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# The Optimal Ability- Education Mix and the Misallocation of Resources within Education Magnitude for Developing Countries

## THE OPTIMAL ABILITY-EDUCATION MIX AND THE MISALLOCATION OF RESOURCES WITHIN EDUCATION MAGNITUDE FOR DEVELOPING COUNTRIES\*

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The central notion of this paper is the hypothesis of factor complementarity between preschool ability and schooling in determining labor productivity. Hence, an optimal allocation of existing educational resources across students with different abilities ought to induce a positive and perfect correlation between ability and schooling. A system where schooling is determined by factors other than ability (i.e., the selection process of that system) induces a misallocation of present resources in education. An analytical framework is specified to derive magnitudes of the economic cost of this misallocation. It is shown that these values are substantial when compared to the welfare cost of other types of resource misallocation in developing countries.

### 1. Introduction

This paper calls attention to a particular type of misallocation of resources having important efficiency and distributional losses within the educational sector of developing countries. It can be defined as the misallocation of preschool talents or abilities across educational categories of individuals or alternatively, as the misallocation of educational investment across individuals with different levels of preschool ability.

Two propositions are central in defining such misallocation: first, the hypothesis that preschool ability and schooling are complementary factors in determining the productivity of an individual. Second, the existence of an educational system that implicitly selects students according to factors other than ability, basically the socio-economic status of the family.

If ability and education are complementary factors in the earnings generating function, the productivity of a given amount of education will be larger if invested in individuals with higher abilities. An optimal allocation of the existing educational resources among individuals with different abilities — in the sense of maximizing the value added of these resources — must

\*The views presented here are those of the authors and do not necessarily represent those of the World Bank.

generate what might be called an optimal ability-education mix. Such a mix will be characterized by a positive and perfect correlation between ability and education, i.e., schooling will become a positive monotonic function of ability. In other words, under such a mix, we will not find a pair of individuals one of whom has higher ability and less schooling than the other.

Under this framework, any other allocation of given educational resources across individuals will be non-optimal in the sense that it will generate a lower net value added. Correspondingly, it will determine a non-optimal ability-education mix, i.e., we could find in such a mix pairs of individuals one of whom has a higher level of ability but less schooling than the other. The economic cost of this misallocation can be thought of as the loss of value added in the existing educational system relative to an optimal system where students (at all schooling levels) are selected according to their preschool ability levels. The educational reform required to transform the present system to the optimal one (or the pure 'meritocratic' system) is defined as 'full reform'.

The economic cost of a suboptimal educational system depends on two factors. The first one is related to the 'quantity' component of the misallocation, the discrepancy between the existing and the optimal ability-education mix. The second factor is related to the 'price' component or valuation of a given 'quantity' of misallocation. Such valuation will depend on the degree of complementarity between ability and education, the stronger the complementarity the larger the cost of a given 'quantity' of misallocation. The degree of complementarity will be basically determined by the functional form and parameter values of the earnings generating function.

This paper derives orders of magnitude for the gains in value added due to a 'full reform' (or the total elimination of the misallocation) as well as for intermediate or partial reforms. Such reforms can be ranked according to the number of educational levels whose new selection criteria becomes the level of preschool ability. Throughout this evaluation the size or capacity of each educational level is held constant so as to isolate the pure qualitative effects of such reforms.<sup>1</sup>

Section 2 of the paper analyzes the factors behind the 'quantity' and 'price' component of the existing misallocation. Section 3 introduces the concept of educational reform which aims at narrowing the gap between the existing and the optimal ability-education mix. Section 4 presents a framework to measure the economic cost of the misallocation. Finally, section 5 presents empirical results based on data for a wide variety of developing countries.

<sup>1</sup>Here we only emphasize the economic or efficiency gains of alternative educational reforms. Some distributional effects are obviously present. If the existing selection criteria is associated with family income, present educational rents flow towards high income groups. At the other extreme, under a fully reformed educational system (or the pure meritocratic case), these rents would flow toward the high ability groups. As long as these two groups are not identical, the educational reforms described before will have a positive distributive effect.

