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## Relative human capital endowments: estimates for selected countries and implications for international capital flows

Kiel Working Paper, No. 545

**Provided in Cooperation with:**

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

*Suggested Citation:* Gundlach, Erich (1992) : Relative human capital endowments: estimates for selected countries and implications for international capital flows, Kiel Working Paper, No. 545, Kiel Institute of World Economics (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/618>

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# Kieler Arbeitspapiere Kiel Working Papers

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December 1992

**Institut für Weltwirtschaft an der Universität Kiel  
The Kiel Institute of World Economics**

ISSN 0342-0787

Kiel Institute of World Economics  
Düsternbrooker Weg 120, D-2300 Kiel  
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9 / 93 *Wirtschaftswissenschaften*

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# Relative Human Capital Endowments: Estimates for Selected Countries and Implications for International Capital Flows

by Erich Gundlach

## Abstract

Despite large rate of return differentials implied by persistent income differentials, relatively little capital flows to poor countries. The rate of return differentials are substantially reduced, however, if different human capital endowments are taken into account, as is shown for a limited sample of countries. Additionally accounting for human capital externalities based on independent empirical evidence turns around the predicted rate of return differentials in favor of the rich countries. Hence, the world economy may converge to a rather unequal distribution of incomes as long as human capital accumulation is neglected as the key variable limiting economic development.

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# Relative Human Capital Endowments: Estimates for Selected Countries and Implications for International Capital Flows\*

## 1. Introduction

International capital movements and trade flows mainly occur between the relatively rich nations of the world economy. This empirical pattern is just the opposite of what could be expected from a simple neoclassical model of trade and growth. With labor and capital as the basic factors of production, and an internationally available technology with constant returns to scale, such a model implies that internationally different per-capita incomes or per worker production levels must be due to internationally different levels of (physical) capital per worker. With a higher marginal product of capital in the relatively poor countries, it follows that capital should flow from rich to poor countries. The model predicts that this process will continue until the returns to the factors of production will be equalized. Hence, profits and wages are supposed to converge in the long-run.

Part of the explanation why we don't see the expected capital flows and an overall quasi-automatic convergence of per-capita incomes may be the existence of external benefits of human capital (Lucas, 1988, 1990). This assumption can change the direction of the predicted capital flows, because it may imply that human capital and not physical capital is the relatively scarce factor in developing countries. That is, the implicit rate of return differentials may vanish if international differences in human capital endowments and possibly existing human capital externalities are properly accounted for.

Apart from the externality question it seems to be almost self-evident that international differences in the stock of human capital are somehow positively related to the observed income differentials between the industrialized and the developing countries. Recent attempts to incorporate human capital variables into the analysis of cross-country growth equations have shown that the hypothesis of long-run (conditional) convergence as derived from a constant returns to scale growth model can not be ruled out (Barro, 1991; Levine, Renelt, 1992; Mankiw et al., 1992). However, it is rather doubtful whether these results rule out the alternative hypothesis of external benefits of human capital, since the speed of (conditional) convergence seems to be rather slow: It is estimated that the halfway time to reach a steady state after an exogenous shock is about 35 years. Therefore, if shocks occur frequently enough the concept of catching up and convergence somehow loses its empirical relevance. Empirical support for the hypothesis of a rather limited potential for catching up

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\* I thank Markus Diehl and Ulrich Hiemenz for helpful comments, and Michaela Rank for research assistance.

in terms of per-capita incomes comes from Quah (forthcoming). Allowing for stochastically time-varying components in the underlying data generating process, he finds that the economies across the world seem to be converging to a distribution where many remain wealthy, and many remain poor; and middle-income countries seem to be a vanishing class. This conclusion introduces the question whether economic policies with respect to human capital formation could change the speed of catching up.

The empirical support for the hypothesis that the stock of human capital is an important determinant of income growth derived from recent cross-country studies rests on rather crude attempts to empirically identify this theoretical variable.<sup>1</sup> Presently, mainly secondary school enrolment rates or literacy rates are used as proxies for the investment in human capital or the stock of human capital. These measures ignore two important factors of human capital accumulation: the experience of the workforce, and international differences in the quality of formal education. Therefore, it is tempting to conclude that all recent studies have used a proxy for human capital which is more or less uncorrelated with the "true" stock of human capital.

Without improved cross-country estimates of the stock of human capital it is rather difficult to evaluate the role of human capital formation for economic development, and even more so to evaluate the externality argument with respect to human capital. Both questions are rather crucial for economic policy considerations. E.g., if such externalities exist, there may be large macroeconomic benefits of economic policies promoting the education and training of the workforce. And even if such externalities do not exist, policies promoting education and training of the workforce may have a more beneficial impact on per-capita incomes than policies enhancing the accumulation of physical capital.

Appropriate human capital stock series might be constructed by defining the human capital investment made during a year by the sum of the social per-capita costs of education over all pupils and students (Schultz, 1992). At least for most developing countries, however, the necessary statistics are not available; and even if they were, the human capital accumulated by experience would not be accounted for. In a seminal paper, Anne O. Krueger (1968) developed a less demanding, but empirically feasible way how to estimate *relative* human capital endowments from Census data for a cross section of countries. I extend her approach and present estimates of human capital endowments for selected countries relative to the United States in 1980. Employing alternative neoclassical models, I use these estimates to reconsider the predicted direction of international capital flows.

