On the Global Misallocation of Human Capital*

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Abstract

Is human capital allocated efficiently across countries? To answer this question, we need to differentiate misallocation from factor intensity differences. We use newly available estimates on natural resources shares from Monge-Naranjo et al. (2017) to correctly measure the factor shares of physical and human capital for a large number of countries and periods. We find that the global efficiency losses of the misallocation of human capital are around 60% of the world's output. Moreover, the misallocation of human capital seems to have worsened in the more recent years. Interestingly, we show that when physical and human capital can both be reallocated, physical capital would often flow from poor to rich countries, contrary to Lucas (1990)'s paradox.

JEL codes: O11, O16, O41.

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1 Introduction

The large dispersion in real wages across countries suggests a potentially huge global misallocation of human capital. Thus, reallocating human capital could substantially increase global output and drastically change the world income distribution. To be sure, reallocating humans across countries is a much more complex endeavor than reallocating physical capital. Migrant workers, and not machines, leave behind friends, families and other attachments, and may face cultural and anti-immigrant resistance. Moreover, the impact –real or perceived– of foreign workers on the local population has been used as a political banner in a way that has no comparison with the impact of capital inflows. Yet, despite all those frictions and barriers, workers and their human capital have been continuously reallocated across countries, oftentimes in great measure. As of today, in the U.S. and in many other countries, such a reallocation is evident not only in high human capital intensive institutions such as universities, hospitals and research institutions, but also much more generally, in stores, restaurants, and farms, all of which often agglomerate workers from all over the world.

In this paper, we assess the potential global efficiency gains and distributional impacts of reallocating human capital across countries. To this end, we face a number of challenges. First, we need to take a stand on which factors are fixed in each country and which factors can be reallocated –if any– along with human capital. Second, we need to control for factor intensity differences across countries to avoid confusing them with distortions. Third, we need to measure or infer the marginal valuation of human capital across countries and incorporate some of the distributional constraints that countries may impose for the entry of workers from abroad. We use the recent work by Monge-Naranjo et al. (2017) that provides exactly the data required to address the three set of issues, for a sample of 76 countries and for the years from 1970 to 2005. First, aside of pure TFP, natural resources are ultimately the only fixed inputs of production in each country. Using the measures in Monge-Naranjo et al. (2017), we assess the curvature of the production function of the different countries with respect to all the mobile factors, i.e. human and physical capital, and evaluate the gains of reallocating human capital only or human and physical capital simultaneously. Second, we use the measures in Monge-Naranjo et al. (2017) to control factor intensity differences across countries, which they show that are not sensitive to policy distortions. Third, we circumvent the lack of direct and reliable measurements of the relative value of human capital across countries and periods, using the model to generate two extreme and opposite bounds for the observed cost of labor across countries.

Our basic efficiency benchmark consists of equating the marginal returns to human capital across countries. Doing so points to large misallocation of human capital during all sample periods, in the range of 40% to 50% of global output, with an upward trend over time. Our findings resemble those in Klein and Ventura (2009) and Kennan (2013), using different models, countries and data. This basic benchmark abstracts from the barriers to reallocating human capital (workers) across countries, which can be very stringent. Some of the barriers are natural, such as the emotional cost of reallocating human beings across countries with different language, culture and values. But other barriers must are the result of policies and legislation, mainly in the more developed countries. Such barriers are surely motivated to prevent a reduction in the

wages of some of the domestic workers. In fact, the large implied global output gains from the basic benchmark come at the cost of drastic reductions in the wage rate (per unit of human capital) in developed countries.

To appraise the potential gains in global output without the negative impact on the native workers of developed countries, we construct policy counterfactuals that are constrained so that the real wages of workers must be kept constant (at the implied levels from the data.) By design, if workers were the only factor that could be reallocated across countries, no reallocation would take place and global gains would be zero. However, if *both* human and physical capital could be reallocated, even under such a conservative exercise, the global gains would be substantially higher than reallocating physical capital alone, around 8% to 9% of global output in the 1970s and up to 6% by the 2000s.[1] Interestingly, the reallocation is largely from the richer and poorer countries (first and fourth income quartiles) toward the middle ones (second and third income quartiles.)

Overall, a proper assessment of global misallocation considers both human and physical capital. The complementarity between these two factors plays a role as they must be directed toward the countries with higher fixed productivity, either because of TFP or natural resources. Observed allocations deviate from such an alignment. More interestingly, if human and physical capital can be reallocated jointly to equalize their marginal returns across countries, the direction of the physical capital flows can be reverted relative to the case when physical capital is the only mobile factor. In fact, the premise that capital should flow from rich to poor countries is unwarranted: When both factors are reallocated, capital and labor would flow from some of the poor and middle-income countries toward some of the richer countries. This simple yet often ignored point could be one of the keys to understanding the consequences of alternative integration schemes with or without labor mobility for countries and regions with different productivities and fixed endowments (e.g. the US and Puerto Rico and the European Community one one side with NAFTA on the other).

The paper is organized as follows. Section 2 describes the data used throughout this paper. Section 3 presents our organizing model framework. Section 4 describes the behavior of the estimated marginal product of human capital. Section 5 presents the main results in terms of misallocation of human capital. Section 6 studies the effect of migration flows on the changes in misallocation over time. Conclusion follows.

