The role of agricultural productivity in Latin American development*

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Abstract

This paper shows that differences in agricultural productivity can explain differences in output per capita among Latin American countries. We calibrate a neoclassical model of structural transformation for Chile, Brazil, Colombia, Mexico and Costa Rica. Using Chile as a benchmark, we show that countries with lower agricultural TFP begin the process of industrialization later, but have faster growth and reach convergence sooner. We also compute the rate of increase of TFP in the nonagricultural sector needed to reduce the output gap with Chile.

Keywords: Economic Growth, Aggregate Productivity, General Equilibrium
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"It's hard to say new things in economics. Economists have said many things over the years...The problem is that many of the points of view in economics are in conflict. They have not been put forward with enough evidence and logic to be convincing" [William W. Lewis in The Power of Productivity]

1 Introduction

Since the seminal papers of Solow [29] and Swam [31] more than half a century ago, developing an adequate model of economic growth has been central in economic analysis. In particular, large efforts have been applied to explain relative growth performance i.e. why some countries grow faster than others and what explains per capita income differences between rich and poor. It was also Solow [30] who developed a method for decomposing economic growth based on the contribution of the primary factors of production (capital and labor) and in the efficiency with which they are used. Later on, Fuentes et.al [9] called the two components of this decomposition the "perspiration" and "inspiration" effects. The former corresponds to factor accumulation and the latter to productivity gains. Factor accumulation is subject to diminishing returns, but the "inspiration" effect can lead to persistent GDP per capita growth. It became apparent then that the study of Total Factor Productivity (TFP) was crucial to understand relative growth performance.

In particular, the role of productivity in the agricultural sector has been proposed as a determinant of when the process of industrialization begins and how fast standards of living progress in a country (Gollin et al.[14]). Increases in agricultural productivity raise food production and allow labor to move to other sectors like manufacturing. In poor countries, a large share of the labor force works in agriculture while in rich countries a very small part of the labor force does. Poor countries would then have most of their labor force in the sector where they are particularly unproductive. Attempts at explaining this apparent deviation from comparative advantage abound. It may be that the non-agricultural sector has greater skill requirements, so that low human-capital economies are constrained in the supply of non-agricultural workers (Caselli and Coleman [4]); or it could be that investment distortions push producers into the home (agricultural) sector (Gollin, et.al [11]); or it could be that economies are subject to a "subsistence constraint," such that resources cannot start moving out of agriculture until agriculture is sufficiently productive to generate a surplus that will feed the industrial class (Gollin, et.al [12]; Restuccia, Yang, and Zhu, [28]); or it could even be that some countries are "trapped" in agriculture by a coordination failure (long tradition; most recently Graham and Temple [15]).[1]

[1] This rationale is not new. Lucas [22] stated that the origins of the modern economic world can be seen, in part, as a transition from a traditional agricultural society to a society of sustained growth in opportunities, of human and physical capital accumulation. In the countries where the Industrial Revolution is well underway, this transition is complete. For instance the share of the workforce in agriculture in U.K. declined from 21 percent in 1851 to 7 percent by 1911 to 2 percent in 1995. In the United States the picture is similar, the fraction of the labor force in agriculture fell from 79 percent in 1820 to 40 percent in 1900, to

Gollin et al.[14] use a simple neoclassical model to demonstrate that differences in agricultural productivities provide a useful theory of wealth disparity. They calibrate the model for the United Kingdom (UK) and perform simulations to analyze the effects of lower agricultural productivities. Their main conclusions are: i) It is misleading to interpret all cross-country differences in income in 2000 as steady-state differences, ii) countries that start the development process later will exhibit faster growth than earlier developers, iii) the development process is slow and iv) a distortion to agricultural activity actually leads to more resources being devoted to this activity.

Using the same simple model, we study the effect of differences in agricultural productivities on the differences in income per capitas for a sub-set of Latin American countries (Chile, Brazil, Colombia, Mexico and Costa Rica). We calibrate TFP and the rate of technological change in agriculture for these countries by matching agriculture's share of employment from the data. We choose Chile as the benchmark because it is the country for which we have the longest consolidated data series. The model replicates fairly well income per capita of each country (relative to 1950) and also each country's relative income per capita with respect to Chile. We show that, indeed, differences in agricultural productivity can explain differences in GDP per capita between countries. Additionally, countries that have lower productivities in agriculture are the ones that started the development process later, and also the ones that display larger rates of growth. For instance, according to the model, Costa Rica began its industrialization process relatively late in 1922, but it has a GDP per capita growth rate of 1.91 percent, therefore Costa Rica's output per capita would converge to that of Chile around 2044.