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<sup>1</sup> See the pioneering work of Denison (1962) for estimating the contribution of improved labor quality (human capital accumulation) to income growth in a time series context.

## 2. Accounting for Human Capital

Following closely the approach suggested by Krueger (1968, pp. 642-45), I assume that all countries have access to the same technology. This common technology may be represented by an aggregate constant returns to scale production function of the general form:

$$Y = f(X_0, X_1, \dots, X_i, \dots, X_n) \quad (1)$$

where  $Y$  is total income, and the  $X_i$ 's are the quantities of the factors of production; let  $X_0$  be the number of persons in the labor force. The marginal products of all factors are assumed to be positive and diminishing, and are denoted by  $f_i'$ :

$$Y = f_0'X_0 + \dots + f_i'X_i + \dots + f_n'X_n \quad (2)$$

Indicated by small letters, the per-capita income version of equation (1) is:

$$y = bf(x_1, x_2, \dots, x_i, \dots, x_n) \quad (3)$$

Where  $b$  is the fraction of the population in the labor force ( $X_0/P$ ),  $x_i = X_i/X_0$ , and  $y = Y/P$ . This framework can be used to account for *relative* human capital endowments even in the absence of complete information about the parameters of the production function and all other factor endowments. Consider the case of a resource rich and a resource poor country. Let  $x^p = (x_1^p, x_2^p, \dots, x_i^p, \dots, x_n^p)$  the factor endowments of the poor country, and let  $x^r$  be the corresponding vector of the factor endowments of the rich country. Assuming that the poor country has less resources of every factor than the rich country on a per-capita basis ( $x^r > x^p$ ), it follows from the production function (3) that :

$$y^r - y^p > \sum_i f_i'(x_i^r - x_i^p) \quad i = 1, \dots, m \quad (4)$$

$$m \leq n$$

where the first  $m$  resources are those for which quantitative information is available.

Equation (4) suggests an empirically feasible way how observed differences in the endowment with *specific* factors of production can be used to explain observed income differentials: The sum of the observed endowment differences multiplied by the respective marginal products of the rich country gives the *maximum* per-capita income attainable in the poor country relative to the rich country.

To see why this is so, first consider the case that both countries have identical factor endowments. Thus, no income differential should exist. Second, assume that the poor and the rich country have the

same endowment of every factor except for human capital, where the poor country has less. Hence, the actual income differential should reflect the different endowments with human capital. Third, assume that the poor country has less of every factor of production, but only human capital endowments can be observed. Then the right-hand-side of equation (4) represents the maximum relative income attainable in the poor country, because all other endowment deficiencies of the poor country are ignored, although they may also contribute to the observed income differential.

Put differently, the use of the marginal products of the rich country will understate the "true" difference in income resulting from the resource disparity, since these marginal products depend on the endowment with all other factors of production which are assumed to be more abundant in the rich country than in the poor country. If human capital endowments are known for both countries, the marginal product of this factor in the rich country can be used to compute a lower bound estimate of the resulting difference in per-capita incomes. Furthermore, something can be said about the relative importance of factor endowments for which no information is available. If a fraction of the observed income differential between the poor and the rich country is known to be due to a deficiency of a subset of  $m$  resources, then all other factors can not account for more than  $y^r - y^p - y_m$ , where  $y_m$  is the fraction of the income differential due to the identified resource differences. This calculation may shed some light on the quantitative importance of different bottlenecks for economic development.

The estimates derived from the right-hand-side of equation (4) can be used to compute the stock of human capital in a poor country relative to a rich country. Suppose that both countries are subject to a Cobb-Douglas per-capita production function:

$$y = h^\beta z^\alpha \quad (5)$$

where  $h$  represents the stock of human capital (labor),  $z$  represents all other resources, and  $\alpha$  and  $\beta$  are the distributional shares of the inputs. If it is possible empirically to construct a human capital index number from equation (4) which has the dimension of the human capital stock raised to the power of labor's share, the relative stock of human capital in the poor country ( $HC^p$ ) is given by:

$$\ln HC^p = \frac{\ln \left[ f_i'(x^r - x^p) \right]}{\beta^p} \quad (6)$$

The inverse of  $HC^p$  gives the labor efficiency equivalent of an average worker from the rich country ( $LEE^p$ ):

$$LEE^p = \frac{1}{HC^p} \quad (7)$$



with the dimension: number of average workers from the poor country per average worker from the rich country. That is,  $LEE^p$  gives the number of average workers from the poor country equivalent to the productivity of one average worker from the rich country, given that all workers are equipped with identical factor endowments except for human capital.

### 3. Estimating the Relative Stock of Human Capital

Estimating the relative stock of human capital by equation (6) requires the identification of resource endowments which are related to the theoretical concept of human capital, and the measurement of the respective marginal products. Following the seminal work of Becker (1964) and Mincer (1974), the major determinants of individual human capital accumulation are the years of formal schooling received, and the experience gained by learning on the job, typically measured by age. These factors have been found to explain a large fraction of observed income differentials between individuals.

