# Investment Rate vs Relative Price of Invesment[1]

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## Abstract

In this paper I accomplish a levels account exercise across countries in order to calculate contributions from differences in the relative price of investment and the investment rate to differences in the physical capital-output ratio -and consequently in output per worker- across countries. I find that differences in the relative price of investment account for most differences in the physical capital-output ratio across countries and, consequently, if capital share on income is broadly consistent with national income accounts data, they have a moderate importance in accounting for differences in output per worker. However, differences in the investment rate account for very little disparity in physical capital-output ratio and output per worker across countries.

Keywords: Physical capital-output ratio, Output per worker, Investment rate, Relative price of investment.

*JEL Classification* E23, O47.

# 1 Introduction

Now, after the works of Hall and Jones (1999) and Klenow and Rodríguez-Clare (1997) we know that if capital share is broadly consistent with national income account data, then differences in the physical capital-output ratio play a secondary role to account for income disparity across countries. They find that the main reason of differences in output per worker across countries are differences in productivity. However, Mankiw, Romer and Weil (1992) attach higher importance to differences in human capital. The disparity between the findings of Mankiw, Romer and Weil (1992) and those of Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999) is due to the different measures of human capital used by these authors.[1]

Despite the secondary role of the physical capital-output ratio, it should not be underestimated. For example, output per worker of the United States multiplied by $25.64$ output per worker of Benin in year 2000. Differences in the Harrod-neutral productivity contributed a factor of $4.78$ and differences in human capital per worker contributed a factor of $3.13$, while differences in the physical capital-output ratio contributed a factor of $1.73$. Therefore, if Benin and the United States had the same physical capital-output ratio, differences in output per worker would be reduced to almost the half.

However, differences in physical capital-output ratio across countries can be due to differences in the investment rate and/or the relative price of investment. But, economic policies if differences in the physical capital-output ratio are mainly caused by differences in the investment rate or the relative price of investment could be very different. Therefore, discovering the main reason of disparity in the physical capital-output ratio would be very useful for economic policy.

Recentely, Hsieh and Klenow (2003) have pointed out that there are in the economic literature two broad sets of explanations for the low investment rates in poor countries. These explanations are (i) the existence of institutions and policies taxing capital income and (ii) the existence of low-savings traps because of susbsistence consumption needs.Therefore, economic policies favoring saving and removing taxes and credit constraints could enhance growth and reduce income disparity among countries.

[1] See McGrattan and Schmitz (1998) and Klenow and Rodríguez-Clare (1997) for a discussion in this respect.

The relative price of investment can differ among countries by a number of reasons. So, differences in distortions to investment or in the level of better technology in practice in each country can lead to differences in the relative price of investment. Distortions to investment have been invoked by a lot of authors as an important reason of observed income disparity among countries. Distortions to investment can be due to (i) fiscal policies in the form of taxation and trade restrictions,[2] (ii) implicit taxation due to obstacles to production (prohibitions, corruption, bureaucratic regulations, among others),[3] and (iii) direct government production of investment goods.[4] Therefore, economic policies favoring technological adoption and removing institutions and economic policies causing distortions to investment could reduce income disparity among countries.

The objective of this paper is to calculate contributions from differences in the relative price of investment and the investment rate to differences in both physical capital-output ratio and output per worker across countries. In order to calculate these contributions I accomplish a levels account exercise in the line of Hall and Jones (1999). I find that differences in the relative price of investment account for most disparity in the physical capital-output ratio across countries, while differences in the investment rate account for very little of the observed disparity. For example, the physical capital-output ratio of the United States multiplied by 3.00 the physical capital-output ratio of Benin in year 2000. Differences in the relative price of investment contributed a factor of 2.96, while differences in the investment rate contributed a factor of 1.05.

I have also calculated contributions from differences in the physical capital-output ratio, human capital and productivity to differences in output per worker across countries. I find that if capital share is broadly consistent with national income account data, then most differences in output per worker can be attributed to differences in productivity and human capital, while contribution from differences in the physical capital-output ratio is lower than the contributions from differences in productivity and human capital,

[2] Nevertheless, differences in tax rates or trade barriers across countries are small to account for the large differences in capital accumulation and income (Easterly and Rebelo (1993)).

[3] See Diaz-Alejandro (1970), Taylor (1997, 1998), De Soto (1986).

[4] See Schmitz (1996, 1997).

but not unimportant. My findings are very similiar to that of Hall and Jones in this respect. Therefore, from my analysis it follows that differences in the relative price of investment play a secondary role to account for income disparity across countries and the role of differences in the investment rate is negligible. For example, output per worker of the United States multiplied by 25.64 output per worker of Benin in year 200. Differences in the relative price of investment contributed a factor of 1.72, while differences in the investment rate contributed a factor of 1.025.

Several works have studied the relationship between the relative price of investment and growth and output. Jones (1994) used PPP-adjusted price of investment divided by the PPP-adjusted price of consumption as a comprehensive measure of the many distortions in capital formation, and he finds a strong negative relationship between growth and the price of machinery.[5] Chari, Kehoe and McGrattan (1997) use the investment price-consumption price ratio from the Summers and Heston data set to measure the tax on investment in a standard neoclassical growth model,[6] and they find that if the capital share is very high, on the order of 2/3, then differences in relative prices on the order of 5 or 6 imply a factor of 30 differences in incomes. Their result is confirmed by Restuccia and Urrutia (2000) who also use the relative price of investment to consumption as a measure of the barriers to investment and find that differences in relative prices cannot account for the income disparity in the data unless the capital share is very high. Restuccia (2001) introduce technology adoption and schooling decisions into a standard growth model and show that required differences in barriers implied by this model are much smaller. Jovanovic and Rob (1998) extend the basic model to include vintage capital and Parente, Rogerson and Wright (1997) introduce home production into the standard model. My paper is also very related to the one by Hsieh and Klenow (2003) in which they show that differences in the PPP investment rates across countries are almost completely driven by differences in the relative price of investment.