Finally the model is also suitable for performing some policy experiments. Here we pose the question: How much should a country increase its TFP in the nonagricultural sector in order to reduce the output gap with Chile in 1/4, 1/2 and 3/4 in the following ten years?. We find, for example, that Brazil should increase its productivity in the nonagricultural sector by 2.39 percent to reduce the gap with Chile in one quarter.

The paper is organized as follows. In section 2 we present the motivation based on GDP per capita comparisons. Section 3 re-states the two-sector neoclassical growth model in Gollin et al.[14]. In section 4 we provide the data and the calibration of the model for the five selected countries as well as the main results based on numerical experiments. Finally, Section 5 concludes.

2 Motivation

Economic growth is a recent phenomenon. Angus Maddison is perhaps the author that contributed more historical evidence on economic growth.[2] Table 1

23 percent in 1930, and then to 3.4 percent in 1980. In Chile the share of labor in agriculture maintained between 43.5 percent in 1810-1853 and 39 percent in 1930. In 1953 it declained to 31 percent and then to 15.7 percent in 1995.

[2] See Maddison [23], [24], [25].

shows the evolution of GDP per capita since year 1.

Table 1: GDP per capita in the world economy (1990 Geary-Khamis dollars)

	1	1000	1500	1820	1900	1913	1950	2000	1820/2000
United States			400	1257	4091	5301	9561	28129	22
Western Europe	450	400	771	1204	2893	3458	4579	19002	16
Eastern Europe	400	400	496	683	1438	1695	2111	5804	8
Latin America	400	400		692	1109	1481	2506	5838	8
Asia	449	449	568	581	638	696	712	3817	7
Africa	430	425	414	420	601	637	894	1464	3
World	445	436	566	667	1262	1525	2111	6012	9

Source: De Gregorio [6], based on Maddison [25]

In a lapse of 1800 years, between year 1 and 1820, GDP per capita grew only a 50 percent. This represents an annual average rate of growth of 0.02 percent. In contrast, growth between 1820 and 1998 has been of 750 percent, which represents an average annual growth of 1.2 percent. In the last column of table 1 we have the GDP per capita growth between 1820 and 2000. It can be seen that growth has been unequal between continents. The countries that today are industrialized countries, are the ones that grew faster.

If we look at Latin America's growth, in table 2, we can observe that it has been uneven and dissapointing. The scale of GDP per capita is less than half of the one of the other regions. For instance Venezuela had an accelerated growth in the post-war period, but its GDP per capita, measured at PPP, has not grown since the 60s. In Brazil we observe the so called economic miracle, occurred between the 60s and the 70s. Finally, remark that Chile experienced an accelerated growth in the middle of the 80s. Between 1900 and 1973 its GDP per capita grew at an annual rate of 1.3 percent, which is the lowest growth range of the XX century. Then Chilean growth shrink to 0.2 percent between 1973 and 1985, but then it recovered to an exceptional 5.4 percent in the last 15 years of the last century.

Table 2: GDP per capita in Latin America (1990 Geary-Khamis dollars)

	1900	1913	1950	1960	1970	1980	1990	2000	2003
Brazil	678	811	1672	2335	3057	5198	4923	5474	5460
Chile	1949	2653	3821	4320	5293	5738	6402	9890	10438
Colombia	973	1236	2153	2497	3094	4265	4840	5179	5312
Mexico	1366	1732	2365	3155	4320	6289	6119	7270	7151
Peru	817	1037	2263	3023	3807	4205	2955	3581	3734
Uruguay	2219	3310	4659	4960	5184	6577	6474	7859	7557
Venezuela	821	1104	7462	9646	10672	10139	8313	8571	6962
Costa Rica			1963	2715	3754	4911	4747	6174	6516

Source: De Gregorio [6] based on Maddison [25]

The question of why some countries are so much wealthier than others is a long-standing challenge for macroeconomists. The evidence shows that growth in Latin America is uneven and so it is important to understand this dsiparity and to extract policy implications. Figure 1 shows GDP per capita performance of the selected countries for our study.