## 2. The price and quantity component of the misallocation

### 2.1. The 'quantity' component of the misallocation

Under the existing educational system the amount of schooling an individual receives is positively correlated with his family income. To understand the ability-education mix generated by this system it is crucial to identify the factors determining the present distribution of (the relevant concept of) ability across individuals.

Such concept of ability, which we denote  $A$ , could be conceived as being innate ability determined by genetic endowment. It is assumed to be a random variable normally distributed and independent of family income, with mean  $\bar{A}$  and standard deviation  $\sigma_A$ .

The innate ability concept implies that the relevant ability is independent of family income, which is the basic variable behind the selection criteria of the existing educational system. In those levels of schooling where family income constitutes the only selection criterion, the expected mean ability of students will be equal to the population mean. Therefore, within these levels, the amount of schooling an individual receives and his ability level are not correlated.<sup>2</sup> This non-correlation between ability and schooling violates the optimal ability-education mix condition and therefore, implies a misallocation of educational resources.<sup>3</sup>

<sup>2</sup>For most developing countries we can think of these levels as being basically primary and secondary education.

<sup>3</sup>The preschool ability concept could also be conceived as being 'partly produced'. In this case, the relevant concept of ability (which we denote  $A^*$ ) can be thought of as depending on innate ability or genetic endowment (which still might be assumed to be a random variable independent of family income) as well as on the quality of the environment to which the individual is exposed between birth and school age. The quality of the environment reflects the impact of variables such as nutrition, health, parental attitudes, psychological stimulation, etc. Since the quality of the environment is likely to be positively correlated with family income, we may write

$$A^* = A^*[A, Q(Y)], \quad (1)$$

where  $A^*$  is the 'partly produced' level of ability,  $A$  the innate ability and  $Q$  the quality of the environment, itself a function of family income  $Y$ . Under this framework, ability is positively correlated with family income. Family income also determines the selection criterion of the existing educational system and therefore the amount of schooling an individual receives. This dual role played by the income variable implies an expected positive correlation between schooling and ability at all levels of the educational system. However, the random element introduced by the innate ability component implies that the positive correlation is not a perfect one, i.e., we can still find two individuals one of whom has less schooling but more produced ability than the others, such an individual might have a low family income but a high level of innate ability. Therefore, even though there exists an expected positive correlation between ability and schooling, we would still expect a misallocation phenomenon. The more important the contribution of innate ability to produced ability, relatively to the contribution of the quality of environment, the larger the magnitude of the expected misallocation.

A different situation characterizes the higher education level. For most countries we can expect the selection criteria in this level to be of a dual nature. First, family income matters because it determines who will apply for admission out of all potential candidates; given the absence of capital markets to invest in education, only those potential candidates who can finance the cost of education out of family income will effectively apply for admission. Second, ability also matters to the extent an excess demand for admission exists (fewer students admitted than the number applying) and ability becomes part of the selection criteria in the process of admission.

This double nature of the selection criteria in higher education induces an expected positive correlation between ability and schooling. However, the existence of potential candidates (secondary graduates) who for economic reasons do not apply for admission implies that this correlation is not perfect. Therefore, there still exists a misallocation of resources at this level. The expected mean ability of students in higher education exceeds the population mean, the opposite being true for those who did apply but were not accepted.

## 2.2. *The 'price' component of the misallocation: The earnings function*

The human capital approach provides a theoretical framework within which the relationship between earnings, preschool ability and school can be rationalized. This approach assumes that wages are equal or proportional to marginal products which in turn are a function of the stock of human capital of each individual. Schooling, preschool ability, experience and other variables are considered as inputs in the production of human capital.<sup>4</sup>

Since we are basically interested in the relationship between schooling and preschool ability in their contribution to earnings we will discuss these two variables neglecting the others. Our emphasis is similar to the one present in the current work being undertaken to isolate the value added of schooling from the contribution of preschool ability.<sup>5</sup>

The most widely used functional form for the earnings function is a log linear one:

$$\log E = a + bS + cA, \quad (2)$$

where  $E$  represents earnings,  $S$  schooling and  $A$  some measure of preschool ability. Mincer (1974) using a schooling investment model, provided a theoretical justification for this semi-log functional form. Heckman and

<sup>4</sup>See for example Mincer (1958, 1974), Ben Porath (1967), Becker (1967).

