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The Latin American Development Problem

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Abstract

By international standards, gross domestic product (GDP) per capita in Latin America is low: around one fourth of that of the United States. Moreover, in the last five decades, Latin America has failed to catch-up in wealth to the level of the United States while other countries at similar or even lower stages of development have been successful. The failure to attain higher levels of relative income represents what I call the development problem in Latin America. Using a development accounting framework, I find that the bulk of the difference in GDP per capita between Latin America and the United States is accounted for by low GDP per hour and, in particular, low total factor productivity (TFP) in Latin America. I calculate that to explain the difference in GDP per hour, TFP in Latin America must be around 60 percent of that in the United States. I then consider a model with heterogeneous production units where institutions and policy distortions lead to a 60 percent productivity ratio between Latin America and the United States. Removing the barriers to productivity can increase long-run GDP per hour in Latin America by a factor of 4 relative to that of the United States. This increase is equivalent to 70-years worth of U.S. post WW-II development.

Keywords: labor productivity, capital, schooling, establishment heterogeneity, policy distortions.
JEL Classification: O1.

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1 Introduction

The economic growth experience of Latin America in the last five decades constitutes one of the most interesting episodes in modern development economics. In 1960, GDP per capita in Latin America relative to that of the United States was 30 percent. By 2009 this statistic had fallen to 23 percent. Not only income is low in Latin American countries, but also it has fallen relative to the technological leader. This poor economic performance contrasts sharply with other regions and countries at similar or lower stages of economic development in 1960.[1] While many countries in Latin America contribute to this relatively poor performance, some countries stand out such as Argentina, Bolivia, Peru, and Venezuela. Broadly speaking, the facts of low and declining relative income motivate what I call the Latin American development problem. What explains this poor economic performance in Latin America?

Using data for 10 Latin American countries, I report the following facts about the development problem in Latin America.[2] First, between 1960 and 2009 Latin America features low and declining GDP per capita relative to the United States. Second, in decomposing GDP per capita I find that none of the difference is explained by differences in the amount of work hours, while less than 20 percent of the difference is explained by a lower employment to population ratio in Latin America. The bulk of wealth difference steams from low GDP

[1] Duarte and Restuccia (2006) report that in 1960 the average Latin American country represented 34 percent of the GDP per worker in the United States. It also represented more than 2.4 times the GDP per worker of the average country in Asia and about half the GDP per worker of Western Europe. By 2000, the same Latin American countries represented about 25 percent of the GDP per worker in the United States. Whereas Latin American countries lost some ground in productivity relative to that of the United States, Asia overtook Latin America's labor productivity (Latin America being 73 percent of Asia) and Western Europe increased its advantage to more than 3 times the level of productivity in Latin America.

[2] The countries are Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay, and Venezuela. See the data appendix for more details.

per labor hour (labor productivity) in Latin America relative to the United States. Third, in decomposing GDP per hour using an aggregate production function that includes physical and human capital as inputs, I show that almost none of the difference is explained by systematic differences in the physical capital to output ratio, that some difference is explained by differences in the quality and quantity of human capital but that most of the difference steams from differences in TFP. This emphasis on the role of TFP in explaining the economic performance of Latin America is consistent with the earlier analysis of Elias (1992), Solimano and Soto (2006), Cole et al. (2005), among others. I argue that in the context of a model with physical and human capital accumulation, TFP in Latin America needs only be about 60 percent that of the United States . Fourth, I report labor productivity in agriculture, industry, and services to argue that aggregate productivity differences between Latin America and the United States are not the result of sector specific distortions. Therefore, I seek for an economy-wide explanation for low productivity in Latin America.

Given these facts, I then consider a model where institutions and policy distortions in Latin America cause relative measured TFP to be 60 percent of the United States. The model follows Restuccia and Rogerson (2008) in extending the neoclassical growth model to allow for establishment heterogeneity. This framework has been extensively used in empirical applications of productivity differences across countries (see for instance Hsieh and Klenow, 2009; Bartelsman, Haltiwanger, and Scarpetta, 2009; Alfaro, Charlton, and Kanczuk, 2007; Pages, 2010; among many others). A related framework has been used for more specific applications of the development problem such as size-dependent policies (Guner, Ventura, and Xi, 2008), financial frictions (Greenwood et al. 2010), restrictions to foreign direct investment (Burstein and Monge, 2009), among others. In the model establishments differ on their factor productivity and reallocation of capital and labor across establishments leads to measured TFP differences. The novelty in the analysis is that, in addition, upon entering establishments invest in the likelihood of higher productivity draws from an invariant distribution. As a result, institutions and policy distortions not only misallocate resources across establishments, as emphasized in the existing literture, but also can shift the distribution of establishments to lower productivity levels. This feature of the model is broadly consistent with the micro data for Latin American countries where the distribution of efficiencies among plants in the manufacturing sector is skewed to the left towards low productivity units (see Pages, 2010). The class of institutions and policy distortions that I consider is broad and abstract. I quantify the impact of institutions that cause an increase in the cost of entry for establishments. There are many examples of these costs (see for instance De Soto, 1986 and Djankov et al. 2002). I also quantify the impact of idiosyncratic distortions that cause a reallocation of resources from the most productive to the less productive establishments. The type of policies that would effectively cause such a reallocation is also very large including public enterprises, trade and labor restrictions, taxation, competition barriers and excessive regulations, among many others. In the calibrated model, I find that these institutions and policy distortions lead to a TFP ratio between the distorted and undistorted economies in the range of 60 to 70 percent. As a result, removing the productivity barriers in Latin America can lead to an increase in relative long-run labor productivity of a factor of 4. Under one metric, this increase in labor productivity is equivalent to 70 years worth of U.S. post-WWII development.

There is an extensive literature analyzing different aspects of the development experience in Latin America. This literature is too vast to reference here but see for instance Solimano and Soto (2006) and the references therein. There is also a recent literature studying country-specific experiences using quantitative models (see for instance Bergoeing et al., 2002; Kydland and Zarazaga, 2002; Cole, et al., 2005; among others). Cole et al. (2005) emphasize the importance of competition barriers in explaining the low productivity levels in Latin America. Many Latin American experiences have been studied in the context of depression episodes such as Mexico and Chile in the 80's (see for instance Bergoeing et al., 2002, Bergoeing et al., 2004). While similar forces may lead to TFP to be below trend, the emphasis in this paper is in explaining the low productivity levels in Latin America.

The paper is organized as follows. In the next section I document the basic facts about the development problem in Latin America. I decompose GDP per capita to show that low labor productivity (and in particular low TFP) is at the core of the development problem in Latin America. Section 3 describes a model of TFP and calibrates it to data for the United States. In section 4 I perform a quantitative analysis of institutions and policy distortions in Latin America with a discussion of policy implications. I conclude in section 5.