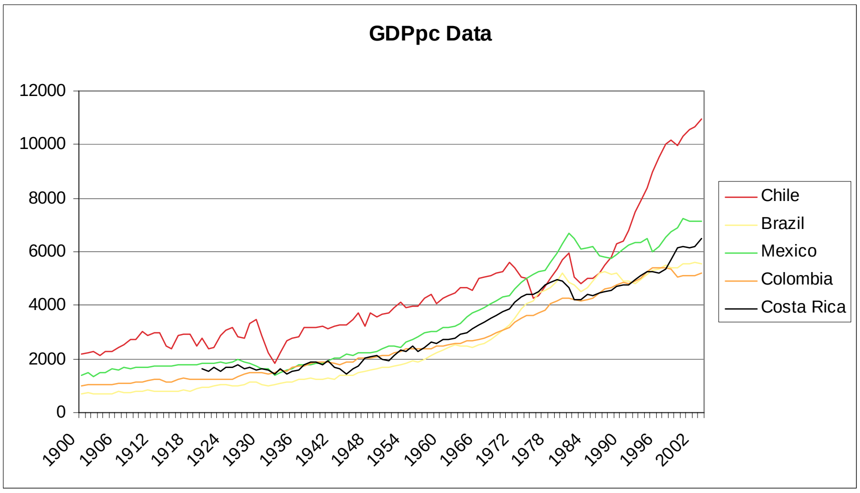

Figure 1: GDP per capita

In these countries we test the hypothesis that agricultural productivity explains the observed differences in incomes per capita. In other words if the model can resemble figure 1.

3 The Model

The model is based on Gollin, et al. [14]. Its basic structure is that of the one sector neoclassical growth model extended to include an explicit agricultural sector. In the model, development is associated with industrialization. We define industrialization as the declining time of agricultural employment. In any country there is a structural transformation that withdraws employment from the agricultural sector. To understand industrialization and consequently development, it is crucial to know when this event occurs. Asymptotically, agriculture's employment share shrinks to zero, and the model becomes identical to the standard one-sector neoclassical growth model.

3.1 The Environment

There is an infinitely-lived representative family endowed with a unit of time in each period. Period utility is defined over a nonagricultural good (c_t) and an agricultural good (a_t). To generate a structural transformation we assume a utility function of the Stone-Geary variety. For simplicity we adopt the following extreme functional form:[3]

[3] Technically we should assume a small endowment of the nonagricultural good that is always consumed to avoid the fact that instantaneous utility is lowered when c increases from

$$U(c_t, a_t) = \begin{cases} \log(c_t) + \overline{a} & \text{if } a_t \geq \overline{a} \\ a_t & \text{if } a_t < \overline{a} \end{cases} \tag{1}$$

Lifetime utility is given by:

$$\sum_{t=0}^{\infty} \beta^t U(c_t, a_t) \tag{2}$$

It follows that once (per capita) output in the agricultural sector reaches $\overline{a}$, all remaining labor will flow out of agriculture regardless of the state of the nonagricultural sector. A more general treatment would allow for the state of the nonagricultural sector to impact the labor allocated to agriculture. This potentially important effect is explored in Gollin et al. [11]. We abstract from it here so as to focus attention on how the state of the agricultural sector affects the labor available for the nonagricultural sector.

3.2 The Nonagricultural Sector

The nonagricultural sector produces output (Y_{mt}) using capital (K_{mt}) and labor (N_{mt}) as inputs:

$$Y_{mt} = A_m[K_{mt}^{\theta}((1+\gamma_m)^t N_{mt})^{1-\theta} + aN_{mt}] \tag{3}$$

In equation (3), A_m is a total-factor-productivity (TFP) parameter, and γ_m is the constant exogenous rate of technological change. This production function is standard except for the term αN_{mt}. It is added to allow an economy with no physical capital to accumulate capital. In the numerical work that follows we will pick α to be a small number.

The parameter A_m is assumed to be countryspecific, being determined by policies and institutions that impact on activity in the nonagriculture sector. In contrast, the parameters γ_m and α are assumed to be identical across countries. Much of the stock of useful knowledge owes its creation to research and development in the rich countries. Since poor countries are generally not in the business of creating ideas, the assumption of exogenous technological change is reasonable from their perspective.

Output from the manufacturing sector can be used for consumption or investment (X_{mt}), and the law of motion for the economy's stock of capital is

$$K_{mt+1} = (1-\delta)K_{mt} + X_{mt} \tag{4}$$

where δ is the depreciation rate.

zero to a small positive amount. We ignore this for simplicity.

3.3 The Agricultural Sector

The agricultural sector produces output (Y_{at}) using only labor (N_{at}). Though we abstract from land as an input, adding land to the production function would have no impact on our results.