The rest of this paper proceeds as follows. Section 2 displays the model used in the levels account exercise. The measures of the variables are described in Section 3. Section 4 displays the results. Finally, Section 5 concludes.

[5] This relationship is also found by Barro (1991).

[6] Easterly (1993) also use the relative price of investment as a measure of policy distortions.

# 2 The model

The national account identity stablishes that nominal Gros Domestic Product (GDP), $P_Y Y$, is the sum of consumption expenditures, $P_C C$, investment expenditures, $P_I I$, government expenditures, $P_G G$, and net exports of goods and services, $P_{NX} XN$,

$$P_Y Y = P_C C + P_I I + P_G G + P_{NX} XN$$

where $Y$, $C$, $I$, $G$, $XN$ respectively are real GDP, real consumption, real investment, real government expenditure and real net exports and $P_i$, $i = Y, C, I, G, XN$ is the price index of $i$.

I assume that real GDP is given by a Cobb-Douglas production function

$$Y_i = K_i^{\alpha} \left(Z_i h_i L_i\right)^{1-\alpha}, \; 0 < \alpha < 1, \tag{1}$$

where $K_i$ is physical capital in country $i$, $h_i$ is human capital per worker in country $i$, $L_i$ is the number of workers in country $i$, and $Z_i$ is Harrod-neutral productivity in country $i$.

The evolution law of physical capital in country $i$ is

$$K_i' = I_i + (1 - \delta) K_i, \tag{2}$$

where $0 \leq \delta \leq 1$ is the depreciation rate.

Human capital per worker is assumed to be an exponential function of the average years of school in country $i$, $u_i \geq 0$,

$$h_i = \mathrm{e}^{\frac{\theta}{1-\beta} u_i^{1-\beta}}, \theta \geq 0, 0 \leq \beta \leq 1. \tag{3}$$

A function of human capital similar to this one has been used in several paper on growth and levels account (see for example Hall and Jones (1999), Klenow and Rodríguez-Clare (1997) and Bils and Klenow (2000)).

The investment rate is defined to be nominal investment divided by nominal GDP

$$s_i = \frac{P_{I,i} I_i}{P_{Y,i} Y_i} = R_i \frac{I_i}{Y_i}, \tag{4}$$

where $R = P_I/P_Y$. From the definition of $s_i$ it follows that the physical capital-output ratio of country $i$ relative to the physical capital output-ratio of the United States is given by

$$\left(\widehat{\frac{K}{Y}}\right)_i = \widehat{s}_i \left(\widehat{\frac{K}{I}}\right)_i \frac{1}{\widehat{R}_i}, \tag{5}$$

where a variable with hat " $\widehat{}$ " denotes the value of this variable relative to USA, $\widehat{x}_i = x_i/x_{usa}$. From previous equation it follows that differences in the physical capital-output ratio among countries can be due to differences in the relative price of investment, differences in the physical capital-investment ratio and differences in the investment rate.

The production function can be rewritten in terms of output per worker relative to the United States as

$$\left(\widehat{\frac{Y}{L}}\right)_i = \left(\widehat{\frac{K}{Y}}\right)_i^{\frac{\alpha}{1-\alpha}} \widehat{h}_i \widehat{Z}_i, \tag{6}$$

where $(\widehat{K/Y})_i^{\frac{\alpha}{1-\alpha}}$, $\widehat{h}_i$ and $\widehat{Z}_i$ respectively are contributions from differences in the physical capital-output ratio, human capital and Harrod-neutral productivity to differences in output per worker. Since $(\widehat{K/Y})_i^{\frac{\alpha}{1-\alpha}}$ is contribution from differences in the physical capital-output ratio it follows from (5) and (6) that $\widehat{R}_i^{-\frac{\alpha}{1-\alpha}}$, $\widehat{s}_i^{\frac{\alpha}{1-\alpha}}$ and $(\widehat{K/I})_i^{\frac{\alpha}{1-\alpha}}$ respectively are contributions from differences in the relative price of investment, the investment rate and the physical capital-investment ratio to differences in output per worker.

# 3 On the measure of the variables

Data are taken from the Penn World Tables 6.1 (PWT 6.1) excepting educational attainments which are taken from Barro and Lee (2000).[7] I have a sample of 92 countries which are listed in the appendix. I use data on output per worker, average educational attainments, physical capital, investment rates and relative prices of investment for year 2000.

[7] The PWT 6.1 are avalaible at the net adress pwt.econ.upenn.edu/ and the Barro and Lee's data are at www.worldbank.org/research/growth/ddbarle2.htm

*Output per worker*

The measure of output per worker, $Y_i/L_i$,used in calculations is rgdpwok, which is a variable of the PWT 6.1 and it is the chain GDP per worker at world prices . Therafter, all variables in black letters are variables of the PWT 6.1. Parameter $\alpha$ in the production function is assumed to be $\frac{1}{3}$, which is broadly consistent with national income accounts data for developed countries and it is used by Hall and Jones (1999).

*Human capital*

I assume that $u_i$ are the average years of school in country $i$ in year 2000 of the total population aged 25 and over reported by Barro and Lee (2000). For the parameters $\beta$ and $\theta$ I respectively take values 0.58 and 0.32, which have been estimated by Bils and Klenow (2000). Psacharopoulos (1994) estimated a mean Mincerian return about 0.099 across 56 countries. As Bils and Klenow (2000) show, the mean Mincerian returns to education equals $\theta u^{-\beta}$. Exploting this fact, Bils and Klenow (2000) estimate $\beta$ to be 0.58 and for this value of $\beta$ the value of $\theta$ so that the mean of $\theta u^{-\beta}$ equals the mean Mincerian return across Psacharopoulos' 56 countries is $\theta = 0.32$.

*Physical capital*

Physical capital stocks are constructed using the perpetual inventory method. I assume $\delta = 0.06$ and my measure of investment $I$ is

$$I = \text{ki} \times \text{rgdpl} \times \text{pop}, \tag{7}$$

where rgdpl is GDP per capita at constant world prices using Laspeyres price index, ki is the investment share of rgdpl and pop is population. The initial value of $K$ is taken to be $K_0 = I_0/(g + \delta)$ where $g$ is calculated as the average geometric growth rate from the initial year of the investment series to ten years after.