Therefore, the analysis starts with a cross classification of the population by years of schooling completed and age, which is available from aggregated United States Census data for 1980 (US Department of Commerce, 1984). Average United States incomes, disaggregated by years of formal schooling completed and specific age groups, are used as the marginal products  $f_i'$  of the reference country (equation 4). Choosing the United States to be the reference country is easily justified with respect to per-capita income differentials, at least for the year 1980. The implication for the present analysis is that the United States is assumed to have more resources of every factor of production on a per-capita basis than any other country in the sample.<sup>2</sup>

Other factors which might influence the measured efficiency of a unit of labor, especially when comparing the United States human capital endowments with human capital endowments of developing countries, are the degree of urbanization and the labor force participation rate of women. Since average urban incomes are higher than rural incomes, and average female incomes are lower than male incomes, human capital endowments of developing countries estimated by the framework of the previous section will be biased upward in the case of less urbanization than in the reference country, and biased downward in the case of a lower female labor force participation. Therefore, I further extend the cross classification, namely by sex and place of residence.<sup>3</sup>

<sup>2</sup> This assumption may be regarded as unreasonable with respect to unskilled and semi-skilled labor. However, on average a high-skilled worker can always do the work of a low skilled worker. Hence, countries with more human capital per worker have as much unskilled labor and more skilled labor per capita than countries with less human capital.

<sup>3</sup> The data for urban residence are not published in US Department of Commerce (1984) but can be computed as the weighted difference of the entries for "Total" and "Rural".

The most recent aggregated Census data for a cross section of countries which allow for a cross classification by years of schooling, age, sex, and place of residence are available from the United Nations (UN) Demographic Yearbook (1985, 1990). The list of countries for which this cross classification is possible is rather short, even if less important statistical problems are ignored. Countries included are: Bangladesh, Brazil, Cameroon, Canada, Ecuador, Honduras, Japan, New Zealand Panama, and Sri Lanka. To match these data with the United States Census data, two major difficulties have to be considered.

First, the aggregated US data exclude all individuals younger than 18 years, whereas the UN data exclude all individuals younger than 15 years. In the computations below I compare the US age cohort 18-24 to the age cohort 15-24 for the other countries in the sample. Since this age cohort accounts for a larger fraction of the population in developing countries, multiplication with the lower than average US marginal products will end up in a downward biased estimate of their relative human capital endowment. Second, for most countries the UN data do not provide information on the years of schooling completed, but only on the *level* of schooling received. Here the main problem arises from differences in the average years of schooling by level: According to the UN data, first and secondary level each consist of six years of schooling, while in the United States the elementary (first) level consists of eight years, and high school (secondary level) consists of four years. To match the UN classification as good as possible with the published US Census classification, I compare 0-7 years of schooling in the United States to first level schooling in the other countries of the sample. This procedure may cause a small upward bias in the estimation of the relative human capital endowments, because the marginal product used is possibly higher than the true marginal product for 0-6 years of formal schooling.

Table 1 presents the incomes (marginal products) assigned to individual classes on the basis of US Census data, aggregated to match the structure of the UN data. The marginal products for the United States ( $f_i'$ ) are derived by summing over individual census classes:

$$f_j' = \frac{\sum_i N_{ij} f_{ij}'}{\sum_i P_{ij}} \quad (8)$$

where  $N_{ij}$  is the number of persons with income in  $i$ th subclass of  $j$  in the United States distribution,  $f_{ij}'$  is mean weakly earnings of those persons with income in the subclass, and  $P_{ij}$  is the total number of persons in the subclass. Multiplication of the  $f_{ij}'$ s with the respective fractions of the population, and summing up over the  $j$  subclasses, gives the human capital index number for the reference country. The human capital index for the country of comparison is derived in the same way by using

its own population distribution (see equation (4)). Then, the estimation of the relative stock of human capital follows from equation (6) using additional information for the labor share ( $\beta$ ) of the country of comparison.

By this computation, those persons with no earnings are assigned mean weakly earnings of zero. This is equivalent to allowing for subclass specific labor force participation rates. Hence, it is assumed that United States subclass specific labor force participation rates resemble the labor force participation rates in the other countries of the sample. Compared to the difficulties that arise in matching the different distributions with respect to age cohorts and level of schooling, this assumption introduces more severe problems.

Since experience gained by learning on the job is one of the major determinants of human capital accumulation, internationally different labor force participation or unemployment rates will create biased estimates of human capital endowments in the present context, because countries with lower labor force participation rates and higher unemployment rates have to face higher depreciation rates of their stock of human capital. If the marginal products derived for the United States labor market experience are applied to a country with weaker labor market conditions, its estimated relative human capital endowment will be biased upward. Therefore, the present framework will produce reasonable results only if it is applied to countries with roughly comparable labor market experiences. In the absence of reliable labor market statistics for most of the developing countries in the sample, I use the growth rate of per-capita income to proxy different depreciation rates of the stock of human capital. Here, I exclude all countries from the analysis with an average growth rate of per-capita income below the US growth rate. This reduces the sample by Bangladesh, Honduras, New Zealand, and Sri Lanka (Table 2).