2 Data

In this section we describe the available data, the countries for which we have consistent reliable data, and the method used to compute inputs share of output.

[1] The gains of reallocating physical capital estimated by Monge-Naranjo et al. (2017) for the same countries and years are about 3%.

2.1 Countries

We use Monge-Naranjo et al. (2017)'s estimates of the factor shares for natural resources, together with data from PWT (Penn World Table) 8.0 for all other variables. We have consistent data for 79 countries from 1970 to 2005. They are:

- Africa: Burkina Faso, Côte d'Ivoire, Cameroon, Kenya, Morocco, Mozambique, Niger, Nigeria, Senegal, Tunisia, Tanzania, South Africa, and Zimbabwe.
- Asia: Bahrain, China, Hong Kong, Indonesia, India, Iran, Israel, Japan, Jordan, Republic of Korea, Kuwait, Sri Lanka, Malaysia, Oman, Philippines, Qatar, Saudi Arabia, Singapore, Thailand, Turkey, and Taiwan.
- Europe: Austria, Belgium, Bulgaria, Switzerland, Cyprus, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Hungary, Ireland, Iceland, Italy, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, and Sweden.
- America: Argentina, Barbados, Bolivia, Brazil, Canada, Chile, Colombia, Ecuador, Costa Rica, Dominican Republic, Guatemala, Honduras, Jamaica, Mexico, Panama, Peru, Paraguay, Trinidad & Tobago, United States, and Uruguay.
- Oceania Australia and New Zealand.

We exclude Burkina Faso, Nigeria, and Oman from our reallocation exercises because these countries do not have data on human capital. This implies a total of 76 countries for our benchmark sample.

In Section 5.2 we expand our analysis to countries for which we can retrieve information on rents of natural resources, factor shares, physical capital, human capital, and output for the year 2005. The improvement on data collection and sources over time and the presence of new countries since the early 1990s (e.g., from Eastern Europe), implies more countries for which the required data are available. This new set of countries includes Armenia, Benin, Botswana, Central African Republic, Croatia, Czech Republic, Estonia, Fiji, Gabon, Kazakhstan, Kyrgyzstan, Latvia, Lesotho, Lithuania, Macao, Mauritania, Mauritius, Moldova, Mongolia, Namibia, Romania, Russia, Rwanda, Serbia, Sierra Leone, Slovak Republic, Slovenia, Swaziland, Tajikistan, Togo, and Ukraine. This yields a total sample of 107 countries for the year 2005.

2.2 Inputs Share of Output

We now explain how we incorporate Monge-Naranjo et al. (2017)'s estimates of the factor shares for natural resources, $\phi^R_{j,t}$, for the computation of the output shares for capital and labor.

We denote the labor share of output by $\theta_{j,t}$. In this paper, we use the PWT variable *labsh*. This measure of the labor share aims to correct for the part of ambiguous income, mainly proprietors' income (i.e., the self-employed), that needs to be attributed to labor income in order to avoid underestimating the contribution of labor to output. This is a particularly relevant issue

in countries in which a significant amount of labor is allocated to family-owned farms and other various forms of self-employment.[2]

For the output share of physical capital, denoted here by $\phi^K_{j,t}$, the standard practice is to equate it to 1 minus the labor share. All non-labor income must be capital income, an assumption driven by a constant returns to scale production function with only physical and human capital as factors. Instead, as proposed by Caselli and Feyrer (2007), correctly accounting for the income shares of natural capital factors, the physical capital share should be calculated as

$$\phi^K_{j,t} = 1 - \theta_{j,t} - \phi^R_{j,t}. \tag{1}$$

Thus, we are able to make this adjustment using data on the income shares of natural capital, $\phi^R_{j,t}$, from Monge-Naranjo et al. (2017). Note that the output share of natural resources is important for our computations because it determines the returns to scale of mobile factors, human and physical capital, in each of the countries.

3 The Model

In this section we set out our baseline model and derive the benchmarks used to evaluate the degrees of misallocation of mobile factors across countries.

3.1 The Baseline Environment

Consider a world economy, populated by an arbitrary number J of countries, indexed by $j = 1, 2, ..., J$. Given our data, we index the (yearly) time periods by $t = 1970, 1971, ...2005$. Our baseline model assumes a single tradable good, which can be consumed or invested across all the countries. In each country, output is produced using the service flows of the country's stocks of physical capital, $K_{j,t}$, natural resources (land and other natural resources), $T_{j,t}$, and human capital-augmented labor, $H_{j,t} = h_{j,t}L_{j,t}$, where $L_{j,t}$ indicates the number of workers in country j in period t and $h_{j,t}$ their average skills or human capital. Production in the country is also a function of the country's overall TFP, $A_{j,t}$.