There are two available technologies for producing the agricultural good: a traditional technology and a modern technology. The key difference is that the modern agricultural technology is subject to exogenous technological change. Using the traditional technology, one unit of time produces $\overline{a}$ units of the agricultural good. There is nothing particularly special about this value, and our results would not be much affected if it were either somewhat higher or lower than $\overline{a}$.[4]

The modern technology is given by:

$$Y_{at} = A_a(1+\gamma_a)^t N_{at} \tag{5}$$

In equation (5), A_a is a TFP parameter that is assumed to be country-specific, and γ_a is the rate of technological change in the modern agricultural technology that we consider also an endogenous variable. Like the nonagricultural TFP parameter, the agricultural TFP parameter is affected by country policy and institutions. It is also affected by both climate and the quantity and quality of land per person. Technological innovations that are useful for a specific crop in a given climate may not be particularly relevant for other crops in other parts of the world, thus generating large differences in cross-country productivity levels that are independent of policy. Output from the agriculture sector can only be used for consumption, so the agriculture resource constraint is simply $a_t \leq Y_{at}$.

3.4 Competitive Equilibrium

We focus on the competitive equilibrium for this economy, and in particular on how different values of the agricultural TFP parameter A_a and the rate of technological change in agriculture γ_a affect the resulting dynamic allocations. Solving for the competitive equilibrium is straightforward and involves two steps. The first step determines the labor allocation across sectors in each period. Preferences imply that labor will be allocated entirely to the agricultural sector until $A_a(1+\gamma_a)^t \geq \overline{a}$. Once this equality is satisfied, agricultural production switches from the traditional technology to the modern technology, and labor flows out of agriculture at a rate of γ_a. Hence,

$$\begin{aligned} N_{at} &= \min\left\{\frac{\overline{a}}{A_a(1+\gamma_a)^t}, 1\right\} \\ N_{mt} &= 1 - N_{at} \end{aligned}$$

[4] There are theoretical reasons to believe that a value close to $\overline{a}$ is appropriate. Models with endogenous fertility suggest that output per capita will be close to subsistence levels for economies that have not begun the process of industrialization (see Oded Galor and David Weil [10]; Hansen and Prescott [16]

Given the time path of labor allocations, the second step solves for the optimal path for investment. This is equivalent to solving the transitional dynamics of the neoclassical growth model with an exogenous time profile of labor input given by N_{mt}. As technology in the agriculture sector increases at rate γ_a, N_{at} eventually approaches 0, and N_{mt} approaches 1. Asymptotically, therefore, the model is identical to the standard one-sector neoclassical growth model.

4 Empirical Results

In this section we show that differences in agricultural productivity explain the observed differences in incomes per-capita between our selected group of Latin American countries and perform some numerical simulations to show the usefulness of the model in providing quantitative analysis and policy implications.

4.1 Data

As argued in the introduction, there are few empirical studies that have analyzed productivity in the agricultural sector, because there is lack of data for this sector. Although data requirements for the model are small, the main variable which is the labor share in agriculture, has been difficult to collect. We obtained discontiunous series of labor share for Brazil, Colombia and Mexico. The series for Mexico goes from 1900 to 1981, for Brazil and Colombia from 1919 to 1980 and for Costa Rica from 1946 to 1980, but for the latter without discontinuities.

Chile is a particular case, since Diaz, et. al. [8] have built up a data set of several variables that goes from 1853 to 1995. All chilean data used in the paper is extracted from this source. In addition it is a reliable and consistent data set, that is why we choose Chile as our benchmark country.

The data of GDP per capita has been extracted form Maddison [25] and the series are expressed in 1990 Geary-Khamis dollars.

4.2 Calibration

We start by calibrating the model for our selected group of countries. A key fact in Gollin et.al [14] is that by calibrating adequately the parameters of the modern agricultural technology, i.e. matching agriculture's share of employment, we should be able to match also quite well the GDP per capita reported in the data. In other words by providing a good calibration in the agricultural sector, we should capture the development of the selected countries over the last 100 years at least.

The following table shows the parameter values used in the calibration and that are common across countries.

Table 3: Exogenous Parameter Values

Parameter	$\overline{a}$	α	θ	A_m	δ	γ_m	β
Value	0.35457	0.0001	0.5	1	0.065	0.013	0.95

All of this values are the same values used by Gollin et.al [14]. In section 3.3 we explained why we can use this assumption. There is nothing particularly special about the value of $\overline{a}$. Recall that this parameter represents a subsistence level of consumption of the agricultural good and it represents just a reference value. Output per capita will be close to $\overline{a}$ for economies that have not begun its process of industrialization.

