Accounting for Cross-Country Income Differences with Public Capital*

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Abstract

This paper offers new evidence on the sources of cross-country income differences by investigating the role public capital in development accounting. I explicitly measure private and public capital stocks, and I find large differences in both types of capital across countries. Moreover, differences in private capital are larger than the ones I find for total capital for the richest and poorest countries. The methodology I use implies a share of public capital in output of at most 10%. My findings indicate that differences in capital stocks can not account for a substantial part of the observed dispersion in income across countries.

*Key words:*Income differences, Public capital, Development Accounting.

JEL Classifications: O11 · O41 · H41.

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1 Introduction

Cross-country differences in income per worker are known to be very high. The observed income ratio between the richest and poorest countries is around 30. The goal of this paper is to investigate the role of public capital in accounting for this observed cross-country income dispersion. Specifically, I ask if differences in private and public capital stocks across countries can account for the large observed cross-country income differences.

I perform a development accounting exercise by introducing public capital into the production function. By using data on public and private capital investments I provide new measures for the corresponding capital stocks for a sample of 45 countries. In addition, I carefully measure the share of each type of capital for the U.S. economy, and I assume they take the same values for all countries. Given my measures for capital stocks and technology parameters, differences in private and public capital across countries cannot go far in explaining the observed income dispersion. This is the main result of this paper and suggests that income differences are largely due to Total Factor Productivity (TFP) differences.

To perform the accounting exercise I first measure capital stocks for a sample of 45 countries. For this purpose, I exploit data on capital investment by governments from the World Bank and OECD that allows me to measure private and public capital stocks separately, for both rich and poor countries. I find that the ratio of aggregate public stocks between the 90th (rich country) and 10th percentile (poor country) countries in my sample is 181. In per worker terms, the ratio of public and private capital stocks between the 90th and 10th percentile countries is 28 and 289, respectively.

In addition, the value for the ratio of private capital-to-output ratios between the rich and poor countries is roughly twice their total capital-to-output ratios (10.8 versus 5). The latter has been interpreted as an indicator of the distortion in the capital accumulation process in poor countries relative to rich countries (see Restuccia and Urrutia (2001)). Therefore, this finding strongly suggests that the private sector accumulation process would be more distorted than what has been originally thought.

This paper provides comparable measures of each type of capital stocks for a sample of countries that includes poor, middle-income and rich countries. Kamps (2004) provides estimates for government net capital stocks for 22 OECD countries. This author presents public capital stock estimates in international dollars for 1980, 1990 and 2000. In his paper he follows a different methodology to obtain measures in international dollars, since public capital stocks are first estimated in national currencies and

then revaluated to international dollars. In addition, he uses PPPs for the GDP and not for investment goods as I do here. Arestoff and Hurlin (2006) estimate public capital stocks for 26 developing countries. These authors only provide measures of the stocks in national currencies.

I also provide new measures for the share of each type of capital in output for the U.S. by using data from NIPA (National Income and Product Accounts) tables. For my purposes, I need to compute the income that can be attributed to private capital and the values of services that come from the use of public capital. In my calibration methodology the values of these parameters depend on the value of the services that emerge from the use of public capital through two channels. The share of public capital is directly affected by the computed value of its services. Since the measure of output that is taken from the NIPA tables does not include the services from public capital, these services need to be added to output and so they affect the share of both types of capital. Furthermore, the value of services from public capital depends upon the definition of public capital considered and the choice of the return rate on public capital investments. I consider public capital as a pure public good and in per worker terms (my approach to congestion). Regarding its return rate I also consider two cases: when the return rate on public capital is equal to the value I obtain for the private return rate (8.3%) and when it is equal to the one suggested in Fernald (1999) (12%) for the U.S. road system, which I consider an upper bound. The value obtained for the share of private capital in output goes from 0.24 to 0.27. For public capital I find its share in output between almost 0 and 0.096.

In my development accounting exercise I assume that the share of public capital in output is constant across countries. It can be argued that for poor countries, this parameter could be higher since the returns to public capital investment could be higher provided their low levels of public capital stocks. However, the main result of this paper is robust to this observation.

Kamps (2004) considers time varying depreciation rates in the calculation of public capital stocks provided that the structure of public capital can change across time. In addition, Arestoff and Hurlin (2006) states that depreciation rates of public capital are different between rich and poor countries. The effect of the introduction of these modifications in my methodology to measure public capital stocks goes in favor of the main result of this paper.

Several papers have contributed to establishing a consensus that TFP differences are more important than factors in accounting for cross-country income differences. (See, for example, Klenow and Rodriguez-Clare (1997), Prescott (1998), Hall and Jones (1999)

and Caselli (2005).) This paper agrees with this view. In Caselli (2005), for instance, a standard development accounting exercise without splitting capital between private and public and with a Cobb-Douglas production function leads to the conclusion that factors of production explain less than 40% of the observed differences in income across countries (see Table 1 in Caselli (2005)).

If I take the factor measures provided in Caselli (2005) and the values of the technology parameters he used, the development accounting exercise would suggest that we need a TFP ratiobetween the richest and poorest countries of about 7 to explain the observed income ratio of 30. However, according to the literature that introduces public capital in the analysis, this result is somehow challenged in the sense that differences in factors can explain a substantial part of the observed income dispersion and so TFP differences between the richest and the poorest countries play a much smaller role. For instance, Chakraborty and Lahiri (2007) incorporate public capital in a neoclassical growth model where public agents produce public capital. The model is calibrated by using cross country data from World Development Indicators (WDI) (average 1990-1997) and it generates an income ratio of 33 with a TFP ratio of only 3. This result is reached with a ratio of public capital per worker between rich and poor countries of only 3 which is obtained by calibrating the parameters of their model (not by directly measuring the public capital stocks as I do in this paper) and technology parameters taken from previous work. Specifically, in their calculations the share of public capital in output is 0.17. In addition, Aschauer (1989) provides an estimated value of 0.39 for this parameter by including the U.S. aggregate public capital stock in the aggregate production function.

However, recall that my measure for the share of public capital in output for the U.S. is at most 10%. The value of this parameter is crucial in analyzing the contribution of public capital in accounting for cross-country income differences. For instance, given my measures of capital stocks and the share of private capital in output, using the value of the share of public capital estimated in Aschauer (1989) would solve the development problem since nearly all the dispersion of income across countries would be explained. Note, however, that in order to obtain the value estimated in Aschauer (1989) using my methodology, I would have to assume a rate of return to public capital of 90%. Therefore, even though I find large differences in public capital across countries the small value of the share of public capital in output I obtain makes me to conclude that differences in public capital cannot account for a substantial part of the observed income dispersion across countries.

