Development Accounting*

Chang-Tai Hsieh
University of Chicago and NBER

Peter J. Klenow
Stanford University and NBER

July 2009

Researchers have made much progress in the past 25 years in accounting for the proximate determinants of income levels: physical capital, human capital, and TFP (Total Factor Productivity). But the field still knows little about *why* these factors vary. We argue that TFP exerts a powerful influence on output not only directly, but also indirectly through its effect on physical and human capital accumulation. We then discuss why TFP itself varies across countries, highlighting misallocation of inputs across firms and industries is a key determinant.

* Emails: chsieh@chicagobooth.edu and pete@klenow.net. We thank Steve Davis, Chad Jones, and David Romer for detailed comments that vastly improved the paper.

1. Introduction

Research on income differences can arguably be classified into one or more arrows in the following chain of causality:

$$\begin{array}{l} \textit{Geography, Climate, Luck} \Rightarrow \textit{Human Capital, Physical Capital, TFP} \Rightarrow \textit{Income} \\ \qquad\qquad \Downarrow \\ \textit{Institutions, Culture} \Rightarrow \textit{Human Capital, Physical Capital, TFP} \Rightarrow \textit{Income} \\ \qquad\qquad \Downarrow \\ \textit{Policies, Rule of Law, Corruption} \Rightarrow \textit{Human Capital, Physical Capital, TFP} \Rightarrow \textit{Income} \end{array}$$

Our focus is on the rightmost arrows, or what is sometimes called "development accounting." First, we describe research from the past 25 years about the *proximate* role of physical capital, human capital and TFP in accounting for income differences across countries. The current state of the debate is as follows: human capital is important (accounting for 10% to 30% of country income differences), physical capital matters as well (around 20%), and residual TFP remains the biggest part of the story (50% to 70%).

Second, we will contend there are important positive feedback effects between human capital, physical capital, and TFP. In particular, the level of TFP of different sectors (investment vs. consumption, human capital vs. final goods) can influence the incentive to accumulate physical and human capital. We will also argue that a key determinant of aggregate TFP is the efficiency of input allocation across firms and industries.

Along the way we will highlight some of the many open questions that remain. In a short paper such as this, however, many vitally important topics must be left out. In the interests of brevity, this survey neglects the work that has been done on any of the leftmost or vertical arrows in the simple schematic above. That is, we neglect the growing and important literature on how geography and climate affect institutions and culture, which in turn determine policies (e.g., tax and tariff rates), corruption and ultimately physical capital, human capital, and TFP.

2. Proximate Development Accounting

First and foremost, the reader should see the excellent survey by Caselli (2005). Ours is a comparatively quick overview of this large literature. Second, we wish to clarify the two main ways the literature has done proximate development accounting. Imagine the simple aggregate production function

$$Y_i = A_i K_i^{\alpha} (h_i L_i)^{1-\alpha} \tag{2.1}$$

where Y_i represents real GDP in country i, A_i is residual TFP, K_i is real physical capital, h_i is human capital per person, and L_i is hours worked per person. Dividing (2.1) by population N_i and rearranging yields a conventional expression for accounting:

$$\frac{Y_i}{N_i} = A_i \left(\frac{K_i}{N_i} \right)^{\alpha} \left(\frac{h_i L_i}{N_i} \right)^{1-\alpha} . \tag{2.2}$$

If one takes logs of both sides of (2.2), one can then linearly decompose the differences in income levels between any two countries (say each country vs. the U.S., or the 90th vs. 10th percentile of country incomes). Alternatively, one could do a variance decomposition using a sample of many countries. A common capital elasticity of around 1/3 is typically assumed based on observed labor shares, following Gollin (2002). Compared to regression studies, this accounting approach need not require that, say, TFP be orthogonal to physical or human capital.

Any accounting provides the answer to a specific question. Accounting with (2.2) asks the hypothetical question: how much would output per person increase in response to variation in one of physical capital per person, effective labor per person, or residual TFP – holding the other two factors fixed.

One objection to accounting with (2.2) is that physical capital per person will endogenously increase in response to increases in effective labor or TFP. Because investments in physical capital are final goods, unlike human capital or TFP, any increase in output will tend to bring forth higher physical capital. Put differently, holding fixed capital per person while increasing human capital or TFP requires a *decrease* in the investment rate in physical capital. It is not obvious why this is a useful thought experiment given that the investment rate in physical capital is presumably driven by factors such as the effective tax rate on capital income and the relative price of capital – but not the level of human capital or TFP per se.

An alternative accounting in the literature asks a different question by rearranging the production function into an intensive form. For example:

$$\frac{Y_i}{N_i} = A_i^{\frac{1}{1-\alpha}} \left(\frac{K_i}{Y_i}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{h_i L_i}{N_i}\right). \tag{2.3}$$

Here the thought experiment is a change in effective labor per person or residual TFP, allowing capital per person (but not the capital-output ratio) to change in response. As pointed out by Mankiw, Romer and Weil (1992), this question is compatible with the steady state of a neoclassical growth model, in which the level of human capital or TFP has no direct effect on the steady state capital-output ratio. For comparing large, persistent differences across countries, a steady state assumption may be a good approximation. The bigger exponents on residual TFP (i.e., $1/(1-\alpha)$ instead of 1) and on effective labor input (1 rather than $1-\alpha$) in (2.3) reflect the impact of these variables on output both directly and indirectly through capital per worker.

A valid objection to accounting with (2.3) is its asymmetry. It asks how much output per person differs when the capital-output ratio changes, holding fixed the levels of human capital and residual TFP. One could instead argue that physical capital is an important input to accumulation of human capital and investments in higher TFP. In this spirit, Mankiw, Romer and Weil (1992) carried out accounting that incorporated an effect of physical capital on human capital. This channel is weaker, however, if investments in human capital and TFP are intensive in human capital more than physical capital. And, in contrast to the well-understood endogeneity of physical capital in the neoclassical growth model, the determinants of human capital and TFP are much less well understood.[1] Still, we will describe the results of accounting with both (2.2) and (2.3), and then return to the issue of what may be driving differences in human capital and TFP.

