TFP in Latin America[*]

Pedro Cavalcanti Ferreira (EPGE/FGV)
Samuel de Abreu Pessôa (EPGE/FGV)
Fernando A. Veloso (Ibmec/RJ)

March 2006

Abstract

Due to widespread government intervention and import-substitution industrialization, there has been a general perception that Latin America has been much less productive than the leading economies in the last decades. In this paper, however, we show that until the mid-seventies Latin America had high productivity levels relative to the US and other regions. Moreover, total factor productivity in Latin America increased relative to the US during this period, declining only in the subsequent years.

1   Introduction

There is a general perception that Latin America has been for many years less productive than the leading economies. Due to widespread government intervention, policy mistakes, institutions not favorable to growth and political instability, the common presumption has been that total factor productivity in the region would have lagged behind other regions during its entire development process. The list of problems and distortions is huge and include import-substitution industrialization, corruption, inflation, low security of property rights and contracts, income inequality, and competitive barriers such as monopolies and barriers to entry, among others.

Recent papers, such as Hopenhayn and Neumeyer (2004) and Cole et al (2005), seemed to confirm empirically this perception. In particular, Hopenhayn and Neumeyer (2004) found that average TFP growth in Latin America was slightly negative between 1960 and 1985. Moreover, Cole et al (2005) found that average TFP levels in Latin America corresponded to roughly 50% of US productivity between 1950 and 2000.

In this paper, however, we show that until the mid-seventies Latin American countries had high productivity levels relative to the US and other regions. On average, total factor productivity (TFP) in Latin America was higher than that

of a sample of Western European countries between 1960 and 1975. Moreover, TFP in Latin America increased relative to the US during this period. As far as 1980 it was around 88% of that of the U.S. and at least 25% above the rest of the world average. It is only after the mid-seventies that we observe a fast decrease of relative TFP in Latin America, which fell to 72% of the Western European productivity and 62% of US TFP in 2000.

Hence, productivity in Latin America was close to that of the US when competitive barriers were highest in the region, between 1960 and 1975, only falling in the subsequent years. This note documents these stylized facts, using different methodologies and data sources. The robustness exercises confirm our main findings and call into question the results obtained in the recent literature on Latin America productivity, such as Hopenhayn and Neumeyer (2004) and Cole et al (2005). This note is organized as follows. In section 2 we present the methodology used to construct the TFP measure used in the paper. Section 3 presents the main results and some robustness exercises. Section 4 concludes.

2   Methodology and Data

Let the production function in terms of output per worker be given by:

$$y_{it} = A_{it} k_{it}^{\alpha} H_{it}^{1-\alpha}, \tag{1}$$

where y_{it} is the output per worker of country i at time t, k stands for physical capital per worker, H is human capital per worker, and A is total factor productivity (TFP). In our exercises we follow Bils and Klenow (2000) to model human capital and set:

$$H = \exp \phi(h) = \exp \left(\frac{\theta}{1-\psi} h^{1-\psi} \right),$$

where h stands for schooling.

In order to compute the value of A_{it}, we use the observed values of y_{it} and the constructed series of k_{it} and H_{it} so that the productivity of the i-th economy at time t was obtained as:

$$A_{it} = \frac{y_{it}}{k_{it}^{\alpha} H_{it}^{1-\alpha}}. \tag{2}$$

The physical capital series is constructed with real investment data from the Penn-World Table 6.1 using the perpetual inventory method. The initial capital stock, K_0, was approximated by $K_0 = I_0/[(1+g)(1+n) - (1-\delta)]$, where I_0 is the initial investment expenditure, g is the rate of technological progress and n is the growth rate of the population. In this calculation it is assumed that all economies were in a balanced growth path at time zero, so that $I_{-j} = (1+n)^{-j} (1+g)^{-j} I_0$.

We use the same depreciation rate for all economies, which was calculated from US census data. We employed the capital stock at market prices, investment at market prices, I, as well as the law of motion of capital to estimate the

implicit depreciation rate according to:

$$\delta = 1 - \frac{K_{t+1} - I_t}{K_t}.$$

From this calculation, we obtained $\delta = 3.5\%$ per year (average of the 1950-2000 period). To minimize the impact of economic fluctuations we used the average investment of the first five years as a measure of I_0. When data was available we started this procedure taking 1950 as the initial year in order to reduce the effect of K_0 in the capital stock series. We obtained the rate of technological progress by adjusting an exponential trend to the U.S. output per worker series, correcting for the increase in the average schooling of the labor force and obtained $g = 1.53\%$. The population growth rate, n, is the average annual growth rate of population in each economy between 1960 and 2000, calculated from population data in the Penn-World Table 6.1. We measured h using average years of schooling of the population aged 15 years and over, taken from Barro and Lee (2000), interpolated (in levels) to fit an annual frequency.