Pritchett (2000) suggests that when doing development accounting we should not take investment data (i.e., data on capital formation) literally, particularly as it applies

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to public investment in poor countries. Intuitively, the value of investment goods is less than their cost (which is what the data represent), and this is different across countries. Related to Pritchett's view is the work by Hulten (1996) which distinguishes between public capital stock that is used effectively or ineffectively. In other words, due to poor maintenance or inadequate management of the total stock of public capital, only a portion makes an effective contribution to the production of output. This could be relevant in the case of infrastructure in poor countries.[1] Following Hulten's lead, it would appear promising to include in my analysis some notion of the differential effectiveness of public capital to help us explain income differences across countries. Along these lines, Caselli (2005) suggests that Prittchet's approach could be promising in accounting for cross-country income differences. To check for the robustness of the main result of this paper to the observations made by these authors, I adjust public capital stocks by assuming that 100% of the total public capital investments contributes to building the public capital stock in rich countries whereas in poor countries only 10% of public capital investments actually build their public capital stocks. Even in this extreme case factors cannot account for any substantial part of the observed dispersion in income across countries.

The paper is organized as follows. In Section 2, I first present the development accounting framework where I introduce public capital in the production function. Then I present my measures of capital stocks and technology parameters. Finally, I present the development accounting results and the robustness analysis. In Section 3 I explain in detail how I measure public, private and human capital stocks for my sample of countries. Section 4 shows how to obtain the measures for the technology parameters for the U.S.. Section 5 presents my conclusions.

2   Development Accounting with Public Capital

In this section I develop the development accounting framework. I include public capital into the aggregate production function in two different ways, as a pure public good and as a public good subject to congestion. Additionally, I present the main result of this paper which comes by performing the development accounting exercise using my measures of public and private capital stocks, human capital and technology parameters.

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[1]Hulten (1996) finds that differences in his effectiveness indicator explain 40% of the differences in growth performance between 1970 and 1990. Also, this effectiveness indicator is the most important source of divergence in growth across countries. Given this result, he interprets the effectiveness index as a proxy variable for TFP.

2.1 Framework

I assume a Cobb-Douglas with constant returns to scale technology to specify the production function for economy i

$$Y_i = A_i KT_i^{\alpha_1} (h_i L_i)^{1-\alpha_1} \tag{1}$$

where Y_i is aggregate output in country i, KT_i is aggregate capital stock, L_i is number of workers, A_i is the parameter that represents total factor productivity in country i, h_i is a measure of country's i human capital and α_1 is the aggregate total capital share on output. Then, dividing (1) by L_i

$$y_i = A_i kt_i^{\alpha_1} h_i^{1-\alpha_1}, \tag{2}$$

where y_i and kt_i are output and total capital per worker in country i, respectively. I call this specification *Specification 1*, which is the standard specification that ignores the distinction between the public and private capital stocks. The term A_i is not observable, but I have data on y_i and I can measure kt_i, h_i and α_1. I rewrite (2) as follows

$$y_i = A_i y_{1,i}, \tag{3}$$

where $y_{1,i} = kt_i^{\alpha_1} h_i^{1-\alpha_1}$ refers to the definition of output implied by *Specification 1* by assuming that only factors of production determine output.

Now I introduce public and private capital separately into the production function of country i. Consider

$$Y_i = A_i G_i^{\lambda_2} K_i^{\alpha_2} (h_i L_i)^{1-\alpha_2}, \tag{4}$$

where G_i is the aggregate stock of public capital of country i, K_i is the aggregate stock of private capital of country i, α_2 is the share of aggregate private capital in output and λ_2 is the share of aggregate public capital in output. Note that this two parameters need not to be the same as in *Specification 1*. I therefore use the subscripts to distinguish them. Dividing both sides by L_i, we obtain an expression for output per worker

$$y_i = A_i G_i^{\lambda_2} k_i^{\alpha_2} h_i^{1-\alpha_2}. \tag{5}$$

In this specification, which I call *Specification 2*, I am assuming that public capital is a pure public good. As usual, we have constant returns to scale at the firm level which takes G, the public good, as given. We have increasing returns to scale at the aggregate level.

As in the case of *Specification 1*, I rewrite (5) as

$$y_i = A_i y_{2,i}, \tag{6}$$

where $y_{2,i}$ is the measured output implied by *Specification 2* when only factors of production are taken into account.

However, public capital is subject to congestion, i.e., services from public capital goods decrease as more agents use them. For instance, the productivity of one mile of an avenue in New York City is not the same as one mile of the same type of avenue in Iowa City, IA. That means that allowing for congestion, public capital is not a pure public good, which means that we can have potentially different degrees of non-rivalry in the use of the public good. In Fernald (1999) we can find empirical evidence about the importance of congestion in the case of the U.S. road system. One possible way to specify congestion could be the one suggested in Glomm and Ravikumar (1994) where public capital is given by $\widehat{G} = \frac{G}{K^\theta L^\epsilon}$, where G and K are aggregate stocks of infrastructure and private capital, respectively, and L is aggregate labor.

I take one possible form of congestion by assuming that $\theta = 0$ and $\epsilon = 1$. I define $g_i = \frac{G_i}{L_i}$ to define the technology corresponding to *Specification 3*, which is represented by the following production function:

$$Y_i = A_i g_i^{\lambda_3} K_i^{\alpha_3} (h_i L_i)^{1-\alpha_3} \tag{7}$$

where g_i is public capital per worker in country i.

As in *Specification 2*, we have constant returns to scale at the firm level and have increasing returns to scale at the aggregate level. The only difference is in the measure of the public good considered.

Since λ_3 represents the share of public capital in output, the value of this parameter changes with the specification of congestion we use and this is why it is different from λ_2. Similarly, the alpha (α) parameter, which is the share of private capital in output, changes under different specifications of the production function. I therefore attach subscripts to the alpha's. As we will see in Section 4, any changes in the way we define congestion will affect our computed measure of the value of services from public capital and this will directly affect the value of the lambda (λ) parameter. In addition, changes in the value of services from public capital, in turn, modify the measure of output and, as such, indirectly affect the value of both α and λ.

Dividing both sides of (7) by L_i we obtain output in per worker terms

$$y_i = A_i g_i^{\lambda_3} k_i^{\alpha_3} h_i^{1-\alpha_3}. \tag{8}$$

Again, I rewrite (8) as

$$y_i = A_i y_{3,i}, \tag{9}$$

where $y_{3,i}$ is the measured output implied by *Specification 3*.

Since I want to account for the observed dispersion in income across countries, I assume that we have two countries, one rich (R, represented by the 90th percentile of income in the sample) and the other poor (P, represented by the 10th percentile of income in the sample). In addition, I assume that both are closed economies, are on a balanced growth path and have the same values for technology parameters in each specification of the production function. In Gollin (2002) we find empirical evidence about the constancy of $(1 - \alpha)$ across countries. It can be argued that for countries in early stages of development λ could be higher since the returns to public capital investment could be higher provided low levels of infrastructure. In subsection 3.2 I show that the main result of this paper is robust to this observation.