*The relative price of investment*

Using the PWT 6.1, investment expenditure in american dollars of a country is given by

$$P_I I = \text{pi} \times \text{ci} \times \text{cgdp} \times \text{pop}, \tag{8}$$

where $\mathsf{pi}$ is the price level of investment, $\mathsf{cgdp}$ is the GDP per capita at world prices and $\mathsf{ci}$ is the investment share of $\mathsf{cgdp}$. Investment is given by (7) and investment expenditure by (8), then price of investment is given by

$$P_I = \frac{P_I I}{I} = \mathsf{pi} \text{ x } \frac{\mathsf{ci}}{\mathsf{ki}} \text{ x } \frac{\mathsf{cgdp}}{\mathsf{rgdpl}}. \tag{9}$$

where $\frac{\mathsf{ci}}{\mathsf{ki}} \text{ x } \frac{\mathsf{cgdp}}{\mathsf{rgdpl}}$ is the implicit deflactor of investment, which equal $\mathsf{1}$ in the base year, 1996 in the PWT 6.1. Using the PWT 6.1, GDP in american dollars of a country is given by

$$P_Y Y = \mathsf{cgdp} \text{ x } \mathsf{pop} \text{ x } \mathsf{p}, \tag{10}$$

where $\mathsf{p}$ is the price level of GDP. My measure of output per worker is $Y/L = \mathsf{rgdpwok}$ and using PWT 6.1 the number of workers of a country is given by $L = \frac{\mathsf{rgdpch}}{\mathsf{rgdpwok}} \text{ x } \mathsf{pop}$, then it follows that the measure of the aggregate output is

$$Y = \mathsf{rgdpch} \text{ x } \mathsf{pop}, \tag{11}$$

where $\mathsf{rgdpch}$ is chain GDP per capita at world prices. From (10) and (11) it follows that the price of output is

$$P_Y = \frac{P_Y Y}{Y} = \frac{\mathsf{cgdp}}{\mathsf{rgdpch}} \text{ x } \mathsf{p}. \tag{12}$$

where $\frac{\mathsf{cgdp}}{\mathsf{rgdpch}}$ is the implicit deflactor of output, which equals $\mathsf{1}$ in the base year, 1996 in the PWT 6.1. Therefore, from equations (9) and (12) it follows that the relative price of investment is given by

$$R = \frac{P_I}{P_Y} = \frac{\mathsf{pi} \text{ x } \frac{\mathsf{cgdp}}{\mathsf{rgdpl}} \text{ x } \frac{\mathsf{ci}}{\mathsf{ki}}}{\mathsf{p} \text{ x } \frac{\mathsf{cgdp}}{\mathsf{rgdpch}}}, \tag{13}$$

The relative price of investment in the base year is $\frac{\mathsf{pi}}{\mathsf{p}}$ because both implicit deflator equal $\mathsf{1}$ in this year. Moreover, the implicit deflactor of investment, $\frac{\mathsf{cgdp}}{\mathsf{rgdpl}} \text{ x } \frac{\mathsf{ci}}{\mathsf{ki}}$, is the same for all countries, therefore $R_i = \frac{P_i}{P_{usa}}$ does not depend on this term.[8]

[8] Differently to Barro (1991), Easterly (1993), Jones (1994) and Chary, Kehoe and McGrattan (1997) I don't use the investment price-consumption price ratio as the measure of the relative price of investment.

*The investment rate*

The investment rate is defined by equation (4).Then, from (8) and (10) it follows that

$$s = \mathsf{ci} \text{ x } \frac{\mathsf{pi}}{\mathsf{p}},$$

which stablishes that the investment rate (at domestic prices) equals the investment rate at world prices, $\mathsf{ci}$, times the price of investment-price of output ratio, $\frac{\mathsf{pi}}{\mathsf{p}}$. Hsieh and Klenow (2003) show that $\mathsf{ci}$ is highly correlated with output across countries, while $s$ not is.[9]

# 4 Findings

Table 1 decomposes output per worker in each country into the three multiplicative terms: the contribution from the physical capital-output ratio, the contribution from human capital and the contribution from Harrod-neutral productivity. Table 2 breaks down contribution from the physical capital-output ratio to output per worker into three multiplicative terms: the contribution of the investment rate, the contribution of the physical capital-investment ratio and the contribution of the relative price of investment.[10] I haven chosen to display my results in terms of the contributions from differences in the investment rate and in the relative price of investment to differences in output per woker. However, contribution from differences in the investment rate (resp. in the relative price of investment) to differences in the physical capital-output ratio equals contribution from differences in the investment rate (resp. in the relative price of investment) to differences in output per worker power to $\frac{1-\alpha}{\alpha}$. Of course, in view of (5), it is clear that contributions from differences in the investment rate and the relative price of investment to differences in the physical capital-output ratio don't depend on $\alpha$.

The findings are the following:

[9] They also show that differences in the ratio $\mathsf{pi}/\mathsf{p}$ across countries are meanly driven by differences in $\mathsf{p}$.