The capital share parameter θ is chosen following Parente and Prescott [26] [27]. This is a somewhat higher value than those typically used in the real business cycle research. The depreciation rate δ is a typical value for annual depreciation and α is a parameter that must be non-zero so that the economy can accumulate capital starting with no capital, but it should be close to zero so that it does not affect the model's prediction once the economy has a positive stock of capital. The γ_m parameter is set to 0.013 which is the growth rate of the per capita output in the United Kingdom over the last 100 years. The TFP parameter in the nonagricultural sector A_m is normalized to 1 and β is chosen so that that the asymptotic annual interest rate is 5 percent.

Using the data of labor share in the agriculture for each country we choose two representative years in order to match agricultural employment shares for each country. In appendix A we display the correponding figures. It can be seen that for all the countries the fit is quiet good, in particular for the decreasing part of the series which is the main part as it represents industrialization. The Mexican case is the most striking since its labor share shows an increasing pattern between 1900 and 1914 and a decreasing pattern between 1946 and 1980.[5]

4.3 Results

The first contribution of our paper is the calibration of the parameters A_a and γ_a for each country. We would like to compare our calibrations with previous estimations, but we could not find any reference related to TFP values estimations. Tamura [32] discusses the effects of changes in agricultural productivity, but he does not provide TFP values. Our TFP values are relative values with respect to UK. Implicitly we are assuming as in Gollin et.al. [14] that A_a in UK is equal to 1. So, the right way to interpret the second column in table 4 is as relative agricultural TFP to that of UK.

Table 4: Agricultural TFP, rate of technological change and year of industrialization.

Country	A_a	γ_a	Year of industrialization
Chile	0.4670	0.0074	1762
Brazil	0.0676	0.0147	1913
Colombia	0.1604	0.0095	1883
Mexico	0.0582	0.0160	1913
Costa Rica	0.0348	0.0191	1922

[5]We want to stress here that we would like to have longer series in order to improve the matching, but we could not find consistent series.

Several interesting implications follow from table 4. First, a country that has a lower agricultural TFP, begins its industrialization process later. Notice that Chile has the highest A_a and begun its industrialization in 1762, while Costa Rica that has the lowest A_a begun its industrialization in 1922. Brazil and Mexico begun to shift labor from the agriculture sector to the nonagriculture sector the same year, but at different rates. Recall that γ_a is the rate at which labor flows out of agriculture.

Second, in contrast to what Gollin et.al [14] assumes, we endogeneized the rate of technological change in agriculture γ_a. Since we are assuming the same γ_m for each country, we can also interpret γ_a as the rate of growth of income per capita of the economy. Gollin et.al [14] argue that countries that start the development process later will exhibit faster growth than earlier developers. The results in table 2 show that this is indeed the case. Costa Rica is the latest developer and has the highest rate of technological change. The opposite occurs with Colombia which has an average growth rate of output per capita of 0.95 percent.

Before continuing with our numerical experiments we have to make sure that our calibrations based on the labor shares N_a translate also in a good matching of output per capita in each country. The figures in appendix 2 show the graphs for each country where we compare relative GDP per capita from the data with relative GDP per capita from the model. By relative output per capita we mean output comparisons relative to 1950. There is nothing special about this year, it is chosen just for comparisons and to avoid differences in scale. Relative income is computed also using year-1995 prices from the benchmark economy. Despite the model's simplicity, it matches quite closely the development and growth experience over the last 100 years for the five selected countries. Only in the last years, in particular for Costa Rica there is a missmatching, but nothing representative for the whole period.[6]

The text book neoclassical model predicts convergence. Herein as we are assuming that A_m is equal to 1, this implies that all income differences will vanish asymptotically, i.e the incomes per capita converge. In this behalf, given the calibrated values values of A_a and γ_a we can predict the speed of convergence of the output per capita of any country to the output per capita of Chile. The following table shows the year in which output per capita of the four selected countries would converge to the output per capita of Chile.

Table 5: Year of convergence with Chile

Country	Year
Brazil	2079
Colombia	2217
Mexico	2060
Costa Rica	2044

[6] To compute the prices we use the marginal productivity of labor of the agricultural and nonagricultural sectors, we equalize both to the real wages and normalize the price of the agricultural good to 1. As labor can move freely between sectors, we obtain the price of the nonagricultural good.

