesos of 2015)

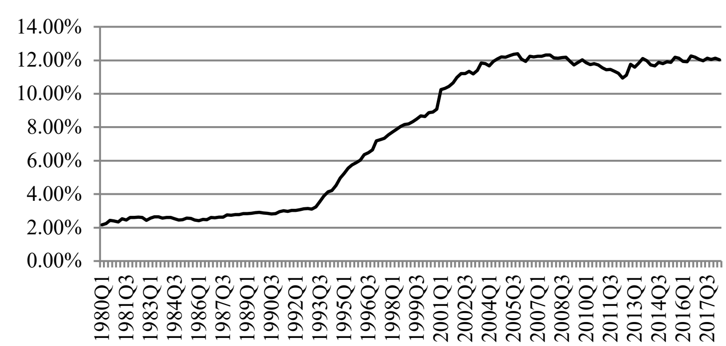


K. Priv: private domestic capital; K. Foreign: foreign capital; C. Gov: government capital.
Source: Own calculations using the perpetual inventories method (see the Appendix) with data from the Bank of Mexico (SIE) and INEGI (BIE).

The stagnation of the growth of government capital and the expansion of foreign capital generated a recomposition of Mexico´s total capital, resulting in an increase in the weight of foreign capital. In 1983 foreign capital represented 2.25% of the total, and from that point, it increased steadily to reach 12.0% in 2004, then remaining around that level until 2018. See Graph II. 3.

Graph II.3

FOREIGN CAPITAL AS PERCENTAGE OF TOTAL CAPITAL STOCK



III. IDEOLOGY AND REALITY

With the economic reforms undertaken as of 1 of December, 1982, it was expected that with the reduction of trade barriers, the decline of the state's participation in the economy and the elimination of barriers to FDI, there would be significant increases in productivity. According to neoliberal ideology, trade openness, in addition to generating specialization gains based on comparative advantage, gives rise to other benefits which are reached through four channels: a) the expansion of demand for domestic companies, which is equivalent to the expansion of the market that allows the full realization of economies of scale; b) the availability of a greater variety of inputs at a lower price, which helps lower production costs and increases productivity; and (c) the increase in competition that forces local companies to reduce costs and improve productivity (the so-called " X efficiency.")

In addition to the reduction in trade barriers, with these reforms there came a modification of the role of the state in the economy. Most of Mexico´s public companies were sold to private capital, many aspects of economic life (such as transport and financial institutions) were deregulated, and public investment was drastically contracted. The process of change included opening the country to capital markets. This decrease in the state´s participation in the economy was based on the assumption that public investment was, by definition, less efficient than private investment, and that public investment was competing with private investment for loanable funds because it was engaged in activities that private investment could more efficiently provide.

With its reforms, it lessened or removed obstacles to FDI concerning which sectors FDI could participate in, reduced requirements of "national content" and increased the percentage of allowable participation of foreign capital in Mexican companies. The main arguments in favor of the elimination of obstacles to FDI were twofold. A) FDI helps to cover the funding needs the country has, with FDI being more stable than other types of investment flows. B) The argument regarding the transfer of technology by FDI goes as follows: if the foreign subsidiary introduces new products or processes in the receiving market, the workers of that company acquire knowledge that raises the human capital of the country. At the same time, companies that are suppliers, clients and even competitors of the foreign companies perceive the effects of technological diffusion indirectly. Therefore, FDI participation in the economy not only improves the performance of the company that receives the investment, but also the performance of other companies, as well. In this mindset, greater FDI in the host country produces higher productivity, a greater number of exports, a higher level of formal employment and foreign exchange, higher levels of national private investment and a higher per capita income.[5]

If these assumptions are true, then how does one explain that in Mexico there has been no such link between the commercial opening of its economy with its corresponding increases in investment, and productivity gains or increases in the standard of living of its citizens? The answer to this question is simply that these links do not necessarily exist; these theoretical relationships are not rooted in empirical evidence.

International trade theory says nothing about the effects of trade liberalization on the growth rate of products or productivity. Different, equally reasonable, models can produce results that are opposite to one another. The general effects of trade are a one-time gain in welfare, and while such gains can accumulate over time, they do not necessarily place the economy on a path of higher technological efficiency. The net benefits of increased levels of trade on economic growth are not necessarily positive, as Grossman and Helpman (1991), and Young (1991), among others, have demonstrated. Empirical work also does not support the idea that greater economic openness generally leads to a higher rate of growth. Although, numerically speaking, most of the empirical works support the notion that trade promotes growth, these works are controversial, and have been the subject of a wide variety of criticisms. Many of these studies have found a positive relationship between trade and income, but this relationship is generally not robust and such studies display methodological problems. Much of this literature consists of cross-country analysis of many countries with very different realities, where income or income growth in several countries, are correlated with some measure of "openness." The problem with these works is precisely how these measures of openness are constructed. In most cases, they use quantitative and qualitative judgments that are very debatable. The consensus is that there is no strong empirical evidence to establish that commercial openness implies increases in productivity or per capita income. As Rodrick (1988) eloquently says, "We have no good reason to expect that trade liberation is in general terms good for technological performance."

[5] These advantages of FDI were taken from Rafael Pampillón (19 July 2009). Economy Weblog.

What can we say about the notion that FDI is a promoter of efficiency and the dissemination of technology? What Chang (2003) has to say about this issue is worth reporting here.

> "While some of the earlier criticisms of TNCs may have been misconceived, over-generalized, and exaggerated, there are many critical areas where there exists an apparent conflict of interest between the TNCs and the host country. These include the issues of 'appropriateness' of technology, transfer pricing, monopolistic practices, restrictions imposed on the subsidiaries, particularly regarding exports and R&D, and even their ability to manipulate the overall national policy regime. Most importantly, recent theoretical developments and empirical studies suggest that long-term productivity enhancement may be better achieved by an industrialization strategy that puts emphasis on building local managerial and technological capabilities and uses TNCs in a selective, strategic manner to accelerate that process (p. 255-256).
>
> "More recently, careful analyses of empirical cases as well as developments in the economics of technology have shown the importance of domestic technological capabilities in sustaining long-term growth, and thus have raised further doubts as to whether inviting TNCs into a country is the best way to promote industrialization. There is a growing consensus that accepting a 'package' of finance, technology, managerial skills, and other capabilities offered by TNCs may not be as good for long-term industrial development as encouraging national firms to construct their packages using their managerial skills - with some necessary outsourcing. As Lall (ed.) (1993) points out, while having more FDI may, on the margin, bring, in net benefits to the host country, there still is a question of choosing; between different strategies regarding the role of FDI in long-term development." Chang (2003) P. 256.
>
> "The experiences of the two 'star performers' of East Asia, namely, Korea and Taiwan, especially during their earlier days of industrialization, also provide interesting insights into the role of TNCs in economic development. While these countries have not been hostile to foreign technology or capital per se, they have preferred, if the situation allowed, using such technology and capital under 'national' management, rather than relying on TNCs. This preference was necessarily somewhat more tempered in Taiwan than in Korea due to the relative absence of

> large private sector firms in Taiwan, but both their governments have possessed a clear and sophisticated notion of the costs and benefits of inviting in TNCs, and they approved FDI only when they thought there were potential net benefits." Chang (2003) p.257.