By the same token, the years of formal schooling received will only represent a comparable fraction of the human capital accumulated if the quality of schooling does not differ internationally. Up to now, there is only very limited empirical evidence on international differences in the quality of formal schooling.<sup>4</sup> Here, I use total public expenditures per pupil in 1980 to decide whether a country should be excluded from the analysis. These data are available from the UNESCO Yearbook (1988). To make them comparable internationally, expenditures are converted to so-called international US-\$ by the use of Purchasing Power Parities provided by Summers and Heston (1991). Somewhat arbitrarily, I exclude all countries from the analysis with a per-capita income differential (with respect to the US) two times higher than the expenditure-per-pupil differential. This happens to be the case for Bangladesh and Sri Lanka, and it points to very careful interpretations in the case of all other

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<sup>4</sup> See Jimenez et al. (1991) for an analysis of the relative efficiency of private and public schools for selected developing countries; see Knight and Sabot (1990) for an analysis of the consequences of different education policy regimes in Tanzania and Kenya.

developing countries included in the sample.<sup>5</sup> Given that the estimates for the growth rate of per-capita income and the expenditures per pupil in Table 2 are reasonable proxies for the depreciation rate of the stock of human capital and the quality of schooling, the remaining countries considered for further analysis are Cameroon, Canada, Brazil, Ecuador, Japan, and Panama.

Apart from international differences in the quality of education and in the rate of depreciation of human capital, the estimates may also be biased because of the level of aggregation used. E. g., if the fraction of those who actually *complete* first, second, or third level education differs internationally, human capital index numbers based on aggregated census data are not comparable. This information is not available from the UN (1985, 1990) data for most of the countries of the sample; and from US Department of Commerce (1984), the highest disaggregation available by years of schooling completed is for eight subgroups which reflect the organization of the US educational system: 0-7 years and 8 years for the first level (elementary); 1-3 years and 4 years for the second level (high school); 1-3 years, 4 years, 5-6 years, and 7 or more years for the third level (college).

The robustness of the human capital estimate with respect to the level of aggregation can be checked, at least for the case of Panama, by using microdata from the Socioeconomic Survey of 1983<sup>6</sup> (Republica de Panama, 1983) which includes information on the years of schooling completed. Since the distribution of the population generally changes very slowly, the discrepancy between the 1980 census data and the 1983 survey data can be neglected. The procedure used to calculate the alternative human capital index for Panama is the same as outlined above, the only difference being the level of aggregation of the years of schooling. Here, I try to match as good as possible the structure provided by the eight subgroups available for the United States. That is, if there are substantial differences of the population distributions *within* first, second, and third level education, then the two human capital stock estimates for Panama should differ.

Table 3 presents the results of the computations of the two central equations of the previous section: an estimate for the maximum income that an average person from a specific country could attain if he were working with United States factor endowments other than human capital [column (2), based on equation (4)]; and, based on this finding, an estimate for the relative stock of human capital for a cross section of countries [column (5), based on equation (6)]. These results indicate that a substantial fraction of the observed per-capita income differentials relative to the United States can be accounted for by differences in human capital endowments, thus replicating the basic finding in Krueger (1968).

<sup>5</sup> Psacharopoulos (1984) reports that public expenditures per pupil have dramatically declined in developing countries between 1960 and 1975. He notes that according to unpublished estimates, the average OECD country invested fifty times more per pupil than did any low-income country in 1977, which is roughly in line with the estimates in Table 2; in 1960, this ratio stood at 16:1.

<sup>6</sup> A detailed description of the Socioeconomic Survey of Panama (SESP) conducted in 1983 is given in Sahota (1990).

The last row in table 3 shows that the estimates for Panama are largely unaffected by the level of aggregation of years of formal schooling received. This finding points to roughly similar cross-country population distributions *within* levels of education, at least in the case of the United States and Panama.

To be more specific, the results in Table 3 can be read as follows. In 1980, the income of the average Brazilian stood at roughly 30 per cent of the income of the average person from the United States [column (1)]. If the average Brazilian were working with United States factor endowments, he would double his income, reaching approximately 60 per cent of the American level. Hence, his human capital endowment would not suffice to reach the average United States income level even if there were no other endowment deficiencies involved, which is why column (2) provides the *maximum* income attainable. Put differently, more than half of the observed income differential between the United States and Brazil is due to the lower Brazilian human capital endowments [column (3)], thus leaving less than half of the observed income differential to be due to other (unidentified) Brazilian resource deficiencies.

For Cameroon and Ecuador, the explanatory power of different human capital endowments for observed income differentials is of the same order of magnitude. In the case of Canada, almost all of the observed income differentials can be explained in terms of different human capital endowments. This result points to relatively identical overall factor endowments for Canada and the United States: if two countries exhibit the same set of factor endowments except for human capital, the observed income differential should reflect the different human capital endowments. Contrary to these cases, the empirical evidence for Panama and Japan suggests that different human capital endowments are less important for an explanation of the observed income differentials than other unidentified factor endowment deficiencies. To turn the argument around, Japan and Panama seem to display relatively low per-capita incomes despite a well-trained labor force. Such a finding may indicate the potential for fast future income growth, since it points to an unexploited resource endowment. Of course, this is not to say that unexploited resource endowments are a sufficient condition for prospective income growth, as the case of Panama proves.