Estimates in Gollin (2002) of the capital share of output for a variety of countries fluctuates around 0.40, so that we set α at this value. Finally, we follow Bills and Klenow and set $\psi = 0.58$ and $\theta = 0.32$.

3   Results

Figure 1 and Table 1 below present the main results of this paper. Figure 1 shows the evolution between 1960 and 2000 of the (geometric) mean and the median of TFP of 18 Latin American countries[1] relative to U.S TFP.[2] Until the mid-seventies, total factor productivity in Latin America was very close to that of the leading economy, corresponding to 93% of US TFP in 1975. Moreover, both the mean and the median Latin American TFP increased relative to the US between 1960 and 1975. Specifically, during this period, average TFP in Latin America increased from 87% to 93% of US productivity whereas median Latin American TFP increased from 82% to 95% of US TFP. However, since the mid-seventies both the mean and the median TFP in Latin America fell continuously, especially since 1980, declining to 62% and 65% of US TFP in 2000, respectively.

In absolute values, TFP grew on average 1.1% per year in Latin America between 1960 and 1975, considerably above the US TFP growth rate of 0.6%. Median growth in Latin America was even higher, at 1.6% per year, because it does not take into account outliers such as El Salvador and Nicaragua that experienced revolutions and high political instability in the period. In the following two and a half decades, however, while U.S. productivity growth kept

---

[1] The Latin America countries are Brazil, Mexico, Colombia, Argentina, Peru, Venezuela, Chile, Ecuador, Guatemala, Dominican Republic, Bolivia, Honduras, El Salvador, Paraguay, Nicaragua, Costa Rica, Uruguay and Panama.

[2] For each country i and year t, relative TFP is given by: A_{it}/A_{USt}. We then computed the unweighted average of this ratio across countries for every year to calculate the Latin America relative TFP.
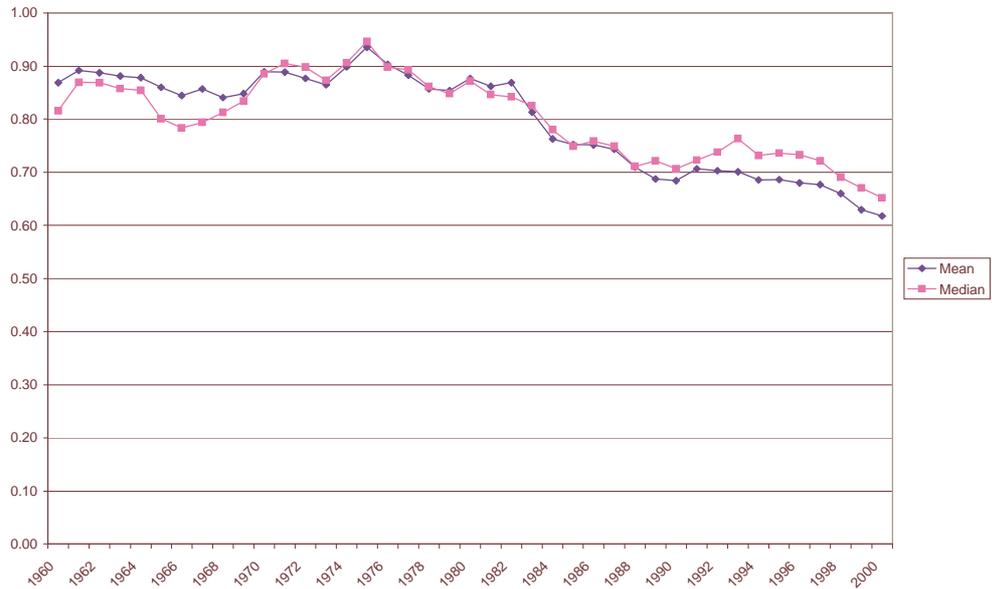
Figure 1:

the same pace, at 0.6% per year,[3] Latin America TFP collapsed, declining at an average annual rate of 1.1%. As a result, in the entire 1960-2000 period TFP in Latin America fell in absolute terms 0.3% a year, and in eleven out of 18 countries of our sample it had zero or negative growth.