Then, using (2), (5) and (8), we have that

$$\frac{y_R}{y_P} = \frac{A_R}{A_P} \left(\frac{kt_R}{kt_P}\right)^{\alpha_1} \left(\frac{h_R}{h_P}\right)^{1-\alpha_1}, \tag{10}$$

$$\frac{y_R}{y_P} = \frac{A_R}{A_P} \left(\frac{G_R}{G_P}\right)^{\lambda_2} \left(\frac{k_R}{k_P}\right)^{\alpha_2} \left(\frac{h_R}{h_P}\right)^{1-\alpha_2}, \tag{11}$$

$$\frac{y_R}{y_P} = \frac{A_R}{A_P} \left(\frac{g_R}{g_P}\right)^{\lambda_3} \left(\frac{k_R}{k_P}\right)^{\alpha_3} \left(\frac{h_R}{h_P}\right)^{1-\alpha_3}. \tag{12}$$

In the development accounting exercise, the left hand side of eqs. (10)-(12), i.e., the ratio of rich-to-poor country income, are observable through data we have on country income. What we want is to dichotomize this ratio of aggregate income into its component parts, as represented by the expressions on the right-hand sides of eqs. (10)-(12). Now, the ratio of TFP's, i.e.,($\frac{A_R}{A_P}$) between rich and poor countries is not observable and so I measure the other factors on the right-hand sides of eqs. (10)-(12), given values for the parameters and capital stocks. In this way, we are able to determine how much of the differences in the observed income ratios can be explained by each of our specifications. In other words, we can determine how much of the observed income ratios can be explained by factors and how much by TFP ratios in each of the specifications. This is clearly seen by using equations (10), (11) and (12) together with (3), (6) and (9);

$$\frac{y_R}{y_P} = \frac{A_R}{A_P} \frac{y_{1,R}}{y_{1,P}}, \tag{13}$$

$$\frac{y_R}{y_P} = \frac{A_R}{A_P} \frac{y_{2,R}}{y_{2,P}}, \tag{14}$$

$$\frac{y_R}{y_P} = \frac{A_R}{A_P} \frac{y_{3,R}}{y_{3,P}}, \tag{15}$$

Following Caselli (2005), I define a first measure of success of each of the model specifications in accounting for the observed income differences, denoted by $s_{I,j}$, as

$$s_{I,j} = \frac{y_{j,R}/y_{j,P}}{y_R/y_P}, \tag{16}$$

for $j = 1, 2, 3$.

Another way to perform the development accounting exercise is by decomposing the variance of observed country's incomes. I therefore decompose the observed variances of income using my three different specifications of the production function. By applying logarithms and then the variance operator to equations (3), (6) and (9) we have

$$var\left[log(y)\right] = var\left[log(A)\right] + var\left[log(y_j)\right] + 2\,cov\left[log(A), log(y_j)\right], \tag{17}$$

for $j = 1, 2, 3$.

Since I want to analyze the explanatory power of each model specification, following Caselli (2005) I assume that $var\left[log(A)\right] = cov\left[log(A), log(y_j)\right] = 0$ and I define a second

measure of success of each of the model specifications in accounting for the observed income dispersion, denoted by $s_{II,j}$, as

$$s_{II,j} = \frac{var\left[log(y_j)\right]}{var\left[log(y)\right]} \tag{18}$$

for $j = 1, 2, 3$.

2.2 Cross-country Income differences with Public Capital

In order to perform the development accounting exercise given my specifications of the production function, first I need data on y. Second, I need measures of capital stocks h, k, G, g. Finally, I need values for the parameters α_j for $j = 1, 2, 3$ and λ_j for $j = 2, 3$.

From PWT (Penn World Tables) I am able to obtain data on real GDP per capita, population and real GDP per worker. Then I can recover the number of workers for each country needed to compute k and g.[2]

I first obtain measures of capital stocks by applying the perpetual inventory method. I calculate a depreciation rate for U.S. which I assume is constant across countries. In subsection 2.3 I discuss the effect of this assumption on my results. The methodology to measure capital stocks is explained in detail in Section 3.

Table 1 presents the measures for capital stocks, income and capital-to-output ratios for a sample of 45 countries. In order to facilitate the analysis, in Table 2 I present the measures for capital stocks for the 90th and 10th percentiles in the sample.

From Table 2 we can observe that the separation between private and public capital has important implications. There are large differences in both private and public capital stocks between rich and poor countries. For instance, note that the ratio between the 90th and 10th percentile for private capital stock is more than twice the one computed for total capital, both taken in per-worker terms. Recall that in Specification 2, public capital enters the production function in its aggregate form (i.e., as a pure public good). Table 2 shows that the dispersion in aggregate public capital stocks is also large but smaller that the ones observed for per-worker private capital stocks. The ratios of the 90th percentile over the 10th percentile are 181.2 and 288.7, respectively. When measuring public capital in per-worker terms (as it enters in Specification 3), there is still is a considerable dispersion (the ratio is more than 26) but it is substantially lower than the dispersion in per-worker private capital stock. The ratio of human capital between

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[2]The variables from PWT used in this step are POP (population), rgdpch (real GDP per capita using chain rule) and rgdpwok (real GDP per worker using chain rule).

rich and poor countries is around 2, which is similar to the value reported in previous literature for the measure of human capital considered here.

Another way to compare capital stocks across countries is by looking at capital-to-output ratios. Table 3 presents those ratios for the 90th and 10th percentile in the sample. The ratio of public capital-to-output ratios between rich and poor countries is 5.5, which is very close to 5.0, the ratio of the total capital-to-output ratios between rich and poor countries.[3] In the case of private capital, the ratio of capital-to-output ratios between rich and poor countries is 10.8, more than twice the ratio for the total capital. The reason is that the ratio of investment rates of private capital (the average in the period considered) between rich and poor countries is almost twice the ratio of investment rates of total capital.

We can interpret the differences in capital-to-output ratios as evidence of the relative distortion in capital accumulation between rich and poor countries. The separation of capital between private and private allows us to exclusively focus our analysis in the private sector, and this result strongly suggests that the private sector accumulation process would be more distorted than what has been originally thought.

The results of the accounting exercise depend crucially on the values of λ and α. In addition, when adding public capital in the production function, the value of these parameters depends on the specification of congestion used for public capital. I measure these parameters for the U.S. by using data from NIPA tables and I assume that they have the same values for all countries in the sample. In Gollin (2002) we find empirical evidence about the constancy of $(1 - \alpha)$ across countries and in subsection 3.2 I discuss the effect of assuming that λ is constant across countries. Details about the procedure followed to measure these parameters are presented in Section 4.

In order to compare the development accounting with public capital (Specification 2 and 3) to the standard accounting exercise, where no separation of capital is considered (Specification 1), I take $\alpha_1 = 1/3$ which is the value widely used in previous literature. The entries of Table 4 and Table 5 are the values obtained for λ and α, respectively, both when public capital is a pure public good and in the congestion case where public capital is taken in per worker terms.

As is made clear in Section 4, the value of these parameters are also affected by the choice of the return rate on public capital. I consider two cases: when the return rate on public capital is equal to the value I obtain for the private return rate (8.3%) and when it

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[3]Note that ratio of total capital-to-output ratios between rich and poor countries of 5.0 is similar to the one obtained by taking almost the same sample of countries from the data reported in Caselli (2005). The only difference in the sample is that Burundi, Dominica, Korea and Swaziland are not included in the sample his sample.

is equal to the one suggested in Fernald (1999) for the case of the U.S. road system (12%) which I consider an upper bound.