2 Some Facts

In this section, I document a set of facts about gross domestic product (GDP) per capita and related factors in order to establish what I call the development problem in Latin America. The analysis will serve to guide the search for an explanation of the development problem in

Latin America. The period of analysis covers 1960 to 2009. I will focus on long-run trends, therefore, the data are trended using the Hodrick-Prescott filter with a smoothing parameter $\lambda = 100$. For a detailed description of the data and sources see the Appendix.

2.1 GDP per Capita

The total amount of goods and services produced in a country within a specified period of time provides a summary measure of wealth in a nation. Between 1960 and 2009, GDP per capita has grown in all Latin American countries. But the growth in GDP per capita has not allowed Latin American countries to catch up to the level of more developed economies. I take the United States, which has observed a high level and stable growth rate of GDP per capita for most of the 20th century, as the benchmark against which to compare the economic performance in Latin America. Relative to that of the United States, GDP per capita in Latin American countries is low and has been declining. Table 1 summarizes these facts. In 1960 Latin America observed 30 percent of the GDP per capita of the United States. By 2009 this statistic has declined to 23 percent. This relative decline is highly influenced by the negative economic performances of Venezuela, Peru, Bolivia, Argentina, and Uruguay. Figure 1 reports the evolution of GDP per capita in Latin American countries relative to the United States between 1950 and 2009. Relative GDP per capita has been stagnant or declining for Latin American countries during this period. With the exception of Chile in recent years, no other Latin American country has grown at rates substantially above the ones in the United States. This occurs despite Latin American countries observing levels of GDP per capita below that of the United States. Even though there is substantial room for catch-up in income to the United States, this process has not occurred for Latin American countries. This performance contrasts sharply with the evolution of GDP per capita in other countries at a similar stage of development (see Duarte and Restuccia, 2006 for a recent comprehensive documentation of these different growth experiences).

Table 1: GDP per Capita in Latin America

Country	Relative GDP per capita 1960	Relative GDP per capita 2009	Annualized Growth (%)
Argentina	0.48	0.33	1.32
Bolivia	0.14	0.09	1.15
Brazil	0.19	0.20	2.17
Chile	0.38	0.42	2.32
Colombia	0.22	0.22	2.11
Ecuador	0.20	0.15	1.61
Mexico	0.27	0.25	1.94
Peru	0.26	0.16	1.03
Uruguay	0.45	0.31	1.37
Venezuela	0.82	0.32	0.17
Latin America	0.30	0.23	1.53
USA	1.0	1.0	2.10

2.2 Decomposing GDP per Capita

What is the source of the poor economic performance of Latin American economies? We can look beyond the aggregate evolution of GDP per capita and decompose it into three factors as follows. At each date, GDP per capita can be written as:

$$\frac{Y}{P} = \frac{Y}{nE} \times \frac{E}{P} \times n,$$

where Y/P is GDP per capita, E/P is the employment to population ratio, n is hours per worker, and Y/nE is labor productivity (GDP per labor hour). Hence, the ratio of GDP per capita between any two countries i and j is given by:

$$\frac{(Y/P)_i}{(Y/P)_j} = \frac{(Y/nE)_i}{(Y/nE)_j} \times \frac{(E/P)_i}{(E/P)_j} \times \frac{n_i}{n_j}.$$

In words, relative GDP per capita between countries i and j is the product of the ratio of labor productivity, the ratio of employment to population, and the ratio of hours worked. Hence, a low relative GDP per capita can be the result of low labor productivity, low employment rates, low hours or any combination of these factors. The evidence from Table 1 indicates that the factor difference in GDP per capita between Latin America and the United States is roughly 1 to 4 (or 25 percent). Which variables in the above decomposition explain a factor of 4-fold difference between GDP per capita in the United States and Latin America? I describe these differences in turn.

Hours I first examine whether hours of work can account for the low relative levels of GDP per capita in Latin America. There are important limitations in collecting and comparing hours of work across a wide range of countries. Nevertheless the available data suggest that hours of work cannot explain the low relative levels of GDP per capita in Latin America. I use data on annual hours per worker collected by the Conference Board and Groningen Growth and Development Centre (2010) from a number of sources. Figure 2 documents the available time series data for a number of Latin American economies and the United States. As the figure shows, Latin American countries systematically work more hours than the United States (about 7 percent more hours in 1960 and 11 percent more hours in 2009). Over time, with the exception of Mexico, hours of work have declined for all countries but hours of work remain higher for Latin American countries relative to the United States. As a result, hours of work not only contribute to a small difference between Latin America and the United States, but also hours contribute negatively to explaining low relative GDP per capita in Latin America. I conclude then that an explanation of low and declining relative GDP per capita in Latin America cannot be based on differences in hours of work.

Employment to Population Ratio I next examine whether differences in the employment to population ratio can explain the low relative GDP per capita in Latin America. Table 2 reports the employment to population ratio across Latin American countries and the United States in 1960 and 2009. While the employment ratio is higher for the United States than most Latin American countries, the difference in the employment ratio can only explain less than 20 percent of the difference in GDP per capita across Latin America and the United States. To see this, notice that the ratio of the employment to population between Latin America and the United States is 0.82 to 0.87 while the ratio of GDP per capita is 0.30 to 0.23, therefore the employment ratio explains between 17 percent of the GDP per capita in 1960 (log(0.82)/log(0.30)) and 10 percent in 2009 (log(0.87)/log(0.23)).

Labor Productivity The previous analysis leaves us with one factor explaining the bulk differences in GDP per capita. That factor is labor productivity or GDP per labor hour. Since I already established that hours differences are small and stable then the bulk of difference in GDP per capita is explained by differences in GDP per worker between Latin

Table 2: Employment to Population Ratio

Country	1960	2009
Argentina	0.39	0.38
Bolivia	0.33	0.40
Brazil	0.38	0.48
Chile	0.31	0.45
Colombia	0.28	0.40
Ecuador	0.27	0.37
Mexico	0.25	0.39
Peru	0.33	0.37
Uruguay	0.32	0.47
Venezuela	0.29	0.35
Latin America	0.31	0.40
USA	0.38	0.46
Ratio (LA/US)	0.82	0.87

American countries and the United States. As a summary measure, the ratio of GDP per hour between Latin America and the United States is 0.34 in 1960 and 0.24 in 2009, explaining 90 percent of the difference in GDP per capita in 1960 (log(0.34)/log(0.30)) and 97 percent in 2009 (log(0.24)/log(0.23)).

To summarize, GDP per capita between Latin America and the United States in 1960 is accounted for by:

$$\underbrace{\frac{(Y/P)_{LA}}{(Y/P)_{US}}}_{.30} = \underbrace{\frac{(Y/nE)_{LA}}{(Y/nE)_{US}}}_{.34} \times \underbrace{\frac{(E/P)_{LA}}{(E/P)_{US}}}_{.82} \times \underbrace{\frac{n_{LA}}{n_{US}}}_{1.07},$$

And relative GDP per capita in 2009:

$$\underbrace{\frac{(Y/P)_{LA}}{(Y/P)_{US}}}_{.23} = \underbrace{\frac{(Y/nE)_{LA}}{(Y/nE)_{US}}}_{.24} \times \underbrace{\frac{(E/P)_{LA}}{(E/P)_{US}}}_{.87} \times \underbrace{\frac{n_{LA}}{n_{US}}}_{1.11}.$$

Hence, low relative GDP per capita in Latin America: A labor productivity problem! Relative labor input ($E/P \times n$) changes from 0.88 in 1960 to 0.97 in 2009.