Physical capital

Using (2.3), Klenow and Rodríguez-Clare (1997) and Hall and Jones (1999) attribute about 20% of variation in income per worker to variation in capital-output ratios. Their variance decomposition evenly splits the covariance terms between any two of physical capital, human capital, and TFP. Caselli (2005) uses (2.2), which gives more weight to physical capital, but also looks at relative variances rather than assigning the covariance terms. These differences roughly offset each other so that he, too, credits about 20% of income variation to physical capital. Despite this broad agreement, open questions remain about measuring the quality of physical capital across countries given possibly differing vintage (e.g., Armenter and Lahiri 2006) and efficiency of the component due to government infrastructure investments (e.g., Pritchett 2000).

Human capital

To measure levels of human capital, Mankiw, Romer and Weil (1992) used the secondary school enrollment rate as a proxy for the investment rate in human capital. They attributed about 50% of income differences to human capital differences in their 1985 sample of 98 non-oil countries. But primary and tertiary schooling must matter as well. And attainment of the workforce – as opposed to the enrollment rate of the shool-age population – should be what matters for the human capital of workers.

Klenow and Rodríguez-Clare (1997) use years of schooling attainment from Barro and Lee (1993), which covers primary, secondary, and tertiary schooling. They also propose that a useful way to capture the impact of attainment is to look at how wages vary with schooling within countries. Based on evidence in the labor literature, they assume a Mincerian log linear relationship between years of schooling and human capital:

$$h_{it} = B_{it}\, e^{\phi_{it} S_{it}} .$$

[1] See Klenow and Rodríguez-Clare (2005) and Cordoba and Ripoll (2007) for models in which TFP endogenously responds to the levels of human and physical capital per worker.

Here S_{it} is years of schooling in country *i* in year *t*, ϕ_{it} is the "Mincerian return" to a year of schooling, and B_{it} captures factors such as the quality of schooling, human capital accumulated in early life, and human capital accumulation on the job. The Mincerian return may also be affected by the quality of schooling, or for that matter early childhood stimulation, nutrition, and so on.

Given data on S_{it}, we need to know ϕ_{it} and B_{it} to implement the Mincerian approach to estimate human capital across countries. Klenow and Rodríguez-Clare (1997) impose $\phi_{it} = .095$ for all country-years and allow B_{it} to vary across countries as a function of estimated teacher human capital and differences in capital-output ratios. If human capital production is as intensive in physical capital as the production of other goods, they find human capital differences explain about 30% of income differences. If, instead, they put more weight on student time and teacher human capital and less weight on capital inputs in the human capital, they find human capital differences explain only about 10% of income differences.

Caselli (2005) goes further in incorporating non-student inputs in measuring human capital: teacher-pupil ratios, human capital of teachers, human capital of parents, classroom materials per student, experience, and even health and nutrition.[2] He finds that such factors could in principle allow human capital to explain the full 80% of income variation not attributable to physical capital. But each time he finds that the required elasticity of human capital with respect to these inputs (and/or the amount of variation in these inputs) is much larger than the limited micro evidence available. He concludes that human capital explains somewhere between 10% and 30% of income variation.

Many estimates, including those by Klenow and Rodriguez-Clare (1997), Hendricks (2002), and Caselli (2005), explicitly attempt to incorporate differences in the quality of schooling that do not show up in the Mincerian return. That notwithstanding, recent papers by Manuelli and Seshadri (2007), Erosa, Koreshkova and Restuccia (2007), and Jones (2008) emphasize the shortcomings of using the Mincerian approach alone to infer variation in human capital across countries. Imagine the log of human capital (of

[2] See Weil (2007) for creative use of micro evidence to try to measure the impact of health differences on income differences across countries.

individual *i* or country *i*) is a function of years of schooling s_i and schooling input x_i: $\ln h_i = f(s_i, x_i)$. Then the Mincerian return to schooling is

$$\frac{d \ln h_i}{ds_i} = \frac{\partial f}{\partial s_i} + \frac{\partial f}{\partial x_i}\frac{\partial x_i}{\partial s_i}.$$

Micro-Mincer regressions run across individuals within a country should capture not only the direct effect of a higher quantity of schooling, but also the indirect effect of the higher quality of schooling of those individuals who tend to get more education within countries. But the *macro-Mincer* relationship that growth economists are interested in can be different. The quality of schooling may covary more with schooling attainment across countries than it does within countries. This is what happens in Manuelli and Seshadri and Erosa et al. because TFP in producing school inputs is higher in rich countries – but all individuals within countries face the same price of school inputs.[3] They posit lower prices of school inputs (relative to the wage) in rich countries because some school inputs are books, equipment, and buildings. Whereas the micro-Mincer semi-elasticity may be 10%, the macro-Mincer semi-elasticity may be 20% or 30%. These papers have the potential to overturn the conventional wisdom described here that human capital explains only 10% to 30% of income differences.

Open questions remain about this approach, namely estimating key parameters for human capital production at home, at school, and on the job – including the importance of non-teacher inputs in human capital accumulation. But the apparently large wage gains to immigrants from poor to rich countries, as documented by Hendricks (2002), are a body blow to the view that the human capital varies so much that there is little residual variation in TFP across countries. We return to some of this work below when we ask *why* human capital is higher in rich countries.

Hours worked per person

A much smaller literature has investigated differences in hours worked per person across countries. Blanchard (2004) and Prescott (2004) attributed the bulk of G7 income

[3] Although richer families may send their children to higher quality schools, public funding may also tend to equalize school quality more within countries than across countries.

differences in the mid-1990s to differences in hours worked per person. But Caselli (2005) does not find people work systematically more in rich vs. poor countries. Across countries, the labor force participation rate increases mildly with income, the unemployment rate is unrelated to income, and the workweek falls with income.

An important caveat to Caselli's results is that there is little data on hours worked per worker outside the manufacturing (or at least urban) sector in developing countries. So it remains an open question whether, say, limited market work contributes importantly to limited market income per worker in rural areas of poor economies. Parente, Rogerson and Wright (2000) make the case that distortions on market activity would predict such low market activity. A related issue is how much informal and home production is captured in income statistics.