As the model predicts, the country with the lowest γ_a but the highest A_a which is Colombia, would be the last to converge to Chile's income per capita, it will converge exactly in year 2217. Certainly the development process is a slow process. Mexico that started to industrialize in 1913 will not be near its steady-state relative output level until the year 2060. Notice that all of the selected countries take more than 100 years to reach its steady-state relative output level. As Gollin et.al [14] state, this transition is much slower than what occurs in the one-sector neoclassical growth model. The reason for this difference is that, in the model, labor moves only slowly into the nonagricultural sector.

Going back to the motivation of the paper (section 2), figure 1 shows that incomes per capita of Brazil, Colombia, Mexico and Costa Rica differ from the chilean income per capita. Certainly, this cross-country differences are not steady state differences. Figure 2 displays the output per capita of each country relative to the output per capita of Chile.

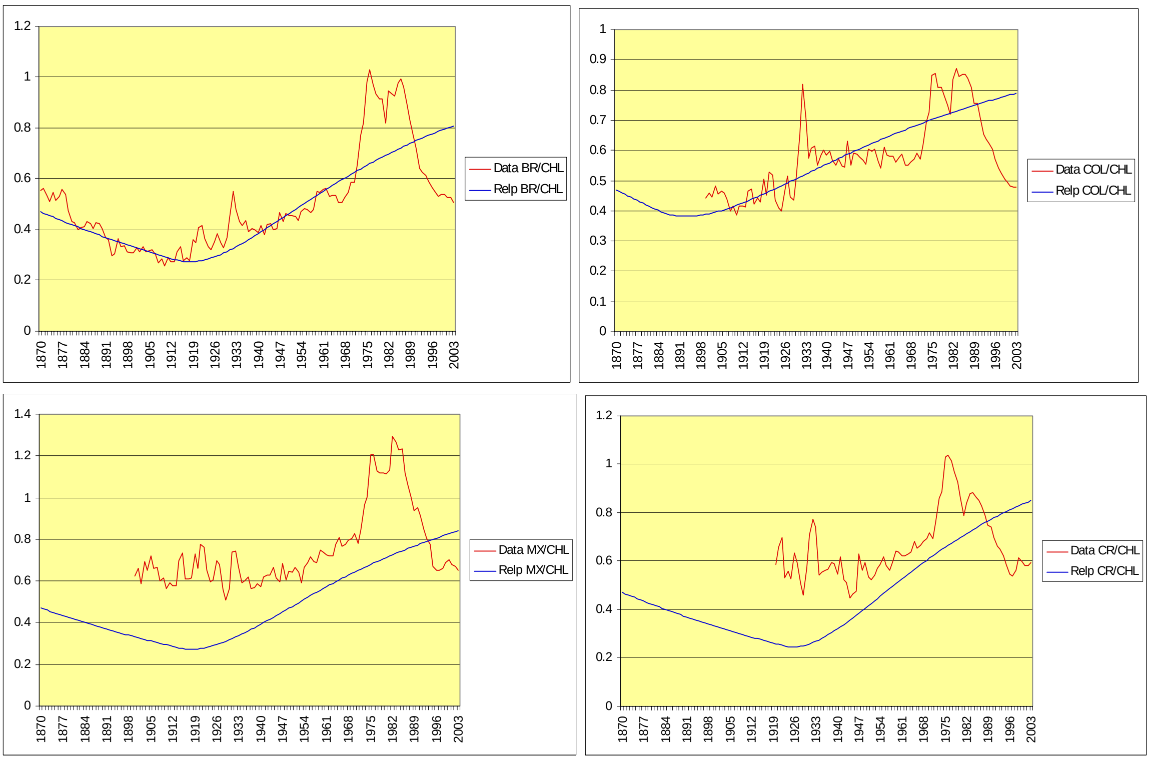

Figure 2: Country's relative output per capita with respect to Chile

Remark that the predicted relative output per capita of any country is very similar to what the data tells. In particular for the modeled series of relative output per capita for Brazil and Colombia fit exactly the data (see the path of the blue line compared to the red line). For Mexico and Costa Rica, their relative output from the model (blue line) is a little bit under the relative output from the data, nevertheless the blue line follows the same course of the red line.