2.3 Decomposing GDP per Hour

To investigate the sources of differences in GDP per hour the standard procedure is to write down an aggregate production function that explicitly states the relevant factors of production. For this purpose, I consider a standard Cobb-Douglas aggregate production function augmented to include human capital,

$$Y = AK^{\alpha}H^{1-\alpha}, \tag{1}$$

where Y is output, K and H are the inputs of physical and human capital services, and A is total factor productivity (TFP). Since ultimately I am interested in broadly separating the importance of factor accumulation (human and physical capital) and TFP, I follow Bils and Klenow (2000) and Klenow and Rodriguez-Clare (1997) in writing the production function above in intensive form. To do this, first I write aggregate human capital (H) as the product of human capital per worker (h), the number of workers (E), and hours of work (n), i.e., $H = hEn$. Using this substitution in equation (1), dividing by Y on both sides, taking Y/nE to the left hand side, and rearranging terms I obtain:

$$\frac{Y}{nE} = A^{\frac{1}{1-\alpha}} \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} h. \tag{2}$$

Using equation (2), the ratio of GDP per hour (Y/nE) between countries i and j is given by:

$$\frac{(Y/nE)_i}{(Y/nE)_j} = \left(\frac{A_i}{A_j}\right)^{\frac{1}{1-\alpha}} \times \left(\frac{(K/Y)_i}{(K/Y)_j}\right)^{\frac{\alpha}{1-\alpha}} \times \frac{h_i}{h_j}. \tag{3}$$

In words, GDP per hour differences can be the result of three factors: differences in TFP, differences in physical capital to output, and differences in human capital per worker. The goal is to investigate the factors on the right hand side of equation (3) that can account for differences in GDP per hour of 1 to 4 between Latin America and the United States.

Physical Capital I first investigate the importance of physical capital accumulation. I focus on institutions and policies that lead to capital to output ratio differences across countries. Notice that differences in TFP could also cause capital accumulation to differ across countries. But in a broad class of models, TFP differences imply no differences in the capital to output ratio. This implication is what leads to the decomposition in equation (2) to be useful in separating the forces directly related to capital accumulation from TFP differences. So the next step is to look for measures of physical capital across countries. Typically the physical capital stock is measured in domestic prices. Cole et al. (2005) and others have used this measure from Nehru and Dhareshwar (1993) in their analysis. In these units the physical capital stock relative to GDP is not systematically different across Latin American countries and the United States. However, measuring the capital stock at domestic prices may give a biased view of capital accumulation since the price of capital goods is systematically higher in poor relative to rich countries (see for instance Restuccia and Urrutia, 2001). Alternatively, a measure of the capital stock at common international prices can be constructed using investment rates from the Penn World Table. I follow this approach in constructing the capital to output ratio for Latin American countries and the United States (see the Appendix for details). I report these estimates in Table 3. The main conclusion I draw is that capital accumulation as measured by the capital to output ratio is not systematically different between Latin America and the United States. In fact, in 1960 the capital to output ratio in Latin America was 13 percent above the level in the United States, whereas in 2009 the capital to output ratio was 31 percent below the level in the United States (see Table 4). Nevertheless, these level differences are too small to account for any substantial portion of the difference in labor productivity across these countries. For instance, with a capital share of 1/3 ($\alpha = 1/3$ in equation (3), a 13 percent higher capital to output ratio translates into a 6 percent higher GDP per hour and a 31 percent lower capital to output ratio translates into a 17 percent lower labor productivity. I conclude that although there are some relevant country differences in the capital to output ratio, these differences are not systematic and quantitatively substantial to explain differences in GDP per hour of a factor of 4 between Latin American countries and the United States.

Human Capital A serious limitation of development accounting studies is the fact that there are no good measures of human capital across countries. In addition, even if these measures were available, it would be difficult to disentangle the role of TFP and other factors in explaining those differences. For this reason, recent studies have used quantitative theory to get at the importance of human capital in development – see for instance Manuelli and Seshadri (2006) and Erosa, Koreshkova, and Restuccia (2010). There is some available

Table 3: Real Physical Capital to GDP Ratio

Country	K/Y 1960	2009
Argentina	1.77	1.81
Bolivia	1.15	1.09
Brazil	1.85	1.50
Chile	3.17	2.31
Colombia	1.62	1.43
Ecuador	3.10	2.21
Mexico	2.23	2.43
Peru	4.41	2.02
Uruguay	2.08	1.53
Venezuela	3.61	1.74
Latin America	2.32	1.76
USA	2.05	2.57

Table 4: Real Physical Capital to Output Differences

	1960	2009
$(K/Y)_{LA}$	2.32	1.76
$(K/Y)_{US}$	2.05	2.57
Ratio	1.13	0.69
$\left(\frac{(K/Y)_{LA}}{(K/Y)_{US}}\right)^{\frac{\alpha}{1-\alpha}}$	1.06	0.83

evidence on the quantity of schooling indicating important differences across countries (see Figure 3) but a theory is needed to assess the importance of those differences in human capital and output across countries. How do productivity differences translate into human capital differences across countries? Standard models of human capital accumulation imply a log linear relationship between human capital and income when economies differ on TFP, i.e.,

$$\log h = c_h + \gamma \log(y),$$

where h is human capital per worker, y is labor productivity, and c_h is a constant. Substituting this expression for h in equation (2), GDP per hour (Y/nE) can be expressed as a function of TFP and capital accumulation, as follows:

$$\frac{Y}{nE} = c_y A^{\frac{1}{(1-\alpha)(1-\gamma)}} \left(\frac{K}{Y}\right)^{\frac{\alpha}{(1-\alpha)(1-\gamma)}}, \tag{4}$$

where c_y is a constant. Using equation (4), GDP per hour between countries i and j is given by:

$$\frac{(Y/nE)_i}{(Y/nE)_j} = \left(\frac{A_i}{A_j}\right)^{\frac{1}{(1-\alpha)(1-\gamma)}} \times \left(\frac{(K/Y)_i}{(K/Y)_j}\right)^{\frac{\alpha}{(1-\alpha)(1-\gamma)}}. \tag{5}$$

Note that the critical difference with equation (3) is the elasticity of the TFP and capital accumulation factors. Differences in TFP across countries lead to differences in physical capital accumulation and human capital accumulation (both in the form of quantity of schooling and on the quality of schooling). These factors can lead to a substantial amplification of TFP differences across countries. To see how important this mechanism can be, first suppose in equation (5) that $\gamma = 0$ and $\alpha = 1/3$ consistent with the standard one-sector growth model. Then in order to generate a factor of 4 difference in labor productivity between the United States and Latin America, a TFP ratio of 2.5 is needed – TFP in Latin America would need to be 0.4 that of the United States. This number is perhaps too small to be justified empirically. But if instead $\gamma = 1/2$, equation (5) would require a TFP ratio of 1.6 in order to achieve a factor of 4 difference in labor productivity. The key question is then how important this amplification mechanism is quantitatively. Or to put it differently, what is a reasonable value for the elasticity parameter summarized by γ?