<sup>5</sup>See, for example, Griliches (1970, 1975), Hause (1971), Griliches and Mason (1972), Taubman and Wales (1973).

Polachek (1974) empirically verified this hypothesis by using the Box and Cox (1964) transformation to test for the correct functional form. Working with several sets of data they concluded that, under the normality assumption, the semilog form was the most appropriate simple transformation to be used in the specification of the earnings function.

Neither Mincer's theoretical argument, nor Heckman and Polachek's empirical test explicitly dealt with the preschool ability variable. However, Griliches (1970) using the Malmö data to regress earnings on schooling and preschool ability concluded that the semilog form fitted the data best on the 'standard error in comparable units criterion'.<sup>6</sup> Given these theoretical and empirical arguments, and following most of the literature on the subject, we will adopt the semilog functional form for the purpose of our analysis. This form implies complementarity between schooling and ability, the absolute contribution of schooling to earnings becomes an increasing function of the level of preschool ability of the individual.<sup>7</sup>

It is, however, important to point out that the analysis and direction of the conclusions hold under any functional form implying complementarity between education and ability. Absence of complementarity would mean lower rates of return and hence lower incentives to attend school for individuals with higher early abilities, a result that is not consistent with the existing empirical evidence.

### 3. The effect of an educational reform

An educational reform at any level of the schooling system implies a change in the selection criteria. A reformed system, rather than selecting students according to family income, will select them entirely on the basis of whichever ability notion is relevant in the context of the earnings function (productivity). It is obvious that, associated with each of these reforms, there must exist a program of loans, grants or other economic incentives which induce low income families to send their children to school if they are admitted.

Fig. 1 illustrates the effect of a reform in an educational level previously selecting students exclusively according to family income. We assume the actual size of this level is equal to  $N_R$ , namely  $N_R$  students are presently enrolled in such level. In the existing system, these  $N_R$  students (represented by the area under the  $N_R$  curve) belong to the highest income groups, those who can afford the private costs of education.  $N$  (the area under the curve  $N$ ) represents the total number of potential candidates to enter this level.<sup>8</sup>

<sup>6</sup>See Husen (1968) for a description of this data.

<sup>7</sup>From expression (1)  $\log E = a + bS + cA$  we can obtain  $[\partial^2 E / \partial S \cdot \partial A] = Ebc > 0$ . Therefore, the larger the ability level, the larger the contribution of schooling.

<sup>8</sup> $N_R$  is a subset of  $N$ .

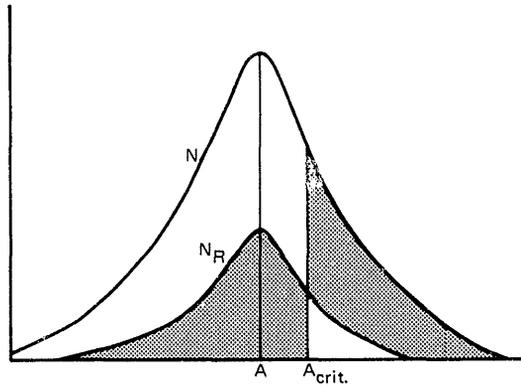


Fig. 1

Given our earlier assumptions, the ability levels of these two groups of individuals are normally distributed with the same mean  $\bar{A}$  and standard deviation  $\sigma_A$ .

The reform, by using ability as the selection criteria to fill the  $N_R$  vacancies out of the  $N$  candidates, determines an expected minimum level of  $A$  required to enter this level,  $A_{CRIT}$ . This critical value is such that the two shaded areas under  $N$  and  $N_R$  are equal in size, i.e., we assume throughout this exercise a constant size of each educational level. This constancy implies that the 'rich' students displaced by the reform by not having an ability level equal to  $A_{CRIT}$  are equal in number to the 'poor' students now being accepted under the new selection test.