[10] Contribution from the physical capital-investment ratio is calculated as a residual.

i *Contribution from the physical capital-output ratio to differences in output per worker is lower than contributions from differences in the Harrod-neutral productivity and human capital.*

This is the same result that as the one found by Hall and Jones (1999). For example, USA output per worker multiplies by 19.23 average output per worker of countries between 10% and 0% of USA output per worker. Differences in the physical capital-output ratio contributed a factor of 1.45, while differences in human capital and productivity respectively contributed a factor of 2.56 and 5.0. However, as argued in the introductory section, removing differences in the physical capital-output would have an important effect in reducing output per worker disparities. For example, for the considered group of countries differences in output per worker would be approximately reduced from a factor of 19.23 to 12.53 if differences in the physical capital-output ratio were removed.[11]

ii *Contribution from differences in the investment rate to differences in the physical capital-output ratio and output per worker -if $\alpha$ equals $\frac{1}{3}$- is very little.*

This fact can be inferred from the fact that the average relative invesment rate on the sample is 1.018 while for every decil of the relative output per worker distribution differences in the investment rate are very small, and also from the fact that correlations of its log with the log of relative output per worker and the relative physical capital-output ratio are low, respectively 0.217 and 0.321. Figure 1 and Figure 2 illustrate the weak relation between the relative investment rate and both relative output per worker and relative physical capital-output ratio.

iii *Differences in the relative price of investment account for most differences in the physical capital-output ratio across countries, and consequently, if capital share is broadly consistent with national income*

[11] Note that multiplying the average contributions from the physical capital-output ratio, human capital per worker and productivity is not equal to the average relative output per worker. The reason is that the average of a product is not equal to the product of the averages of the factors. But, difference is little in the data and I abstract from this problem.

*accounts data, then they have a moderate importance in accounting for differences in output per worker.*

For example, USA physical capital-output ratio multiplies by 2.1 the average physical capital-output ratio of countries with output per worker between 10 and 0 per cent of USA output per worker and USA output per worker multiplies by 19.23 the average output per worker of this same group of countries. Differences in the relative price of investment contributed a factor of 2.8 to the difference in the physical capital-output ratio, while they contributed a factor of 1.67 to the difference in output per worker. Moreover, in Table 2 it can be seen that correlations of the log of the relative price of investment with the logs of the relative physical capital-output ratio and relative output per worker are high, respectively $-0.868$ and $-0.717$. Figure 3 and Figure 4 illustrate the strong relation between the relative price of investment and both relative output per worker and relative physical capital-output ratio.

Contribution from the relative price of investment to output per worker is given by $R_i^{\frac{-\alpha}{1-\alpha}}$. Therefore, it heavily depends on the choice of $\alpha$. In this work I chosen $\alpha = \frac{1}{3}$, as in Hall and Jones (1999), which implies that $\frac{\alpha}{1-\alpha}$ equals $\frac{1}{2}$. So, it is the square root of the difference in the relative price of investment what matters for output per worker. When $\alpha$ increases so does the contribution of differences in the relative price of investment. It explains the result of Chari, Kehoe and McGrattan (1997) and Restuccia and Urrutia (2000) that differences in the relative price of investment can not account for the income disparity in the data unless we assume a capital share very high. However, little differences in the relative price of investment could provoke great differences in output per worker even if capital share is low if we assume that these differences cause differences in human capital accumulation and/or Harrod-neutral productivity. This way is explored by Restuccia (2001).

# 5 Conclusion

In this paper I calculated contributions from differences in the relative price of investment and the investment rate to differences in output per worker and physical capital-output ratio across countries. I show that if capital share is broadly consistent with national income accounts data for developed countries -about 1/3- then the contribution from differences in the relative price of investment to differences in output per worker is moderate, but lower than the contribution from differences in human capital or Harrod-neutral productivity. However, differences in the relative price of investment are the main reason of differences in the physical capital-output ratio across countries, while the role played by differences in the investment rates is very small. So, contribution from differences in the investment rate to differences in output per worker is negligible.

Distinction between contributions from the relative price of investment and the investment rate could be very important for economic policy. If differences in the investment rate were the main cause of differences in the physical capital-output ratio, then efforts of economic policy should be concentrated in the capital market, favoring saving and removing credit constraints. However, if the main reason are differences in the relative price of investment -as I found- economic policy should be aimed in favoring technological adoption and removing distortions to investment.

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# Appendix A

Table 3: Productivity Calculations

| Country | Code | $Y/L$ | $\widehat{K/Y}^{\frac{\alpha}{1-\alpha}}$ | $\hat{h}$ | $\hat{Z}$ | $\hat{R}^{\frac{-\alpha}{1-\alpha}}$ | $\hat{s}^{\frac{\alpha}{1-\alpha}}$ | $\widehat{K/I}^{\frac{\alpha}{1-\alpha}}$ |
|---|---|---|---|---|---|---|---|---|
| Ireland | IRL | 1,008 | 0,836 | 0,769 | 1,569 | 0,848 | 1,091 | 0,904 |
| U. S. A. | USA | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Belgium | BEL | 0,879 | 1,116 | 0,749 | 1,053 | 0,960 | 1,019 | 1,140 |
| Norway | NOR | 0,837 | 1,220 | 0,971 | 0,707 | 1,024 | 1,033 | 1,154 |
| Italy | ITA | 0,836 | 1,119 | 0,633 | 1,180 | 0,944 | 0,993 | 1,193 |
| Canada | CAN | 0,810 | 1,082 | 0,939 | 0,797 | 1,029 | 1,002 | 1,049 |
| Netherlands | NLD | 0,809 | 1,079 | 0,784 | 0,957 | 0,918 | 1,043 | 1,127 |
| Hong Kong | HKG | 0,808 | 1,048 | 0,800 | 0,965 | 0,870 | 1,153 | 1,045 |
| Australia | AUS | 0,799 | 1,076 | 0,877 | 0,846 | 0,964 | 1,009 | 1,107 |
| Denmark | DNK | 0,787 | 1,110 | 0,843 | 0,841 | 0,978 | 1,021 | 1,111 |
| Austria | AUT | 0,784 | 1,158 | 0,753 | 0,898 | 0,931 | 1,088 | 1,144 |
| France | FRA | 0,761 | 1,145 | 0,724 | 0,918 | 0,989 | 0,996 | 1,162 |
| Finland | FIN | 0,755 | 1,108 | 0,847 | 0,805 | 0,922 | 0,990 | 1,215 |
| Switzerland | CHE | 0,735 | 1,265 | 0,864 | 0,672 | 1,041 | 1,011 | 1,202 |
| Germany | GER | 0,719 | 1,180 | 0,819 | 0,744 | 0,942 | 1,036 | 1,209 |
| Sweden | SWE | 0,704 | 1,080 | 0,934 | 0,698 | 0,977 | 0,931 | 1,187 |
| Island | ISL | 0,698 | 1,096 | 0,750 | 0,850 | 0,994 | 1,081 | 1,020 |
| U.K. | GBR | 0,692 | 0,996 | 0,791 | 0,878 | 0,980 | 0,923 | 1,101 |
| Spain | ESP | 0,684 | 1,105 | 0,650 | 0,952 | 0,915 | 1,112 | 1,086 |
| Israel | ISR | 0,675 | 1,090 | 0,783 | 0,790 | 1,043 | 0,966 | 1,082 |
| New Zealand | NZL | 0,610 | 1,085 | 0,946 | 0,594 | 0,950 | 1,008 | 1,134 |
| Japan | JPN | 0,600 | 1,306 | 0,817 | 0,562 | 0,981 | 1,119 | 1,190 |
| Korea | KOR | 0,571 | 1,144 | 0,869 | 0,574 | 0,882 | 1,197 | 1,083 |
| Greece | GRC | 0,546 | 1,099 | 0,734 | 0,677 | 0,925 | 1,046 | 1,136 |
| Portugal | PRT | 0,542 | 1,047 | 0,499 | 1,039 | 0,890 | 1,192 | 0,987 |
| Slovenia | SVN | 0,514 | 0,944 | 0,656 | 0,830 | 0,926 | 1,156 | 0,881 |
| Barbados | BRB | 0,511 | 0,706 | 0,775 | 0,934 | 0,430 | 0,935 | 1,755 |
| Mauritius | MUS | 0,467 | 0,704 | 0,539 | 1,231 | 0,604 | 1,114 | 1,047 |
| Malaysia | MYS | 0,426 | 0,973 | 0,691 | 0,634 | 0,802 | 1,111 | 1,092 |
| Trinidad & Tob. | TTO | 0,419 | 0,729 | 0,674 | 0,852 | 0,622 | 0,953 | 1,230 |