Our baseline model stems from the standard one-sector growth model, assuming that production of the good in country j at time t is Cobb-Douglas. Specifically, we consider a production function of $Y_{j,t}$ in the form

$$Y_{j,t} = A_{j,t}(K^{\gamma_{j,t}}_{j,t} T^{1-\gamma_{j,t}}_{j,t})^{1-\theta_{j,t}} (H_{j,t})^{\theta_{j,t}}, \tag{2}$$

where $0 < \theta_{j,t} < 1$ is the labor share of output. The non-labor share of output, $1-\theta_{j,t}$, is divided between a share $\gamma_{j,t}\,(1-\theta_{j,t})$ for produced capital, $K_{j,t}$, and an output share, $(1-\gamma_{j,t})\,(1-\theta_{j,t})$

[2] See Cooley and Prescott (1995), Gollin (2002), and Feenstra et al. (2015).

for natural resources. This specification extends the standard model in two dimensions. First, it introduces non-produced capital (natural resources) $T_{j,t}$. Second, it allows for country-time variation in the factor shares as documented in the previous section.

In our framework, the marginal product of one unit of human capital in terms of quantity of goods ($QMPH_{j,t}$) is simply given by

$$QMPH_{j,t} = \theta_{j,t}\frac{Y_{j,t}}{H_{j,t}}.$$

Similarly, the marginal product of one unit of physical capital in terms of quantity of goods ($QMPK_{j,t}$) is given by

$$\begin{aligned} QMPK_{j,t} &= \phi_{j,t}\frac{Y_{j,t}}{K_{j,t}} \\ &= \gamma_{j,t}(1-\theta_{j,t})\frac{Y_{j,t}}{K_{j,t}}. \end{aligned}$$

3.2 Efficient Allocations

To study the efficient allocations we relabeled the fixed factors in each country, TFP and natural resources, in the term $Z_{j,t} \equiv A_{j,t}T_{j,t}^{(1-\gamma_{j,t})(1-\theta_{j,t})}$.

Baseline. The optimal global allocation is defined by

$$Y_{W,t}^{K^*,H^*} = \max_{\{K_{j,t},\, H_{j,t}\}} \sum_{j=1}^{J} Z_{j,t}\left(K_{j,t}\right)^{\gamma_{j,t}(1-\theta_{j,t})}\left(H_{j,t}\right)^{\theta_{j,t}},$$

subject to

$$\sum_{j=1}^{J} H_{j,t} \leq H_{W,t} \text{ and } \sum_{j=1}^{J} K_{j,t} \leq K_{W,t}$$

where $H_{W,t} \equiv \sum_{j=1}^{J} H_{j,t}^{O}$ and $K_{W,t} \equiv \sum_{j=1}^{J} K_{j,t}^{O}$ for all t, and $H_{j,t}^{O}$ and $K_{j,t}^{O}$ are the observed levels of human and physical capital. In addition to equalizing the $QMPK_{j,t}$ of all countries to a common world price, r_t^K, efficiency requires that all $QMPH_{j,t}$ be equalized to a common price

$$r_t^H = \theta_{j,t}Z_{j,t}\left(K_{j,t}\right)^{\gamma_{j,t}(1-\theta_{j,t})}\left(H_{j,t}\right)^{\theta_{j,t}-1}. \tag{3}$$

Thus, the world supply levels $K_{W,t}$ and $H_{W,t}$, and the productivities and endowments of natural resources $Z_{j,t}$ of all countries pin down the equilibrium r_t^K and r_t^H. These prices and the factor

shares determine the factor intensity of each country,

$$\frac{K_{j,t}}{H_{j,t}} = \frac{\gamma_{j,t}\left(1-\theta_{j,t}\right)}{\theta_{j,t}} \frac{r_t^H}{r_t^K}.$$

The efficient allocation implies that human and physical capital are allocated across countries to complement their TFP and natural resources as allowed by their country-specific returns to scale of mobile factors.There is not a closed-form solution except for the case of common (time-varying) factors shares, but the numerical optimization is trivial.

We will also present results for reallocating only human capital. In that case, the allocation of physical capital is taken as given, in the same way that the allocation of natural resourcss is taken as given in the problem presented above.

Value benchmark. The previous benchmark presumes that workers are indifferent as to where to work, and cross-country differences in output per worker are sustained by barriers to worker migration. The completely opposite view is that barriers are not the key limitation, and wage differences are sustained by compensating differences: differences in QMPH, and thus in wages, are sustained because workers demand different wages to live in different places.

Attempting to model and empirically discipline the behavior of compensating differences lies outside the limits of this paper.[3] Instead, we focus on a simple exercise that reallocates workers and capital but subject to constant real wages of workers, in terms of consumption goods, $w_{j,t}^h P_{j,t}^C / P_{j,t}^Y$, as inferred in the data in each country in each period. Since we do not have direct measurements on wages in terms of output, $w_{j,t}^h$, we use our model and infer it as $w_{j,t} = \theta_{j,t} Y_{j,t}/H_{j,t} = QMPH_{j,t}$. Thus, by fixing real wages of all countries at a point in time, this counterfactual is consistent with any decomposition of those wages arising from compensating differentials or barriers to mobility of workers. Notice also that if only workers, but no physical capital, are allowed to move, the reallocation would be minimal, due only to the small variation in the data for the relative price $P_{j,t}^C / P_{j,t}^Y$.