It becomes clear that the expected mean ability level of the students entering this educational level will be higher under the reformed system. This change will be larger the smaller the ratio of  $N_R$  to  $N$ , i.e., the stronger the lack of 'openness' of the system and the larger the variance of the ability distribution. This change in expected mean ability induced by the reform will reduce the discrepancy between the existing and the optimal ability-education mix and correspondingly the degree of misallocation.

Fig. 2 illustrates the somewhat different case of a reform in the higher education system where the selection process is of a dual nature. Given the capacity of the system not all students who can afford the cost of higher education (those applying for admission) can be admitted. What we assume here is that in most developing countries some selection device based on ability does exist in the process of filling these vacancies. There exists a selection criteria related to ability over and above the income based criteria.

In fig. 2,  $N$  represents the number of high school graduates or potential candidates for higher education. From this group, only  $N_R^A$  students have the minimum income required to become effective candidates. Under the present

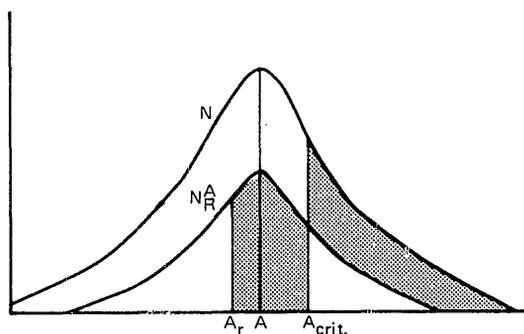


Fig. 2

system those effective candidates with an ability level higher than  $A_r$  are admitted into the system,  $A$ , being the existing critical level determined by the ratio of vacancies to effective candidates. The expected mean ability of the students accepted is higher than the population mean, the opposite being true for those effective candidates not being admitted.

The purpose of reforming this level is to fill those same vacancies by selecting the most able candidates out of all potential candidates, including those who presently do not apply. A constant number of vacancies and an increased number of potential candidates will imply a higher critical level of  $A$  required to be admitted, i.e.,  $A_{CRIT}$ . Once again, given the constant number of vacancies, the two shaded areas in fig. 2 will be equal in size. The reform will increase the expected mean ability of the students in higher education reducing the discrepancy between the existing and the optimal ability-education mix and its corresponding degree of misallocation.

If the reforms described above were simultaneously undertaken at all levels of the educational system, the resulting ability-education mix would approach the optimal one and the misallocation cost would disappear. The simultaneous implementation of these reforms at all levels constitutes what we call a 'full' reform.<sup>9</sup>

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#### 4. The measurement of the economic cost

This section develops a methodology to appraise the magnitude of the economic cost of the misallocation phenomenon described earlier. For this purpose two basic simplifying assumptions are being used: (a) Whatever is the relevant concept of ability in the context of productivity, we will assume

<sup>9</sup>The nature of the misallocation phenomenon does not change if we accept the notion of a 'partly produced' ability,  $A^* = A^*[A, Q(Y)]$ . However, given that this framework does generate a positive — but non perfect — correlation between schooling and ability the contribution of the reforms would be smaller.

it to be a random variable normally distributed and independent of family income. (b) The selection process to be used in the educational reforms will be based on that same concept of ability.

As we mentioned earlier, the economic cost of the misallocation phenomenon can be thought of as the incremental value added of an educational reform being simultaneously undertaken at all levels of the educational system. However, not all reforms need be of such an exhaustive nature. In this section we first define a range of reforms (ranging from partial to full reforms) and then analyze their effects on the mean ability level of individuals with different amounts of schooling. Second, we introduce a methodology to compute the economic gains of such reforms.