| Country | Code | $Y/L$ | $\widehat{K/Y}^{\frac{\alpha}{1-\alpha}}$ | $\hat{h}$ | $\hat{Z}$ | $\hat{P}^{\frac{-\alpha}{1-\alpha}}$ | $\hat{s}^{\frac{\alpha}{1-\alpha}}$ | $\widehat{K/I}^{\frac{\alpha}{1-\alpha}}$ |
|---|---|---|---|---|---|---|---|---|
| Argentina | ARG | 0,398 | 0,950 | 0,732 | 0,572 | 0,867 | 0,877 | 1,250 |
| Hungary | HUN | 0,395 | 1,063 | 0,754 | 0,492 | 0,841 | 1,213 | 1,043 |
| Chile | CHL | 0,389 | 0,894 | 0,692 | 0,628 | 0,838 | 1,063 | 1,002 |
| Mexico | MEX | 0,381 | 0,937 | 0,615 | 0,661 | 0,891 | 1,058 | 0,993 |
| Czech Rep. | CZE | 0,377 | 1,176 | 0,799 | 0,401 | 0,841 | 1,197 | 1,169 |
| Slovak Rep. | SVK | 0,365 | 1,309 | 0,780 | 0,358 | 0,853 | 1,205 | 1,274 |
| South africa | ZAF | 0,341 | 0,736 | 0,691 | 0,670 | 0,633 | 0,850 | 1,367 |
| Uruguay | URY | 0,328 | 0,821 | 0,650 | 0,615 | 0,786 | 0,818 | 1,277 |
| Poland | POL | 0,314 | 1,059 | 0,830 | 0,357 | 0,877 | 1,131 | 1,068 |
| Tunisia | TUN | 0,305 | 0,783 | 0,454 | 0,859 | 0,639 | 1,150 | 1,067 |
| Iran | IRN | 0,303 | 0,891 | 0,483 | 0,705 | 0,794 | 0,982 | 1,143 |
| Brasil | BRA | 0,298 | 0,962 | 0,476 | 0,650 | 0,811 | 0,993 | 1,195 |
| Croatia | HRV | 0,279 | 0,737 | 0,600 | 0,632 | 0,788 | 1,030 | 0,907 |
| Venezuela | VEN | 0,275 | 0,971 | 0,543 | 0,522 | 0,833 | 0,920 | 1,266 |
| Jordan | JOR | 0,251 | 0,821 | 0,657 | 0,465 | 0,682 | 0,989 | 1,217 |
| Dominican Rep. | DOM | 0,251 | 0,713 | 0,515 | 0,683 | 0,706 | 1,069 | 0,944 |
| Russia | RUS | 0,247 | 0,698 | 0,871 | 0,406 | 0,715 | 0,909 | 1,073 |
| Panama | PAN | 0,246 | 1,021 | 0,693 | 0,348 | 0,880 | 1,206 | 0,962 |
| Syria | SYR | 0,244 | 0,673 | 0,552 | 0,657 | 0,551 | 0,971 | 1,258 |
| Turkey | TUR | 0,236 | 0,917 | 0,492 | 0,523 | 0,909 | 1,034 | 0,976 |
| Costa rica | CRI | 0,230 | 0,850 | 0,569 | 0,475 | 0,813 | 0,908 | 1,153 |
| Algeria | DZA | 0,225 | 0,921 | 0,487 | 0,503 | 0,640 | 1,072 | 1,343 |
| Egypt | EGY | 0,213 | 0,518 | 0,508 | 0,811 | 0,455 | 1,073 | 1,061 |
| El salvaor | SLV | 0,210 | 0,632 | 0,473 | 0,702 | 0,661 | 0,903 | 1,058 |
| Gutemala | GTM | 0,206 | 0,623 | 0,385 | 0,857 | 0,660 | 0,898 | 1,051 |
| Thailand | THA | 0,197 | 1,177 | 0,575 | 0,291 | 0,844 | 1,052 | 1,326 |
| Swaziland | SWZ | 0,194 | 1,010 | 0,551 | 0,349 | 0,862 | 0,972 | 1,205 |
| Bulgaria | BGR | 0,184 | 0,630 | 0,818 | 0,358 | 0,610 | 0,890 | 1,162 |
| Colombia | COL | 0,178 | 0,783 | 0,505 | 0,450 | 0,787 | 0,768 | 1,296 |
| Ecuador | ECU | 0,169 | 0,995 | 0,602 | 0,282 | 0,811 | 0,901 | 1,361 |
| Paraguay | PRY | 0,162 | 0,790 | 0,552 | 0,371 | 0,641 | 1,031 | 1,195 |
| Peru | PER | 0,156 | 1,018 | 0,655 | 0,235 | 0,852 | 0,984 | 1,214 |
| Indonesia | IDN | 0,139 | 0,873 | 0,486 | 0,327 | 0,727 | 0,929 | 1,293 |