For this benchmark, the maximization is the same but the resource constraints are different. First, the global amount of goods paid for human capital services in each period is equal to the one inferred in the data:

$$\sum_{j=1}^{J} \frac{P_{j,t}^C}{P_{j,t}^Y} w_{j,t}^h H_{j,t} \leq H_{W,t}^N, \tag{4}$$

where $H_{W,t}^N \equiv \sum_{j=1}^{J} \frac{P_{j,t}^C w_{j,t}^h}{P_{j,t}^Y} H_{j,t}^O$ and $H_{j,t}^O$ is the observed data value for country j in period t. Similarly, we impose the restriction

$$\sum_{j=1}^{J} \frac{P_{j,t}^K}{P_{j,t}^Y} K_{j,t} \leq K_{W,t}^N. \tag{5}$$

[3]For that, see Klein and Ventura (2009).

Finally, as mentioned above, this maximization is also subject to providing the same amount of consumption goods to workers as implied by the data.

There is an intuitive interpretation for this exercise. Imagine a firm owner who is able to reallocate resources across countries and his firm is small enough that takes prices as given. In terms of wages, imagine this person is limited by country-specific regulations (unions, minimum wages, and so on) to pay the period t wage in country i for any worker that he reallocates to country i in period t. She is given the task of reallocating workers across countries to maximize real output subject to keeping the company's payroll constant. Since we measure wages by $QMPH$ (disregarding $P^C_{j,t}/P^Y_{j,t}$ differences), the firm's owner has no incentives to reallocate workers if capital cannot be reallocated. In this sense, this exercise provides a lower bound for the global gains of human capital reallocation. Once capital can also be reallocated, there are potential gains of reallocating workers even subject to the constraint of keeping wages constant in each country.

The optimality conditions required the equalization across countries of the price-corrected marginal product of physical and human capital across countries; that is,

$$R^K_t = \frac{P^Y_{j,t}}{P^K_{j,t}} \gamma_{j,t} \left(1-\theta_{j,t}\right) A_{j,t} T_{j,t}^{(1-\gamma_{j,t})(1-\theta_{j,t})} \left(K_{j,t}\right)^{\gamma_{j,t}(1-\theta_{j,t})-1} \left(H_{j,t}\right)^{\theta_{j,t}}, \tag{6}$$

for physical capital and

$$R^H_t = \frac{P^Y_{j,t}}{P^C_{j,t} w^h_{j,t}} \theta_{j,t} A_{j,t} T_{j,t}^{(1-\gamma_{j,t})(1-\theta_{j,t})} \left(K_{j,t}\right)^{\gamma_{j,t}(1-\theta_{j,t})} \left(H_{j,t}\right)^{\theta_{j,t}-1}, \tag{7}$$

for human capital. Note that, given the world's returns R_t and R^H_t, the physical-to-human capital ratio in country j should be

$$\frac{K_{j,t}}{H_{j,t}} = \frac{\gamma_{j,t}\left(1-\theta_{j,t}\right)}{\theta_{j,t}} \frac{P^C_{j,t} w^h_{j,t}}{P^K_{j,t}} \frac{R^H_t}{R^K_t}.$$

Thus, in the efficient allocation, the physical capital intensity, relative to human capital, varies across countries according to their (i) factor shares in production, (ii) relative price of consumption and capital goods, and (iii) effective cost of labor. While natural resources, $T_{j,t}$, and pure TFP, $A_{j,t}$, enhance the amount of human and physical capital a country should receive, the cost in terms of output of both factors, respectively $P^K_{j,t}/P^Y_{j,t}$ and $P^C_{j,t} w^h_{j,t}/P^Y_{j,t}$, reduces them. It is trivially true that this maximization dominates the one where only capital can be reallocated. The interesting question is how much and whether capital flows change in magnitude and direction.

Table 1: Decomposition of the Variance of $\ln QMPH_{j,t}$ (1970-2000)

Year	Variances (logs of each variable)			Covariances (logs of each variable)				
	$QMPH_{j,t}$	$\theta_{j,t}$	$\frac{Y_{j,t}}{H_{j,t}}$	$\theta_{j,t}, \frac{Y_{j,t}}{H_{j,t}}$	$QMPH_{j,t}, QMPK_{j,t}$	$QMPH_{j,t}, \frac{P^Y_{j,t}}{P^K_{j,t}}$	$QMPH_{j,t}, \frac{Y_{j,t}}{H_{j,t}}$	$QMPH_{j,t}, \frac{Y_{j,t}}{K_{j,t}}$
1970	0.756	0.064	0.788	-0.048	-0.082	-0.019	0.740	-0.042
1980	0.713	0.061	0.726	-0.037	-0.169	0.058	0.689	-0.105
1990	0.748	0.058	0.642	0.024	-0.149	0.111	0.666	-0.107
2000	0.978	0.059	0.899	0.010	-0.038	0.029	0.909	-0.021

Source: Authors' calculations based on PWT 8.0.