#### 4.1. *Effects of the reforms on the distribution of abilities by educational groups*

4.1.1. For the purpose of defining educational reforms, let us conceive an educational system having a primary and secondary level with six years of schooling each and a higher educational level with five years of schooling. Allowing for dropouts we will define seven types of labor:  $L_i$  ( $i=0, 3, 6, 9, 12$ ), as individuals entering the labor force with  $i$  years of schooling  $L_{12}$  are those who enter the labor force with twelve years of schooling without applying to higher education while  $L'_{12}$  are those who apply but were not accepted.

Five different reforms can be defined ( $R_i; i=1, \dots, 5$ ) according to the number of educational levels whose selection process becomes entirely based on ability. They range from one where only the highest educational level is modified by the reform to one where all levels of the educational system are affected. This last one constitutes what we have called the 'full reform' and defines an educational system of a pure meritocratic nature.<sup>10</sup> Each of these five reforms defines a given educational state  $E_i$ . If we add to these five hypothetical educational states the existing one we can define six educational states ( $E_i; i=0, 1, \dots, 5$ ). The difference in value added between any educational state and the existing one represents the benefit of the reform defining each educational state.

<sup>10</sup>(i) *Reform 1*: this reform induces all secondary school graduates (independently of their family income) to apply for admission to higher education. (ii) *Reform 2*: in addition to undertaking Reform 1, it reforms part of the secondary school system. Dropouts from secondary schools ( $L_9$ ) are now selected according to ability instead of family income. For this purpose, we can conceive secondary education as consisting of two sublevels, where the size of the second one is  $C_s$  times the first one. (iii) *Reform 3*: in addition to undertaking the previous reforms, it introduces further changes in secondary education. Students entering secondary schools are now selected among all primary school graduates according to their ability levels. (iv) *Reform 4*: in addition to undertaking the previous reforms, it introduces some changes in primary education. Dropouts from primary schools are selected according to their ability levels instead of family income. For this purpose we can again conceive this level as composed by two sublevels where the size of the second one is  $C_p$  times the first one. (v) *Reform 5*: in addition to undertaking the previous reforms, it introduces further changes in primary education. Students entering primary schools are now selected among all children of school age according to their ability levels.

4.1.2. In all educational levels where the selection process is based on family income, the expected mean ability of students will be equal to the population mean. When ability is introduced into the selection process it imposes a critical (minimum) level of that ability that divides the candidates into two groups: those with abilities below that critical value and those with abilities above that value. If the mean ability of all candidates is equal to the population mean, the mean ability of the former group will be below the population mean. The opposite will be true for the latter group.

The above conclusion will not be necessarily true for a given level of schooling if lower levels have already been 'reformed'. In this case, the arriving candidates at each level would already have a mean ability above the population mean. Therefore, both the accepted candidates as well as the rejected ones might have mean abilities above the population mean. It is important to realize that this result can only take place at the expense of substantially reducing the mean ability level of those students leaving the educational system at earlier levels. The reason is that the mean ability of the total cohort is unaffected by the reforms and is always equal to the population mean. The reforms as such do not 'create' abilities but only redistribute them across educational groups or, alternatively, they redistribute given educational resources across groups with different abilities.<sup>11</sup>