Table 1 presents data on relative TFP for the largest economies in Latin America. In some countries TFP surpassed that of the US before 1980 (e.g., Brazil in 1975, Venezuela between 1960 and 1975 and Mexico from 1960 to 1980), and in eleven out of the 18 economies of our sample TFP was at least 80% of the American TFP between 1960 and 1980. This contrasts drastically with the situation in 2000, when relative TFP in Latin America was, on average, 62% of US TFP and in only two economies it was above 0.80.

---

[3] It should be noted, however, that the growth in US productivity was not constant between 1975 and 2000. In particular, it was close to zero between 1975 and 1983, corresponding to the well-known productivity slowdown. It increased since then, especially after 1995, averaging 1.4% between 1995 and 2000.

Table 1: Relative TFP (U.S=1)

	1960	1965	1970	1975	1980	1985	1990	1995	2000
Argentina	0.99	0.93	0.93	0.98	0.93	0.75	0.58	0.74	0.69
Brazil	0.83	0.80	0.88	1.07	1.02	0.86	0.75	0.80	0.73
Chile	0.68	0.64	0.73	0.64	0.76	0.65	0.72	0.87	0.80
Colombia	0.81	0.80	0.90	0.91	0.96	0.87	0.90	0.77	0.64
Mexico	1.09	1.11	1.10	1.18	1.13	0.99	0.79	0.74	0.77
Peru	0.58	0.66	0.69	0.83	0.66	0.57	0.45	0.44	0.40
Uruguay	0.77	0.68	0.73	0.76	0.86	0.61	0.69	0.76	0.73
Venezuela	1.33	1.55	1.64	1.20	0.88	0.73	0.77	0.73	0.61
Latin America	0.87	0.86	0.89	0.93	0.88	0.75	0.68	0.69	0.62

Individual examples may be illustrative. TFP in Mexico corresponded to 77% of US TFP in 2000, whereas it was 18% above US TFP in 1975. The fall in Argentina was even more dramatic, and maybe the worst case was that of Venezuela, were relative TFP reached 1.64 in 1970, but in 2000 it was only 61% of US TFP.

We have identified, hence, two general patterns: relative TFP in Latin America was high and it was increasing until the mid-seventies and since then it fell continuously in the region. Is this a general fact observed in other regions? Figure 2 shows that this is not the case. From 1960 to 1975 average TFP in Latin America was higher than that of Western Europe and 60% higher than East Asia TFP.[4] Hence, productivity in Latin America was not only high but above that of richer or similar regions. However, while in Western Europe and East Asia we observe a convergence to the US productivity level between 1960 and 2000, particularly dramatic in the latter, in Latin America there was increasing divergence relative to US TFP since the mid-seventies. Specifically, in 2000 both regions surpassed Latin America TFP by more than 20%.

We observe the same qualitative patterns if we compare Latin America TFP with average TFP in a larger sample of 83 developed and developing countries.[5] In particular, mean TFP in Latin America was 20% above the average world TFP between 1960 and 1975. However, in 1995 it was only 5% above and five years later it was 3% below average world TFP. Without any doubt, the region

---

[4] The countries included in our comparison are as follows. Western Europe: Austria, Italy, Finland, Belgium, France, Norway, Iceland, Denmark, Germany, Netherlands, Sweden and Switzerland. East Asia: Taiwan, Hong Kong, Korea, Singapore, Thailand and Japan.