Empirical evidence for the mere presence of FDI causing positive externalities in the host countries is very scarce, as Rodríguez and Rodrik point out (2000). "Literature on economic policy is full of extravagant findings of the existence of positive spillovers derived from FDI, but the evidence is very austere." Smarzynska (2002) states, "In fact, the difficulties associated with unraveling the different effects that come into play and the limitations of the data prevent the researchers from providing conclusive evidence of the existence of positive externalities derived from FDI." Alfaro et al. (2005), with data from several countries for the period 1975 and 1995 find that FDI plays an ambiguous role in economic growth. However, they point out that in countries with well-developed financial markets, the benefits of FDI increase significantly. Herzer et al. (2008), working at the macroeconomic level, perform a Granger causality study for several countries and find that almost no country shows a long-term positive effect of FDI on per capita GDP. In countries where they see a long-term positive effect, they show two-way causality, which means that FDI could generate growth, and that economic growth could attract foreign investment. Other studies on causality, such as those of Liu et al. (2002) and Chakraborty and Nunnenkamp et al. (2007), only find two-way causality, or do not see any causal relationship. Almfraji and Almsafir (2014), in a review of the literature of 1994-2012, find that most of the studies on the relationship between FDI and economic growth find positive effects of FDI on the economic growth of the host country. Only in some cases did adverse or null impact occur; to further explore how these effects happened, several influencing factors were investigated: adequate levels of human capital, well-developed financial markets, and open-trade regimes were found to play a decisive role in the relationship between FDI and economic growth, while heavy dependence on foreign investment and technology gaps contributed negatively to the link. Kamil and Bazoumana (2018), based on a sample of developed and developing countries during the period 1970-2007, conclusively claimed that FDI affects growth via the accumulation of inputs, but not through total factor productivity; in other words, its results suggest that factors other than FDI may have contributed to the increase in productivity recorded in some developing countries during the recent decade.

In the case of Mexico, Romo Murillo (2005) notes, "It is interesting to note that these studies found evidence of spills using data from the 1970s when the Mexican economy was still closed and highly regulated. More recent database analyses from 1985, as well as more complex econometric techniques find evidence only in favor of spills of market access, not on productivity." Soto R. C. (2008) from the Integration Center for the Automotive and Aeronautical Industry of Sonora, A.C. notes, "Mexico occupies a preferential place in both the flow of FDI and the preferences of large transnational corporations, but the long-term impact of these investments are minimal." Mendoza Osorio (2008) also performed a macroeconomic study of FDI's effects on growth in Mexico and found that an increase of one percent in FDI led to an increase of 0.08 percent in GDP, reflecting a positive impact, but not as substantial as had been expected. Geijer, K. (2008) analyzed the relationship between FDI and growth at the macroeconomic level based on a dynamic adjustment model to study the per capita ln(GDP) and ln(FDI) dependency; data from 1993 to 2007 from two different sources was used to contrast the results, reporting that the coefficients of ln(FDI) and its lags were not statistically significant at the level of 5%. Also, an analysis was performed without the lagged variable ln(FDI), and this variable was not significant, either. Mendoza Cota J.E. (2011) empirically analyzed the impact of FDI on the growth of the Mexican manufacturing sector for the period 1999-2008. The methodology used included estimating an econometric model of panel data using 9 manufacturing subsectors of the Mexican economy. The results showed a positive effect for the opening of the manufacturing sector. On the other hand, the impact of FDI was not statistically significant (conclusive).

IV. LABOUR PRODUCTIVITY AND FDI

Following Romero (2012), Zhang (2001), De Mello (1997) and Ramírez (2006), labor productivity can be derived from a production relationship:

$$GDP = AL^a K_p^b K_f^c K_g^d H^e \qquad \text{(IV.1)}$$

where GDP is total production; L is the labor force (we assume full employment); K_p is the domestic private capital stock, K_f is the foreign capital, K_g, the government capital and H is the human capital. *a, b, d, d*, and *e* are parameters (they do not represent participation of the factors in total production since we do not assume that the relation is homogeneous of degree one). *A* represents efficiency in production. We assume that *a, b, c, d,* and *e* are greater than zero and less than one so that there are decreasing returns from labor and different types of capital. There is no restriction that the sum of *a, b, c, d,* and *e* is equal to one, so there is the possibility of increased returns to scale. Expressing the equation (IV.1) in logarithms we obtain:

$$ln(GDP) = ln(A) + a\ln(L) + \ bln(K_p) + cln(K_f) + dln(K_g) + eln(H) \qquad \text{(IV.2)}$$

Deriving equation (IV. 2) with respect to time, we obtain an expression in terms of growth rates:

$$g_Y = g_A + ag_L \ + bg_{K_p} \ + \ cg_{K_f} + dg_{K_g} \ \ + dg_H \qquad \text{(IV.3)}$$

where $g_{Y,}\ g_A,\ g_L,\ g_{K_p}, g_{K_f}, g_{K_g}$ and g_H are the growth rates of GDP, *A, L,* K_p, K_f, K_g, and *H,* respectively. Finally, to obtain an expression for the growth of the labor productivity, we subtract from both sides of the equation (IV.3) the term g_L, and obtain:

$$g_Y - g_L = g_A + (a-1)g_L \ + bg_{K_p} \ + cg_{K_f} + dg_{K_g} + dg_H \qquad \text{(IV.4)}$$

With this operation, the coefficient of g_L in equation (IV.4) is negative given that we assume that $0 < a < 1$.

V. THE EMPIRICAL MODEL

In this section we begin with the process of estimating the growth model of labor productivity (and therefore, of economic growth). The equation (IV. 4) can be rewritten as:

$$\Delta\ln\left(\frac{GDP}{L}\right)_t = \alpha_0 + \beta_1\Delta l_t + \beta_2\Delta k_{p,t} + \beta_3\Delta k_{f,t} + \beta_4\Delta k_{g,t} + \alpha_1\Delta h_t + \beta_5\Delta rer_t + \varepsilon_t \qquad \text{(V.1)}$$

where Δ represents increments and lowercase variables are in logarithms. β_1 is expected to be negative, and β_2, β_3, β_4, and α_1 are expected to be positive. The regression also includes the percentage variation of the real exchange rate [$\Delta rer_t = ln(RER_t) - ln(RER_{t-1})$] as an explanatory variable. An increase in *RER* means a real depreciation of the peso. In principle, β_5 should be positive, given that if the Marshall Lerner condition is fulfilled, a depreciation should increase the net external demand, and with this, growth. However, the opposite can occur, an abrupt nominal devaluation (such as occurred in 1954, 1976, 1981, 1994, etc.) as a product of a balance-of-payments crisis can generate inflationary pressures that are usually contained by austerity programs, thus constraining domestic production. So β_5 can be positive or negative.