Note in Table 4 that when separating the capital stock into private and public the contribution of public capital to output is much smaller than that of private capital. Interestingly, for the case of public capital in per worker terms (congestion) the value of λ is approximately zero. [4] This is in line with the value of λ obtained in Holtz-Eakin (1994). In the case of public capital being a pure public good the value of λ goes from 0.075 to 0.096. The value of 0.075 for λ is similar to the value that could be obtained by using the measures for the value of services from public capital found in Martin, Landefeld and Peskin (1984). In addition, in Otto and Voss (1998) the estimated value of λ is 0.06 using Australian data and the same specification for the production function. However, it differs largely from the ones used by Chakraborty and Lahiri (2007) and the one estimated in Aschauer (1989). In Aschauer (1989) the estimate for λ is 0.39 using data on aggregate public capital stocks. Chakraborty and Lahiri (2007)use λ=0.17 with public capital in per worker terms. [5] In order to obtain the value estimated in Aschauer (1989), by using my methodology I would have to assume a rate of return to public capital of 90%.

Now I perform the development accounting exercises. That means, given my measures for capital stocks for each country and values for the parameters in each of the specifications, I compute $s_{I,j}$ and $s_{II,j}$ for $j = 1, 2, 3$.

Table 6 and Table 7 show the values for s_I and s_{II}, respectively, in each of the specifications of the production function considered.

First, using the standard specification (Specification 1) for the production function, the fraction of the observed income dispersion explained by factors is 0.29 in the case of s_I and 0.40 in the case of the alternative measure of success s_{II}. Note that these values are similar to the ones obtained by Caselli (2005) (0.34 and 0.39, respectively) and using the data in Hall and Jones (1999) (0.34 and 0.40, respectively). Recall that the dispersion in public capital stocks across countries was larger when it is defined as a pure public good (see Table 2). That means that Specification 2 (the one in which public capital enters in its aggregate form or is a pure public good) is the one that gives the best chance to public capital in accounting for the observed cross-country income differences. The measure of the success of Specification 2 goes from 0.32 or 0.34 (depending the rate of return on public capital considered) for the case of s_I (see rows 2 and 3 of Table 6) and the value

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[4]Although I do not present the results here, this is also the case if I specify congestion as $\frac{G_t}{L_t^{0.5}K_t^{0.5}}$ or $\frac{G_t}{K_t}$ or $\frac{G_t}{Y_t}$.

[5]For a survey of the literature on the estimation of λ, see Chapter 14 in Batina and Ihori (2005).

of s_{II} goes from 0.46 or 0.48 (see rows 2 and 3 of Table 7). Therefore, given public capital the best chance, these measures of success increase but not substantially.

As it is clear in Table 1, observed dispersion in physical capital stocks are amplified when separating capital between public and private so one might expect to obtain more explanatory power coming from this dispersion in factors across countries. However, since the value of λ is relatively small and α is smaller than the value considered in Specification 1, then the dispersion in income explained by the model is reduced, and the fraction of income dispersion across countries explained by factors of production remains under 50% in both measures of success considered.

The effect of the values of the parameters in the success of the models is even clearer when considering Specification 3. In Specification 3, the measured value of α is bigger than the one obtained in Specification 2 (0.27 versus 0.24) and so it raises the role of private capital in accounting for the observed income differences. In this specification, public capital is taken in per-worker terms (congestion), and as it is shown in Table 2, cross-country differences in public capital stocks are substantially reduced when comparing this definition of public capital to the one that considers it as a pure public good (see columns 2 and 3 of Table 2). But also the fact that the share of public capital in output is approximately zero ($\lambda_3 \simeq 0$) eliminates the role of public capital in accounting for cross-country income differences. These two contrary effects together cause both measures of success to be reduced to values that are even smaller than the ones obtained under Specification 1 (from 0.29 to 0.26 in the case of s_I and from 0.40 to 0.38 in the case of s_{II}). Therefore, in this specification, where public capital is introduced into the production function in a more realistic way, the results of the development accounting exercise suggest that factors of production explain less of the observed cross-country income differences. Therefore, differences in capital stocks across countries cannot go far in explaining the observed income differences between them. This suggests that differences in income are largely due to TFP differences, which is the residual in these calculations.

2.3 Robustness

As it is detailed in Section 3, in my methodology to measure public capital stocks I take the average scrapping depreciation rate for U.S. government capital as an approximation to the depreciation rate which is assumed constant across time and countries. Kamps (2004) also uses scrapping depreciation rates calculated from by using NIPA accounts to estimate public capital stocks for 22 OECD countries. However, this author considers a

time varying pattern for the depreciation rate since in that way, one takes into account the effect of changes in the composition of the capital stock across time. He finds that the depreciation rate has increased in the U.S. over the last 40 years, probably due to a increasing weight of short lifetime assets.

Arestoff and Hurlin (2006) estimate public capital stocks for 26 developing countries. In their methodology, they also use time varying depreciation rates. In addition, they state that depreciation rates in poor countries need not to be the same as the one calculated for rich countries, given the different composition of the public capital stocks observed in Latin America. For this reason, using data on the depreciation rates for different types of assets in the U.S. and the weight of some assets in Latin American countries, they provide estimates of depreciation rates for developing counties for 1980 to 1998. They find that the estimated depreciation rates slightly increase during the period of analysis.

Even though in the period I analyze, the scrapping depreciation rates I obtain for the U.S. do not vary much, in order to check for the robustness of my result and, in particular, of my capital stock measures, I incorporate the time varying scrapping rates. Specifically, I use the U.S. scrapping depreciation rates I calculated for each period, in my calculations of capital stocks for the OECD countries in my sample. In addition, to measure the capital stocks of the rest of the countries, I use the depreciation rates obtained in Arestoff and Hurlin (2006)[6]. The only effect these modifications is to minimally decrease the dispersion in public capital stocks across countries. Specifically, the ratio of aggregate capital stocks between rich and poor countries is 167.5 instead of 181.2 (second column of Table 2) and the ratio of the public capital stock per worker is 25.9 instead of 27.6 (third column of Table 2). More importantly, since the effect is to reduce public capital differences across countries, it lowers the explanatory power of factors of production in accounting for cross-country income differences. That means that these modifications goes in favor of the main conclusion of this paper.

In my methodology I assume that the share of public capital in output (λ) is the same for all countries. It can be argued that for countries in early stages of development λ could be higher since the returns to public capital investment could be higher provided low levels of public capital stocks. That means, the value of the parameter λ for poor countries would be higher than the one for rich countries. But again, if this is the case, since poor countries have lower public capital stocks than rich countries, we would have less dispersion the output obtained from the calibrated production function. In other

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[6]For years previous to 1980 I use the depreciation rate for 1980 and for years after 1998 the one obtained for 1998

words, differences in capital stocks would explain lower portion of the observed cross-country income differences. For instance, in the case of public capital being a pure public good, if I take $\lambda_{rich} = 0.075$ (the same as before) and $\lambda_{rich} = 0.15$ (which is the maximum value I obtain for the U.S.), the value of $s_{I,2}$ is 0.18 (compared to 0.32) and the value of $s_{II,2}$ is 0.24 (compared to 0.46).