Residual TFP

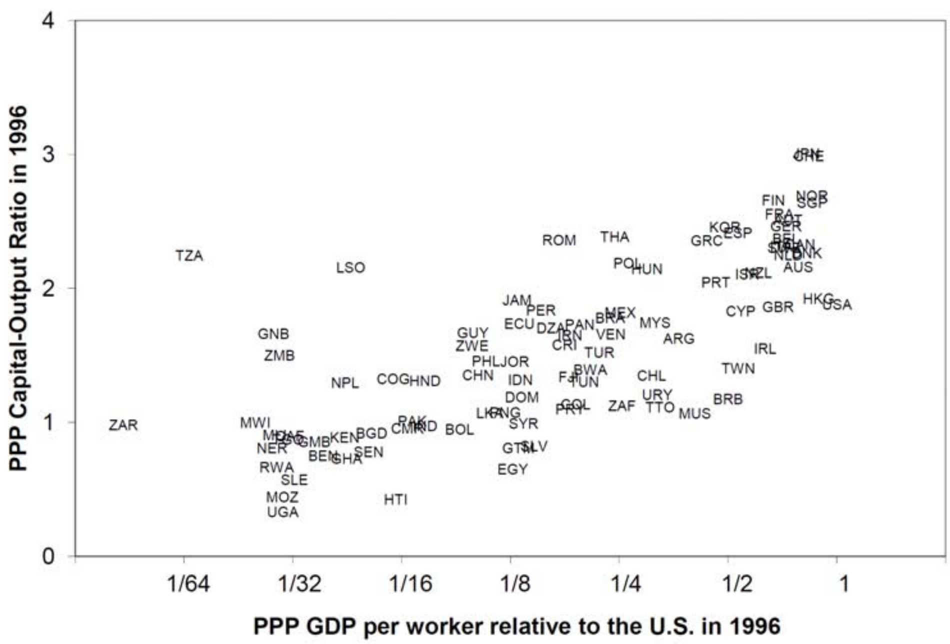
The upshot is that 50% or more of cross-country income variation appears to remain unexplained by a combination of physical capital, human capital (including health), and hours worked. This broad conclusion is not sensitive to whether the accounting uses (2.2) or (2.3).

III. Why does physical capital vary?

We now turn to work on the underlying causes of factor differences, starting with physical capital. Figure 1 shows PPP capital-output ratios across 97 countries in 1996, derived from data in Penn World Table 6.1 (see Summers, Heston and Aten, 2002). The ratios differ by factor of about four across rich and poor countries, from a low of about 3/4 in the poorest countries to a high of about three in the richest countries. Behind this graph is one of the strongest relationships established in the empirical growth literature: the positive correlation between the investment rate in physical capital and the level of output per worker (see Levine and Renelt, 1992, and Sala-i-Martin, 1997).

Why is the PPP investment rate higher in richer countries? A first thought is that the savings rate is simply lower in poorer countries. Parente and Prescott (2000), for example, document lower savings rate in poorer countries. Possible reasons include subsistence savings needs, financial underdevelopment (low returns to savers and high cost of borrowing for investment), and high implicit tax rates on capital income (taxes, expropriation, corruption) in poorer countries. A shallow local savings pool and inability to tap foreign pools may limit opportunities to finance domestic investment.

FIGURE 1: Capital-Output Ratios vs. Income Levels



As noted, there is indeed evidence of lower savings rates in poorer countries. But if low savings rates explain the low *PPP* investment rates in poor countries, then we expect the investment rate to be low in poor countries at *domestic prices*. These terms are related as follows:

$$\text{PPP Investment Rate in country } j = \frac{I_j}{Y_j}$$

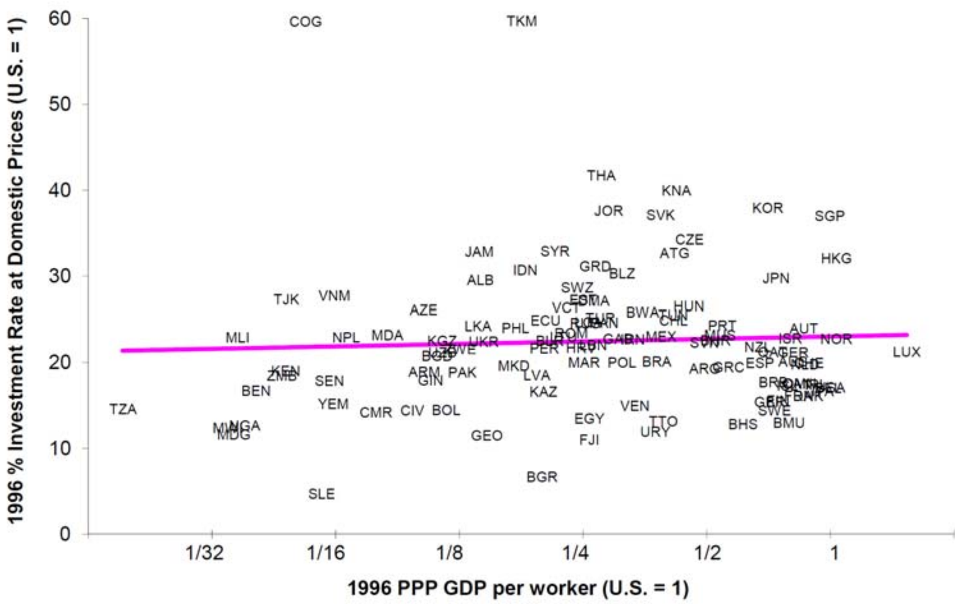
$$\text{Domestic Price Investment Rate in country } j = \frac{P_{I,j}\ I_j}{P_{Y,j}\, Y_j}$$

I_j and Y_j denote the value of investment goods and output, respectively, in country *j* valued at a common set of *international* (PPP) prices.[4] $P_{I,j}$ and $P_{Y,j}$ are the *domestic* prices investment and output, respectively, in country *j* relative to the international prices

[4] PPP prices are a weighted average of prices in different countries (Heston, Summers and Aten, 2002).

of investment and output. Figure 2, taken from Hsieh and Klenow (2007), shows that in 1996 there was no tendency for richer countries to invest a higher fraction of their GDP at domestic prices. Foreign capital inflows (including official aid) must have fully offset low domestic savings in poorer countries. Thus the key to understanding the low PPP investment rates in poor countries is to understand their high domestic relative price of investment (compared to the international relative price of investment).