[5] The countries included in the sample are: Brazil, Mexico, Colombia, Argentina, Peru, Venezuela, Chile, Ecuador, Guatemala, Dominican Republic, Bolivia, Honduras, El Salvador, Paraguay, Nicaragua, Costa Rica, Uruguay, Panama, Austria, Italy, Finland, Belgium, France, Norway, Iceland, Denmark, Germany, Netherlands, Sweden, Switzerland, Taiwan, Hong Kong, Korea, Singapore, Thailand, Japan, Ireland, United Kingdom, United States, Australia, Canada, New Zealand, Cyprus, Portugal, Spain, Greece, Turkey, Syria, Tunisia, Israel, Iran, Jordan, Malaysia, Indonesia, Pakistan, India, Nepal, Papua New Guinea, Bangladesh, Philippines, Fiji, Barbados, Trinidad & Tobago, Guyana, Jamaica, Botswana, Lesotho, Mauritius, Malawi, Zimbabwe, Uganda, Tanzania, Kenya, Ghana, Cameroon, Togo, Senegal, Mozambique, Zambia, Niger, Central African Republic, South Africa and Congo.
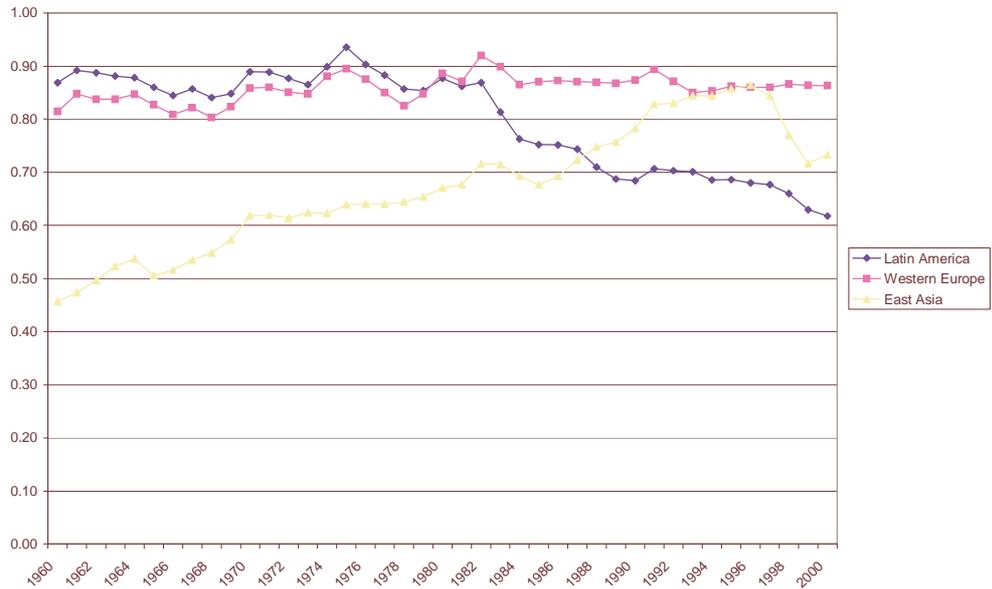
Figure 2:

lost ground and only Sub-Sahara Africa fares worst in terms of TFP reduction in the period.

It could be the case that our results are driven by measurement error in the TFP series. In particular, if our capital stock is measured with error due, for instance, to the procedure used to construct the initial capital stock or to our hypothesis about the depreciation rate, our TFP calculations could be biased. Of course, this problem would affect not only Latin America but all countries, so that there is no reason to think that our findings are due only to the particular methodology we use. In any case, we present below a group of robustness exercises and show that the results do not change.

We first reconstructed the capital stocks series using a 10% depreciation rate and the same methodology as above. This new capital stock series was then used to generate a new TFP series according to (**??**). This exercise is important because a higher depreciation rate reduces the importance of the initial capital stock in the capital stock series. However, results did not chance much. From 1960 to 1975 average TFP in Latin America remained above that of Europe and corresponded on average to roughly 80% of US TFP. After this date it fell continuously and in 2000 it was only 45% of the US productivity level and 56% of European TFP.

If we eliminate from the sample those countries for which we do not have investment data starting in 1950, our main findings are not affected. If we use a capital stock series that starts in 1950, by 1960 most of the initial capital is

already depreciated (more than 60% with $\delta = 10\%$), so that any error in its construction is mostly washed out. In this case, Latin America was on average 82% as productive as the US in 1960, 86% in 1970 and 83% in 1980, but only 46% in 2000.

Using the capital-output ratio instead of the capital-labor ratio to construct the TFP series, as in Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999), also does not affect our findings. In this case, after manipulation of (??), TFP of country i at time t is calculated by:

$$A_{it} = \frac{y_{it}}{\kappa_{it}^{\frac{\alpha}{1-\alpha}} H_{it}}.$$

where κ is the capital-output ratio.

Using this methodology we find that in 1960 average TFP in Latin America was 79% of that of the U.S. and above European TFP. In 1975, relative TFP in Latin America had increased to 89% of US productivity. However, in 2000 the TFP in the region was only 45% of that of the U.S. while in Europe there was considerable catch-up, reaching around 80% of US productivity in the same year.