The estimates for the relative stock of human capital resemble these considerations [column (5), based on equation (6)]. The average person from Cameroon has a stock of human capital in the range of 20 per cent of the average American; the average person from Latin America (the approximated average of Brazil, Ecuador, and Panama) has two times as much human capital as the average Cameroonian (40 per cent of the US level); and the average Japanese or Canadian has almost as much human capital as the average American. Turning to labor efficiency equivalents [column (6), based on equation (7)], these results reveal that international productivity assessments based on per-capita (or per-worker) incomes may lead to unduly pessimistic conclusions. While per-capita income

differentials imply that the average American is as productive as 10 Cameroonians or 4 Panamanians [column (1)], the consideration of different human capital endowments reduces such estimates to a factor of 5 in the case of Cameroon and to a factor of 2 in the case of Panama.

Taken together, the apparent variance of the cross-section estimates for the relative stock of human capital may point to a high explanatory power of this concept with respect to different per-capita incomes. Needless to say that all the estimates should be interpreted very carefully, since they may suffer from a number of measurement and comparability problems some of which were outlined above. Compared to the presently available evidence for the stock of human capital,<sup>7</sup> however, these estimates provide more reliable information. First of all, they additionally include a measure of human capital accumulated by experience (proxied by the age structure of the population), and they additionally include third level education as well as adjustments for differences in the degree of urbanization and between male and female wages.

#### 4. Human Capital Endowments and International Capital Flows

Large differences in per-capita incomes across the world can be interpreted as indicating a high marginal productivity of physical capital in poor countries, implicitly predicting large international capital flows. Actually, this does not happen. The relative human capital endowments estimated in this paper can be used to give an explanation of this puzzle in terms of a quantitative assessment.

Following Lucas (1990)<sup>8</sup>, I reproduce the performance of three simple neoclassical models in predicting the direction of international capital flows between the United States, as the country of reference, and Cameroon, Canada, Japan, and Latin America.<sup>9</sup> First consider a Cobb-Douglas constant returns technology with a common intercept and assume that this technology is available for all countries:

$$Y = AK^\alpha L^{1-\alpha} \quad (9)$$

where Y is total income, K is physical capital, and L is labor. Per-capita income is given by:

<sup>7</sup> See Lau et al. (1991) where an estimate for the stock of human capital is based on primary and secondary school enrollment rates only. This paper served as a background paper for the World Development Report 1991 (World Bank, 1991).

<sup>8</sup> Lucas (1990) found that external benefits of human capital could account for a near equivalence of the rates of return to physical capital between the United States and India, thereby explaining the apparent lack of net international capital flows to the latter.

<sup>9</sup> In the following, I use the term Latin America when referring to the stylized facts for Brazil, Ecuador, and Panama. Compared to the United States, in 1980 these countries had an average per-capita income (y) in the range of 25 per cent and a per-capita stock of human capital (h) in the range of 40 per cent (Table 3).

$$y = Ak^\alpha \quad (10)$$

where  $y$  and  $k$  are income and physical capital, both per-capita. The marginal product of capital ( $r$ ) is given by:

$$r = \frac{\partial y}{\partial k} = A\alpha k^{\alpha-1} \quad (11)$$

Using the inverse of the production function, the marginal product of capital in terms of per-capita income is given by:

$$r = A^{1/\alpha} \alpha y^{(\alpha-1)/\alpha} \quad (12)$$

Hence, for average capital shares ( $\bar{\alpha}$ ) and  $y$  measured relative to the United States, equation (12) implies that the rate of return to capital in any country is  $y^{(\bar{\alpha}-1)/\bar{\alpha}}$  times higher than in the United States. That is, this model predicts that the rate of return to capital in Cameroon is 32 times, in Latin America 8 times, and in Japan 3 times higher than in the United States; and no rate of return differential seems to exist for Canada (Table 4, model 1).

An apparent reason why these rate of return differentials are exaggerated is the use of the per-capita concept, which treats persons in the United States and elsewhere as having the same productivity. Considering international differences in the stock of human capital, the production function reads:

$$Y = AK^\alpha (hL)^{1-\alpha} \quad (13)$$

where  $h$  is the stock of human capital per person. Income per *effective* person ( $y_e$ ) is given by:

$$y_e = Ak_e^\alpha \quad (14)$$

$$\text{with } y_e = \frac{Y}{hL} \quad \text{and } k_e = \frac{K}{hL}$$

Similar to equation (12), the marginal product of capital in terms of income per effective person is given by:

$$r = A^{1/\alpha} \alpha (y/h)^{(\alpha-1)/\alpha} \quad (15)$$

Following this model, the previously estimated rate of return differentials (from equation (12)) are sharply reduced, but there still remain substantial differences in the case of Cameroon and Latin America (Table 4, model 2). E.g., if the rate of return to capital in stylized Latin America really were 100 percent higher than in the United States as predicted by this model, one would expect to see a large amount of capital flowing from the north to the south, and the United States to be a net exporter of capital. But on average, the United States was neither a net exporter nor importer of capital from 1950 to 1980.<sup>10</sup> Instead, labor seems to flow at maximum allowable rates to the United States. If there is a strong motive for labor to flow in one direction, there should be an equally strong motive for capital to flow in the opposite direction. Why this doesn't happen can be explained by a model which includes an internal as well as an external effect related to the stock of human capital (Lucas, 1988). Its production function for income per effective person is given by:

$$y_e = Ak_e^\alpha h^\gamma \quad (16)$$

The term  $h^\gamma$  can be interpreted as an external effect which multiplies the productivity of a worker at any skill level. Hence, equation (16) says that an increase in the average stock of human capital by 1 per cent will increase the human capital of an individual working in this environment by  $\gamma$  per cent. The implication is that this model can account for different incomes per effective person, even if the rates of return to physical capital are equalized and the technology is generally available. In the previous models, rates of return to capital couldn't equalize as long as per-capita incomes differed. Here, the remaining spread may just be offset or even turned around by the human capital externality. The corresponding equation for the marginal product of capital clarifies this interpretation:

$$r = A^{1/\alpha} \alpha y_e^{(\alpha-1)/\alpha} h^{\gamma/\alpha} \quad (17)$$

This model requires an empirical estimate for  $\gamma$ . Lucas (1988, p.22) shows how to derive such an estimate. First rewrite equation (12) in terms of *per-capita* income:

$$y = Ak^\alpha h^{(1-\alpha)} h^\gamma \quad (18)$$

Then, the marginal product of capital equation reads:

$$r = A\alpha k^{(\alpha-1)} h^{(1-\alpha)} h^\gamma \quad (19)$$

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<sup>10</sup> Compare Summers and Heston (1991, columns 3, 4, and 5): [100-c-i-g] equals the current account balance (per cent of GDP); a positive current account balance would indicate a net outflow of capital.



With the Cobb-Douglas technology used here, the marginal product of capital equals the profit share times the average product. Writing equation (19) in logs ( $\ln$ ) and using  $r = \alpha \frac{y}{k}$  gives the steady state solution of the model for a common growth rate of per-capita income ( $\ln y$ ) and per-capita capital ( $\ln k$ ) as:

$$\ln y = \left( \frac{1 - \alpha + \gamma}{1 - \alpha} \right) \ln h \quad (20)$$

At least for the United States, it is possible to estimate  $\gamma$ , given that the average annual growth rate of the stock of human capital ( $\ln h$ ) can be proxied by an estimate based on the growth of formal schooling alone.

Lucas (1988, 1990) computed a value for  $\gamma$  of approximately 0.4 using estimates for  $\ln y_{US} = 0.014$ ,  $\alpha_{US} = 0.25$ , and  $\ln h_{US} = 0.009$  for the period 1909-57 from Denison (1962). Here, I compute an alternative estimate for  $\gamma$  of approximately 1.4 which is based on estimates for  $\ln y_{US} = 0.017$  for the periods 1820-1989 and 1820-1973 derived from Maddison (1991), and on estimates for  $\ln h_{US} = 0.006$  for the periods 1929-69, 1947-69, and 1929-82 derived from Denison (1974, 1985), with  $\alpha_{US} = 0.25$  as before. Somewhat unrealistically, the estimate for  $\gamma$  implies that a doubling of all inputs would increase output by a factor of five. However, the results for  $\gamma$  are very sensitive with respect to the proxy for  $\ln h$  and should only be taken as a range of possible outcomes. Nonetheless, some conclusions with respect to rate of return differentials and the direction of international capital flows can be drawn.

Going back to equation (17), the rate of return differentials further decline if an externality ( $\gamma = 0.4$ ) is introduced. By and large, the results for Canada, Japan, and Latin America could be interpreted as representing rate of return equalization; the results for Cameroon points to a somewhat lower rate of return than in the United States (Table 4, model 3). By giving a stronger weight to the human capital externality, the results become more diverse. Broadly speaking, for the extreme case of  $\gamma = 1.4$ , the estimates are not too far away from rate of return equalization in the case of Canada and Japan, but reveal rate of return differentials *in favor* of the United States by a factor of 100 in the case of Cameroon and by a factor of 12 in the case of Latin America. Hence, one shouldn't expect *any* investment in physical capital occurring in Cameroon and in Latin America. However, these countries not only experienced positive investment rates, but also attracted some capital inflows,<sup>11</sup> at least until the early eighties. Therefore, obviously, an estimate for  $\gamma$  closer to 0.4 than to 1.4 seems to be more reasonable.

<sup>11</sup> Compare Summers and Heston (1991, columns 3, 4 and 5): [100-c-i-g] gives a negative current account balance (per cent of GDP), which indicates net capital inflows.

These back-of-the-envelope calculations reveal that accounting for human capital externalities may change the predicted direction of international capital flows, contrary to what may be indicated by per-capita income differentials. The empirical plausibility of a human capital externality can be assessed by equation (20). The externality disappears ( $\gamma = 0$ ) if the growth rate of per-capita income equals the growth rate of the per-capita stock of human capital. Put differently, with relatively well documented estimates for the long-run growth rate of the United States per-capita income ( $\ln y_{US} \approx 1.7$ ) and for the capital share ( $\alpha_{US} \approx 0.25$ ), the Denison (1962, 1974, 1985) estimates for the long-run growth rate of the stock of human capital would have to be corrected by a factor of 2 or 3 to eliminate the externality effect.