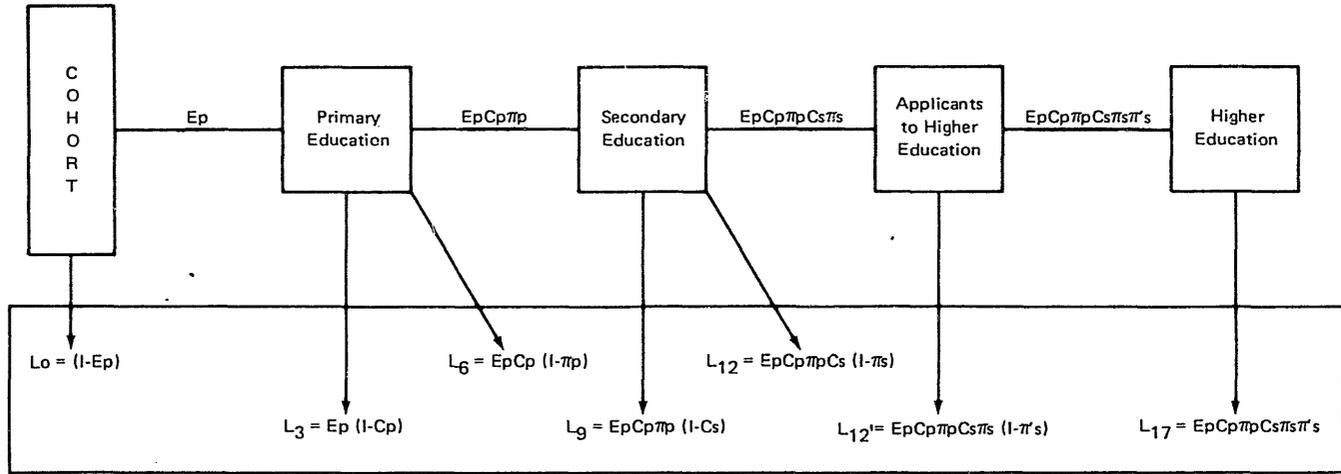
#### 4.2. *The concept of value added by a cohort and the measurement of the misallocation cost*

4.2.1. Fig. 3 illustrates the educational process of a cohort of individuals going through the educational system and entering the labor force at different stages. This educational process can be thought of as an investment project generating a stream of costs and benefits over time. The costs associated with this kind of investment are of two types: a direct component ( $K$ ), including building rentals, teachers salaries and other elements required to perform schooling activities. Second, an indirect component represented by the foregone earnings (productivity) of students while they are enrolled in

<sup>11</sup>Once we know the lower and upper ability bounds ( $A_L, A_U$ ) of an educational level out of a given reform, we can compute the expected mean ability of the students in the level as

$$\bar{A}_i = \frac{\int_{A_L}^{A_U} A f(A) dA}{\int_{A_L}^{A_U} f(A) dA}, \quad (3)$$

where  $\bar{A}_i$  is the expected mean ability of group  $L_i$  resulting from that particular reform and  $f(A)$  is the normal density function. A detailed explanation of how these bounds are derived — for each educational group and under alternative reforms — can be found in S. Piñera and M. Selowsky, 'The Economic Cost of the Internal Brain Drain', World Bank Staff Working Paper no. 243.



The following symbols are used in defining these flows:

- $C$  = Size of the cohort of individuals.
- $E_p$  = Primary school enrollment rate: number of students entering primary education as a fraction of the total cohort.
- $C_p, C_s$  = Primary and secondary completion rates: number of students finishing each level as a fraction of those originally enrolled in that level.
- $\pi_p$  = Primary progression rate: number of students entering secondary education as a fraction of those who finished primary education.
- $\pi'_s, \pi''_s$  = Secondary progression rates. The first is defined as the number of students applying to higher education as a fraction of those who finished secondary school. The second is defined as the number of students entering higher education as a fraction of those applying for admission.

Fig. 3. Flow of students as a fraction of the initial cohort.

the system. It can be measured by the wages they would have otherwise earned had they entered the labor force. The benefits of such a project are the increased wages (productivity) of those students when they enter the labor force induced by the educational process. The net present value (*NPV*) of this stream of costs and benefits represents the present value of the value added of the existing educational system.

As mentioned earlier, the existing educational system determines a given structure of expected mean abilities (and therefore wages) for individuals entering the labor force with different schooling levels. Each reform will determine a new structure of mean abilities and wages by educational groups. The mean ability of those groups with high educational levels will tend to increase and so their level of wages, the opposite being true for the groups with low education.<sup>12</sup>

Given the above considerations, it is clear that each reform will change the net present value of the lifetime production of the cohort. Since the reform has been undertaken holding constant the amount of real resources in the educational system, the entire change in such lifetime production can be attributed to the reform. The present value of this change in lifetime production represents the marginal value added of the educational system induced by that reform (*MPV*).<sup>13</sup> The expressions for *NPV* as well as *MPV* can be found in the appendix.