Total Factor Productivity The relationship implied by equation (5) can be used to establish the difference in TFP between Latin America and the United States that is needed in order to explain a difference in GDP per worker of 1 to 4. Using cross-section heterogeneity across people in the United States, Erosa, et al. (2010) estimate that γ is around 0.46.[3] Given this estimated value for γ, equation (5) implies that in order to generate a factor of 4 differences in GDP per worker between the United States and Latin America, TFP must be 60 percent higher in the United States. In the next section I consider a theory of TFP that can potentially explain a productivity difference of this magnitude between Latin America and the United States.

To summarize, relative GDP per hour in 1960 is accounted for by:

$$\underbrace{\frac{(Y/nE)_{LA}}{(Y/nE)_{US}}}_{.30} = \underbrace{\left(\frac{A_{LA}}{A_{US}}\right)^{\frac{1}{(1-\alpha)(1-\gamma)}}}_{.27} \times \underbrace{\left(\frac{(K/Y)_{LA}}{(K/Y)_{US}}\right)^{\frac{\alpha}{(1-\alpha)(1-\gamma)}}}_{1.12}.$$

And relative GDP per hour in 2009:

$$\underbrace{\frac{(Y/nE)_{LA}}{(Y/nE)_{US}}}_{.23} = \underbrace{\left(\frac{A_{LA}}{A_{US}}\right)^{\frac{1}{(1-\alpha)(1-\gamma)}}}_{.32} \times \underbrace{\left(\frac{(K/Y)_{LA}}{(K/Y)_{US}}\right)^{\frac{\alpha}{(1-\alpha)(1-\gamma)}}}_{.71}.$$

The TFP gap (A_{LA}/A_{US}) is 0.62 in 1960 and 0.66 in 2009. Low relative income in LA driven by low TFP. Decline in relative income in LA driven in part by a decline in capital accumulation.

[3]Roughly speaking, the parameters of the human capital production function that generate an elasticity of TFP on income across countries also generate an elasticity of heterogeneity across people and their earnings. So cross-section heterogeneity within a country gives some information on the relevant cross-country elasticity.

2.4 Sectoral Labor Productivity

Before I move on to the model, one last point about the data. An argument could be made about Latin America suffering low productivity in specific sectors or distorting activity that affects some sectors of the economy more than others. This view of the development problem in Latin America is not consistent with the facts. The evidence from three broad sectors –agriculture, industry, and services– shows that low labor productivity relative to the United States is prevalent in all the sectors of the economy. For a summary of these facts see Duarte and Restuccia (2010). I conclude that low labor productivity in Latin America is not the result of sector specific policies or distortions, instead it is an economy-wide phenomenon. All countries go through a process of structural transformation whereby the agricultural sector is replaced in importance by the industrial sector and later by the service sector. While labor productivity improvements in agriculture and specially industry have proven essential in explaining episodes of substantial catch-up in aggregate productivity between new industrialized countries and the United States such as Korea, Japan, Singapore, and many European countries, sectoral labor productivity in Latin America has failed to catch up in all sectors. While these facts underscore the importance of sector specific distortions or frictions, the analysis in Duarte and Restuccia (2010) indicate that productivity growth in the service sector may be the best avenue for Latin America to mount a substantial catch up in income to the technological leader.

3 A Model of TFP

I present an extension of a model of measured total factor productivity developed by Restuccia and Rogerson (2008). The theory builds from the industry equilibrium framework of Hopenhayn (1992) embedded into a standard neoclassical growth model. The basic ingredient of the theory is the heterogeneity in total factor productivity across establishments. In the context of this model, the allocation of factors of production across establishments leads to a role of policy distortions on aggregate measured TFP differences across countries. I now go onto the details of the model.

3.1 Economic Environment

There is an infinitely-lived representative household with preferences over streams of consumption goods at each date described by the utility function,

$$\sum_{t=0}^{\infty} \beta^t u(C_t),$$

where C_t is consumption at date t and $0 < \beta < 1$ is the discount factor. Households are endowed with one unit of productive time in each period and $K_0 > 0$ units of the capital stock at date 0.

Differently than in the standard neoclassical growth model, the unit of production is the establishment. Each establishment is described by a decreasing returns-to-scale production function

$$f(s,k,n) = sk^{\alpha}n^{\gamma}, \qquad \alpha, \gamma \in (0,1), \quad 0 < \gamma + \alpha < 1.$$

with capital services k and labor services n as factor inputs. The technology parameter s varies across establishments. I assume that s can take on a discrete and finite number of values, $s \in S \equiv \{s_1, ..., s_{ns}\}$. As in Restuccia and Rogerson (2008), I abstract from variation in s over time. All establishments face an exogenous and constant probability of death λ. Exogenous exit realizations are *iid* across establishments and across time.

New establishments pay a set-up cost of c_e measured in terms of output. After paying this cost a realization of the establishment-level productivity parameter s is drawn but plants can invest in the likelihood of higher realizations of productivity levels. In particular, incurring the cost $c(q)$ in units of output, with probability q productivity is drawn from the higher productivity set $S_H \equiv \{s_{n_{\hat{s}}+1}, ..., s_{n_s}\}$ according to a *pdf* $h_H(s)$, while with probability $1 - q$ productivity is drawn from the lower set $S_L \equiv \{s_1, ..., s_{n_{\hat{s}}}\}$ according to *pdf* $h_L(s)$, where $n_{\hat{s}} \in \{1, ..., n_s\}$. Draws are *iid* across entrants and there is a continuum of potential entrants. I denote by N_t the mass of entry in period t. I parameterize the cost function as

$$c(q) = Bq^{\phi}, \qquad B, \phi > 0.$$

Feasibility in this model requires:

$$C_t + X_t + c_e N_t + c(q_t) N_t \leq Y_t,$$

where C_t is aggregate consumption, X_t is aggregate investment in physical capital, $c(q_t)$ is the investment cost in establishment quality, N_t is aggregate entry, and Y_t is aggregate output. As in the standard neoclassical growth model, the aggregate law of motion for capital is given by:

$$K_{t+1} = (1-\delta)K_t + X_t.$$

I focus on institutions and policies that create idiosyncratic distortions to establishment-level decisions as emphasized in Restuccia and Rogerson (2008). The empirical counterpart of these policies will be discussed later. Broadly speaking these policies will be represented by a tax on output of operating plants τ. As in Restuccia and Rogerson (2008), I assume that τ can take on three values: a positive value reflecting that an establishment is being taxed, a negative value reflecting that the establishment is being subsidized, and zero reflecting no distortion for the establishment. Different specifications of policy are denoted by $\mathcal{P}(s,\tau)$ representing the probability that an establishment with productivity s faces policy τ and it is possible that the value of the establishment-level tax rate be correlated with the draw of the establishment-level productivity parameter. From the point of view of the establishment what matters is the joint probability distribution over s and τ and I denote this by $g_H(s,\tau)$ and $g_L(s,\tau)$ for productivity in the high and low sets. Not all policy configurations will lead to a balanced budget for the government so I assume that the government imposes a lump-sum tax (or transfer) T to consumers in order to balance the budget.