4 The Marginal Product of Human Capital

First, we report salient features in the behavior of the cross-country dispersion in human capital and its marginal product (MPH). The dispersion of MPH is large and growing over time, and the accumulation of human capital does not track the behavior of the determinants of MPH. Second, to the extent that differences in MPH are driven by barriers to the mobility of labor across countries, the global gains of reallocating human capital would be an order of magnitude higher than those of reallocating physical capital. Third, the ability to reallocate workers would not only enhance the gains in global output from reallocating physical capital, but, more interestingly, also induce a reversal in the direction of reallocation of capital across countries. Instead of flowing from richer to poorer countries, capital from poorer countries would follow some of their workers in the direction of richer countries. This simple result could be useful in understanding the difference between integration agreements with labor mobility (e.g., the EU) and without it (e.g., NAFTA.)

We can simply decompose the cross-sectional variance of $\ln QMPH_{i,j}$ in terms of the labor share of output and the output-to-human capital ratios:

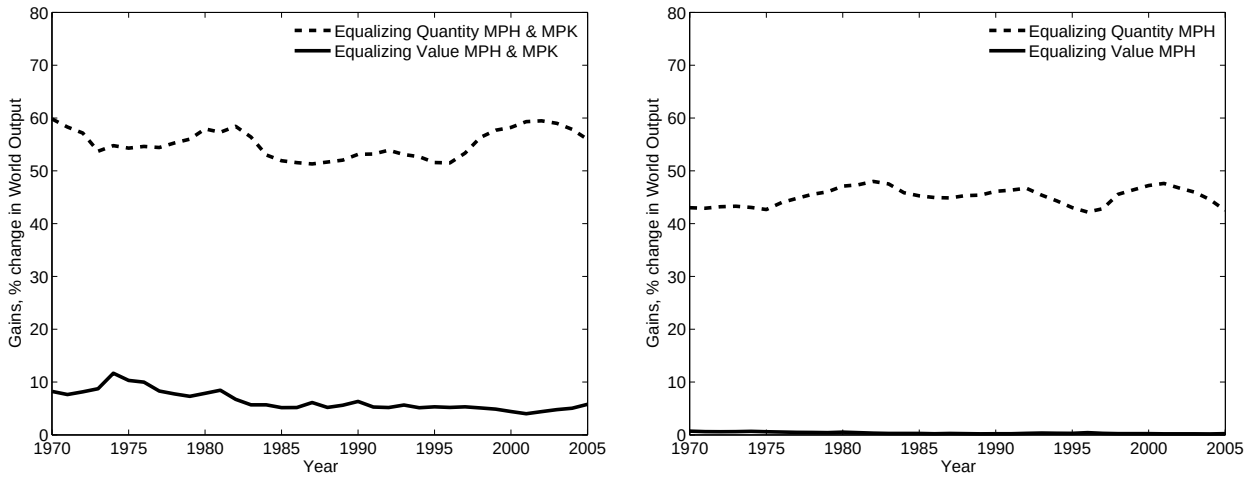
$$var\left[\ln QMPH_{i,j}\right] = var\left[\ln \theta_{j,t}\right] + var\left[\ln\left(Y_{j,t}/H_{j,t}\right)\right] + 2cov\left[\ln \theta_{j,t}, \ln\left(Y_{j,t}/H_{j,t}\right)\right].$$

Table 1 reports the values of these variances and the covariance for a number of years over the sample period. The right side of the panel also reports a number of covariances of interest with respect to the joint reallocation of human and physical capital across countries.

There is an upward trend in the dispersion in the $\ln QMPH$. From a low value of 0.713 in 1980, the variance in $\ln QMPH$ grows thereafter until reaching its highest value of 0.978 in 2000. Almost all of the variation is driven by the dispersion in $\ln\left[Y_{j,t}/H_{j,t}\right]$. Indeed, the cross-country correlation $\ln QMPH$ and $\ln\left[Y_{j,t}/H_{j,t}\right]$ is always above 0.95. Differences in the variance of labor share of output, $\ln \theta_{j,t}$, account for at most 9% of this variations, a contribution that remains flat around 7%-8% during the sample period. The covariance between $\ln \theta_{j,t}$ and $\ln\left[Y_{j,t}/H_{j,t}\right]$ provides a negligible contribution.

The cross-country covariation between the marginal products of human and physical capital is key for the potential gains of jointly reallocating these factors. We find that while negative, the

Figure 1: Global Output Gains of Production Factors Reallocation



Reallocating H and K

Reallocating only H

Source: Authors' calculations based on PWT 8.0, World Bank, and FAOSTAT.

magnitude of this covariation is rather weak (a very similar pattern is followed by the correlation between $\ln QMPH_{j,t}$ and $\ln [Y_{j,t}/K_{j,t}]$).

5 Gains of Reallocation

We conpute the gains of reallocation for two samples. The first one consist of 76 countries with consistent reliable data from the year 1970 to 2005. Then, we extend the sample considering countries with data available for the year 2005.

5.1 Results for the years 1970 to 2005

Figure 1 shows the global output gains of reallocating both physical and human capital and human capital only, respectively. In each panel, the dashed lines represent the gains from the benchmark. The solid lines represent the gains from the value benchmark defined above.

The most salient result is that the global gains of reallocating workers and physical capital can be very large. The quantity benchmark indicates that, for all the years in the sample, the global gains would be approximately 55% of world output. Those gains remain relatively flat over the sample period. The value benchmark also indicates a large gain. A second important result is that the complementarity between human and physical capital is an important determinant for the larger gains from their joint reallocation. As shown in the right panel, reallocating human capital per se leads to very large gains in the quantity benchmark counterfactual, but they do

not account for the total gains of joint reallocation. This finding is even clearer in the value benchmark, where the gains of reallocating labor only would be negligible.