| Country | Code | $\widehat{Y/L}$ | $\widehat{K/Y}^{\frac{\alpha}{1-\alpha}}$ | $\hat{h}$ | $\hat{Z}$ | $\hat{P}^{\frac{-\alpha}{1-\alpha}}$ | $\hat{s}^{\frac{\alpha}{1-\alpha}}$ | $\widehat{K/I}^{\frac{\alpha}{1-\alpha}}$ |
|---|---|---|---|---|---|---|---|---|
| Jamaica | JAM | 0,113 | 1,068 | 0,518 | 0,205 | 0,757 | 1,138 | 1,240 |
| Pakistan | PAK | 0,109 | 0,697 | 0,342 | 0,456 | 0,696 | 0,868 | 1,154 |
| Bolivia | BOL | 0,106 | 0,721 | 0,539 | 0,272 | 0,713 | 0,937 | 1,080 |
| Bangladesh | BGD | 0,103 | 0,669 | 0,342 | 0,450 | 0,665 | 1,054 | 0,953 |
| Honduras | HND | 0,099 | 0,865 | 0,446 | 0,256 | 0,700 | 1,300 | 0,950 |
| India | IND | 0,096 | 0,690 | 0,490 | 0,285 | 0,690 | 1,075 | 0,930 |
| China | CHN | 0,096 | 0,831 | 0,552 | 0,209 | 0,730 | 1,250 | 0,910 |
| Nicaragua | NIC | 0,084 | 0,901 | 0,468 | 0,200 | 0,676 | 1,289 | 1,034 |
| Zinbawe | ZWE | 0,079 | 0,950 | 0,497 | 0,168 | 0,748 | 0,789 | 1,609 |
| Camerun | CMR | 0,064 | 0,621 | 0,389 | 0,265 | 0,544 | 0,891 | 1,282 |
| Congo, Rep. of | COG | 0,057 | 0,755 | 0,484 | 0,156 | 0,392 | 0,959 | 2,011 |
| Nepal | NPL | 0,054 | 0,803 | 0,309 | 0,218 | 0,751 | 1,084 | 0,987 |
| Senegal | SEN | 0,053 | 0,581 | 0,328 | 0,276 | 0,546 | 0,978 | 1,088 |
| Lesotho | LSO | 0,052 | 1,120 | 0,471 | 0,099 | 0,820 | 1,396 | 0,979 |
| Ghana | GHA | 0,043 | 0,586 | 0,442 | 0,166 | 0,419 | 1,069 | 1,310 |
| Gambia | GMB | 0,041 | 0,591 | 0,303 | 0,230 | 0,608 | 0,914 | 1,063 |
| Zambia | ZMB | 0,040 | 0,898 | 0,532 | 0,085 | 0,830 | 0,900 | 1,200 |
| Benin | BEN | 0,039 | 0,577 | 0,319 | 0,209 | 0,581 | 0,976 | 1,019 |
| Kenya | KEN | 0,038 | 0,673 | 0,440 | 0,129 | 0,711 | 0,779 | 1,214 |
| Togo | TGO | 0,033 | 0,717 | 0,367 | 0,127 | 0,715 | 0,994 | 1,009 |
| Mozambique | MOZ | 0,033 | 0,411 | 0,256 | 0,314 | 0,345 | 1,274 | 0,934 |
| Mali | MLI | 0,032 | 0,592 | 0,222 | 0,239 | 0,480 | 1,045 | 1,180 |
| Uganda | UGA | 0,031 | 0,340 | 0,374 | 0,240 | 0,415 | 0,935 | 0,877 |
| Malawi | MWI | 0,029 | 0,651 | 0,351 | 0,126 | 0,486 | 0,795 | 1,687 |
| Niger | NER | 0,028 | 0,559 | 0,227 | 0,222 | 0,547 | 0,715 | 1,430 |
| Rwuanda | RWA | 0,028 | 0,471 | 0,315 | 0,187 | 0,430 | 0,855 | 1,280 |

Table 1: Contributions to differences in output per worker

| Decil | $\widehat{Y/L}$ | $\widehat{K/Y}^{\frac{\alpha}{1-\alpha}}$ | $\hat{h}$ | $\hat{Z}$ |
|---|---|---|---|---|
| $\geq$ 80 | 0.874 | 1.063 | 0.830 | 1.028 |
| 80-70 | 0.756 | 1.140 | 0.833 | 0.803 |
| 70-60 | 0.660 | 1.113 | 0.789 | 0.771 |
| 60-50 | 0.537 | 0.998 | 0.707 | 0.881 |
| 50-40 | 0.437 | 0.802 | 0.635 | 0.905 |
| 40-30 | 0.354 | 0.965 | 0.680 | 0.574 |
| 30-20 | 0.244 | 0.790 | 0.559 | 0.588 |
| 20-10 | 0.146 | 0.882 | 0.569 | 0.312 |
| 10-0 | 0.052 | 0.690 | 0.390 | 0.200 |
| Average | 0.344 | 0.888 | 0.608 | 0.540 |
| Stand. desv. | 0.280 | 0.218 | 0.190 | 0.308 |
| Corr.. w/ $\widehat{Y/L}$ | 1.000 | 0.696 | 0.840 | 0.879 |
| Corr.. w/ $\widehat{K/Y}$ | 0.696 | 1.000 | 0.726 | 0.326 |
| Corr.. w/ $h$ | 0.840 | 0.726 | 1.000 | 0.527 |

Note: correlations refer to the variables in logs.