Data from Baier, Dwyer and Tamura (2004) lead to similar results. This dataset comprises historical data that goes as far as 1900 for some Latin America countries. In 1930, average TFP in this region was equal to that of "Western Countries". After this date it fell slightly in relative terms, but until 1980 it remained above the mean TFP of any other region or group of countries besides the Western Countries, including Southern Europe and the NICs. Twenty years later, however, TFP of Latin America was well below TFP of these two groups and of the Western Countries.[6]

Finally, we repeat our exercises using capital and output data from Nehru and Dhareshwar (1993). This is important as Cole et al (2005) used this data to conclude that Latin America TFP during the post-war period corresponded only to 50% of the US TFP. We use expression (??) to construct TFP measures for Latin America, Western Europe and East Asia.[7] Education data, as before, is from Barro and Lee (2000). Results (TFP relative to the US) for the period 1950-1990 are presented in Figure 3:[8]

---

[6] Western Economies are basically Western European countries plus U.S, Australia, New Zeland and Canada. They do not include the "Southern European" economies: Italy, Spain, Greece, Portugal, Turkey and Cyprus. The NICs are Hong Kong, Japan, Singapore, South Korea and Taiwan.

[7] We use the same sample for Latin America, Western Europe and East Asia that we have been using in the paper.

[8] We do not include Brazil in the Latin America average because its relative TFP in the first years are way below that of any other country (e.g., less than 15% of the US TFP) indicating some data problem. However, although the level would change slightly with its inclusion, the time-series behavior woundn´t.
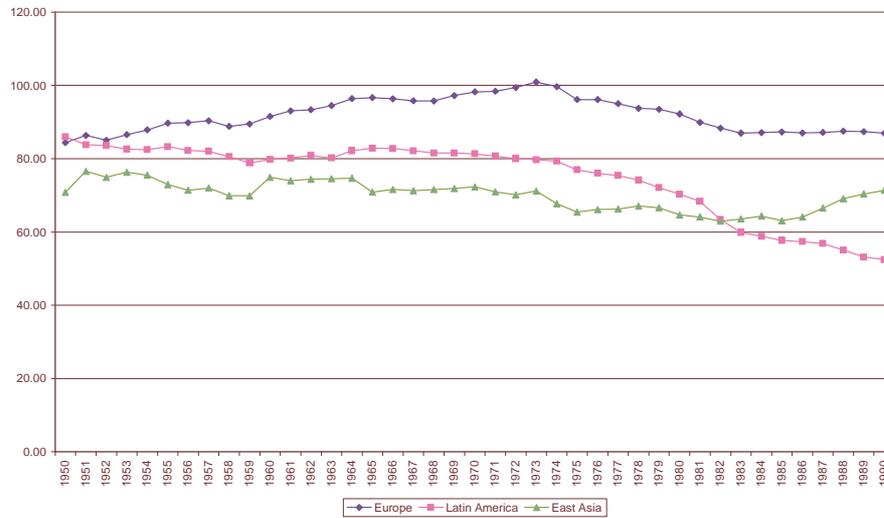
Figure 3: Relative TFP, Region and Continent Averages (U.S.=1, Nehru and Dhareshwar (1993))

From 1950 to 1975, average TFP in Latin America fluctuates a little above 80% of US TFP. Similarly to what we found before, mean relative TFP in Latin America fell continuously after the mid-seventies and in 1990 it was only 55% of American TFP. Moreover, average TFP for East Asia was below Latin America´s until the early-eighties, even though the TFP difference for earlier years is much smaller than that displayed in Figure 2. Likewise, for earlier years Latin American economies are not too far from European countries, although its TFP never surpassed that of Europe for this dataset. Hence, we can conclude that our previous findings are confirmed using Nehru and Dhareshwar (1993)´s data set.

These observations look puzzling. It has been long believed that low productivity in Latin America was caused by policy mistakes - e.g., trade barriers - or its "wrong" institutions - e.g., political instability, rent seeking - so that most of the gap in income per capita between Latin America and the US would be due to low TFP in the former. Cole et al (2005), for instance, argue that competitive barriers imposed by interest groups are possibly an important determinant of low TFP in Latin America. Related research by Hopenhayn and Neumeyer (2004) argues that import substitution industrialization and targeted investment subsidies may be key determinants of low productivity in Latin America.

Our results put in question these conjectures, since productivity in Latin America was relatively high in a period (1960-1975) that was characterized by widespread state intervention in the economy and import substitution industrialization. In fact, in some countries during the seventies the TFP level was even higher than that of the US. Moreover, TFP in Latin America was not only high but it was increasing relative to US productivity between 1960 and 1975.

8

Latin America TFP was much lower than US productivity in 2000, but this is due to the productivity collapse observed in all Latin American countries (with the exception of Chile) since the mid-seventies and early eighties.