FIGURE 2: Domestic Price Investment Rates vs. Income Levels



A corollary to Figure 2 is that the marginal product of capital looks higher in poor countries at international prices, but not at domestic prices. Caselli and Feyrer (2007) make this point, and further adjust the marginal product of reproducible capital (equipment and structures that go into *K*) by subtracting payments to nonreproducible capital (land, minerals). In their definitions:

$$\text{Naive } MPK_j = \frac{\alpha_j Y_j}{K_j} \qquad \text{Corrected MPK} \equiv \frac{\alpha_j P_{Y,j} Y_j - \text{rents}_j}{P_{K,j} K_j}$$

Figures 3 and 4 use data from Caselli and Feyrer on the marginal product of capital in 52 countries in 1996. In Figure 3, naïve marginal products hover around 10% in the OECD countries and range from 15% to almost 50% in poorer countries. So it looks as though capital flows fail to equalize marginal products. It is as if risk or implicit tax payments mandate higher marginal product in poorer economies.

FIGURE 3: Naïve MPK vs. Income Levels

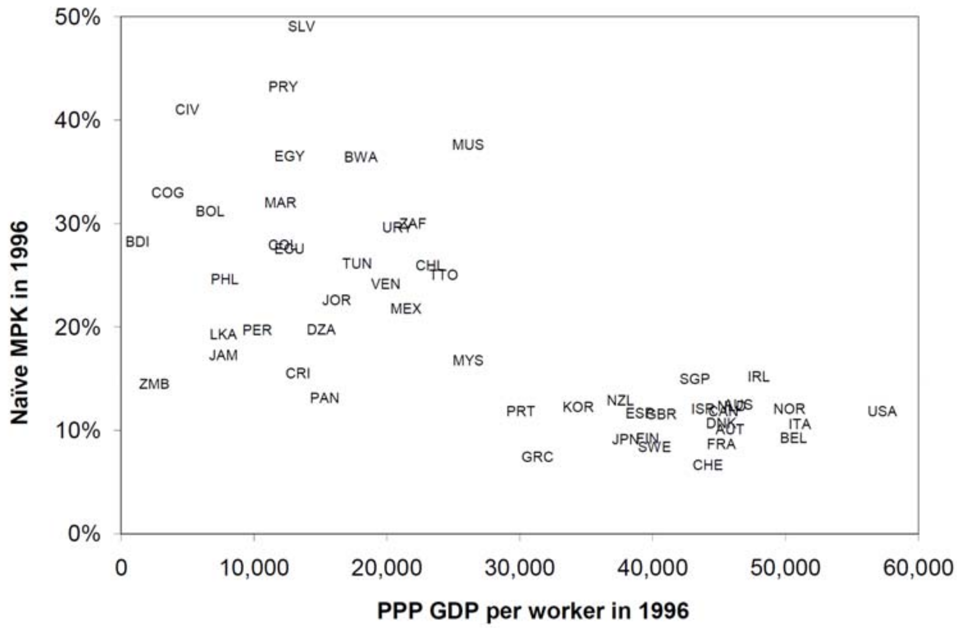


FIGURE 4: Corrected MPK vs. Income Levels

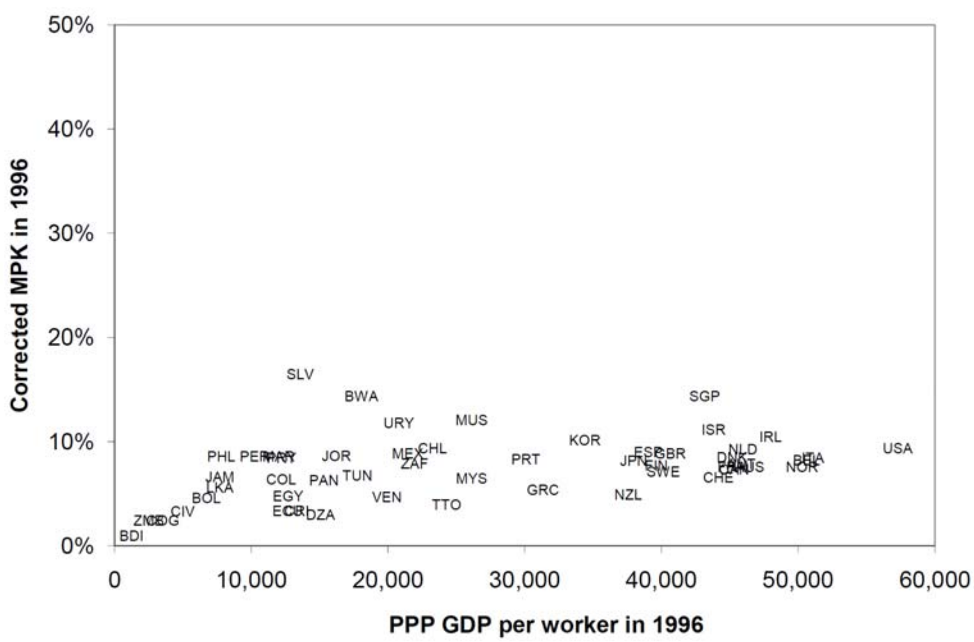
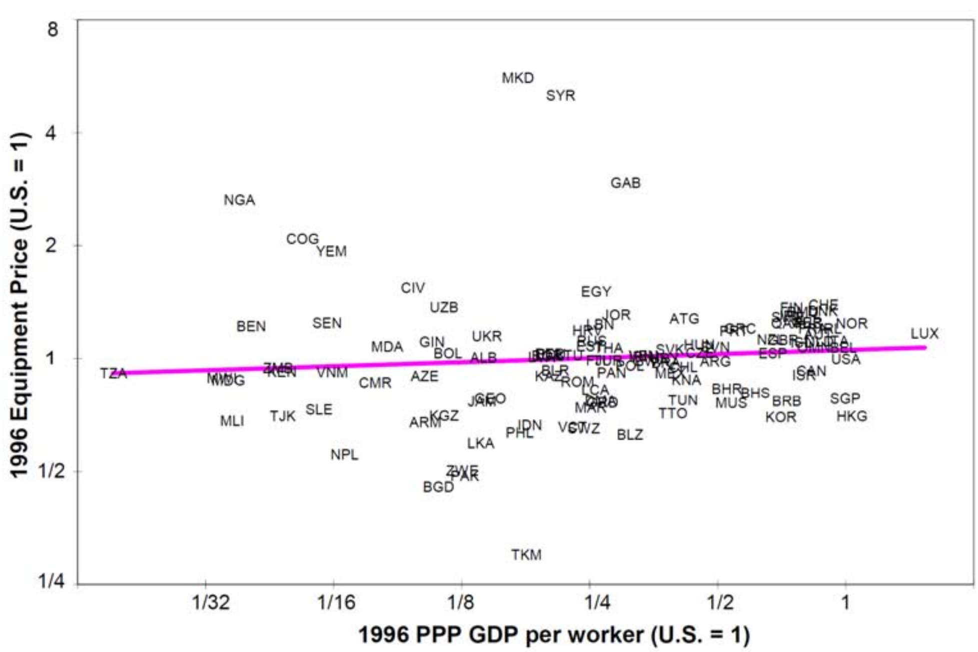