According to Pritchett (2000), capital is different from what he calls Cumulated, Depreciated, Investment Effort (CUDIE). In general, when we use the data on government investment (or more precisely capital formation by governments) we are assuming that it represent the actual contribution to build the public capital stock. However, Pritchett (2000) argues that the actual investment effort is not what the data represent and moreover it is just a portion of it. In other words, governments investment goods purchases is what is registered in the data but a portion of them is lost because of inefficiencies, corruption, etc.. The investment data builds what he calls CUDIE and the data less the lost portion builds what would be the relevant stock of public capital. Pritchett shows that the difference between them is empirically relevant and it varies across countries.

In Chakraborty and Lahiri (2007) we find a similar idea but with some microeconomic foundations. In a neoclassical one sector growth model, public capital investments are not converted totally into public capital stocks. A portion of the public capital investments is lost because agents charged with carrying out public investment projects do not have the incentives to do their best.

I can link Prittchet's work with Hulten (1996) who studies the effectiveness of public capital. Public capital stock can be used effectively or ineffectively in the sense of Hulten (1996). In other words, of the total stock of public capital, only a portion is used effectively and so contributes to the production of output. This could be due to poor maintenance or inadequate management and can be significant in the case of infrastructure in poor countries. The 1994 World Development Report presents estimates on the effectiveness of different types of infrastructure. Using these data Hulten develops an effectiveness index that covers all types of infrastructure capital. Hulten finds that differences in the effectiveness indicator explain 40% of the difference in growth performance between 1970 and 1990 and that it is the most important source of divergence. Given this result, he interprets the effectiveness index as a proxy variable for TFP.

Caselli (2005) argues that Pritchett's point could be relevant in accounting for cross-country income differences. In particular, as suggested by Prittchet, when measuring public capital stocks we need to add an additional parameter in the perpetual inventory

method equation. That means, for country i

$$G_{i_t} = \gamma_i I_{ipub_t} + (1 - \delta)G_{i_{t-1}},$$

where G_{i_t} is the aggregate public capital stock of country i in period t, I_{ipub_t} is public capital investment of country i in period t, δ is the depreciation rate and γ_i is a parameter that represents the effectiveness of public investment to build public capital, i.e., the portion of the public investment that actually contributes to building the stock of public capital. For a developed country this parameter may be close to one and for a developing country would be less than one. According to Pritchett's (2000) estimation results, half or more of government investment spending has not created equivalent capital. In other words, 50% percent of the total government expenditures in investment goods is lost and does not actually contributes to building the stock of public capital.

For my purposes, I assume an extreme case when $\gamma_{rich} = 1$ and $\gamma_{poor} = 0.1$. Table 8 shows the dispersion in the new measured capital stocks which I call "adjusted" under this assumption. Private capital and human capital stocks are the same as before since I do not change anything in the procedure to obtain measures of them. The ratio of aggregate public capital stocks between the 90th and 10th percentiles is now 770.5. Under this extreme assumption I am penalizing public capital investments in poor countries and this is why the dispersion in public capital stock is even larger than the previous case.

Table 9 and Table 10 present the values of s_I and s_{II}. Note that in both cases, under Specification 1, the model does a better job than before, since I have amplified the dispersion of public capital stocks. However, if we compare the values of both measures of success with both Specification 2 and Specification 3 I obtain the same qualitative results. This suggests that the implications for the sources of cross-country income differences are robust against this alternative method of measuring public capital stocks. In other words, even in the extreme case when only 10% of public capital investment contributes to building the public capital stock in poor countries and taking public capital as a pure public good, income differences across countries may still be explained by TFP differences.

3 Measuring Public, Private and Human Capital Stocks

To compute aggregate private capital stocks, as in Hall and Jones (1999) and Caselli (2005) among others, I use the perpetual inventory method

$$K_{it} = I_{ipriv_t} + (1-\delta)K_{it-1},\tag{19}$$

where K_{it} is aggregate private capital stock of country i in period t, I_{ipriv_t} is aggregate private investment in country i in period t and δ is the depreciation rate.

I follow the same procedure to measure aggregate public capital stocks

$$G_{it} = I_{ipub_t} + (1-\delta)G_{it-1},\tag{20}$$

where G_{it} is aggregate public capital stock of country i in period t, I_{ipub_t} is aggregate public investment in country i in period t and δ is the depreciation rate.

I approximate the depreciation rate δ to its implicit average scrapping rate for the U.S.. I calculate scrapping rates for private and public capital stocks for each period from 1950-2003, by dividing the depreciation over the next capital stock in the same period. Then I compute the average in the period. I use the depreciation data reported in NIPA tables 1.7.5, and 7.3A and 7.3B , for private and public capital stocks, respectively. The net stocks of private and public capital are obtained from NIPA tables 2.1, and 7.1A and 7.1B , for private and public capital stocks, respectively. I obtain a depreciation rate of 4% for both types of capital. I assume that this rate is the same for all countries and it is not time varying. I discuss these assumptions below.

First, I need to calculate initial capital stocks for both types of capital. Now, in performing a development accounting exercise, one assumes that all countries are on a balanced growth path, as in Hall and Jones (1999). Therefore, in order to obtain the needed initial capital stocks, I use the balanced growth path expression for both kinds of capital in the Solow model. In the case of private capital I have that

$$K_{i0} = \frac{I_{ipriv_0}}{[(1+Y)(1+n_i)-(1-\delta)]},\tag{21}$$

where Y is the rate of technological progress which is common for all countries and n_i is the population growth rate of country i.

Similarly, for public capital the expression for the initial stock is given by

$$G_{i0} = \frac{I_{i pub_0}}{[(1+Y)(1+n_i) - (1-\delta)]}. \tag{22}$$

I use data on Gross Fixed Capital Formation (GFCF) by governments in local currency obtained from the World Bank Development Indicators database and OECD.Stat Extract online database (series codes are NE.GDI.FPUB.CN and GP51P, respectively). In addition, I use total GFCF as a percentage of Gross Domestic Product (GDP), also form the World Bank's Development Indicators (series code NE.GDI.FTOT.ZS). From the PWT v. 6.2 database I can calculate GDP in local currency.[7] This allows me to recover private GFCF, as the difference between total GFCF and public GFCF. The first data point varies with countries (from 1960 to 1992). I drop countries for which I do not have data before 1987[8]. My sample includes 45 countries listed in Table 1.

Then I deflate public GFCF and private GFCF time series in order to convert them into a common basket of goods (also called international dollars). The deflator is a Purchase Power Parity (PPP) convertor for investment goods, denoted by $PPPinv$, which I define as $PPPinv = P_I{}^* XRAT/100$ where P_I are prices of investment goods, and $XRAT$ are purchase power parity exchange rates, both as reported in PWT.[9] Therefore, after deflating, I have time series data on I_{pub} and I_{priv} in international dollars for 45 countries from the first period for which data are available for each country to 2003.