3.2 Equilibrium

The analysis focuses exclusively on the steady-state competitive equilibrium of the model. In a steady-state equilibrium the rental prices for labor and capital services are constant as well as all aggregates in the economy including the invariant distribution of establishments in the economy. The consumer's side of the model is entirely standard so I will skip the details. The important aspect to keep in mind from the consumer's problem is that the real interest rate in the economy is pinned down by preference parameters and the depreciation rate of the capital stock, i.e., in steady state the real interest rate, denoted by R, is given by

$$R = r - \delta = \frac{1}{\beta} - 1.$$

Incumbent Establishments The decision problem of an establishment to hire capital and labor services is static. The per-period profit function $\pi(s, \tau)$ satisfies:

$$\pi(s, \tau) = \max_{n,k \geq 0} \left\{ (1 - \tau) s k^{\alpha} n^{\gamma} - wn - rk \right\}.$$

It is simple to derive the optimal factor demands from this problem which I denote $\bar{k}$ and $\bar{n}$. Because both the establishment-level productivity and tax rate are constant over time, the discounted present value of an incumbent establishment is given by,

$$W(s, \tau) = \frac{\pi(s, \tau)}{1 - \rho},$$

where $\rho = \frac{1-\lambda}{1+R}$ is the discount rate for the plant, R is the (steady-state) real interest rate, and λ is the exogenous exit rate.

Entering Establishments Conditional upon entering, an establishment invests $c(q)$ in productivity. This investment leads to a probability q of drawing productivity from the set

S_H. I denote the optimal investment decision by $\bar{q}$. Potential entering establishments make their entry decision knowing that they face a distribution over potential draws for the pair (s, τ). The expected value of entering establishments is given by,

$$W_e = \max_q \left\{ q \sum_{\tau, s \in S_H} W(s,\tau) g_H(s,\tau) + (1-q) \sum_{\tau, s \in S_L} W(s,\tau) g_L(s,\tau) - c(q) \right\} - c_e.$$

Whether a potential entering establishment decides to enter or not depends on the expected value of entering W_e being greater than zero. In an equilibrium with entry, W_e must be equal to zero since otherwise additional establishments would enter. This condition is typically referred to as the free-entry condition.

Definition of Equilibrium A *steady-state competitive equilibrium* with entry is a wage rate w, a rental rate r, a lump-sum tax T, an aggregate distribution of establishments $\mu(s, \tau)$, a mass of entry N, value functions $W(s, \tau)$, $\pi(s, \tau)$, W_e, policy functions $\bar{k}(s, \tau)$, $\bar{n}(s, \tau)$, $\bar{q}$ for individual establishments, and aggregate levels of consumption (C) and capital (K) such that:

(i) (Consumer optimization) $r = 1/\beta - (1 - \delta)$,

(ii) (Establishment optimization) Given prices (w, r), the functions π, W, and W_e solve incumbent and entering establishment's problems and $\bar{k}$, $\bar{n}$, $\bar{q}$ are optimal policy functions,

(iii) (Free-entry) $W_e = 0$,

(iv) (Market clearing)

$$\begin{aligned} 1 &= \sum_{s,\tau} \bar{n}(s,\tau)\mu(s,\tau), \\ K &= \sum_{s,\tau} \bar{k}(s,\tau)\mu(s,\tau), \\ C + \delta K + c_e N + c(\bar{q})N &= \sum_{s,\tau} f(s,\bar{k},\bar{n})\mu(s,\tau), \end{aligned}$$

(v) (Government budget balance)

$$T + \sum_{s,\tau} \tau f(s,\bar{k},\bar{n})\mu(s,\tau) = 0,$$

(vi) (μ is an invariant distribution)

$$\mu(s,\tau) = \begin{cases} \frac{N}{\lambda}\bar{q}g_H(s,\tau), & \forall s \in S_H, \forall \tau, \\ \frac{N}{\lambda}(1-\bar{q})g_L(s,\tau), & \forall s \in S_L, \forall \tau. \end{cases}$$

3.3 Calibration

I calibrate the model to data for the United States assuming that this is an economy with no distortions. The general strategy follows Cooley and Prescott (1995) in calibrating the neoclassical growth model. A period in the model corresponds to one year in the data. The discount factor is selected to match a real rate of return of 4 percent, implying $\beta = 0.96$. The parameter controlling decreasing returns to scale at the establishment is quantitatively important. I assume $\alpha + \gamma = 0.85$. Recent related studies have argued for values around this level, in particular, Atkeson and Kehoe (2005) using manufacturing data. But others using different calibration procedures and empirical strategies have arrived to similar values (see for instance Veracierto, 2001; Basu and Fernald, 1997; and Atkeson, Khan, and Ohanian, 1996). For more discussion on the implications of this choice see Restuccia and Rogerson (2008). Given this value, I separate α and γ according to the income share of capital and labor (1/3 and 2/3), hence $\alpha = 0.28$ and $\gamma = 0.57$. The depreciation rate of capital δ is chosen so that the capital to output ratio is equal to 2, implying $\delta = 0.10$. The exit rate λ is assumed to be 10 percent consistent with the evidence of job destruction rates in Davis, Haltiwanger, and Schuh (1996) and exit rates of plants in Tybout (2000).

In the economy with no distortions there is a simple mapping between establishment-level productivity and employment. So I choose the range of productivity to match the range of employment levels in the data. With the lowest establishment productivity normalized to one, this calibration implies that the highest productivity is 3.78. I use a log-spaced grid of establishment productivity with 100 points, i.e., $n_s = 100$. The next step is to restrict the probability distributions. I choose $n_{\hat{s}}$ to be 20 percent of n_s. With the calibrated distributions this implies that establishments in the set S_L represent close to 40 percent of all establishments. The mapping of productivity to employment implies that I can choose values of $[qh_H(s), (1-q)h_L(s)]$ to match the distribution of plants across employment sizes. This puts a restriction on the values of q and $h_H(s)$ and $h_L(s)$. For the cost function $c(q)$, I set $\phi = 2$ and then choose B so that the equilibrium $\bar{q} = 0.615$ which is the value implied by the U.S. establishment data. I use statistics from the U.S. Census Bureau (2007) to restrict these distribution. An important property of the U.S. establishment data is that there is a large number of establishments with a small number of workers and therefore

Table 5: Distribution of Plants and Employment

	Share of (%)			
	Establishments		Employment	
Workers	Data	Model	Data	Model
Less than 10	51.4	51.4	4.0	3.8
Between 10 and 50	31.2	31.2	15.2	13.6
Between 50 and 500	16.0	16.0	48.3	43.8
More than 500	1.4	1.4	32.5	38.8

these establishments account for a small share of the employment in the economy. About 50 percent of the establishments have less than 10 workers and these account for only 4 percent of the employment, while only half of a percent of establishments have more than 2,500 workers and represent 30 percent of the employment. Table 5 reports these statistics from the data and the calibrated economy. As the table shows, the calibrated economy matches the distribution statistics very well. Table 6 summarizes the parameter values and targets for the calibrated economy.