Figure 4 displays marginal products for the same 52 countries, only corrected for local differences in the price of capital relative to output and for payments to non-reproducible capital. Strikingly, marginal products now appear lower in most countries outside the OECD. Figure 4 suggests that rates of return are far more equalized than previously imagined. This is because the price of investment relative to output is higher in poor countries, and a higher fraction of capital income goes to non-reproducible capital in poor countries (e.g., in land-intensive agriculture).

The relative price adjustment conjures a second hypothesis for low PPP investment rates in developing countries: expensive investment goods relative to rich countries.[5] Eaton and Kortum (2001) establish that developing countries import most of their equipment, so transportation costs and trade barriers (tariffs and nontariff barriers alike) might make investment more expensive in poor countries. Hsieh and Klenow (2007) show this is not the case if one compares Penn World Table prices of investment goods across countries. Figure 5, taken from Hsieh and Klenow (2007), plots the price of equipment (relative to the US price) against relative income across countries in 1996.

FIGURE 5: Equipment Prices vs. Income Levels

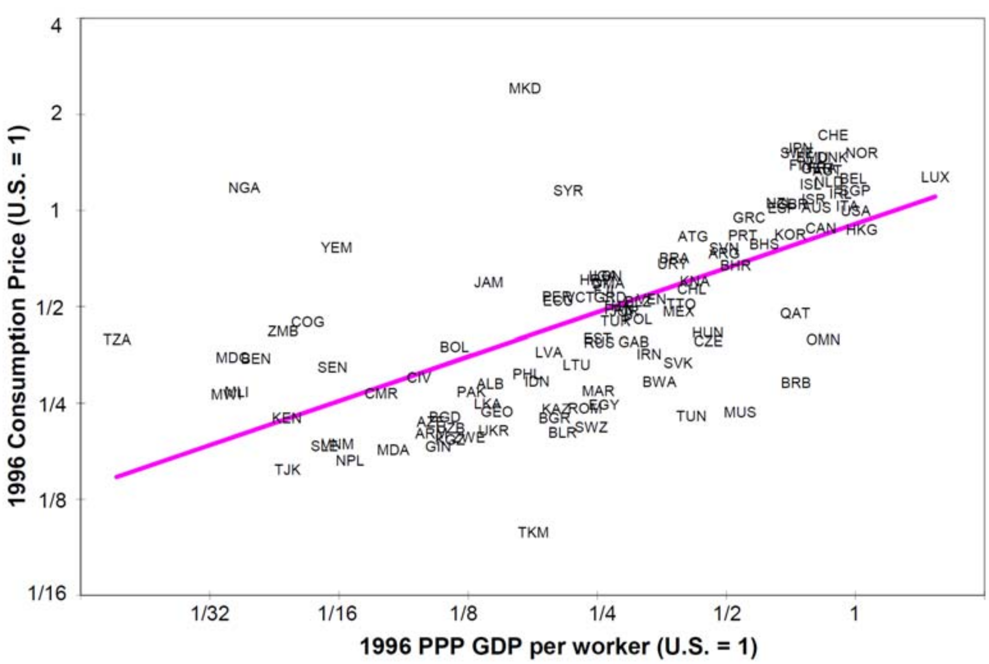


[5] The high relative price of investment in poor countries has been well-known since at least Barro (1991).

The price of equipment varies more among poor countries, but appears no higher in poor countries on average. Any import barriers seem to be offset by lower markups or lower local distribution costs.[6]

If investment is not particularly expensive in poor countries, then consumption must be cheap. Figure 6, also from Hsieh and Klenow (2007), confirms that PPP consumption prices are indeed lower in poor than rich countries. As an explanation, we proposed that poor countries have lower TFP in producing investment goods (relative to consumption goods). This relative TFP explanation can simultaneously rationalize why poor countries have lower PPP investment rates, similar domestic price investment rates, similar investment good prices (at least for tradable investment), and lower consumption good prices. The upshot is that relative TFP can exert a powerful indirect effect on income differences through its impact on capital accumulation.

FIGURE 6: Consumption Prices vs. Income Levels

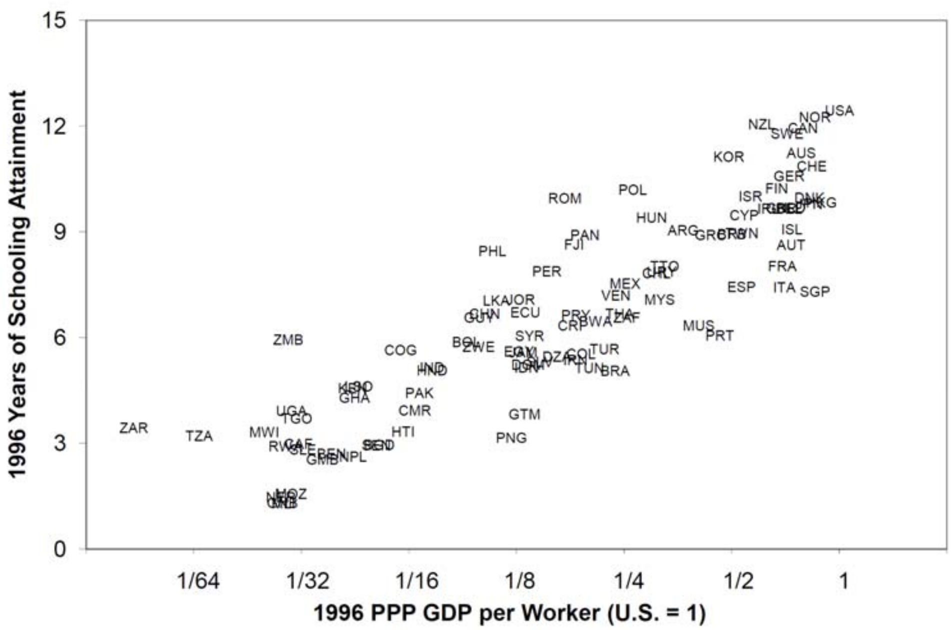


[6] An important caveat regards data quality. PPP prices are supposed to be quality-adjusted prices. Eaton and Kortum (2001) suggest this might not fully be the case, given that many developing countries produce some equipment but rarely export it, as if it is not competitively priced for the global market.