To calculate initial capital stocks, from PWT I obtain population data for my sample of countries which I use to compute the average growth rate from 1950 to 2003. Also, $Y = 1.8\%$ which I calculate by averaging the growth rate of Real RGDP per worker for the U.S., also obtained from PWT.

In order to measure human capital stocks, I follow Caselli (2005), who uses the specification provided by Hall and Jones (1999) in which human capital is given by

$$h_i = e^{\phi_{S_i} S_i}, \tag{23}$$

where S_i is the average years of schooling in the population over 25 years old of country i and ϕ_{S_i} is a coefficient that depends on the value of S_i and represents the returns on schooling years. To compute human capital stocks I use the data provided by Barro and

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[7]Specifically, I calculate GDP by multiplying the series cgd by the series PPP.

[8]In the case of Uruguay, the data are missing for 1988 and 1989 so I took the average of the adjacent years. For Zimbabwe the data for 2002 and 2003 are missing and so I use the values reported for 2001.

[9]Here, while knowing that it is not necessarily true, I am nevertheless assuming that prices are the same for both types of investment goods. I justify this assumption by arguing that, to my knowledge, there are no separate data on prices for private or public investment goods.

Lee (2001) for 2000.[10] From Caselli (2005), I take the following estimates of ϕ_S (common for all countries):

- 0.13 for $S \leq 4$,

- 0.10 for $4 < S \leq 8$, and

- 0.07 for $8 < S$.

The results are presented in columns 2-4 of Table 1 for the whole sample of countries and in columns 2-4 of Table 2 for the 90th and 10th percentile of the sample.

Kamps (2004) provides estimates for government net capital stocks for 22 OECD countries. This author presents public capital stock estimates in PPP for 1980, 1990 and 2000. However, instead of converting the investment series into international dollars to then use them to construct the capital stocks, these stocks are first estimated in national currencies and then revaluated to international dollars. In addition, this author uses PPP for GDP, not for investment goods as I do here.

Arestoff and Hurlin (2006) estimate public capital stocks for 26 developing countries. These authors only provide measures of the stocks in national currencies.

I use (21) and (22) to compute an initial measure of the stocks. In order to analyze the impact of this way of calculating initial stocks, I follow Caselli (2005) by computing the portion of the initial stock (which I call η_j for $j = K, G$) that survives the sample period, given the depreciation rate δ. In other words, what fraction of the initial stock is part of the stock in 2003? This is given by

$$\eta_K^j = \frac{(1-\delta)^t K_0}{(1-\delta)^t K_0 + \sum_{i=0}^{t}(1-\delta)^i I_{priv_{t-i}}},$$

for private capital, and

$$\eta_G^j = \frac{(1-\delta)^t G_0}{(1-\delta)^t G_0 + \sum_{i=0}^{t}(1-\delta)^i I_{pub_{t-i}}},$$

for public capital, for country j, where $t = 2003$, and 0 represents the year for which I have the first data point on investment for each country which are the same for both η_K and η_G. The average across countries of η_K is 0.08 and the values computed for each country are not correlated with their GDP per worker (the correlation coefficient is 0.02). In the case of public capital stocks, η_G is 0.09 but the values computed are negatively

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[10]2000 is the year nearest to 2003 for which Barro and Lee (2001) provide data.

correlated with GDP per capita (correlation coefficient is -0.28) which means that I may be overestimating public capital stock for poor countries. However, as is clear from Section 2, this does not affect the main result since it is mainly driven by the small value of the parameter λ.

4 Measuring Technology Parameters for the U.S.

Let λ be the share of public capital in output. That means that λ is the value of services that come from public capital divided by output,

$$\lambda = \frac{VS}{VS + GNP}, \tag{24}$$

where VS is the Value of Services from public capital and GNP is Gross National Product. Note that I divide by $GNP + VS$ as an approximation to actual output, since VS is not included in measured GNP.

However, it is not straightforward to compute the value of services from public capital because they are not normally traded in markets, as is the case with private capital. Following Martin, Landefeld and Peskin (1984), I compute the value of services by computing the cost of public capital assuming that all public investment projects are financially evaluated. Therefore, using this cost approach, the value of services is the sum of depreciation (*Dep*) and the net returns from public capital (*Net Returns*),

$$VS = Dep + Net\ Returns. \tag{25}$$

Depreciation is the annual allowance for using up public capital. *Net Returns* are measured by multiplying a rate of return on public capital, r_{pub}, by the value of the net stock of public capital (*Net Stock*), that means

$$Net\ Returns = r_{pub}{}^*(Net\ Stock). \tag{26}$$

In this approach, r_{pub} represents the opportunity cost of invested capital and I take two different values of this rate to measure *Net Returns*. This means, of course, that I am going to have two different values for VS. First, I use the return rate on public capital of 12% (which I consider an upper bound) estimated in Fernald (1999) for the case of the U.S. road system.

Second, I use the return rate on private capital calculated following the procedure described in Cooley and Prescott (1995). That means, I first define income from private

capital as unambiguous income (UI) plus its ambiguous component (AI) plus Depreciation (DEP). Let I_K be the income from private capital, so that

$$I_K = UI + AI + DEP. \tag{27}$$

The unambiguous component of private capital income is given by

$$UI = Rental\ Income\ +\ Corporate\ Profits\ +\ Net\ Interest \tag{28}$$

The ambiguous component of income from private capital includes Proprietors Income (PI) and the difference between Net National Product (NNP) and National Income (NI). Here I follow the same strategy as in Cooley and Prescott (1995): I assign this ambiguous income according to the share of private capital in measured GNP which I call α_M and it is defined as

$$\alpha_M = \frac{I_K}{GNP}, \tag{29}$$

that means

$$I_K = \alpha_M GNP. \tag{30}$$

Therefore

$$AI = \alpha_M [PI + (NNP - NI)]. \tag{31}$$

Then from (27) and (30) we have

$$UI + AI + DEP = \alpha_M GNP, \tag{32}$$

and by substituting (31) we get

$$UI + \alpha_M (PI + NNP - NI) + DEP = \alpha_M GNP. \tag{33}$$

Now from (33) we can solve for α_M

$$\alpha_M = \frac{UI + DEP}{GNP - (PI + NNP - NI)}. \tag{34}$$

I calculate UI by using data on the three terms on the right hand side of (28) obtained from NIPA Table 1.12 for each year from 1950 to 2003; specifically lines 12, 13 and 18 are *Rental Income*, *Corporate Profits* and *Net Interest*, respectively. In addition, from the same table PI (line 9) is obtained. From NIPA Table 1.7.5 I obtain DEP (line 6), NNP (line 14), NI (line 16) and GNP (line 4) for the same period. I compute α_M for each year from 1950

to 2003 and then I take the average over this period. The value is 0.27.