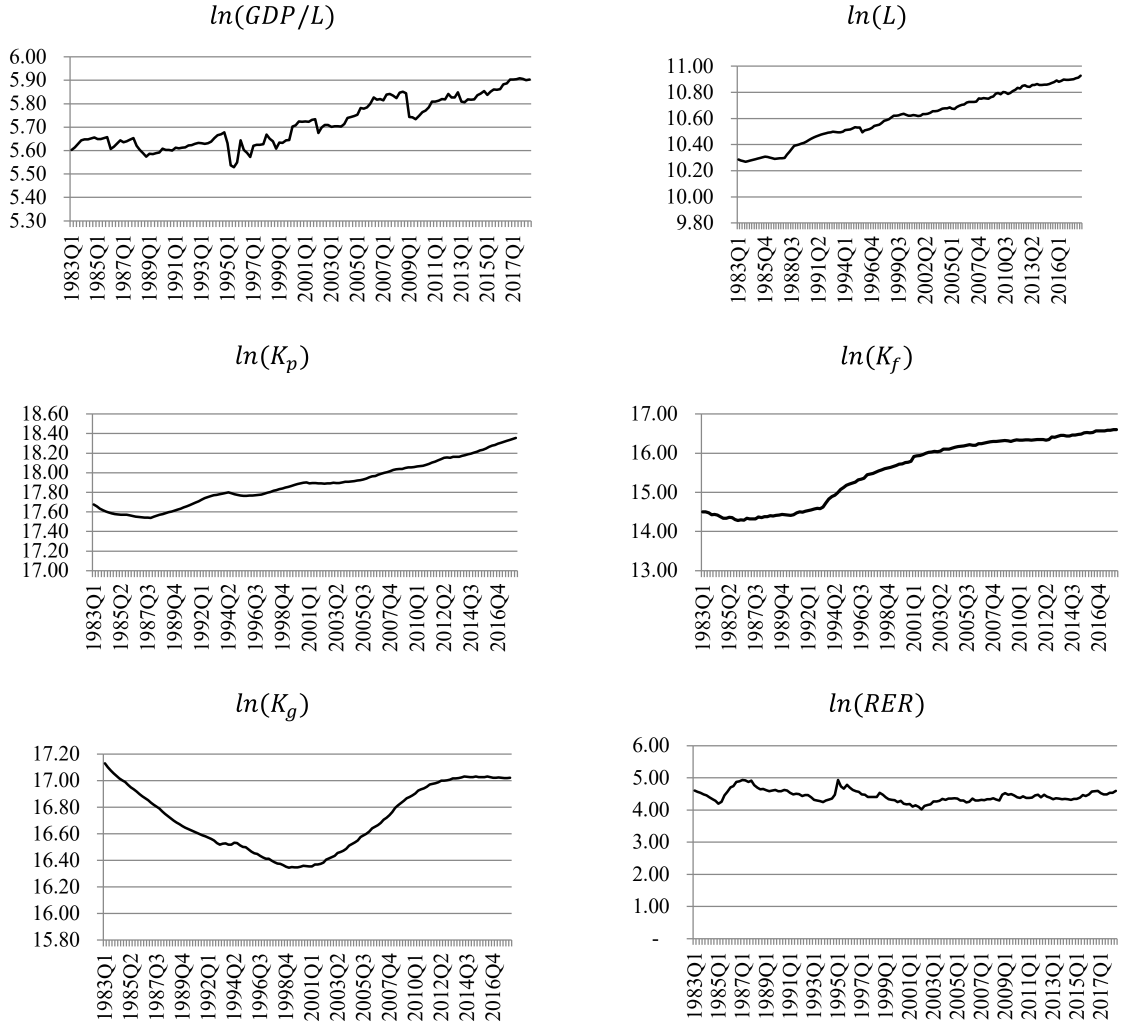
A serious problem in the empirical application of the equation (V. 1) is that human capital H cannot be adequately measured due to the limitation of data on human capital stock; By defining $y \equiv ln(PIB/L)$, and taking into account this data limitation, the growth accounting of the equation (V.1) can be modified as follows:

$$\Delta y_t = \beta_0 + \beta_1 \Delta l_t + \beta_2 \Delta k_{p,t} + \beta_3 \Delta k_{f,t} + \beta_4 \Delta k_{g,t} + \beta_5 \Delta rer_t + \varepsilon_t \qquad \text{(V.2′)}$$

where $\beta_0 = \alpha_0 + \alpha_1 h_t$.

For the estimation of the equation (V.5') during the period 1983Q1-2018Q2, we use quarterly data of the real GDP, total employment, gross private domestic investment, gross government investment, foreign direct investment, and the real exchange rate. GDP and employment series were seasonally adjusted. The data was obtained from the Bank of Mexico (SIE) and INEGI (BIE). To transform the amounts of FDI from current dollars to pesos of 2015, we use the U.S. Producer Price Index and the mid-2015 peso-dollar exchange rate. The exchange rate was obtained from the SIE, and the data for the U.S. producer price index was retrieved from the online database of the Federal Reserve Economic Data Bank of St. Louis Missouri (FRED) and is expressed in thousands of pesos of 2015 and employment, in thousands of workers. Domestic private investment was obtained by subtracting the amount of foreign direct investment from total private investment. The other investment figures were derived directly from the data. With this information, we proceeded to calculate the amounts of each capital type using the perpetual inventories method, which is described in the appendix. The RER is the one reported by the Bank of Mexico for 111 countries. With this information, the series used for the estimation of the model were constructed, which include labor productivity (GDP/L), labor (L), National Private Capital (K_P), foreign capital (K_f), government capital (K_g) and real exchange rate (RER). In Graph 1, the series are presented in logarithms.

Graphic V.1
Series



Unit root tests are shown in Tables V.1 and V.2 using the Phillips-Perron Test[6] for the six quarterly series expressed in logarithms for the 1983Q1-2018Q2 period. These tests indicate that all the series have the same level of integration, all are I (1).