IV. Why does human capital vary?

Figure 7 combines Penn World Table 6.1 incomes with Barro-Lee (2000) data on educational attainment. Average schooling attainment ranges from about three years in the poorest countries to about twelve years in the richest countries. Earlier we dwelt on whether the Mincerian return across countries was closer to 10% (so that schooling contributes a factor of 2.5 to income differences) or 30% (implying income differences closer to a factor of 15). Here we ask *why* schooling attainment is higher in richer countries. We hasten to add that this section is admittedly more speculative than the previous one on physical capital. As we note below, we will omit many factors that could well be critical for explaining schooling differences across countries.

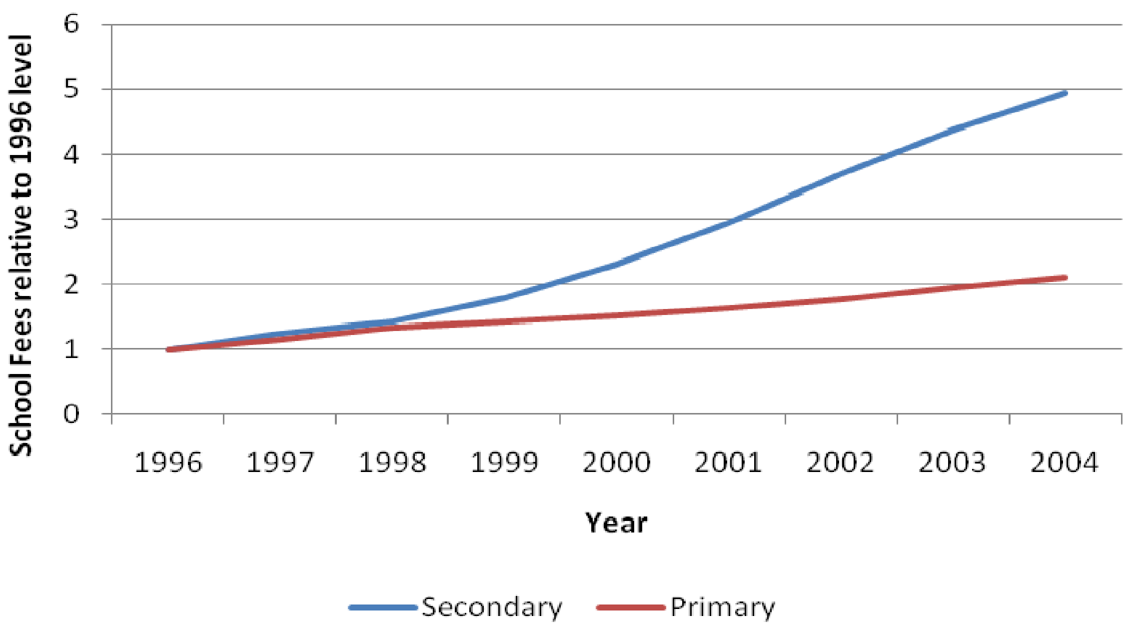
FIGURE 7: Schooling Attainment vs. Income Levels



A first candidate is that richer countries may provide greater public subsidies to education. Consider, for example, the case of Mexico. From 1991 to 2004 the *share* of government expenditures devoted to schooling rose from 15% to 26%. And public spending per student rose from 5% of GDP per capita to 15% of GDP per capita. This more generous public funding may have helped boost the secondary school enrollment rate from 45% in 1991 to 67% in 2004 in Mexico.[7]

But now consider China, which reduced public support for education at the same time. The share of public expenditures on education fell from 21% in 1994 to 15% in 2004, forcing students to finance more of their education out of tuition and fees, which rose from 7% to 32% of school spending over the same period. These ratios actually understate the decline in support for primary and secondary schooling in China, because at the same time it increased public support for universities. Figure 8 plots fees (in constant prices) for public primary and secondary schools in China from 1996 to 2004. Despite the increasing cost of public schooling, the enrollment rate in secondary schooling rose from 50% to 70% from 1991 to 2004 in China – almost parallel to the increase in Mexico.[8]

FIGURE 8: Public School Fees in China from 1996 to 2004



[7] The source of the numbers cited in the paragraph for school enrollment and spending in Mexico is the World Development Indicators.

[8] Figure 8 and the share of tuition and fees in total spending are from Hannum et al. (2008). Public spending on schools as a share of government spending and secondary school enrollment are from the World Development Indicators.

Clearly, other factors besides government funding are important for schooling attainment in China, and presumably elsewhere. To hint at some candidates, imagine that the marginal costs and benefit of additional schooling are

$$\text{MC}_i = \text{Direct Cost}_i + \text{Opportunity Cost}_i = P_i(S_i)$$

$$\text{MB}_i = \frac{\phi_i W_i(S_i)}{\delta(r_i, g_i, T_i - S_i)}.$$

The direct cost is tuition and the opportunity cost is foregone earnings, both of which are presumably increasing with the level of schooling S. The marginal benefit is the present discounted value of additional earnings. Here ϕ_i represents the Mincerian return to schooling, $W_i(S_i)$ is the wage for an individual with schooling S_i, and δ is an appropriate discount rate. The effective discount rate should be increasing in the real interest rate r_i, decreasing in the growth rate of wages g_i, and increasing in the number of years working $T_i - S_i$, where T_i is the retirement age. For simplicity let $T_i = \infty$ so that $\delta_i = r_i - g_i$. Then equating the marginal cost and marginal benefit of schooling yields

$$P_i(S_i) = \frac{\phi_i W_i(S_i)}{r_i - g_i} \Rightarrow \frac{P_i(S_i)}{W_i(S_i)} = \frac{\phi_i}{r_i - g_i}.$$