The fact that the model is also effective in resembling the relative output of each country, makes it suitable for giving policy implications. A typical question in the growth literature is: How long would it take to close 1/4, 1/2 or 3/4 of the relative GDP gap in a determined period? Assume that we (or a government) is interested in answer this question for the next ten years. What would the model predict? The last exercise that we achieve consists in computing how much the TFP in the nonagricultural sector should increase in order to reduce the gap in the aforementioned magnitudes in the following ten years (2008-2018). In other words we relax the assumption that A_m is equal to 1 and calibrate it to attain the specified reductions. We keep the value of A_m for Chile fixed at 1.[7]

Table 6: Rate of change of nonagricultural TFP to reduce the gap with Chile

	Percentage of the Gap		
Country	1/4	1/2	3/4
Brazil	2.39	4.75	7.02
Colombia	3.1	6.12	9.05
Mexico	1.86	3.69	5.49
Costa Rica	1.56	3.09	4.61

Table 6 presents the results of this simple exercise and shows the percentage changes in nonagricultural TFP needed to reduce the relative output gap with Chile. Costa Rica which is the country that is closer to the GDP per capita of Chile will need lower rates of growth of nonagricultural TFP to reduce its relative output gap. TFP of the nonagricultural sector in Colombia will need to grow at 3.1 percent, 6.12 percent and 9.05 percent to reduce the gap with Chile in a quarter, a half and three quarters, in the next ten years.

In sum, the model is capable not only to analyze why some countries are so much wealthier than others, but it also can be used to analyze how much productivity in the nonagricultural sector, let's say manufacture, should be raised in order to reduce income per capita differences among any two countries. How can productivity in the manufacturing sector be enhanced is a question of another paper. We just indicate how much should it be raised.

5 Conclusions

Using a simple model developed by Gollin et.al [14] we have shown that differences in agricultural productivity can explain differences in income per capita between a selected group of Latin American countries. Furthermore the simplicity of the model make us believe that the model can be used to explain income per capita differences between any rich and poor country.

[7] We move A_m and not A_a because moving A_a would imply changing the data of industrialization and all our calibrations.

Here we performed several exercises comparing the development of Brazil, Colombia, Mexico and Costa Rica with the development of Chile. We selected Chile as our benchmark economy, because it shows a similar path of industrialization to that of UK, of course with different magnitudes, it has been a leading country in terms of growth in the region and it is the only Latin American country for which consistent data for a long period is available. The other countries have been selected as representative countries of South, Center and North America.

We calibrated the model for the five countries matching the agriculture's share of employment from the data. A good matching in terms of employment share is reflected in a good matching also in output per capita. The model generated series of output per capita (relative to 1950) very similar to the ones displayed using the Maddison data. In addition our calibrations resemble the figures of a country's relative output per capita with respect to Chile. In sum all the figures displayed in the paper bear as a test of precise calibrations.

Caselli [5] mentions that, unlike the industrial sector, studies of agricultural TFP are few, mainly because there is a lack of data. Therefore, one of the main contributions of the paper is the calibration of the agricultural TFP (A_a) and the rate of technological change in the modern agricultural technology (γ_a). Furthermore we recover the mesage that appeared prominently in the traditional development literature, that growth in agricultural productivity is key for the development of a country (see e.g., Timmer [33]).

The results show that Chile started its industrialization process in 1762, Colombia in 1883, Brazil and Mexico in 1913 and Costa Rica in 1922. According to Gollin et.al [14] this occurs because countries have different productivities in agriculture and those countries that have a lower productivity are the ones that start the industrialization process later, indeed that is the case of Costa Rica. Chile and Colombia are the countries that have the largest TFP and so they are early developers.

Gollin et.al [14] also states that the development process is slow and for a country it tooks more than 100 years to reach its steady-state relative output level. We demostrate that it is true that a country's output per capita would take more than 100 years to converge to that of the benchmark. But it is also true that a country that started its development later will exhibit higher rates of growth. For instance Costa Rica, that started later its growth process will reach its steady-state relative output level in 2044, while Colombia that started long before Costa Rica will converge just in the year 2217. This results are driven by the value of γ_a.

Finally the model is suitable not only to make a retrospective analysis, but also to make a prospective analysis and provide policy implications. We show that if Brazil, Colombia, Mexico and Costa Rica would like to reduce half of their output gap relative to Chile, they would have to increase the nonagricultural TFP (assume TFP in manufacturing) by 4.75 percent, 6.12 percent, 3.69 percent and 3.09 percent respectively in the following ten years.