Table V.1
PHILLIPS PERRON - LEVELS *

Serie	Intercept	Trend and intercept	None
ln(GDP/L)	-0.6527	-2.8602	1.3735
ln(L)	-0.3720	-2.5518	5.6543
$ln(K_p)$	1.7290	-3.5770	3.2738
$ln(K_f)$	-0.3658	-1.3479	3.5388

[6] One advantage of the Philips-Perron test is that it is non-parametric, i.e., it is not necessary to select the serial correlation level as in the ADF test. Instead, it adopts the same estimation scheme as the DF test, but corrects the statistic by Autocorrelation and heteroscedasticity. The PP test is based on asymptotic theory; therefore, it works better in medium and large samples. In our case, we have 142 observations, which justify using this test.

ln(K_g)	-1.2919	-2.6188	-0.2514
ln(RER)	-2.8185	-2.8107	-0.1111

Note: the critical values of the Phillips-Perron test with intercept, trend and intercept and none to the significance levels of 1%, 5% and 10% are, respectively: -3.4771, -2.8820, -2.5777; -4.0245, -3.4420, -3.1456; -2.5815, -1.9431, -1.6152.

Table V.2

PHILLIPS PERRON – FIRST DIFFERENCE

Serie	Intercept	Trend and intercept	None
ln(GDP/L)	-11.4415	-11.5834	-11.2981
ln(L)	-10.2048	-10.1713	-8.8834
ln(K_p)	-4.4331	-4.5939	-3.1531
ln(K_f)	-8.5792	-8.5500	-7.2774
ln(K_g)	-3.3502	-4.7231	-3.3921
ln(RER)	-10.8218	-10.8074	-10.8589

Note: the critical values of the Phillips-Perron test with intercept, trend and intercept and none to the significance levels of 1%, 5% and 10% are, respectively: -3.4775, -2.8821, -2.5778; -4.0249, -3.4422,-3.1457; -2.5816, -1.9431, -1.6152.

Since the variables are of order *I(1),* it is necessary to determine whether a stable relationship exists in levels between the variables. For this purpose we used the technique of multivariate cointegration of Johansen Juselius (1990) to test cointegration.

To perform the co-integration test, we must build a non-constrained VAR (Auto-Regressive Vector) to establish the number of optimal lags and the appropriate cointegration test. This VAR includes *ln(GDP/L)*, *ln(L)*, *ln(K_p)*, *ln(K_f)*, *ln(K_g)* and *ln(RER)*. After estimating the VAR, we proceed to determine the order of the lags.

TABLE V.3

VAR Lag Order Selection Criteria
Endogenous variables: *ln(GDP/L), ln(L), ln(K_p), ln(K_f), ln(K_g)* and *ln(RER)*
Exogenous variables: C
Sample: 1983Q1 2018Q2
Included observations: 134

Lag	LogL	LR	FPE	AIC	SC	HQ
0	683.2231	NA	1.64e-12	-10.10781	-9.978054	-10.05508
1	2349.543	3158.547	4.45e-23	-34.44094	-33.53267	-34.07185
2	2438.193	160.0990	2.03e-23	-35.22676	-33.53996*	-34.54130
3	2473.050	59.82891	2.08e-23	-35.20970	-32.74437	-34.20787
4	2521.199	78.33280	1.76e-23	-35.39104	-32.14719	-34.07284
5	2610.739	137.6505	8.13e-24	-36.19014	-32.16776	-34.55557
6	2682.199	103.4567	4.97e-24	-36.71939	-31.91849	-34.76846*
7	2727.245	61.18135*	4.58e-24*	-36.85440*	-31.27497	-34.58710
8	2761.695	43.70643	5.04e-24	-36.83128	-30.47333	-34.24761

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The LR, FPE and AIC criteria suggest seven lags; the SC Criterion suggests two and the HQ criterion suggests using six lags. We adopt the SC criterion[7] with two lags, but add one more to avoid possible risks of autocorrelation. The next step is to perform the Juselius Johansen test with three lags for *ln(GDP/L), ln(L),* $ln(K_p)$, $ln(K_f)$, $ln(K_g)$ and *ln(RER)*. Using the same VAR, both the Akaike and Schwarz criteria suggest that the cointegration test should include intercept, but not tendency (Model iii).[8] Therefore, we use the model with intercept, but without tendency (Model iii) with three lags. Table II.2 and II.3 show the results of the Johansen Juselius tests. The Johansen method suggests two statistics to determine the number of vectors of cointegration: the trace statistic and the test of the maximum eigenvalue. The critical values appropriate for the test are the Osterwald Lenmum (1992). The null and alternative hypotheses are tested using these statistics.

Table V.4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob**
None*	124.3055	95.75366	0.0001
At most 1 *	74.01225	69.81889	0.0222
At most 2	42.36391	47.85613	0.1488
At most 3	22.80362	29.79707	0.2559
At most 4	10.01359	15.49471	0.2797
At most 5	0.081550	3.841466	0.7752

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

Table V.5

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob**
None *	50.29320	40.07757	0.0026
At most 1	31.64834	33.87687	0.0901
At most 2	19.56030	27.58434	0.3724
At most 3	12.79003	21.13162	0.4717
At most 4	9.932035	14.26460	0.2164
At most 5	0.081550	3.841466	0.7752

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

---

[7] Asghar, and Irum (2007) compared five criteria of lag sizes: AIC, SC, HQ, FPE, and AIC, with a known lag of five. His research reveals that for samples of 120 observations or more, the SC criterion has the highest probabilities of a correct estimate p.8. (Table 1.1). "The determination of the length of the lag of an autoregressive process is one of the most difficult parts of the ARIMA model. We have compared these criteria of lag length selection for three different cases: under normal errors, under non-normal errors and structural breakdown using a Monte Carlo simulation. We find that SC is the best criterion for large samples." Op. Cit. P.1. See also Ivanov, V., & Kilian, L. (2005). P. 30.

[8] The sample goes from 1983Q1 to 2018Q2; this gives us 138 observations after adjustments. The model assumes that there is no deterministic trend. Lag intervals are (in first differences) from one to three.

Johansen's cointegration test suggests that the hypothesis of non-cointegration vector can be rejected at least at the level of five percent, thus indicating the presence of a cointegration equation. The presence of at least one relation cointegration between the variables in levels justifies the use of a VEC model, that is, a model that combines the short-term properties of economic relationships with long-term data information, in the form of a level provided by the Johansen test.

The next step is to estimate a VEC and then concentrate on the first equation:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{N} \beta_i \,\Delta y_{t-i} + \sum_{i=1}^{N} \delta_{1,i}\,\Delta x_{1,t-i} + \cdots + \sum_{i=1}^{N} \delta_{j,i}\,\Delta x_{j,t-i} + \sum_{i=1}^{M} \theta_i D_i + \varphi Z_{t-1} + \mu_t \qquad \text{(V.3)}$$

where y is the dependent variable in the first equation of the VEC, x_i ,*i=1,..,4* are the variables that appear as dependent on the other equations of the VEC, but as independent in the first equation, D_i are exogenous variables for all the VEC and Z_{t-1} is the residual of the cointegration equation. The error-correction term, φ, is related to the fact that the deviation of the last period of the long run equilibrium (the error), influences the dynamics of short-term of the dependent variable. Thus, the coefficient φ measures the speed of adjustment, to which *ln(GDP/L)* returns to equilibrium after a change in the independent variables.