Although not necessary for the qualitative points we wish to make, we can obtain a closed form solution if we assume the cost of schooling relative to the wage is

$$\frac{P_i(S_i)}{W_i(S_i)} = \frac{P_i}{W_i} S_i^{\beta},$$

where P_i is the price of inputs to schooling, W_i is the wage, and $\beta > 1$. Combining the previous two equations yields

$$S_i^* = \left(\frac{\phi_i}{(P_i / W_i) \cdot (r_i - g_i)} \right)^{\frac{1}{\beta}}.$$

So optimal years of schooling are increasing in the Mincerian return and decreasing in the relative price of schooling (P_i / W_i) and decreasing in the effective discount rate ($\delta_i = r_i - g_i$). Do rich countries have higher schooling because of higher Mincerian returns, say due to skill biased technology? Banerjee and Duflo (2005) say no. They conclude Mincerian returns are pretty flat across countries with high vs. low schooling attainment. Might rich countries have lower discount rates because of better financial systems or better protection of property rights? If so, then the marginal product of capital should be lower in rich countries, contrary to the evidence in Caselli and Feyrer (2007). Related, if discount rates are lower in rich countries then we might expect to see *lower* Mincerian returns in rich countries, contrary to the Banerjee and Duflo evidence. See Card (2001) and Schoellman (2009) for expositions closely tying the Mincerian return to discount rates and the relative price of schooling. It is possible, of course, that discount rates and skill-biased technology differ in offsetting ways across countries. That is an open question for future research, as is the potential role for heterogeneity in discount rates across individuals.

Might the relative price of schooling fall with development? The Mexico vs. China comparison notwithstanding, perhaps rich countries subsidize schooling at a higher rate. Caselli (2005) finds little evidence for this in the Barro-Lee (2000) data on schooling expenditures. In China, growth in TFP may be reducing the price of non-time inputs to schooling (books, equipment, buildings) relative to the wage per unit of human capital. This is precisely the thesis of Manuelli and Seshadri (2007) and Erosa et al. (2007). Another possibility is that teacher salaries are lower relative to average wages in richer countries.

One would need a richer model to take to the data. This simple model does not incorporate many factors that surely affect schooling decisions, such as liquidity constraints, the ability to learn (presumably endogenous to early childhood investments), life expectancy, schooling costs not tied to the general level of wages, any direct consumption value of schooling, and cultural and institutional differences (in attitudes toward girls, for example).[9] But as of now we lack information on critical parameters even for this simple model. What does the human capital production function look like?

[9] Manuelli and Seshadri (2007) and Erosa, Koreshkova and Restuccia (2007) do incorporate several of these factors.

What is the price of schooling across countries? What is the curvature parameter β? We leave these vital questions for future research in growth, labor, and development fields.

V. Why does TFP vary?

As described, development accounting yields sizable residual TFP terms. We have argued in the previous two sections that TFP can indirectly affect physical and human capital accumulation through the relative price of physical and human capital. The natural next question is to ask why TFP itself varies.

One can decompose aggregate TFP into the (unweighted) average of firm level TFPs, and the efficiency of input allocation across firms. Parente and Prescott (2000) examine some of the many factors that affect TFP at the firm level, such as disembodied TFP, work rules, government ownership, and corruption.

Here we focus instead on how TFP can be affected by the efficiency of resource allocation across firms. This is an old idea, but there has been a recent surge of models and evidence on misallocation. Restuccia and Rogerson (2008) show that modest distortions can have nontrivial effects on aggregate TFP in a Lucas span-of-control model. Hopenhayn and Rogerson (1993) is an early model on misallocation of labor due to firing costs. Caselli and Gennaioli (2003) model misallocation of capital due to capital market imperfections, as do Buera and Shin (2008). Guner, Ventura and Xu (2008) analyze the consequences for TFP of size-dependent policies. Jones (2009) demonstrates that complementarities across industries can allow modest industry-level distortions to have larger effects on aggregate TFP.

As for evidence on the magnitude of resource misallocation, Banerjee and Duflo (2005) present suggestive evidence that India's low TFP in manufacturing relative to the U.S. could reflect misallocation of capital across plants. In Hsieh and Klenow (2009) we compare misallocation in China and India to that in the U.S. We document much wider dispersion in the value marginal products of capital and labor within manufacturing industries in China and India. We argue that misallocation could explain around one-third of the manufacturing TFP gap between China or India and the U.S. In China allocative efficiency appeared to improve over their 1998 through 2005 sample, just as inefficient state-owned enterprises faded in importance and manufacturing TFP surged.

In India we find no such improvement over 1987 to 1994 despite reforms, consistent with India's tepid manufacturing TFP growth.

In Hsieh and Klenow (2009) we also report a thick left tail of small plants in India even within the formal manufacturing sector. Here, we show how thick the left tail of small plants in India is when we include both formal and informal firms. Figure 9 compares the distribution of plant size (in terms of employment) in Indian vs. U.S. manufacturing, where Indian plants include formal and informal firms. The U.S. data is from the 1997 Census of Manufactures, and the Indian data is from combining the 1999 Annual Survey of Industries (which covers larger plants) with the 1999 National Sample Survey (which covers even the smallest plants). The majority of plants in Indian manufacturing have five or fewer workers, whereas in the U.S. most plants have more than forty workers.

Major questions for future research include the following: how much of the dispersion is real versus a byproduct of measurement error? What specific distortions (man-made or natural) generate greater dispersion in marginal products in poorer countries? How large are the misallocations across sectors? Why is the distribution of firm size so left-skewed in poor countries? We hope to see progress on these questions in the years to come.

Figure 9: Distribution of Plant Size, India vs. U.S.

VI. Conclusion

We have learned a great deal in the last two decades about the proximate determinants of income and growth differences. Although important questions remain, particularly about the role of human capital differences, there is a broad consensus that differences in human capital account for 10 to 30% of country income differences, physical capital accounts for 20%, and residual TFP may be the biggest part of the story (accounting for 50% to 70%).

But we have much less understanding why these factors differ. We suggest that boosting TFP may not only have a direct effect on output, but may also have an important indirect effect on physical capital and human capital by lowering the price of capital and schooling relative to the price of output. However, we need to know more, particularly about the production function for human capital, before we can make more definitive statements. Finally, we suggest the misallocation of inputs across firms and industries may be an important determinant in explaining differences in residual TFP, but it remains to be seen what the forces behind the misallocation are.