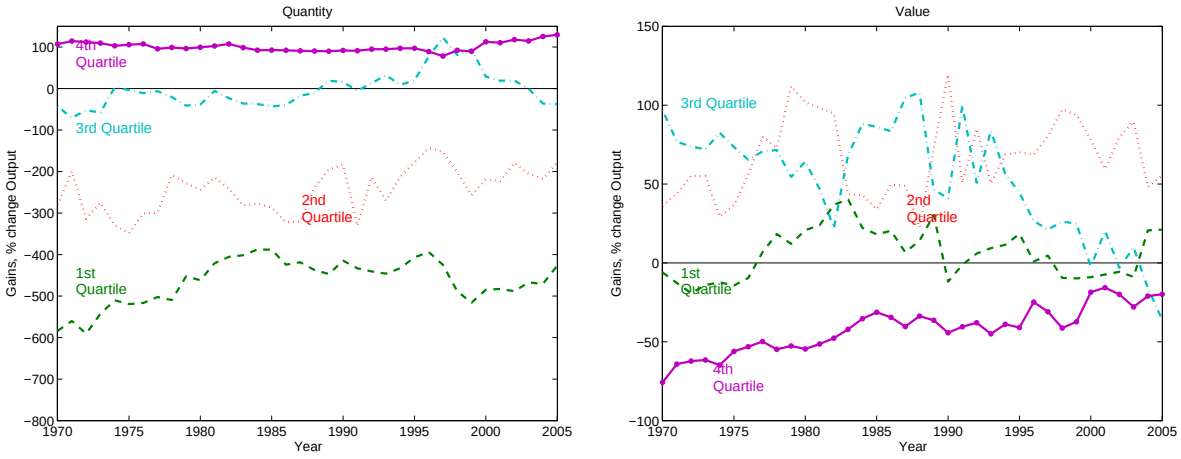
We finish this section by examining the distributional implications of the counterfactual efficient reallocations. In Figure 2, we show the change in the output of the country groups by income quartiles. In the left panel, we show the results of equating both quantity marginal products—$QMPK$ and $QMPH$—across countries. The right panel shows the results for the counterfactual with prices—that is, equating $VMPK$ and $VMPH$ across countries, where we impose that the wages of workers across countries must remain constant at the level before the reallocation. Two interesting patterns emerge. First, in the quantity counterfactual, the richer countries (fourth income quartile) and sometimes the middle-to-high income countries (third quartile) would expand production, while the poorer countries (first and second quartiles) always contract. Such a reallocation from poor to rich necessarily involves physical capital. Clearly, the required reallocation is exactly the opposite from Lucas (1990). This simple result could prove useful for understanding the resulting capital flows from economic integrations, differentiating between those in which workers can be reallocated (e.g., the European Community and the US-Puerto Rico), and those in which they cannot (e.g., NAFTA and Central America Free Trade Agreement, CAFTA). This simple result could also be useful in understanding the allocation of physical and human capital across regions within large countries (e.g., USA, Brazil and China). Second, the quantity and the value counterfactuals lead to very different patterns from each other. Once we impose the distributional restriction that foreign workers must earn the same income as domestic ones, the direction of global reallocation reverts, from rich to poor. Wage restrictions of the form imposed here endogenously make the human capital of countries behave as fixed factors, and reallocations tend to be similar as when physical capital is the only mobile factor. The wages of developed countries are too high, resulting in factor flows to countries in the second and third income quartiles, but not to the poorest ones because of their lower productivity and larger curvature.

5.2 Results Extending the Sample of Countries

So far, we focused on a sample of 76 countries for which we were able to consistently retrieve information on rents of natural resources, factor shares, physical capital, human capital, and output from 1970 to 2005. With improvement on data collection with time, as well as the emergence of new countries in the 1990s (for example, after the fall of communism in Eastern Europe), data for more countries are available in the present than in the past. In this section, we extend our benchmark sample to the set of 107 countries for which we can retrieve all necessary information to perform our analysis for the year 2005. Thus, we explore the robustness of our main results to the increased sample size.

We compare the global output gains from equalizing physical and human capital between our benchmark sample and the extended sample in Table 2. We find minor differences across samples or, if at all, our benchmark sample tends to underestimate the global gains or reallocation compared with the extended sample. First, equalizing MPH yields similar insights. Second, the joint global reallocation of physical and human capital implies that, in quantity terms, our output

Figure 2: Gains of Reallocating Human and Physical Capital across Income Quartiles



Note: Results of equalizing QMPK and QMPH (left panel) and VMPK and VMPH (right panel) across countries from 1975 to 2005.
Source: Authors' calculations based on PWT 8.0, World Bank, and FAOSTAT.

gains in the benchmark sample are 56.0%, while in the extended sample these are 57.3%. That is, our extended sample to leads to more global output gains. These underestimation are more apparent in value terms where output gains are 5.8% in our benchmark sample and 7.7% in our extended sample.