VI. Estimation of the VEC model.

The results of the estimation of the equation (V.3) appear in Table VI.1[9]. The R^2 is 0.81, above 50%, so we have a good fit. We also find that the first term of error correction, φ, has the expected sign and is significant: -0.226, (0.036), [-6.286]; this implies that the model returns to its equilibrium level at a rate of 22.67% per quarter. These results confirm that there exists a long-term joint *causality* of all independent variables towards labor productivity.

[9] To achieve normality we use 14 dummy variables. D1:1986Q1, D2:1988Q1, D3:1988Q3, D4:1988Q4, D5:2000Q1, D6:2002Q1, D7:2007Q4, D8:2008Q4, D9:2009Q1, D10:2009Q3, D11: 2009Q4, D12:2012Q2, D13:2013Q1, D14:2013Q4.

Table VI.1

Dependent Variable: Δy
Method: Least Squares (Gauss-Newton / Marquardt steps)
Sample (adjusted): 1984Q1 2018Q2
Included observations: 138 after adjustments

$\Delta y_t = C(1)Z_{t-1} + C(2)\Delta y_{t-1} + C(3)\Delta y_{t-2} + C(4)\Delta y_{t-3} + C(5)\Delta l_{t-1} + C(6)\Delta l_{t-2} + C(7)\Delta l_{t-3} +$
$C(8)\Delta k_{p,t-1} + C(9)\Delta k_{p,t-2} + C(10)\Delta k_{p,t-3} + C(11)k_{f,t-1} + C(12)\Delta k_{f,t-2} + C(13)\Delta k_{f,t-3} +$
$C(14)\Delta k_{g,t-1} + C(15)\Delta k_{g,t-2} + C(16)\Delta K_{g,t-3}$ $+C(17)\Delta tcr_{t-1} + C(18)\Delta tcr_{t-2} + C(19)\Delta tcr_{t-3} +$
$C(20)D1 + C(21)D2 + C(22)D3 + C(23)D4 + C(24)D5 + C(25)D6 + C(26)D7 + C(27)D8 + C(28)D9+$
$C(29)D10 + C(30)D11 + C(31)D12 + C(32)D13 + C(33)D14$

	Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	φ	-0.226670	0.036060	-6.285903	0.0000
C(2)	Δy_{t-1}	-0.064932	0.049196	-1.319868	0.1898
C(3)	Δy_{t-2}	-0.217202	0.052112	-4.167980	0.0001
C(4)	Δy_{t-3}	-0.362205	0.053354	-6.788659	0.0000
C(5)	Δl_{t-1}	-0.637639	0.133269	-4.784613	0.0000
C(6)	Δl_{t-2}	0.072829	0.131410	0.554211	0.5806
C(7)	Δl_{t-3}	-0.523282	0.138362	-3.781988	0.0003
C(8)	$\Delta k_{p,t-1}$	-0.021190	0.368190	-0.057553	0.9542
C(9)	$\Delta k_{p,t-2}$	1.967965	0.452867	4.345564	0.0000
C(10)	$\Delta k_{p,t-3}$	0.791722	0.441715	1.792380	0.0760
C(11)	$\Delta k_{f,t-1}$	-0.053201	0.053427	-0.995764	0.3217
C(12)	$\Delta k_{f,t-2}$	0.027470	0.058218	0.471843	0.6380
C(13)	$\Delta k_{f,t-3}$	0.109789	0.054847	2.001741	0.0479
C(14)	$\Delta k_{g,t-1}$	0.031330	0.162214	0.193138	0.8472
C(15)	$\Delta k_{g,t-2}$	0.119691	0.199748	0.599209	0.5503
C(16)	$\Delta k_{p,t-3}$	0.622431	0.169834	3.664931	0.0004
C(17)	Δtcr_{t-1}	-0.061381	0.014425	-4.255106	0.0000
C(18)	Δtcr_{t-2}	-0.032143	0.014874	-2.160967	0.0330
C(19)	Δtcr_{t-3}	-0.023644	0.014884	-1.588563	0.1152
C(20)	*D1*	-0.001887	0.002631	-0.717029	0.4750
C(21)	*D2*	-0.046545	0.011915	-3.906456	0.0002
C(22)	*D3*	-0.030384	0.011130	-2.730021	0.0074
C(23)	*D4*	-0.043007	0.012049	-3.569460	0.0005
C(24)	*D5*	-0.039032	0.012019	-3.247551	0.0016
C(25)	*D6*	0.042520	0.010952	3.882395	0.0002
C(26)	*D7*	-0.068536	0.011298	-6.066214	0.0000
C(27)	*D8*	-0.024073	0.011090	-2.170700	0.0322
C(28)	*D9*	-0.038902	0.011562	-3.364577	0.0011
C(29)	*D10*	-0.102083	0.011693	-8.730312	0.0000
C(30)	*D11*	-0.064981	0.012662	-5.132139	0.0000
C(31)	*D12*	-0.029369	0.013070	-2.247048	0.0267
C(32)	*D13*	-0.033828	0.011160	-3.031233	0.0031
C(33)	*D14*	-0.044411	0.012272	-3.618833	0.0005

R-squared	0.813113	Mean dependent var	0.001879
Adjusted R-squared	0.753812	S.D. dependent var	0.021491
S.E. of regression	0.010663	Akaike info criterion	-6.034143
Sum squared resid	0.011825	Schwarz criterion	-5.312936
Log-likelihood	450.3559	Hannan-Quinn criter.	-5.741062
F-statistic	13.71167	Durbin-Watson stat	1.971736
Prob(F-statistic)	0.000000		

Where the cointegration equation is given by[•]

$y_{t-1} =$	4.223	-	l_{t-1}	+0.661	kp_{t-1}	+0.243	kf_{t-1}	+0.294	kg_{t-1}	- 0.0485	tcr_{t-1}
		(0.1967		(0.1432)		(0.0271)		(0.0344)		(0.0294)	
		[		[-4.6160]		[-8.9745]		[-8.5692]		[1.6505]	

The residual is given by:

$Z_{t-1} \equiv y_{t-1}$ - 4.22394849845 + 1.77265281282 l_{t-1} - 0.660996588726 $k_{p,t-1}$– 0.242951642474 $k_{f,t-1}$ - 0.294328464638 $k_{g,t-1}$ + 0.0484600442245 rer_{t-1}

[•] Standard errors are in parentheses and t-statistic in brackets.