Table 6: Calibration

Parameter	Value	Target
α	0.28	Capital income share
γ	0.57	Labor income share
β	0.96	Real rate of return
δ	0.10	Capital to output ratio
c_e	1.0	Normalization
λ	0.1	Annual exit rate
$\{s_1, ..., s_{n_s}\}$, $h_H(s)$, $h_L(s)$	see text	Size distribution of plants
$n_{\hat{s}}$	20	–
ϕ	2	Baseline
B	2.4	$q = 0.615$

4 Quantitative Analysis

I study three types of experiments in the model. First, I consider a modification of the benchmark economy to allow for an increase in the cost of entry of plants c_e. This higher cost of entry is motivated by a variety of evidence for Latin American economies. Second, I consider policies that distort the prices faced by different producers, what Restuccia and Rogerson (2008) call idiosyncratic distortions. In particular, I evaluate a policy configuration where the output of the 50 percent most productive plants gets taxed at the rate of 40 percent and the remaining 50 percent of plants get subsidized. I choose the subsidy rate to maintain capital accumulation as in the benchmark economy. Third, I compute equilibrium for an economy that features the previous two scenarios – a higher entry cost and policy distortions. Tables 7 and 8 summarize the results of these experiments. All statistics (except distributional statistics) are reported relative to the benchmark economy without distortions and with the normalized entry cost of 1.

Entry Costs Higher entry costs discourage establishments entering the market (see column 2 in Table 7). This reduces productivity compared to the benchmark economy because establishment sizes are distorted. With the higher entry cost the average establishment has more workers than in the benchmark economy. The aggregate effect of the higher entry cost is not large, it reduces output per worker in about 5 percent compared to the benchmark economy. The effect of the higher entry cost on average establishment size is somewhat mitigated by the fact that the lower wage rate encourages more investment in plant productivity, so q in this economy is 76 percent as compared to 61.5 percent in the benchmark economy.

Table 7: Aggregate Implications

Variable	B.E. $c_e = 1$ $\tau = 0$	Experiments $c_e = 1.5$ $\tau = 0$	$c_e = 1$ $\tau = 0.1$	$c_e = 1.5$ $\tau = 0.1$
Relative Y	1.00	0.95	0.69	0.60
Relative TFP	1.00	0.96	0.69	0.61
Relative E	1.00	0.62	1.85	1.19
Relative w	1.00	0.95	1.00	0.95
q	0.62	0.76	0.11	0.08

Table 8: Distributional Implications

Variable	B.E. $c_e = 1$ $\tau = 0$	Experiments $c_e = 1.5$ $\tau = 0$	$c_e = 1$ $\tau = 0.1$	$c_e = 1.5$ $\tau = 0.1$
Relative Y	1.00	0.95	0.69	0.60
Share of Establishments:				
<10	0.51	0.32	0.50	0.50
10 to 49	0.31	0.41	0.26	0.03
50 to 499	0.16	0.25	0.24	0.47
$\geq$ 500	0.02	0.02	0.00	0.00
Share of Employment:				
<10	0.04	0.02	0.04	0.03
10 to 49	0.14	0.11	0.35	0.02
50 to 499	0.44	0.41	0.57	0.92
$\geq$ 500	0.38	0.46	0.04	0.03

Idiosyncratic Distortions I now implement a set of policies that create differences in the output prices of different producers. Many policies take effectively this form and Restuccia and Rogerson (2008) study a general configuration of these policies. More recently, Hsieh and Klenow (2009) for China and India and Pages (2010) for Latin American countries, have shown that output wedges across establishments are a prevalent feature of the data for developing countries. I set the tax rate to 40 percent and then compute the subsidy rate that leaves capital accumulation the same. Holding capital accumulation constant is motivated by the observations discussed above that capital accumulation is not a fundamental factor in explaining low relative labor productivity in Latin America. The effect on output is larger for this policy (see Table 7 column 3). Output falls by more than 30 percent. This is mainly the result of a systematic distortion on establishments – productive plants become small because of the tax on output while unproductive plants become larger because of the subsidy. This distortion entails a misallocation of resources across plants with different productivity. In addition, the policy leads to decrease in investment in plant productivity so q falls to 11 percent compared to 61.5 percent in the benchmark economy. This shifts the distribution of plants by employment size to the left, reducing the average establishment size in more than 40 percent. This effect on the average establishment size is consistent with the evidence in Tybout (2000) and Pages (2010) that production in developing countries takes place in smaller units (see Table 8). When combined with higher entry costs, policy distortions create a fall in output and productivity of almost 40 percent (see Table 7 column 4). This is the magnitude in productivity that is needed to generate the observed difference between Latin America and the United States in labor productivity when capital accumulation is augmented to include human capital.

Discussion While the policy experiments considered above are simplified and abstract, they capture the essence of the empirical evidence on the cost of doing business in Latin

America relative to developed countries and the systematic bias against large and productive establishments. I briefly discuss some of this evidence. There is abundant evidence on the higher cost of doing business in Latin America. The most well-known empirical cases are De Soto (1986) and Djankov, La Porta, Lopez-de-Silanes, Shleifer (2002). For instance, according to the data on barriers to entry in Djankov et al. (2002), Latin American countries have a cost of entry for firms – a measure of cost of entry (time and goods) relative to per capita GDP – that ranges between 20 to 300 percent. These costs represent less than 2 percent in developed economies. (See some of these figures in Table 9.) More recently, the World Bank has collected systematic data for a large number of countries ranking them in categories such as starting a business, dealing with licences, protecting investors, enforcing contracts, trade and other restrictions. The data is reported every year (see World Bank Doing Business Database, 2010). Not surprisingly, Latin American economies rank at the bottom on most of these measures. (See also Fantoni, 2007). Broader measures of regulation and their effect on economic performance have been constructed and analyzed by Loayza, Oviedo, and Serven (2007). Again these indices indicate that Latin America has an overly regulated economy, many of these restriction impose higher costs of operating a business but many of them become a de facto tax on large and productive firms. For instance, Galindo, Schiantarelli, and Weiss (2007) document the empirical evidence from developing countries that financial reforms affect the allocation of investment, leading to higher productivity.