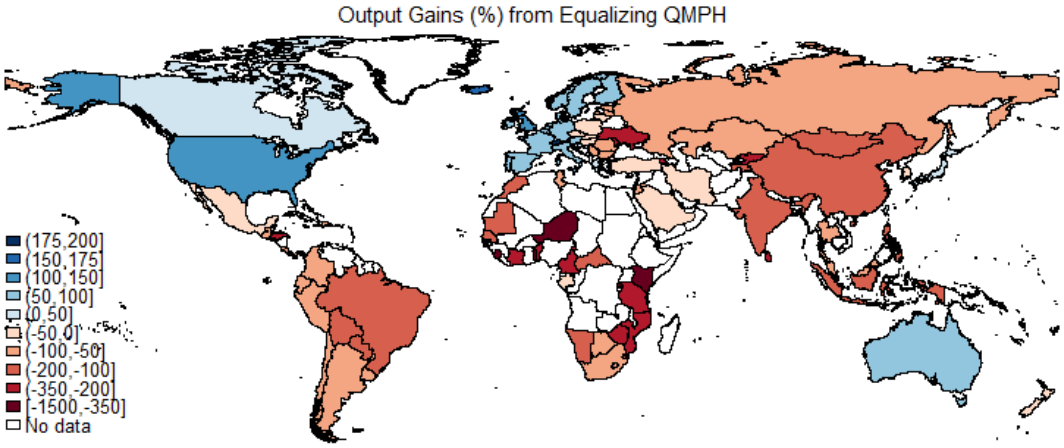
Table 2: Comparing Gains (%) in Output in 2005

	Quantity		Value	
	Benchmark	Extended Sample	Benchmark	Extended Sample
Equalizing MPH	42.52	42.18	0.25	0.25
Equalizing MPK & MPH	55.96	57.32	5.78	7.74
Number of countries	76	107	76	107

Source: Authors' calculations based on PWT 8.0, World Bank, and FAO stat.

With the extended sample, we use maps in Figure 3 to describe winners and losers of reallocation. The pattern of reallocation of human capital is quite interesting. The countries receiving migrants (blue in the map) are all developed: the United States, Canada, Western Europe, and Australia. The countries sending human capital abroad are China, India, Ukraine, Brazil, and other Eastern European and African countries.

Figure 3: Winners and Losers of Reallocation with the Extended Sample



Source: Authors' calculations based on PWT 8.0, World Bank, and FAO stat.

6 Another Reallocation Puzzle?

The previous results suggest that instead of physical capital, the culprit of misallocation is human capital. Even in our restrictive prices-value benchmark, the ability of reallocating workers across countries would greatly enhance the global output gains of reallocation of physical capital. Moreover, there is indication that the allocation of labor have not improved over time because the gains of joint reallocation are flat over time, while the gains of reallocating physical capital have declined—as shown by Monge-Naranjo et al. (2017). There is already a literature discussing the puzzling direction of physical capital flows (Feldstein and Horioka, 1980; Gourinchas and Jeanne, 2013; Ohanian et al., 2013; Monge-Naranjo et al., 2017). In this section we do an analogous analysis of human capital flows.

To examine whether there is a reallocation puzzle for human capital, we regress the change in human capital on several variables. The measure of the initial MPH appears insignificant in the regression to account for the change in human capital (displayed in Table 3). Changes in TFP and physical capital are insignificant in accounting for changes in human capital. The R-squared values of these regressions are low, indicating that these driving forces are not that important in driving investment in human capital. These results seem to be in line with Easterly (2002), who argues that "The growth response to the dramatic educational expansion of the last four decades has been distinctly disappointing ... creating skills where there exists no technology to use them is not going to foster economic growth."

To measure the role of human capital flows more directly we construct a counterfactual sequence of human capital stock for each country $\tilde{H}_{j,t}$. More precisely, the stock of human

Table 3: Population-Weighted OLS Regression, ΔH (1970-2005)

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \ln Z$	0.081	0.098	0.044	-0.044	-0.021	-0.067
	(0.085)	(0.091)	(0.093)	(0.095)	(0.089)	(0.083)
$\Delta \ln K$	0.092	0.033	0.070	0.117*	0.065	0.109
	(0.069)	(0.070)	(0.106)	(0.067)	(0.062)	(0.081)
$\Delta \ln \theta$	-1.133**	-0.935**	-	-0.706	-0.568	-
	(0.429)	(0.385)	-	(0.429)	(0.383)	-
$\Delta \ln \frac{P_Y}{P_C}$	1.157**	-	-	1.083***	-	-
	(0.455)	-	-	(0.373)	-	-
$VMPH_{1970} \times 10^{-3}$	-0.015	-	-	-0.025	-	-
	(0.014)	-	-	(0.015)	-	-
$QMPH_{1970} \times 10^{-3}$	-	-0.024*	-	-	-0.030	-
	-	(0.014)	-	-	(0.018)	-
$\left(\frac{Y}{H}\right)_{1970} \times 10^{-3}$	-	-	-0.014	-	-	-0.011
	-	-	(0.013)	-	-	(0.013)
Includes OECD	Y	Y	Y	N	N	N
Observations	76	76	76	53	53	53
R^2	0.411	0.340	0.176	0.471	0.349	0.174

Note: Robust standard errors are listed in parentheses. One asterisk means $p < 0.1$; two asterisks mean $p < 0.05$; and three asterisks mean $p < 0.01$.