References

Armenter, Roc and Amartya Lahiri. 2006. "Endogenous Productivity and Development Accounting." Federal Reserve Bank of New York Staff Report 258.

Banerjee, Abhijit and Esther Duflo. 2005. "Growth Theory Through the Lens of Development Economics." In *Handbook of Economic Growth Volume 1A*, ed. Philippe Aghion and Steven Durlauf, 473-552. New York: North-Holland.

Barro, Robert J. 1991. "Economic Growth in a Cross-Section of Countries." *Quarterly Journal of Economics* 106(2): 407-443.

Barro, Robert J. and Jong-Wha Lee. 1993. "International Comparisons of Educational Attainment." *Journal of Monetary Economics* 32(3): 363-394.

Barro, Robert J. and Jong-Wha Lee. 2000. "International Data on Educational Attainment: Updates and Implications," National Bureau of Economic Research Working Paper 7911.

Blanchard, Olivier. 2004. "The Economic Future of Europe." *Journal of Economic Perspectives* 18(4): 3-26.

Buera, Francisco and Yongseok Shin. 2008. "Financial Frictions and the Persistence of History: A Quantitative Exploration." Unpublished.

Card, David. 2001. "Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems." *Econometrica* 69(5): 1127-1160.

Caselli, Francesco 2005. "Accounting for Income Differences Across Countries." In *Handbook of Economic Growth Volume 1A*, ed. Philippe Aghion and Steven Durlauf, 679-741. New York: North-Holland.

Caselli, Francesco and James Feyrer. 2007. "The Marginal Product of Capital." *Quarterly Journal of Economics* 122(2): 535-568.

Caselli, Francesco and Nicola Gennaioli. 2003. "Dynastic Management." National Bureau of Economic Research Working Paper 9442.

Cordoba, Juan Carlos and Marla Ripoll. 2007. "Endogenous TFP and Cross-Country Income Differences." *Journal of Monetary Economics* 55(6): 1158-1170.

Eaton, Jonathan, and Samuel Kortum. 2001. "Trade in Capital Goods." *European Economic Review* 45(7): 1195-1235.

Erosa, Andres, Koreshkova, Tatyana, and Diego Restuccia. 2007. "How Important is Human Capital? A Quantatitive Theory Assessment of World Income Inequality." Unpublished.

Gollin, Douglas. 2002. "Getting Income Shares Right." *Journal of Political Economy* 110(2): 458-474.

Guner, Nezih, Gustavo Ventura, and Yi Xu. 2008. "Macroeconomic Implications of Size-Dependent Policies." *Review of Economic Dynamics* 11(4): 721-744.

Hall, Robert E. and Charles I. Jones. 1999. "Why Do Some Countries Produce So Much More Output Per Worker Than Others?" *Quarterly Journal of Economics* 114(1): 83-116.

Hannum, Emily, Jere Behrman, Meiyan Wang, and Jihong Liu. 2008. "Education in the Reform Era." In *China's Great Economic Transformation*, ed. Loren Brandt and Thomas Rawski, Cambridge University Press.

Hendricks, Lutz. 2002. "How Important is Human Capital for Development? Evidence from Immigrant Earnings." *American Economic Review* 92(1): 198-219.

Heston, Alan, Robert Summers and Bettina Aten. 2002. "Penn World Table Version 6.1." Center for International Comparisons at the University of Pennsylvania.

Hopenhayn, Hugo and Richard Rogerson. 1993. "Job Turnover and Policy Evaluation: A General Equilibrium Analysis." *Journal of Political Economy* 101(5): 915-38.

Hsieh, Chang-Tai and Peter J. Klenow. 2007. "Relative Prices and Relative Prosperity." *American Economic Review* 97(3): 562-585.

Hsieh, Chang-Tai and Peter J. Klenow. 2009. "Misallocation and Manufacturing TFP in China and India." Forthcoming in the *Quarterly Journal of Economics* 124(4).

Jones, Benjamin F. 2008. "The Knowledge Trap: Human Capital and Development Reconsidered." National Bureau of Economic Research Working Paper 14138.

Jones, Charles I. 2009. "Intermediate Goods and Weak Links: A Theory of Economic Development." Unpublished.

Klenow, Peter J., and Andrés Rodríguez-Clare. 1997. "The Neoclassical Revival in Growth Economics: Has It Gone Too Far?" In *NBER Macroeconomics Annual***,** ed. Ben Bernanke and Julio Rotemberg, 73-103. Cambridge: MIT Press.

Klenow, Peter J. and Andrés Rodríguez-Clare. 2005. "Externalities and Growth." In *Handbook of Economic Growth Volume 1A*, ed. Philippe Aghion and Steven Durlauf, 817-861. New York: North-Holland

Levine, Ross, and David Renelt. 1992. "A Sensitivity Analysis of Cross-Country Growth Regressions." *American Economic Review* 82(4): 942–63.

Mankiw, N. Gregory, David Romer, and David N. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics* 107(2): 407-437.

Manuelli, Rodolfo and Ananth Seshadri. 2007. "Human Capital and the Wealth of Nations." Unpublished.

Parente, Stephen L., and Edward C. Prescott. 2000. *Barriers to Riches***.** Cambridge: MIT Press.

Parente, Stephen L., Richard Rogerson, and Randall Wright. 2000. "Homework in Economic Development: Home Production and the Wealth of Nations." *Journal of Political Economy* 108(4): 680-687.

Prescott, Edward C. 2004. "Why Do Americans Work So Much More Than Europeans?" National Bureau of Economic Research Working Paper 10316.

Pritchett, Lant. 2000. "The Tyranny of Concepts: CUDIE (Cumulated, Depreciated, Investment Effort) Is Not Capital." *Journal of Economic Growth* 5(4): 361-384.

Restuccia, Diego, and Richard Rogerson. 2008. "Policy Distortions and Aggregate Productivity with Heterogeneous Plants." *Review of Economic Dynamics* 11(4): 707-720.

Sala-i-Martin, Xavier. 1997. "I Just Ran Four Million Regressions." National Bureau of Economic Research Working Paper 6252.

Schoellman, Todd. 2009. "Measuring and Accounting for Cross-Country Differences in Education Quality." Unpublished.

Weil, David. 2007. "Accounting for the Effect of Health on Economic Growth." *Quarterly Journal of Economics* 122(3): 1265-1306.