Table 9: Barriers to Entry in Latin America

Country	Cost
USA	2
Chile	24
Argentina, Colombia	≈ 35
Brazil	45
Peru, Uruguay, Venezuela	≈ 53
Mexico	83
Ecuador	91
Bolivia	300

5 Conclusions

In this paper I made two main points. First, I showed that low GDP per capita in Latin America relative to the United States (what I call the development problem of Latin America) is due to low relative total factor productivity. In other words, the development problem of Latin America is a productivity problem. I calculate that in order to explain a factor of 1 to 4 difference in GDP per worker between Latin America and the United States only a 1 to 1.6 difference in TFP would be needed. The larger difference in labor productivity arises as an amplification of productivity through physical and human capital accumulation. Second, I consider a framework where institutions and policy distortions create a misallocation of factors across heterogeneous producers that explains the low relative productivity in Latin America. Barriers to formal market entry, regulation and barriers to competition, trade barriers and employment protection, among others may be at the core of productivity differences between Latin America and the United States. Removing these barriers can lead to an increase in long-run labor productivity in Latin America relative to the United States of a factor of 4. This increase in income amounts to 70 years worth of U.S. post-WWII development.

References

[1] Alfaro, L., Charlton, A., and Kanczuk, F. (2007) "Firm-Size Distribution and Cross-Country Income Differences," manuscript, Harvard Business School.

[2] Atkeson, A. and Kehoe, P. (2005) "Modelling and Measuring Organizational Capital," *Journal of Political Economy*, 113, pp. 1026-53.

[3] Atkeson, A., Khan, A., and Ohanian, L. (1996) "Are Data on Industry Evolution and Gross Job Turnover Relevant for Macroeconomics?" *Carnegie-Rochester Conference Series on Public Policy*, 44, pp. 215-39.

[4] Barro, R. and Lee, J. (2010) "A New Data Set of Educational Attainment in the World, 1950-2010," NBER Working Paper 15902.

[5] Basu, S. and Fernald, J. (1997) "Returns to Scale in U.S. Production: Estimates and Implications," *Journal of Political Economy*, 105(2), pp. 249-83.

[6] Bartelsman, E., Haltiwanger, J., and Scarpetta, S. (2006) "Cross-Country Differences in Productivity: The Role of Allocative Efficiency," manuscript, University of Maryland.

[7] Bergoeing, R., Kehoe, P., Kehoe, T., and Soto, R. (2002) "A Decade Lost and Found: Mexico and Chile in the 80s," *Review of Economic Dynamics,* 5(1): pp. 166-205.

[8] Bergoeing, R., Loayza, N., and Repetto, A. (2004) "Slow Recoveries," *Journal of Development Economics* 75: pp. 473-506.

[9] Bils, M. and P. Klenow (2000) "Does Schooling Cause Growth?" *American Economic Review*, 90(5): pp. 1160-83.

[10] Burstein, A. and Monge, A. (2009) "Foreign Know-How, Firm Control, and the Income of Developing Countries," *Quarterly Journal of Economics.*

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

[12] Conference Board and Groningen Growth and Development Centre (2010). Total Economy Database. January.

[13] Cooley, T. and Prescott, E. C. (1995) "Economic Growth and Business Cycles," in *Frontiers of Business Cycle Research,* ed. T. Cooley. New Jersey: Princeton University Press.

[14] Davis, S., Haltiwanger, J., and Schuh, S. (1996) *Job Creation and Destruction,* The MIT Press: Cambridge, Massachusetts.

[15] De Soto, H. (1986) *El Otro Sendero.* Editorial Sudamericana.

[16] Djankov, S., La Porta, R., Lopez-de-Silanes, F., and Shleifer, A.(2002) "The Regulation of Entry," *Quarterly Journal of Economics*, 67(1): 1-37.

[17] Duarte, M. and Restuccia, D. (2006) "The Productivity of Nations," Federal Reserve Bank of Richmond *Economic Quaterly* 92 (3) Summer, pp. 195-224.

[18] Duarte, M. and Restuccia, D. (2010) "The Role of the Structural Transformation in Aggregate Productivity," *Quarterly Journal of Economics*, 125(1): pp. 129-73.

[19] Elias, V. (1992) *Sources of Growth: A Study of Seven Latin American Economies.* San Francisco; ICS Press.

[20] Erosa, A., Koreshkova, T., and Restuccia, D. (2010) "How Important is Human Capital? A Quantitative Theory Assessment of World Income Inequality," *Review of Economic Studies*, 77(4): pp. 1421-49.

[21] Fantoni, R. (2007) "Checking Latin America's Vital Signs," *The McKinsey Quarterly,* special edition.

[22] Galindo, A., Schiantarelli, F., and Weiss, A. (2007) "Does Financial Liberalization Improve the Allocation of Investment? Micro-evidence from Developing Countries," *Journal of Development Economics*, 83: pp. 562-87.

[23] Greenwood, J., Sanchez, J., and Wang, C. (2010) "Fianncing Development: The Role of Information Costs," *American Economic Review.*

[24] Guner, N., Ventura, G. and Xu, Y. (2008) "Macroeconomic Implications of Size-Dependent Policies," *Review of Economic Dynamics.*

[25] Heston, A., Summers, R., and Atten, B. (2002) Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP), <http://pwt.econ.upenn.edu>.

[26] Kydland, F. and Zarazaga, C. (2002) "Argentina's Lost Decade," *Review of Economic Dynamics* 5(1): pp 152-65.

[27] Hopenhayn, H. (1992) "Entry, Exit, and Firm Dynamics in Long Run Equilibrium," *Econometrica* 60: 1127-50.

[28] Hsieh, C. and Klenow, P., 2009, "Missallocation and Manufacturing TFP in China and India," *Quarterly Journal of Economics*, 124(4): pp. 1403-1448.

[29] Klenow, P. and A. Rodriguez-Clare, 1997, "The Neoclassical Revival in Growth Economics: Has it Gone Too Far?," NBER Macroeconomics Annual. University of Chicago Press.

[30] Loayza, N., Oviedo, A., and Serven, L. (2007) "Regulation and Macroeconomic Performance," manuscript, the World Bank.

[31] Manuelli, R. and Seshadri, A. (2006) "Human Capital and the Wealth of Nations," manuscript, University of Wisconsin.

[32] Nehru, V. and Dhareshwar, A. (1993) "A New Database on Physical Capital Stock: Sources, Methodology, and Results. *Revista de Analisis Economico* 8(1): pp. 37-59.

[33] Pages, C. (2010) The Age of Productivity: Transforming Economies from the Bottom Up. (New York: Palgrave MacMillan).

[34] Restuccia, D. and Rogerson, R. (2008) "Policy Distortions and Aggregate Productivity with Heterogeneous Establishments," *Review of Economic Dynamics*, 11(4): pp. 707-20.

[35] Restuccia, D. and Urrutia, C. (2001) "Relative Prices and Investment Rates," *Journal of Monetary Economics*, 47(1): pp. 93-121.