Source: Authors' calculations based on PWT 8.0, World Bank, and FAOSTAT.

capital of country j in year t is

$$\tilde{H}_{j,t} = s_{j,1970} \cdot H_{W,t},$$

where $H_{W,t}$ is the world stock of human capital and $s_{j,1970} = \frac{H_{j,1970}}{H_{W,1970}}$.

We also examined the flows of human capital by analyzing net migration flows to each particular country $\{f^H_{j,t}\}$. Since we do not have information about the human capital of the migrants, we assume that migration changes the number of persons living in a country but not the average human capital index or the share of people employed. For example, that would be the case if the net flows from each country have the same characteristics as the population of that country.

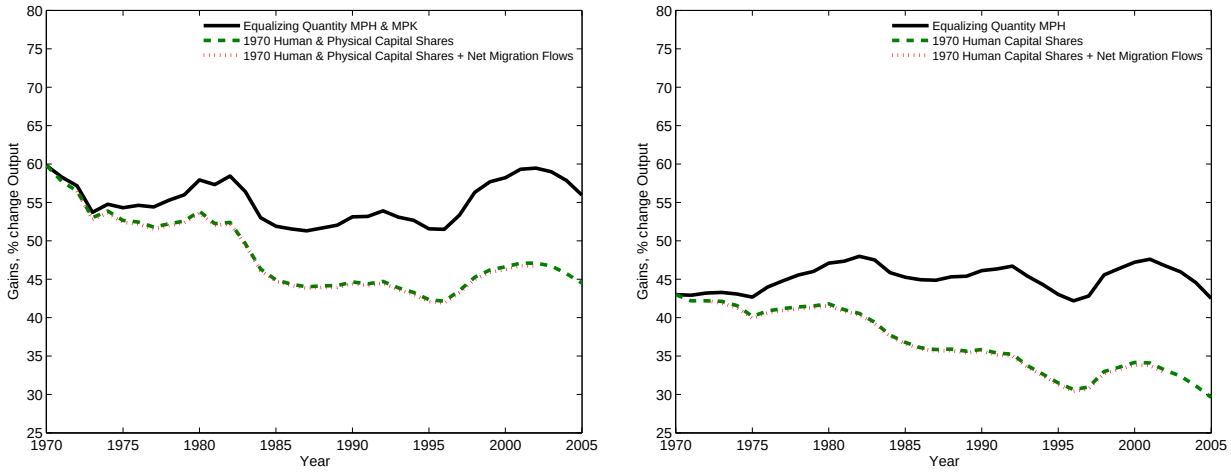
Data on net migration are taken from the World Bank and are available at 5-year intervals starting in 1972; we use linear interpolation to infer missing flows. To construct human capital flows $\hat{f}^H_{j,t}$ from population flow data $f^H_{j,t}$, we make several assumptions. We assume that a share d_t of migrants $f^H_{j,t}$ are employees. This share is equal to the average employment-to-population ratio:

$$d_t = \sum_j^N \frac{L_{j,t}}{P_{j,t}}/N.$$

To convert these employment flows $d_t f^H_{j,t}$ to human capital-augmented labor $\hat{f}^H_{j,t}$, we assume that migrant human capital is equal to the human capital in the country $h_{j,t}$ into/out of which labor is flowing, so that $\hat{f}^H_{j,t} = h_{j,t} \cdot (d_t f^H_{j,t})$. Assuming migrant human capital is equal to the global mean yields similar results. As with physical capital, the sum of human capital flows does not add up to zero. Adjusting the flows to ensure these flows add up to zero does not change our results.

We find that the investments in human capital since 1970 made the global allocation of human capital significantly worse (Figure 4). If in 2005 human capital was distributed according to the shares per country of 1970, the gains of reallocation would be 30 percent instead of 43 percent. The difference, 13 percent of global output, is a measure of how much worse is the allocation of human capital due to changes that have taken place since 1970. Adding migration flows does not change the picture, so the changes in human capital that worsen the allocation of human capital are internal.

Figure 4: Counterfactual Global Output Gains of Production Factors Reallocation



Reallocating H and K

Reallocating only H

Source: Authors' calculations based on PWT 8.0, World Bank, and FAOSTAT.

7 Conclusions

We use new data on natural resources shares from Monge-Naranjo et al. (2017) for uncovering the degree of global misallocation of human capital. We find the implied global efficiency losses of the misallocation of human capital are almost 60%. If anything, the misallocation of human capital seems to have worsened. Some interesting patterns results arise when we explore the joint reallocation of physical and human capital. First, the gains are substantially higher. Second, the direction of reallocation can change and, instead of capital flowing from rich to poor countries, as first explored by Lucas (1990), we find that capital—and workers—should flow from poor to rich countries. This simple point could help in understanding the consequences of alternative integration schemes with or without labor mobility for countries and regions with different productivities and fixed endowments (e.g. the US and Puerto Rico and the European Community one one side with NAFTA on the other).

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