We continue with the diagnosis of the residuals; that analysis consists of three parts: a) autocorrelation test; b) heterocedasticity test and c) normality test.

Let's start with the Breusch-Godfrey autocorrelation test with three lags. The test results appear in Table VI.2.

Table VI.2

Breusch-Godfrey Serial Correlation LM Test

F- stadistic	0.087	Prob. F(3,101)	0.967
Obs*R-squared	0.357	Prob. Chi-Square(3)	0.949

Since the probability value, 94.9% is higher than the required 5%, we accept the null hypothesis; that is, our model does not have serial correlation in the residuals at the 5% confidence level.

We continue with the heteroscedasticity test, for which we use the Breusch-Pagan-Godfrey test. The results appear in Table VI.3.

Table VI.3

Heteroskedasticity Test: Breusch-Pagan-Godfrey

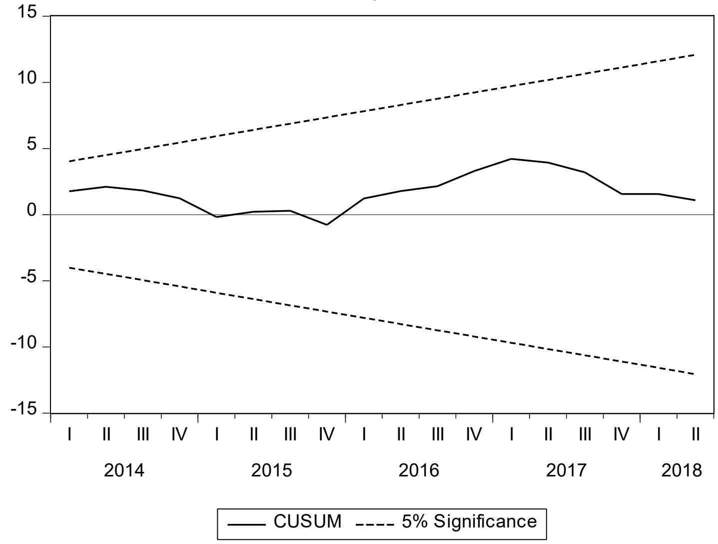
F-statistic	1.0567	Prob. F(38,99)	0.4035
Obs*R-squared	39.8190	Prob. Chi-Square(38)	0.3891
Scaled explained SS	18.5865	Prob. Chi-Square(38)	0.9966

Since the probability of Obs * R-squared is 38.9%, higher than the 5% required, we cannot reject the null hypothesis and conclude that our model does not have heteroscedasticity in the residuals.

Next, we perform the normality test of residuals where we find a value of 0.732 for the Jarque-Bera coefficient with a probability of 0.694. This value of 69.4% is higher than the 50% required, so we cannot reject the null hypothesis and, therefore, conclude that our model presents normality in the residuals.

After verifying that our model is correctly estimated, we check if the model is stable; to do this we use the CUSUM test. This test tells us if the parameters are stable; the parameters are stable if the CSUM line does not exceed the 5% limits. In Graph VI.1 we show the results for this model, and since the limits are not exceeded, we conclude that our model is stable.

Graph VI.1
Stability Test



VII. CAUSALITY TEST, IMPULSE RESPONSE, AND VARIANCE DECOMPOSITION.

Once we check that our model has the right properties, we start making inferences. From Table VI.1 we can obtain the aggregated effects of the lags of the leading independent variables. Its aggregated effects, its standard errors, and t-statistics appear in Table VII.1.

TABLE VII.1
The cumulative effect on the growth of (GDP/L)

	Sum of lag coeficients	Standard Error of the Sum*	"t"
ln(KP)	2.738	0.732	3.741
ln(KF)	0.084	0.096	0.874
ln(KG)	0.773	0.308	2.509
ln(TCR)	- 0.117	0.026	- 4.593

* The standard error of the sum was calculated adding the square of the respective standard errors of every lagged variable that appears in Table VII.1, and extracting the square root of the sum. $S.E. = \sqrt{s_1^2 + s_2^2 + s_3^2}$

As shown in Table VII.1, we found a positive and significant cumulative effect of the growth of national private capital and government capital on labor productivity growth. Aggregate real exchange rate growth has a negative and significant impact. Most surprisingly, the cumulative effect of foreign capital growth does not significantly affect productivity growth.

To be more confident of these results, we calculate the short-term causality of each of the independent variables on the growth of labor productivity in the economy. We begin by analyzing whether the growth of domestic private capital causes the growth of labor productivity in the short run. We run the Wald test, with the null hypothesis being that C(8)=C(9)=C(10)=0 (see the first column of Table VI.1). These results appear in Table VII.2. Given that the probability of the χ^2 is less than 5%, we reject the null hypothesis and conclude that in the short run the lags in the growth of domestic private capital cause the growth of output per worker.

Table VII.2

Wald Test
Null Hypothesis: C(8)=C(9)=C(10)=0

Test Statistic	Value	df	Probability
F-Stadistic	20.65748	(3, 104)	0.0000
Chi-square	61.97244	3	0.0000

We now analyze whether the growth of foreign capital causes the growth of labor productivity in the short term. The null hypothesis is that C(11)=C(12)=C(13)=0. These results appear in Table VII.3. The value of the F-statistic is 2.1239 < $F_{3,104}$= 2.20 at a level of 5%. The value of the χ^2 is 6.3718 < 12.59 to the 5% level. Therefore, we reject the null hypothesis at a level of 5%, and we find that there is no short-run causality of foreign capital growth on labor productivity growth.

Table VII.3

Wald Test
Null Hypothesis: C(11)=C(12)=C(13)=0

Test Statistic	Value	df	Probability
F-Stadistic	2.1239	(3, 104)	0.1017
Chi-square	6.3718	3	0.0949

We continue analyzing if the growth of the government´s capital causes the growth of labor productivity in the short term. The null hypothesis is that C(14)=C(15)=C(16)=0. The results appear in Table VII.4. Since the probability of χ^2 is less than 5%, we reject the null hypothesis and conclude that the lags in the growth of government capital cause the growth of labor productivity in the short run.

Table VII.4

Wald Test
Null Hypothesis: C(14)=C(15)=C(16)=0

Test Statistic	Value	df	Probability
F-Stadistic	16.4579	(3, 104)	0.0000
Chi-square	49.3737	3	0.0000

Finally, we check whether the growth of the real exchange rate, causes the growth of labor productivity in the short run. The null hypothesis is that C(17)=C (18)=C (19)=0. The results appear in Table VII.5. Since the probability of the χ^2 is less than 5%, we reject the null hypothesis and conclude that the lags of real exchange rate growth cause in the short run the growth of labor productivity.