[36] Solimano, A. and Soto, R., (2006) "Economic Growth in Latin America in the Late Twentieth Century: Evidence and Interpretation," in Vanishing Growth in Latin America, The Late Twentieth Century Experience, A. Solimano Ed., Edward Elgar Publishing: Massachusetts.

[37] Tybout, J. (2000) "Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?" *Journal of Economic Literature,* 38(1): 11-44.

[38] U.S. Department of Commerce (1997), Census of Manufactures.

[39] Veracierto, M. (2001) "Employment Flows, Capital Mobility, and Policy Analysis," *International Economic Review* 42(3): 571-95.

[40] World Bank (2010). *Doing Business Database.* Washington D.C.

A Data Sources and Definitions

The data covers 10 Latin American countries. These are Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay, and Venezuela. For most countries the time series include data from 1950 to 2009. The main source of data is the Conference Board and Groningen Growth Centre (2010).

I use data from Penn World Tables version 6.2. (see Heston, Summers, and Aten, 2002) to construct annual time series of PPP-adjusted investment to GDP ratio. This series cover the period 1950 to 2009 for all countries. I use the investment rates at international prices to obtain a measure of physical capital to output ratio (K/Y)at international prices. I proceed as follows: (1) Estimate K/Y in 1954 using the average I/Y from PWT 1950-54 and the steady-state relationship implied by a standard Solow model, i.e., $K/Y = \frac{I/Y}{(n+g+\delta+ng)}$ where n is the growth rate of population, g is the growth rate of productivity, and δ is the depreciation rate of capital. I assume $\delta_2 \equiv n + g + ng + \delta = 0.10$. (2) Use I/Y to compute K/Y over time using the standard capital accumulation equation $K_{t+1} = (1-\delta)K_t + I_t$. This implies, $\frac{K_{t+1}}{Y_{t+1}} = \hat{g}_t \times \left[(1-\delta)\frac{K_t}{Y_t} + \frac{I_t}{Y_t}\right]$ where $\hat{g}$ is the gross growth rate of output (growth in output per capita times population growth). The sectoral data is from Duarte and Restuccia (2010) for details see their appendix. Data on years of schooling is from Barro and Lee (2010).

All series are trended using the Hodrick-Prescott filter with a smoothing parameter $\lambda =$ 100 before any ratios are computed.

Figure 1: GDP per Capita relative to the United States

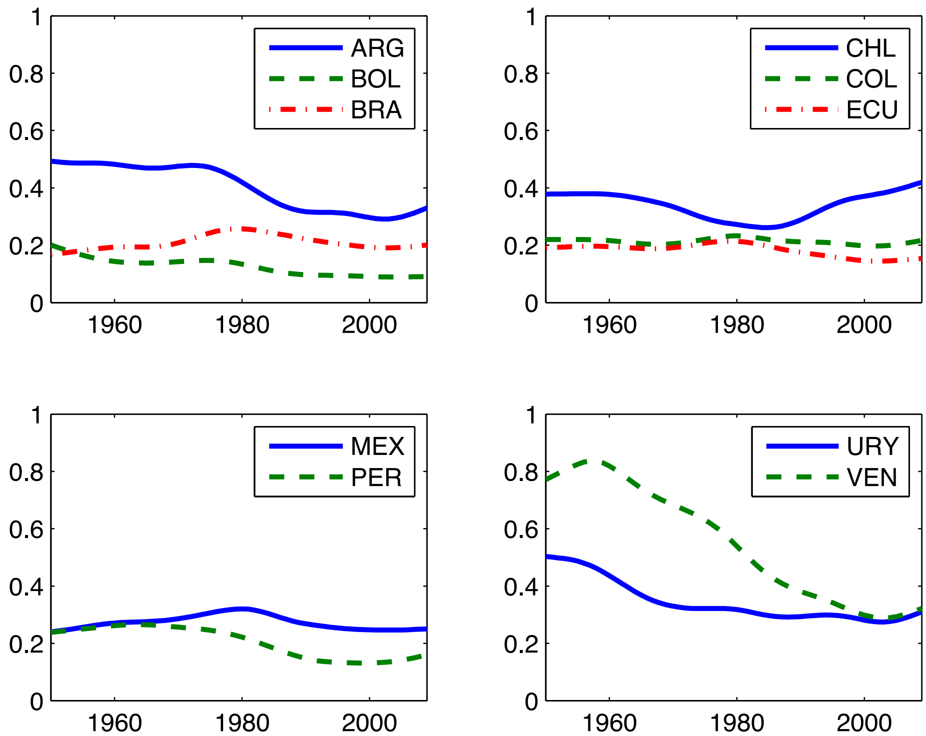

Figure 2: Annual Hours per Worker

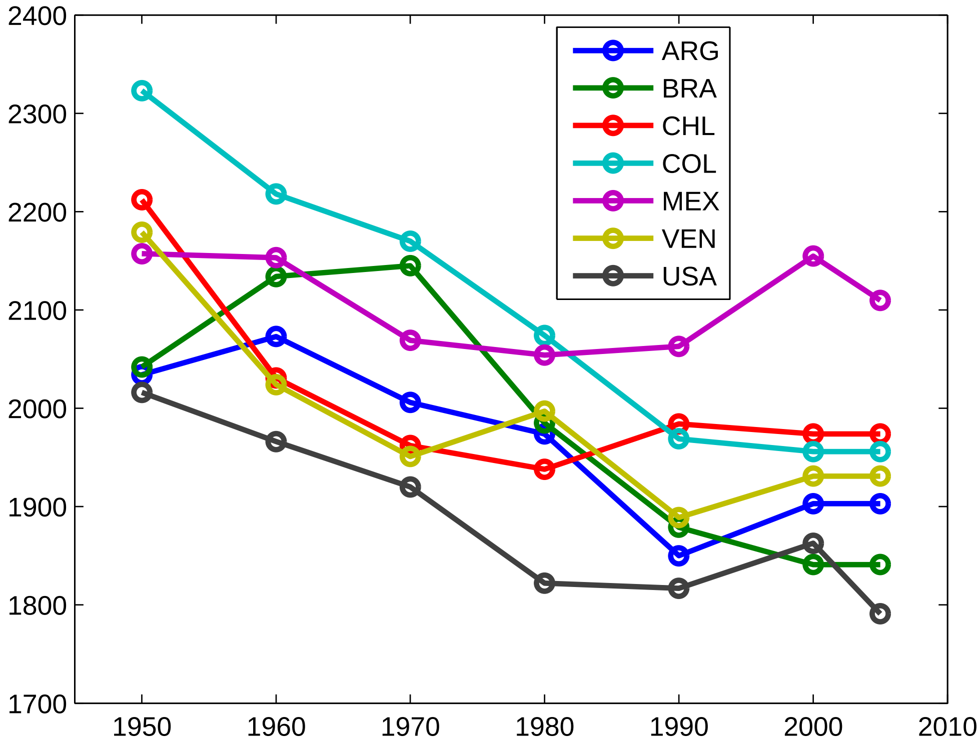

Figure 3: Average Years of Schooling