Table 2: Differences in the physical capital-output ratio

| Decil | $K/Y^{\frac{\alpha}{1-\alpha}}$ | $\hat{s}^{\frac{\alpha}{1-\alpha}}$ | $K/I^{\frac{\alpha}{1-\alpha}}$ | $\hat{R}^{-\frac{\alpha}{1-\alpha}}$ |
|---|---|---|---|---|
| $\geq$ 80 | 1.063 | 1.042 | 1.076 | 0.949 |
| 80-70 | 1.140 | 1.010 | 1.167 | 0.968 |
| 70-60 | 1.113 | 1.035 | 1.102 | 0.977 |
| 60-50 | 0.988 | 1.105 | 1.168 | 0.811 |
| 50-40 | 0.802 | 1.059 | 1.123 | 0.676 |
| 40-30 | 0.965 | 1.050 | 1.150 | 0.805 |
| 30-20 | 0.790 | 0.998 | 1.105 | 0.722 |
| 20-10 | 0.882 | 0.971 | 1.222 | 0.743 |
| 10-0 | 0.690 | 1.012 | 1.181 | 0.598 |
| Average | 0.888 | 1.018 | 1.154 | 0.767 |
| Stand. Desv. | 0.218 | 0.127 | 0.084 | 0.171 |
| Corr.. w/ $Y/L$ | 0.696 | 0.217 | -0.125 | 0.717 |
| Corr.. w/ $K/Y$ | 1.000 | 0.321 | 0.084 | 0.868 |
| Corr.. w/ $\hat{h}$ | 0.726 | 0.170 | 0.019 | 0.686 |
| Corr.. w/ $\hat{z}$ | 0.326 | 0.128 | -0.245 | 0.436 |
| Corr.. w/ $\hat{R}^{-1}$ | 0.868 | 0.169 | -0.246 | 1.000 |
| Corr., w/ $\hat{s}$ | 0.321 | 1.000 | -0.532 | 0.169 |
| Corr.. w/ $K/I$ | 0.084 | -0.532 | 1.000 | -0.246 |

Note: correlations refer to the variables in logs.