Table VII.5

Wald Test
Null Hypothesis: C(17)=C(18)=C(19)=0

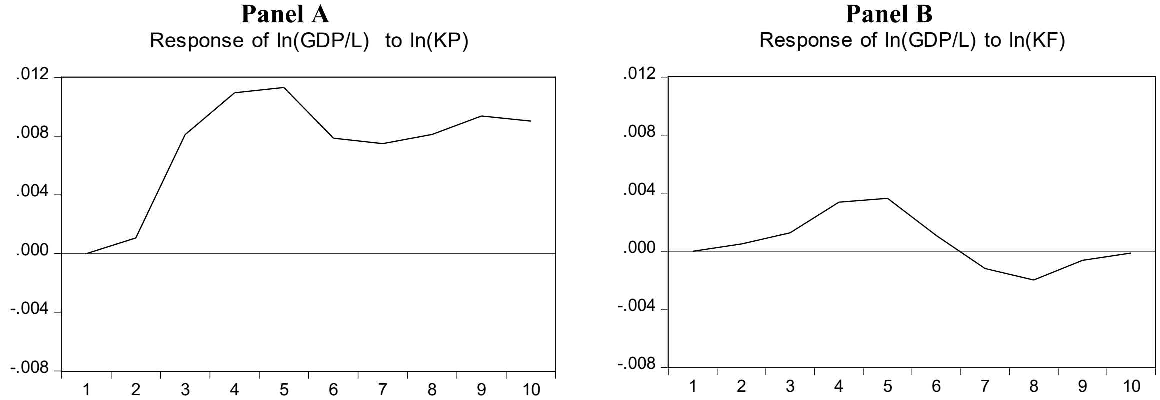
Test Statistic	Value	df	Probability
F-Stadistic	7.8749	(3, 104)	0.0001
Chi-square	23.6246	3	0.0000

These results confirm what we had found from the analysis of Table VII.1, especially, the irrelevance of foreign capital growth in explaining labor productivity growth.

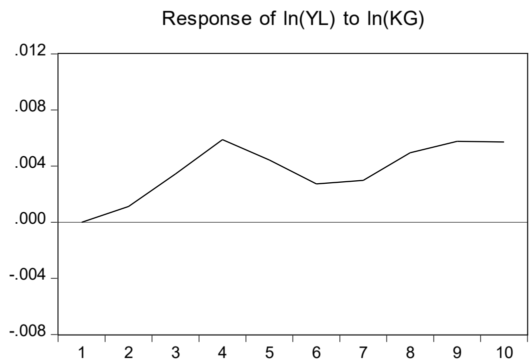
Impulse Response. The evolution of ln(GDP/L) caused by a shock of a standard deviation in the value of ln(K_p), ln(K_f), ln(K_g) and ln(RER) appear, respectively, in Panels A, B, C and D of Graph VII.1.

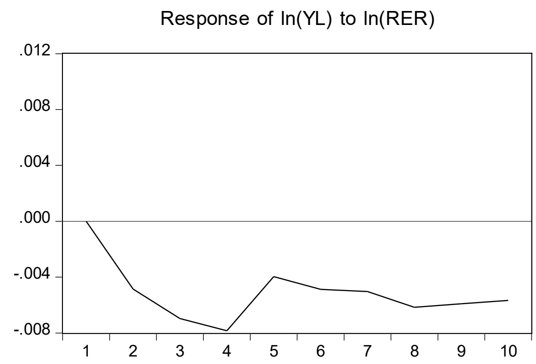
Graph VII.1
Response to Cholesky One S.D. Innovations

Panel A **Panel B**



Panel C **Panel D**





Graph VII.1 also confirms what was found in the analysis in Table VII.1. A positive and significant response to a shock in ln(K_p) on ln(GDP/L) is observed in Panel A. The same goes for the shock of a standard deviation of ln(K_g) on ln(GDP/L); the response is positive and significant. In contrast, Panel B shows an oscillating non-significant effect of foreign capital on labor productivity.

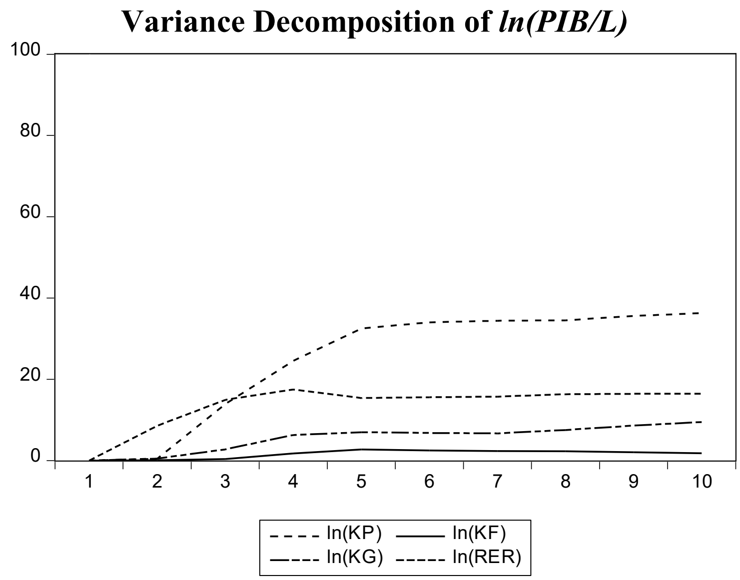
Variance Decomposition. This analysis calculates what percentage of the variance ln(GDP/L) is explained by an impulse, innovation, or shock in the variables of equation one of the VEC. The results are shown in Table VII.6.

Table VII.6
Variance Decomposition of *ln(PIB/L)*

Period	S.E.	ln(K_P)	ln(K_F)	ln(K_G)	ln(RER)
1	0.010663	0.000000	0.000000	0.000000	0.000000
2	0.016595	0.414594	0.092261	0.462612	8.532954
3	0.021938	13.87873	0.384547	2.722058	14.94224
4	0.027612	24.50915	1.742843	6.261278	17.48611
5	0.031141	32.49419	2.740880	6.955717	15.36868
6	0.033307	33.98182	2.499818	6.753410	15.57698
7	0.035485	34.40351	2.315539	6.655968	15.73241
8	0.038045	34.48602	2.286829	7.484643	16.30650
9	0.040631	35.55631	2.029217	8.573915	16.40611
10	0.042925	36.28247	1.818954	9.455538	16.44385

An initial impulse in ln(K_p) has little effect in the short term, but as periods pass, it may explain the 36.28% of the variance of ln(GDP/L). A similar, albeit, minor effect is observed in the impulses of ln(K_g) and ln(TCR) that, respectively, explains a 9.46% and 16.44% of the variation in ln(GDP/L) in Period 10. A very different thing happens with a shock to ln(K_f) that in Period 10 only explains 1.82% of the variation in ln(GDP/L). These results are also shown in Graph VII.2.