4.2.2. Of additional interest is the assessment of the impact of the reforms on the rate of return to a particular level of schooling. For such purpose what becomes relevant is the change in the mean ability of students at that particular level, not the change in the mean ability of those students leaving the system after completing that level.

The purpose of the reforms is to increase the mean ability of the students remaining in the educational system at the expense of those who leave it. Therefore, none of the reforms will ever reduce the mean ability of students in a particular level of schooling; unambiguously, each educational reform will increase the mean ability of the levels being affected by the reform.

The expected mean ability of students at each educational level is a weighted average of the ability levels of the different types of students in that level. These types of students are defined according to the amount of time they will remain in the educational system. The weights are the number of

<sup>12</sup>Note that the full reform implies a lower level of ability for those individuals not entering at all the educational system. This negative effect is obviously part of the total effect of that reform.

<sup>13</sup>Note that the value added by the existing educational system plus the incremental value added by the reform *i* corresponds to the value added of the educational state *i* ( $NPV + MPV_i = NPV_i$ ).

students of each type relative to the total number of students in the level in question.

The rate of return to the  $i$ th year of schooling can be written as

$$r_i = \frac{W_i(A) - W_{i-1}(A)}{W_{i-1}(A) + K}, \quad (4)$$

where  $r_i$  is the rate of return and  $W_i(A)$  is the wage of an individual with  $i$  years of schooling and an ability level equal to  $A$ .  $K$  corresponds to the direct cost of that year of schooling. Using expression (2) we can rewrite (4) as

$$r_i = b \left/ \left( 1 + \frac{K}{W_{i-1}(A)} \right) \right. = b \left/ \left( 1 + \frac{K}{\exp \{a + b(i-1) + cA\}} \right) \right. \quad (5)$$

In order to assess the impact of changes in the mean ability of students perceiving the  $i$ th year of schooling on the rate of return, we differentiate (5) with respect to  $A$ :

$$\left( \frac{\hat{c}r_i}{r_i} \right) / \hat{c}A = c \left/ \left( 1 + \frac{W_{i-1}(A)}{K} \right) \right. > 0. \quad (6)$$

From (6) it is clear that an increase in the mean ability will increase the rate of return, the effect being stronger the larger the coefficient  $c$  and the larger the value of  $K$  relatively to  $W_{i-1}$ . The fact that the ratio of direct cost to foregone income ( $K/W_{i-1}$ ) conditions the effect of the change in  $A$  on the rate of return is of crucial importance.

The importance of the  $K/W_{i-1}$  ratio can be clearly seen by returning to expression (4). The existence of  $K$  (which is independent of  $A$ ) means that a reform, by increasing  $A$ , increases the benefit of education (the numerator of  $r_i$ ) by a higher proportion than the increase in costs via increases in the foregone income (the denominator of  $r_i$ ).<sup>14</sup>

From the above considerations we can conclude that the relative contribution of the reforms will be larger the larger the contribution of direct costs to the total costs of the educational process. This condition is precisely the one that tends to characterize developing countries.

<sup>14</sup>Under an extreme situation where direct costs are absent ( $K=0$ ) the rate of return becomes independent of the ability level of students, benefits and costs increase proportionally under increases in  $A$ .

## 5. Empirical evaluation

### 5.1. Parameters characterizing the 'quantity' and 'price' component of the misallocation

5.1.1. The quantity component depends on two types of parameters: First, the ones determining the degree of 'openness' of the educational system, i.e., the enrolment, progression and completion rates. Second, the variance characterizing the distribution of preschool abilities in the population.

By looking at enrollment, progression and completion data for 62 countries, it was decided to group them according to regions and per capita income. The resulting groups are the following:<sup>15</sup>

		Region	Per capita income, 1972
Group I	(La 1)	Latin America	Less than \$400
Group II	(La 2)	Latin America	More than \$400
Group III	(Af 1)	Africa	Less than \$100
Group IV	(Af 2)	Africa	Between \$100 and \$300
Group V	(Af 3)	Africa	More than \$300
Group VI	(Me 1)	Middle East	
Group VII	(As 1)	Asia	Less than \$200
Group VIII	(As 2)	Asia	More than \$200

Regarding the variance of the distribution of ability, the findings tend to support a value of approximately 15 given a population mean of 100. This is based on IQ measurements as the proxy for ability. Therefore, for our purposes, we will assume the ability variable to be normally distributed with  $\bar{A} = 100$  and  $\sigma_A = 15$ .