Now I move to calculate the return rate for private capital (r) which is given by

$$r = \frac{I_K}{K}, \tag{35}$$

where K is the net stock of private capital. By using the value obtained for α_M and (30) I calculate I_K from 1950 to 2003. I obtain K from line 1 in NIPA Table 2.1 for each year for the period considered. From (35) I calculate r for each year and take the mean which is 8.3%.

According to equations (24), (25) and (26) we still need values for *Net Stock* and *Dep* of public capital in order to measure λ. From line 1 in NIPA Tables 7.3A and 7.3B, I obtain data for the amount of depreciation of the U.S. government (Federal and State and Local) fixed assets (*Dep* in equation (25)), and from line 1 in Tables 7.1A and 7.1B I have estimates for the value of the net stock of U.S. government fixed assets (*Net Stock*), from 1950 to 2003. I measure λ both for the case of public capital as a pure public good and in the congestion case when public capital enters in the production function in per-worker terms. Hence, in the case of pure public good, I use the amount of depreciation and the net stocks of fixed assets as it is given in the NIPA tables, and in the case of public capital in per-worker terms, I divide these variables by the number of workers of the U.S. economy calculated from PWT. Therefore, we have a different value for λ for the return rate on public capital used and with the definition of public capital considered. Table 4 shows the values obtained for λ.

Now I operationalize α which, is the share of private capital in output. Since the value of services from public capital is not measured in GNP, the correct measure for the share of private capital in output is given by

$$\alpha = \frac{I_K}{GNP + VS}.$$

Given the data for GNP and the values calculated for VS and I_K obtained when I measure λ, we can compute α for each period and then take the average. However, the measure for VS depends on the return rate of public capital used and also on whether public capital is a pure public good or is subject to congestion. So, as in the case of λ, α varies with these two measures of VS. In Table 5 I present the values calculated for α.

5 Conclusions

This essay offers new evidence on the sources of cross-country income differences by investigating the role of the composition of capital between public and private across countries. Using data on public capital investments, I provide new measures for public and private capital stocks for a sample of 45 countries. Two important results emerge from my calculations. First, I find large differences in public capital stocks across countries. Second, the ratio of private capital-to-output ratios between rich and poor countries is twice the one for total capital-to-output ratio. The latter has been interpreted as an indicator of the distortion in the capital accumulation process in poor countries relative to rich countries. The separation of capital between private and private allows me to exclusively focus the analysis in the private sector, and this finding suggests that the private sector accumulation process would be more distorted than it has been originally thought. In addition, I carefully measure the share of each type of capital for the U.S. economy. When public capital is taken in per-worker terms (my approach to congestion), I find that the share of public capital in output is almost zero, and when it is a pure public good its share in output is less than ten percent. My calculations have important implications in accounting for cross-country income differences. Giving the best chance to public capital (pure public good), differences in factors of production across countries cannot go far in explaining the observed income differences between them. This conclusion is unchanged even when assuming that only ten percent of the public capital investments in poor countries effectively contributes to the building of the stock of public capital. This result confirms the view that cross-country income differences are largely due to TFP differences. My specification of the production function implies a minimum departure from the previous literature in developing accounting, and implies complementarities between private and public capital. Future research should investigate the specification of production technologies with public capital and provide the proper microfoundations.

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Tables

Table 1: Capital stocks, income and capital-output ratios in 2003

Country	G	k	g	h	y	k/y	kt/y
U.S.A.	3,380,042,102,917.4	146,764.2	22,477.8	3.4	67,865.4	2.2	2.5
Norway	69,820,997,388.43	163,684.3	29,477.7	3.3	65,698.8	2.5	2.9
Belgium	25,599,705,113.1	188,072.8	6,008.3	2.7	61,541.4	3.1	3.2
Austria	19,572,460,871.7	184,882.7	5,208.7	2.7	59,788.6	3.1	3.2
France	333,939,909,312.0	161,973.8	12,340.1	2.6	56,909.0	2.8	3.1
Netherlands	125,529,448,744.8	162,252.2	16,877.6	2.8	56,789.6	2.9	3.2
Australia	164,507,848,914.8	136,531.9	16,335.4	3.0	54,600.5	2.5	2.8
Italy	157,995,939,016.8	161,647.2	6,194.7	2.3	52,097.0	3.1	3.2
United Kingdom	386,582,190,856.4	103,925.5	13,000.2	2.8	51,923.9	2.0	2.3
Canada	332,560,632,804.0	127,984.4	19,553.8	3.2	51,795.9	2.5	2.8
Finland	24,776,978,365.5	152,206.2	9,581.5	3.0	48,015.7	3.2	3.4
New Zealand	26,645,935,360.3	103,910.8	13,492.0	3.3	44,346.6	2.3	2.6
Trinidad and Tobago	10,843,126,409.1	64,140.6	21,220.1	2.5	39,797.3	1.6	2.1
Mauritius	4,868,449,284.0	35,025.9	9,117.8	2.0	37,324.2	0.9	1.2
Korea, Rep.	481,202,783,222.2	100,330.0	19,464.3	3.0	33,783.7	3.0	3.5
Swaziland	3,157,956,835.8	15,534.1	7,325.9	2.0	24,108.6	0.6	0.9
Uruguay	15,941,181,289.8	24,317.6	10,279.9	2.4	19,491.3	1.2	1.8
Mexico	432,856,505,126.4	29,882.9	9,735.2	2.3	18,627.6	1.6	2.1
Dominica	16,665,540.4	22,450.4	560.2	1.9	17,701.3	1.3	1.3
Iran, Islamic Rep.	419,669,880,879.4	22,345.2	16,620.0	1.8	17,297.4	1.3	2.3
Algeria	99,645,113,741.3	15,617.7	8,234.3	1.8	16,254.0	1.0	1.5
Paraguay	10,928,245,206.5	14,960.2	4,697.0	2.0	12,237.2	1.2	1.6
Egypt, Arab Rep.	118,528,553,307.0	3,880.1	4,016.7	1.9	12,051.2	0.3	0.7
Turkey	240,829,206,911.9	17,280.6	7,087.3	1.9	11,812.4	1.5	2.1

Note: This table presents the measures of aggregate public capital stock (G), public capital stock per worker (g), private capital stock per worker (k), human capital stock (h), income per worker (y), private capital-to-output ratio (k/y) and total capital-to-output ratio (kt/y) for 2003 in international dollars for the whole sample of countries considered in this paper which are ordered by income per worker.