Figure 1: Investment Rate and the Physical Capital-Output ratio

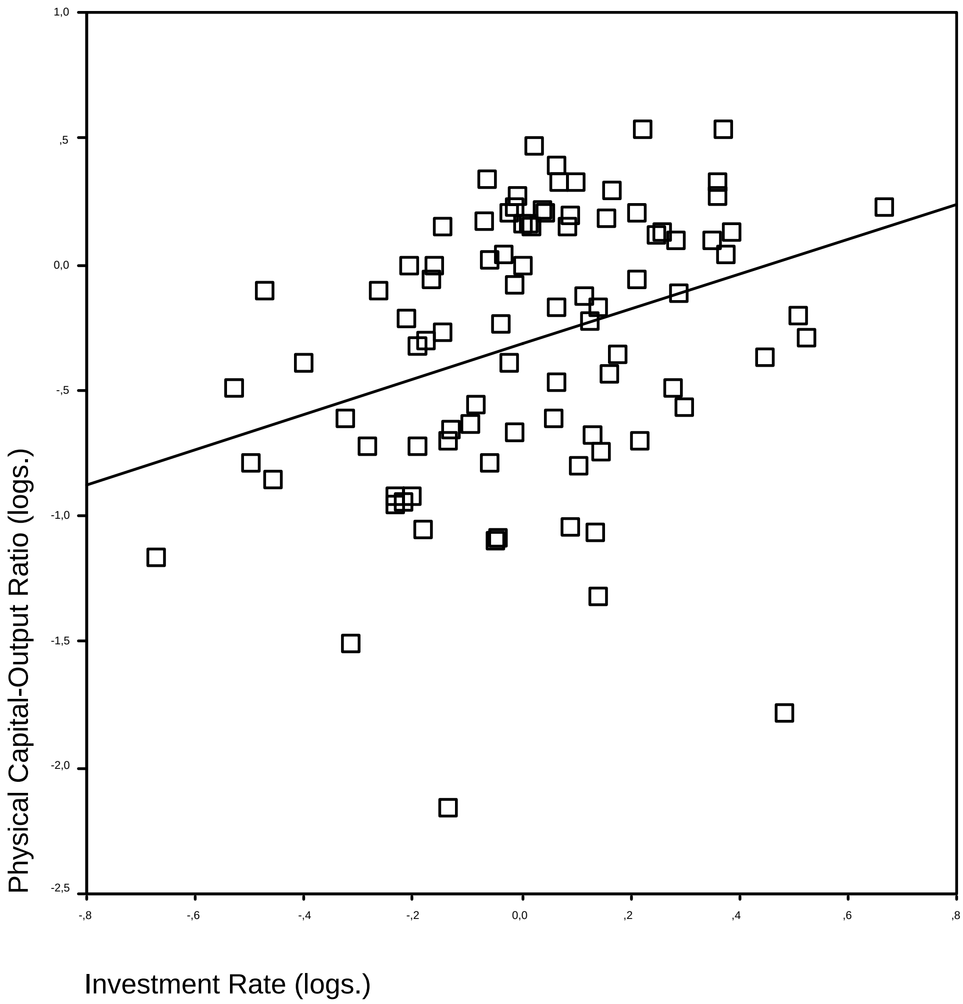

Figure 2: Investment Rate and Output per Worker

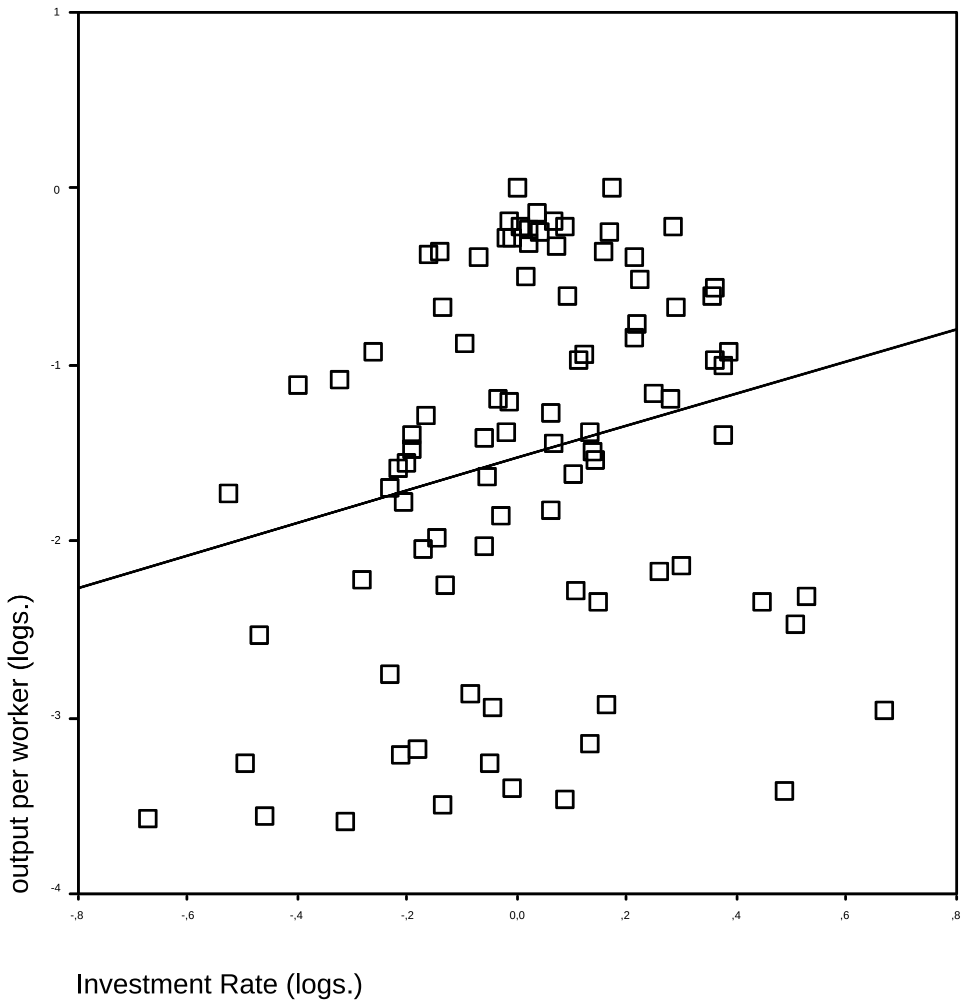

Figure 3: Relative Price of Investment and Physical Capital-Output Ratio

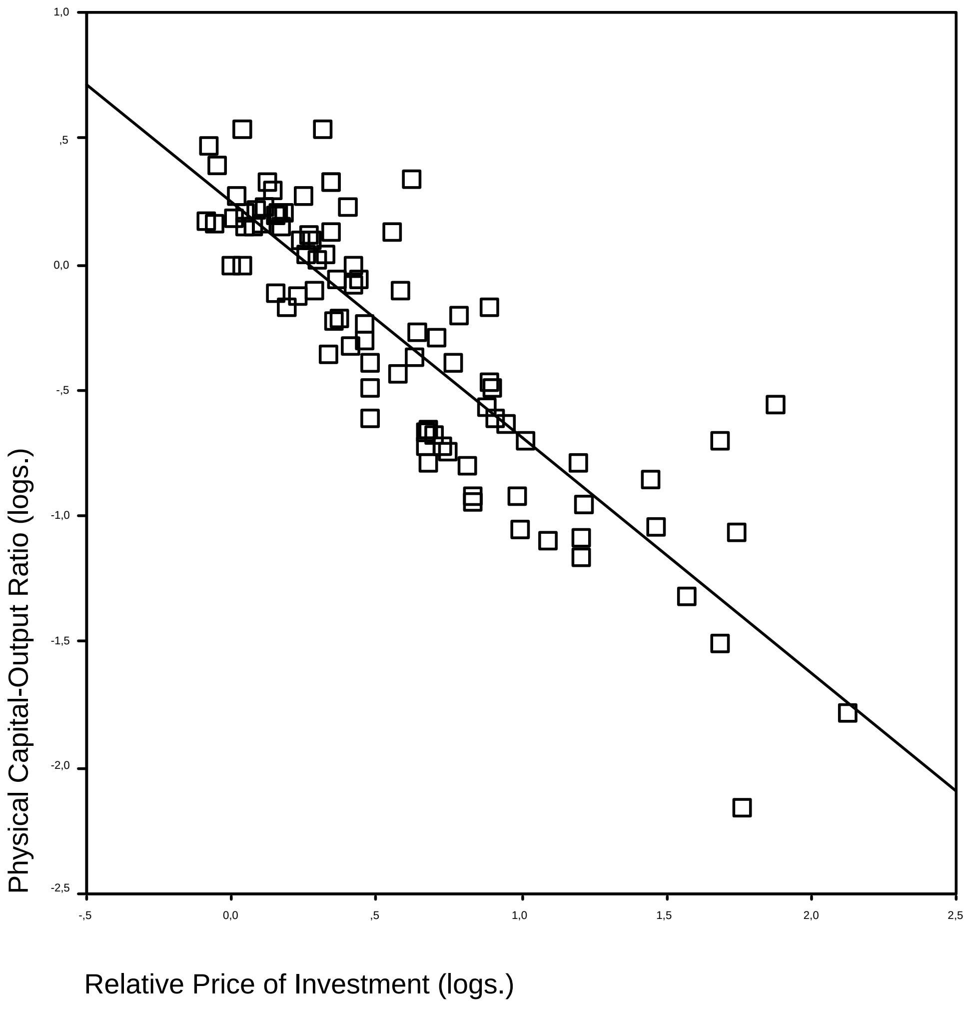

Figure 4: Relative price of Investment and Output per Worker