Graph VII.2



VIII. INTERPRETATION OF RESULTS

With the VEC model, we find that there is a combined long-run causality that goes from national private capital, foreign capital, government capital and the real exchange rate on labor productivity. We also find short-term causality for the growth of national private capital, government capital and the real exchange rate on labor productivity growth. However, the most important finding is that we do not find short-run causality for growth of foreign capital over labor productivity growth.

IX. COMMENTS AND CONCLUSIONS

The findings of this paper are not surprising because Mexico, instead of establishing a development policy, only fully opened its market for goods, services and capital, signed trade agreements in the hope of attracting FDI, and waited for these actions do a miracle.

From 1950 to 1982 Mexico grew at an average annual rate of 6.10 percent, a rate much higher than that of the United States, which was only 3.35 percent. In contrast, from 1983, the year of the initiation of neoliberal economic policies, Mexico's GDP grew at an average annual rate of only 2.66 percent, below that of the United States, which was 2.75 percent for the same period. This slow growth has caused Mexican per capita income to grow at an average rate below 1% per annum. This low growth made Mexico lag, not only behind the

United States, but also behind other countries that had lower per capita incomes than Mexico in 1980. This was the case of South Korea, a country that, instead of indiscriminately opening to trade and FDI, carried out meticulous economic planning through a selective industrial policy.

The question becomes how to improve the effectiveness of capital so that the economy will be able to grow faster. This will not be achieved by merely eliminating "market-inherent distortions," but, instead, by resolute state intervention. This was the way that current developed countries were able to develop, and is what countries with rapid growth rates, now do. These countries applied an industrial policy as a growth strategy, creating new competitive advantages, limiting the role of foreign direct investment in these strategies, and tried to minimize the impact of the constraints that they imposed by **implementing** intellectual property rights protection agreements.

To find a path forward, we must search world economic history to learn how the current developed countries achieved that development level, and specifically, learn from the experiences of developed countries with very recent industrialization. Especially, we can learn from the strategies pursued by various East Asian countries to achieve faster and more sustained economic growth. These countries have managed to develop in a historically short time period. For example, in 1986 South Korea had the same per capita income as Mexico, while in 2017, it registered an inhabitant income three times higher, within a period of fewer than twenty years. A quick overview of some indicators of the economies of South Korea and Mexico help us to identify the differences in terms of policies and their results. In South Korean, from 1990 to 2017, exports, investment and trade were comparatively much more important than in Mexico during the same time period, but foreign direct investment was less significant in Korea.

The phenomenon of vertiginous development observed in Japan after the post-World War II era, that of the Asian tigers in the 1980s, that achieved by China, and recently by Vietnam, have no other explanation than growth planning. These state interventions developed new competitive advantages and raised the per capita income of those countries in record times, which are unprecedented in world economic history.

The Mexican policies of indiscriminate commercial opening, and the attraction of FDI without a master plan, have provoked the slow growth of the Mexican economy. FDI has been admitted without regulation, as minority partnerships with national companies. Such partnerships could facilitate technology transfer, as does occur in many parts of East Asia. However, the Mexican government does not impose requirements of national content on FDI, which prevents exports from having any meaningful impact on GDP. Finally granting FDI “national treatment," has vastly inhibited any industrial policy, which might have helped México to develop its own technological capacities.

Finally, companies with FDI are mainly responsible for manufacturing Mexican exports. These companies pressure the Mexican government to maintain the status quo and are the most interested in keeping a free trade agreement with the U.S. at any cost. These foreign companies, in addition to not contributing directly to economic growth, as we have shown, inhibit growth, indirectly, through the political influence they exert on the Mexican government to not take measures contrary to their particular interests.

APPENDIX[10]

The perpetual inventories method (*PIM*) considers an exogenously fixed depreciation rate, and the investment accumulates in successive periods.[11] Formally, MIP is expressed as:

$$KS_t = (1 + \delta)KS_{t-1} + I_t \quad \text{(A.1)}$$

Where: KS_t = Stock of real capital at time t; δ = depreciation rate and I_t = investment at time t.

A problem that arises from equation (1) is to get KS_{t-1}; that is, to find a starting point from which to start the count. The usual way of calculating is to assume that KS_0=0 (1980), KS_{1981}=I_{1981} for the second observation, and only from Observation 3 (1982), capital begins to accumulate due to added investment.[12]

According to Shiau et al. (2002), assuming that *KS* is zero at the first observation, and that this increases rapidly until it stabilizes at the end of approximately 10 observations, this represents a technical disadvantage because with this the accumulation of investment and the effect of depreciation begins to be felt several quarters later. Therefore Shiau et al. suggest adding an adjustment factor that mitigates this problem. Shiau et al. (2002) retake the suggestion of Almon (1999) when considering an adjustment factor for the series. We define Adj_t as:

$$Adj_t = (1 - \delta)Adj_{t-1} + 1 \quad \text{(A.2)}$$

It is assumed that Adj_t =1 for the initial observation and it grows until reaching the equilibrium value of the average depreciation rate equal to 1/δ. Based on this factor of adjustment and the estimation of *KS* through equation (A.1), a new adjusted series of KS_t is calculated that we will call K_t:

$$K_t = \frac{(KS_t / Adj_t}{\delta} \quad \text{(A.3)}$$

where: K_t = Adjusted capital stock at time t.

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[10] This section is based on Loría and De Jesús (2006).
[11] See Santaella (1998); Bergoeing et al. (2002), Bosworth and Collins (2003) Blázquez and Santiso (2004) and Loría and De Jesús (2006).
[12] To avoid that KS0 = 0, some authors decide to traverse a backward observation. In other words, if KS is required for the period 1983-2018, the period is extended to 1980-2018. So 1980 = 0 and 1983 will take the real investment value of that observation, so the series for the period 1983-2018 no longer depart from zero.

With the expression (A.3) we calculate stocks of national private capital, K_p, foreign capital K_f and of the government capital K_g.

There is no consensus to determine the depreciation rate; Shiau et al. (2002) assume a depreciation rate of 12%, Blázquez and Santiso (2004) of 8%; Faal (2005) and Santaella (1998) of 10% and Borgoeing et al. (2002) of 5%. We use depreciation rates based on figures used for the calculation of PIM by the Office for National Statistics (ONS) of the United Kingdom.[13] This information appears in Table A.1

Table A.1

Type of asset	Depreciation rate
Machinery and equipment	0.06
Buildings	0.02
Transportation equipment	0.20
Weighted average	**0.11**

Based on this data, we adopt the value of $\delta = 0.11$ for our calculations of the national, foreign and public-private real capital.

[13] Martin (2002).

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