Country	G	k	g	h	y	k/y	kt/y
Turkey	240,829,206,911.9	17,280.6	7,087.3	1.9	11,812.4	1.5	2.1
Jordan	13,537,536,183.0	11,119.9	7,564.1	2.4	11,420.0	1.0	1.6
China	5,915,241,385,789.8	7,051.7	7,661.4	2.0	8,283.8	0.9	1.8
Bolivia	13,442,821,786.8	4,666.0	3,778.9	2.0	7,256.0	0.6	1.2
Cameroon	4,795,690,005.5	3,664.0	734.2	1.5	6,539.3	0.6	0.7
Honduras	7,516,065,872.9	6,434.4	3,010.5	1.7	6,121.0	1.1	1.7
Syrian Arab Rep.	18,289,432,932.5	2,594.1	3,115.4	2.0	6,039.0	0.4	0.9
Zimbabwe	9,745,985,219.7	10,690.9	1,721.2	1.9	5,416.6	2.0	2.3
Congo, Rep.	2,570,885,926.3	5,015.9	2,141.6	1.8	3,495.7	1.4	2.0
Senegal	4,861,365,901.3	1,677.6	1,030.3	1.3	3,154.1	0.5	0.9
Benin	4,105,097,518.9	1,281.6	1,281.2	1.3	2,956.7	0.4	0.9
Ghana	9,091,152,625.3	939.0	887.3	1.7	2,876.1	0.3	0.6
Mozambique	6,067,551,613.0	652.8	624.4	1.2	2,775.0	0.2	0.5
Mali	4,348,416,980.0	1,080.0	772.9	1.1	2,446.2	0.4	0.8
Rwanda	1,623,238,050.3	375.0	382.0	1.3	2,392.6	0.2	0.3
Uganda	2,494,214,398.5	499.7	200.8	1.5	2,297.5	0.2	0.3
Sierra Leone	1,003,250,470.5	679.2	474.2	1.3	1,931.5	0.4	0.6
Togo	2,076,561,079.6	1,577.9	899.2	1.5	,1855.0	0.9	1.3
Niger	5,733,967,113.5	459.5	1,131.8	1.1	1,821.4	0.3	0.9
Gambia	685,645,238.8	1238.7	887.7	1.3	1,820.7	0.7	1.2
Malawi	5,332,726,393.7	488.5	954.7	1.4	1,607.4	0.3	0.9
Burundi	2,581,525,724.1	116.7	796.0	1.2	1,434.8	0.1	0.6

Note: This table presents the measures of aggregate public capital stock (G), public capital stock per worker (g), private capital stock per worker (k), human capital stock (h), income per worker (y), private capital-to-output ratio (k/y) and total capital-to-output ratio (kt/y) for 2003 in international dollars for the whole sample of countries considered in this paper which are ordered by income per worker.

Table 2: Dispersion in Capital Stocks in 2003

	G	g	k	kt	h
Rich (90th pctile)	$406,434.8 \times 10^6$	$18,429.6$	$161,843.2$	$172,285.2$	3.0
Poor (10th pctile)	$2,243.6 \times 10^6$	668.4	560.6	1,343.1	1.3
Ratios	181.2	27.6	288.7	128.3	2.3

Note: This table presents the measures of aggregate public capital stock (G), public capital stock per worker (g), private capital stock per worker (k), total capital stock per worker (kt) and human capital stock (h) in international dollars in 2003 for the 90th *pctile* and 10th *pctile* of the sample of countries. The last row contains the ratio between the value that each variable takes for the rich country over the value that takes for the poor country.

Table 3: Capital-to-output ratios

	g/y	k/y	kt/y
Rich (90th pctile)	0.61	2.92	3.16
Poor (10th pctile)	0.11	0.27	0.63
Ratios	5.5	10.8	5.0

Note: This table presents the measures of public capital-to-output ratio (g/y), private capital-to-output ratio (k/y) and total capital-to-output ratio (kt/y) in international dollars in 2003 for the 90th *pctile* and 10th *pctile* of the sample of countries. The last row contains the ratio between the value that each variable takes for the rich country over the value that takes for the poor country.

Table 4: Measures of λ for the U.S.

	Private rate	Fernald (1999)
λ_2 (Pure public good)	0.075	0.096
λ_3 (Per worker)	$\simeq 0$	$\simeq 0$

Note: This table presents the measures of the share of public capital in output for the U.S. both when public capital is a pure public good (λ_2) and when public capital is taken in per worker terms (λ_3). The second column presents the results when I use a private rate of return for public capital whereas the third column shows the values for these parameters when I assume a rate of return of 12% provided in Fernald (1999).

Table 5: Measures of α for the U.S.

	Private rate	Fernald (1999)
α_2 (Pure public good)	0.25	0.24
α_3 (Per worker)	0.27	0.27

Note: This table presents the measures of the share of private capital in output for the U.S. both when public capital is a pure public good (α_2) and when public capital is taken in per worker terms (α_3). The second column presents the results when I use a private rate of return for public capital whereas the third column shows the values for these parameters when I assume a rate of return of 12% provided in Fernald (1999).

Table 6: Development Accounting. Success s_I

	s_I
$s_{I,1}$	0.29
$s_{I,2}$ Private rate	0.32
$s_{I,2}$ Fernald's rate	0.34
$s_{I,3}$	0.26

Note: This table presents the values for $s_{I,1}$, $s_{I,2}$ and $s_{I,3}$ which are the values of the first measure of success considered for specifications 1, 2 and 3, respectively, of the production function (see Section 2 for the definitions).

Table 7: Development Accounting. Success s_{II}

	s_{II}
$s_{II,1}$	0.40
$s_{II,2}$ Private rate	0.46
$s_{II,2}$ Fernald's rate	0.48
$s_{II,3}$	0.38

Note: This table presents the values for $s_{II,1}$, $s_{II,2}$ and $s_{II,3}$ which are the values of the second measure of success considered for specifications 1, 2 and 3, respectively, of the production function (see Section 2 for the definitions).

Table 8: Dispersion in Capital Stocks in 2003. "Adjusted" public capital.

	G	g	k	kt	h
Rich (90th pctile)	$333,388.2 \times 10^6$	16,660.7	161,843.2	172,285.2	3.0
Poor (10th pctile)	432.7×10^6	124.8	560.6	784.6	1.3
Ratios	770.5	133.5	288.7	219.6	2.3

Note: This table presents the measures of aggregate public capital stock (G), public capital stock per worker (g), private capital stock per worker (k), total capital stock per worker (kt) and human capital stock (h) in international dollars in 2003 for the 90th *pctile* and 10th *pctile* of the sample of countries when only 10% of public investment in poor countries contributes to build their public capital stock ("Adjusted" public capital). The last row contains the ratio between the value that each variable takes for the rich country over the value that takes for the poor country.

Table 9: Success s_I. "Adjusted" public capital

	s_I
$s_{I,1}$	0.34
$s_{I,2}$ Private rate	0.36
$s_{I,2}$ Fernald's rate	0.40
$s_{I,3}$	0.26

Note: This table presents the values for $s_{I,1}$, $s_{I,2}$ and $s_{I,3}$ which are the values of the first measure of success considered for specifications 1, 2 and 3, respectively, of the production function (see Section 2 for the definitions).

Table 10: Success s_{II}. "Adjusted" public capital.

	s_{II}
$s_{II,1}$	0.47
$s_{II,2}$ Private rate	0.50
$s_{II,2}$ Fernald's rate	0.54
$s_{II,3}$	0.38

Note: This table presents the values for $s_{II,1}$, $s_{II,2}$ and $s_{II,3}$ which are the values of the second measure of success considered for specifications 1,2 and 3, respectively, of the production function (see Section 2 for the definitions) in the case that only 10% of public investment in poor countries contributes to build their public capital stock("Adjusted" public capital).