To conclude this discussion, we should make a few comments about the discrepancies between our results and the findings documented in Cole et al (2005) and Hopenhayn and Neumeyer (2004). As we mentioned before, Cole et al (2005) found that between 1950 and 2000 Latin America TFP was about one-half of the US level. This result was based on the key assumption that Latin America has been near its steady state growth path during this period. This assumption was in turn motivated by the evidence that the investment-output ratio has been constant around 20% in Latin America and very close to the value observed for the US. Our results coincide with Cole et al (2005)´s for recent years, but are very different for the period between 1960 and the mid-seventies. The reason is that, as shown in Figure 1, Latin America was not near its steady state growth path throughout the period, and its TFP level experienced a sharp decline since 1975.

On the other hand, Hopenhayn and Neumeyer (2004) found that Latin America TFP growth was close to zero and in fact slightly negative between 1960 and 1985, using data from Klenow and Rodriguez-Clare (1997). Using our data set, we obtained exactly the same rate of TFP growth in Latin America between 1960 and 1985 as the one found by Hopenhayn and Neymeyer (-0.02% per year). The important point, however, is that, as shown in Figure 1, TFP growth in Latin America was considerably higher until the mid-seventies and even until 1980. In other words, the inclusion of the period 1980-1985 distorts the picture that prevailed since 1960, due to the productivity collapse in the early eighties.

4   Conclusion

In this note it was shown that at least until the mid-seventies the average Latin America economy was relatively productive, with a TFP level close to or above most rich nations. This result is very robust, as it was found using different datasets and alternative methodologies to construct capital stocks and total factor productivity. Moreover, TFP in Latin America increased relative to US productivity between 1960 and the mid-seventies. Another regularity is that TFP fell very fast in Latin America after 1975-80, and in 2000 TFP in the region was 62% of the U.S TFP. In only one country, Chile, relative total factor productivity in 1995 was not below its corresponding value in 1975.

These results allow us to conclude that at least until the mid-seventies, TFP was not the may cause for the relative poverty of the region. The main determinants of low income per capita in the region were factors of production, namely physical and human capital. However, after the mid-seventies the TFP decline was the main explanation for Latin America stagnation.

The puzzle raised by these results is that policies in Latin America during the entire post-war period were very distortive and in theory were supposed

to be associated with low TFP. In particular, the period between 1960 and the early eighties was characterized by widespread govenment intervention and import-substitution industrialization in Latin American economies. To cite a few of the distortions associated with these interventions, there were competitive barriers of different forms, including barriers to international trade, licensing and cartelization, persistent government budget deficits, high inflation and target investment subsidies. In spite of this, TFP in the region was relatively high and increased relative to US productivity during this period. Why this is so and why only later productivity started to decline are open questions that need to be investigated in the future.

References

[1] **Baier, S. L., G. P. Dwyer, Jr. and R. Tamura, 2004.** "How Important Are Capital and Total Factor Productivity for Economic Growth?," Mimeo, Research Department, Federal Reserve Bank of Atlanta.

[2] **Barro, R. and J. W. Lee, 2000.** "International Data on Educational Attainment: Updates and Implications," NBER Working Paper #7911.

[3] **Bills, M. and P. Klenow, 2000.** "Does Schooling Cause Growth?," *American Economic Review*, 90(5): 1160-1183.

[4] **Cole, H. L., L. E. Ohanian, A. Riascos and J. A. Schmitz Jr., 2005**. "Latin America in the Rearview Mirror". *Journal of Monetary Economics*, 52: 69-107.

[5] **Gollin, D., 2002.** "Getting Income Shares Right: Self Employment, Unincorporated Enterprise, and the Cobb-Douglas Hypothesis," *Journal of Political Economy*, 110(2): 458-472.

[6] **Hall, R.E. and C. Jones, 1999.** "Why do Some Countries Produce so Much More Output per Worker than Others?," *Quarterly Journal of Economics*, February, 114: 83-116.

[7] **Hopenhayn, H. A. and P.A. Neumeyer, 2004.** "Latin America in the XXth Century: Stagnation, then Collapse." Working Paper.

[8] **Klenow, P. J. and A. Rodríguez-Clare, 1997.** "The Neoclassical Revival in Growth Economics: Has it Gone Too Far?," *NBER Macroeconomics Annual 1997* eds. Ben S. Bernanke and Julio J. Rotemberg, Cambridge, MA: The MIT Press, 73-103.

[9] **Nehru, V. and A. Dhareshwar, 1993.** "A New Database on Physical Capital Stock: Sources, Methodology and Results," *Revista de Análisis Económico,* 8: 37-59.