The only drawback that we encountered in our research has been the lack of longer series for the agricultural share of employment. The lack of data impeeded us to make the same calibrations for other Latin American countries also. Nevertheless we believe that our results show that the neoclassical growth model is not dead and it is very useful in explaining long run growth of any country.

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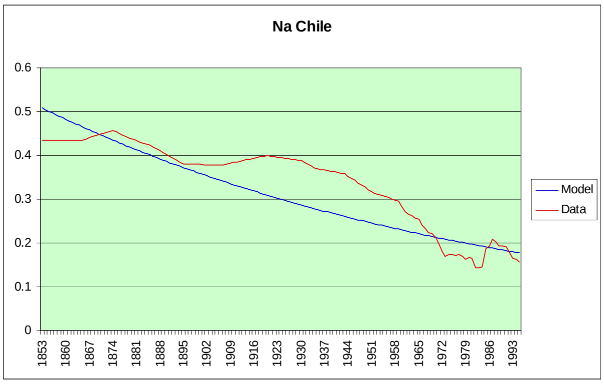
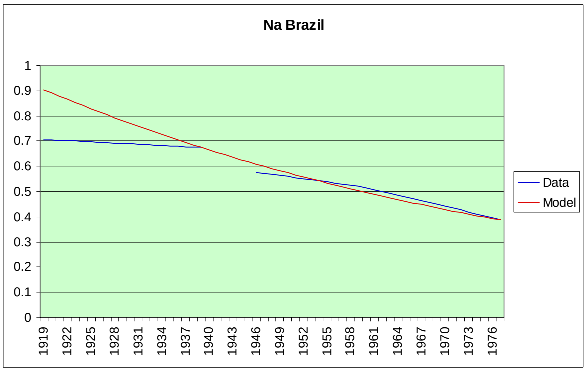
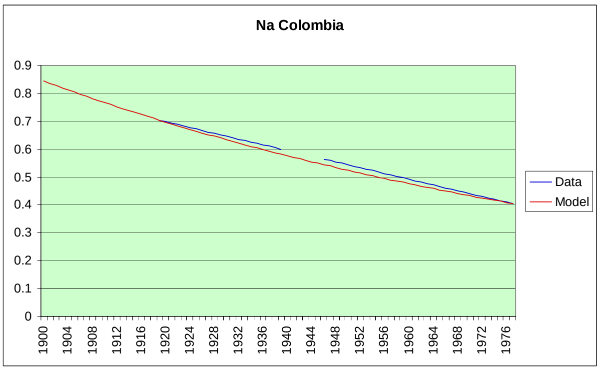
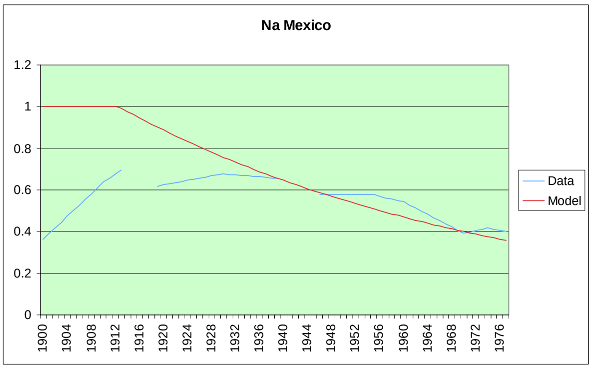
Appendix 1

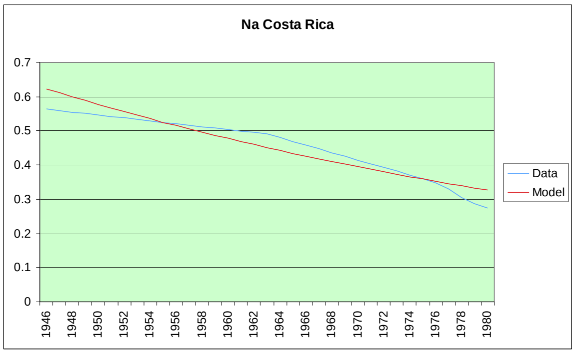
The following figures show the agriculture's share of employment in each of the countries. The fact that we have the longest series for Chile allowed us to obtain a better fit for Chile than for the other countries. Certainly, if longer series were available we would be able to reach a better matching with the data. Nevertheless the model matches quite well the labor share of each country.











Appendix 2

The following figures compare GDP per capita from the model and GDP per capita from the data, both relative to 1950 and using year-1995 prices from the benchmark economy Chile.