Therefore, it is somewhat difficult to deny the existence of a human capital externality in the context of the present model, although a conclusive point estimate for its actual size can not be derived from the presently available empirical evidence. The implication of this hypothesis is that the incentive for capital to flow to relatively poor countries is probably even much lower than indicated by human capital adjusted income differentials. As a consequence, the catching up potential of relatively poor countries may be severely restricted by their ability to raise their stock of human capital.

This interpretation, notwithstanding its underlying rather limited sample of countries, is corroborated by Quah's (forthcoming) finding of a "two-camp world", thereby highlighting that human capital formation is a crucial bottleneck for economic development. Of course, this is well known. But the empirical evidence presented in this paper reveals that the explanatory power of the human capital approach with respect to the predicted direction of international capital flows should be reconsidered, if externalities are involved. In turn, this may lead to a reconsideration of the relative importance of development policies encouraging the accumulation of human capital.

## 5. Conclusions

Despite the unequal distribution of incomes in the world economy, relatively little capital is flowing to poor countries. A fair description of tendencies prevailing since World War II seems to be that the world economy is converging to a distribution of incomes where *many* countries remain wealthy, and *many* remain poor (Quah, forthcoming). One way to explain this empirical pattern is to stress "political risk" as the decisive factor limiting international capital flows to poor countries. Following this interpretation, international factor (for that matter, capital) mobility could induce a catching up of the have-nots, and finally a convergence of per-capita incomes, if only political risks were eliminated.

Recently, advances in growth theory have led to "endogenous" growth models that are capable of explaining persistent income differentials. The crucial feature of these models is a departure from the usual assumption of diminishing returns to the factors of production. As was first shown by Romer (1986), a competitive dynamic equilibrium can exist if overall increasing returns to scale are external to the firm. For the empirical analysis, the question remains were to look for an externality. While many models can replicate the empirical pattern, Lucas' (1988) model of a human capital externality provides a promising starting point, because it includes variables that can be measured, at least in principle. Employing this model first of all requires cross-country information on the stock of human capital.

The estimates for the relative stock of human capital presented in section 3 provide a first step in this direction. They are limited to a rather small sample of countries, and certainly suffer from a number of shortcomings which call for further research. Still, they are more comprehensive than any other presently available estimate for the stock of human capital. Their empirical plausibility can be assessed within a production function framework. The results suggest that accounting for human capital *endowments* somewhat reduces the implicit rate of return differentials based on different per-capita incomes, thereby partly explaining why relatively little capital flows to poor countries.

In the presence of political risk, remaining rate of return differentials in favor of poor countries may not suffice to encourage substantial capital flows. This interpretation is compatible with the empirical facts, as well as a alternative interpretation, focussing on human capital externalities. Referring to independent empirical evidence for the United States, it is difficult to deny the plausibility of human capital externalities. Given the estimates for the relative stock of human capital for the sample of countries used in this paper, accounting for human capital *externalities* reveals that rates of return to physical capital may be substantially higher in *rich* countries than in poor countries.

Without improved empirical evidence, it seems to be rather difficult to discriminate between the externality- and the political risk-hypothesis. Both hypotheses may be relevant for an explanation of real world phenomena. But if the rates of return to capital are actually higher in rich countries, net capital flows to poor countries will be fully offset by a reduction of domestic investment. Therefore, external and internal development policies should mainly focus on human capital accumulation, on investing in people rather than investing in physical capital. Obviously, this strategy will fail to induce a catching up of poor countries, if political risk is the decisive limiting factor of economic development. Still, even eliminating political risks will not suffice to induce a catching up as long as large differences in human capital endowments exist in the presence of human capital externalities.

Table 1 - Mean Weekly Earnings in 1979 by Age and Education, United States 1980 (US-\$)

Age	Education		
	First level	Second level	Third level
	1. Urban males		
18-24	112	159	174
25-34	173	271	343
35-44	213	340	529
45-54	222	348	585
55-64	173	288	518
65+	34	72	204
	2. Urban females		
18-24	57	99	128
25-34	68	120	191
35-44	73	122	196
45-54	66	115	195
55-64	47	88	162
65+	8	18	41
	3. Rural males		
18-24	103	167	187
25-34	162	278	337
35-44	203	335	477
45-54	201	326	508
55-64	152	256	421
65+	43	80	159
	4. Rural females		
18-24	43	87	121
25-34	54	95	157
35-44	56	101	163
45-54	53	93	167
55-64	37	67	131
65+	11	20	44

Source: US Department of Commerce (1984); for details see Appendix.

Table 2 - Per-Capita Growth Rates and Total Expenditures per Pupil for Selected Countries

Country	Average annual growth rate of real per-capita income, 1950-80 (per cent) (1)	Total expenditures per pupil, 1980 (international US-\$) (2)
United States	1.9	3,447
Bangladesh	0.4 <sup>1</sup>	63
Brazil	5.0	551
Cameroon	3.6 <sup>2</sup>	187
Canada	2.3	3,530
Ecuador	3.4	469
Honduras	1.6	171
Japan	6.7	2,178
New Zealand	1.6	1,657
Panama	3.4	480
Sri Lanka	0.9	175

<sup>1</sup> 1959-80. - <sup>2</sup> 1960-80

Source: Summers and Heston (1991); UNESCO (1988); for details see Appendix.

Table 3 - Relative Per-Capita Incomes and Relative Human Capital Endowments, 1980

Country	Relative per-capita income (per cent)	Maximum attainable relative per-capita income (per cent)	Percentage income differential explained by different human capital endowments (per cent)	Labor share	Relative stock of human capital per person (per cent)	Labor efficiency equivalent per average person from the United States (per cent)
	(1)	(2)	(3)	(4)	(5)	(6)
Cameroon	10.1	55.4	49.6	0.36	19.4	5.2
Canada	92.9	94.0	85.7	0.69	91.4	1.1
Brazil	29.7	61.5	55.0	n.a. <sup>1</sup>	37.8	2.6
Ecuador	21.7	60.5	50.6	0.39	27.6	3.6
Japan	63.8	88.3	32.5	0.64	82.3	1.2
Panama	23.3	71.1	37.5	0.56	54.4	1.9
Panama (SESP)	-	73.9	33.9	-	58.3	1.7

<sup>1</sup> Approximated to be 0.5

Source: Republic of Panama (1983); Summers and Heston (1991); US Department of Commerce (1984); United Nations (1985, 1989, 1990); for details see Appendix.

Table 4 - Predicted Rate of Return Differentials Relative to the United States (Factor of Proportionality)

Country	Relative per-capita income (y)	Relative per-capita stock of human capital (h)	Average profit share ( $\bar{\alpha}$ )	Rate of return in country ... is ... times higher than in the United States			
				Model 1	Model 2	Model 3 $\gamma = 0.4$ $\gamma = 1.4$	
Cameroon	0.10	0.2	0.4	32	2.8	0.6	0.01
Canada	0.95	0.9	0.3	1	0.9	0.8	0.60
Japan	0.65	0.8	0.3	3	1.6	1.3	0.70
Latin America <sup>a</sup>	0.25	0.4	0.4	8	2.0	0.8	0.08

<sup>a</sup> Approximated averages for Brazil, Ecuador, Panama.

Source: Table 3; for details see Appendix.

Appendix: Detailed Sources and Methods of Computation

## Table 1:

US Department of Commerce (1984), table 295, pp. 447-50 and pp. 471-74.

First level	=	0-7	years of schooling
Second level	=	8-12	years of schooling
Third level	=	12+	years of schooling

## Table 2:

Column 1: Computed from Summers and Heston (1991), column 2

$$\left[ (\ln RGDPCH_t / \ln RDGPCH_0) / t \right]$$

Column 2: Computed from UNESCO (1988), tables 3.4, 3.5, 3.7 and 4.1; and Summers and Heston (1991), columns 13 and 17.

Exp/pup:	Total expenditure per pupil
P:	Price Level of GDP
ExR:	Exchange Rate
PPP:	Purchasing Power Parity (GDP) = $P * ExR$

$$\left[ (Exp / pup) * PPP \right]$$

## Table 3:

Column 1: Summers and Heston (1991), column 8

$$[y]$$

Column 2: computed from

United Nations (1985), table 38 ( $x^P$ )United Nations (1990), table 34 ( $x^P$ );Republica de Panama (1983) [Panama SESP], ( $x^P$ );US Department of Commerce (1984), table 296, pp. 447-50 and pp. 471-74 ( $x^r, f^r$ )

$$\left[ \frac{\sum f_i^r x_i^P}{\sum f_i^r x_i^r} * 100 \right]$$

Date of Census:	Bangladesh 1981
	Brazil 1980
	Cameroon 1976
	Canada 1986
	Ecuador 1974
	Honduras 1983
	Japan 1980
	New Zealand 1981
	Panama 1980
	Sri Lanka 1981

Column 3: computed from column (1) and (2)

$$\left[ \frac{100 - (2)}{100 - (1)} * 100 \right]$$



Column 4: Computed from United Nations (1989), table 6.

$\beta$ : labor share  
 GDP: gross domestic product  
 W: compensation of employees  
 T: indirect taxes  
 S: subsidies  
 D: depreciation (approximated to be 10 per cent).

$$\left[ \beta = \frac{W}{GDP - T - D + S} \right]$$

Column 5: computed from columns (2) and (4)

$$\left[ e^{\frac{\ln(2)}{100}/(4)} \right]$$

Column 6: computed from column (5)

$$[1/(5)]$$

Table 4:

All columns (computed) from table 3.

$$\alpha = 1 - \beta$$

$$\bar{\alpha} \approx (\alpha_i + \alpha_{US}) / 2$$

$$\text{model 1: } [y^{(1-\alpha)/\alpha}]$$

$$\text{model 2: } [(y/h)^{(1-\alpha)/\alpha}]$$

$$\text{model 3: } [(y/h)^{(1-\alpha)/\alpha} h^{7/\alpha}]$$

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