Table 1 summarizes the structure of expected mean abilities of individuals of the cohort entering the labor force with different levels of schooling. These results are shown for the existing educational system as well as for the fully reformed system.<sup>16</sup>

5.1.2. The parameters determining the price component of the misallocation are the schooling and ability coefficients of the earnings function and the ratio of direct costs of education to foregone income,  $k = K/W$ .

Significant empirical evidence tends to support the notion that the schooling coefficient is larger in developing countries than in more developed

<sup>15</sup>The particular countries included as well as the data on enrolment, progression and completion rates is reported in Piñera and Selowsky (op. cit.).

<sup>16</sup>The values for partial or intermediate reforms are reported in Piñera and Selowsky (op. cit.).

Table 1  
 Structure of expected mean abilities under the present system and under a fully reformed system (in parentheses).

Type of labor	Group I (La 1)	Group II (La 2)	Group III (Af 1)	Group IV (Af 2)	Group V (Af 3)	Group VI (Me 1)	Group VII (As 1)	Group VIII (As 2)
$L_0$	100 (83.9)	100 (79.0)	100 (93.9)	100 (88.7)	100 (84.1)	100 (83.9)	100 (85.2)	100 (71.1)
$L_3$	100 (103.9)	100 (97.6)	100 (123.7)	100 (106.0)	100 (99.0)	100 (99.2)	100 (103.0)	100 (81.2)
$L_6$	100 (118.2)	100 (110.2)	100 (126.4)	100 (116.1)	100 (110.7)	100 (106.4)	100 (111.9)	100 (88.4)
$L_9$	100 (124.0)	100 (115.9)	100 (130.9)	100 (124.8)	100 (123.2)	100 (110.6)	100 (115.6)	100 (93.8)
$L_{12}$	93.0 (129.1)	95.0 (120.0)	92.9 (135.0)	93.0 (130.1)	96.0 (130.3)	93.1 (116.7)	92.8 (120.9)	92.9 (101.4)
$L_{17}$	106.5 (136.8)	102.9 (128.7)	107.2 (142.0)	106.1 (137.5)	108.7 (138.3)	110.3 (128.1)	107.4 (130.4)	107.2 (117.1)

Table 2  
Survey of ability coefficients by schooling level (ability measured by I.Q.).

Schooling level	Rogers Sample	Husen Sample 1	NBER Thorndike	Husen Sample 2	Selowsky-Taylor
<i>Elementary</i>	(1)	(2)	(3)	(4)	(5)
Incomplete		0.0032		↑	↑
Complete		0.0032			
<i>High School</i>					
Incomplete	0.00024	0.004			
Complete	0.0070	0.010	0.0032	0.0042	0.0076
<i>College</i>					
Incomplete	0.0036		0.0026		
Graduate (one degree)	0.0092	0.011	0.0032		
Graduate (two degrees)	0.0132		0.0086		
<i>Doctors Lawyers</i>			0.0036	↓	↓

ones.<sup>17</sup> For developing countries this coefficient appears to be bounded by 0.15 and 0.25.<sup>18</sup> For the purpose of our analysis we will use two alternative values, namely 0.15 and 0.20. Table 2 presents a review of the empirical evidence concerning the ability coefficient. The first three columns of table 2 present the results of regressing log earnings on ability for different educational levels and using different samples. Such results are reported in Hause (1972). The last two columns of table 2 show the results of studies regressing earnings on ability and schooling (this last variable is explicitly introduced) reported in Griliches (1970) and Selowsky-Taylor (1973). Of the first three columns, only the Husen sample provides estimates for low educational levels, the estimates of the columns four and five being relevant for all schooling levels. For the purpose of our empirical evaluations, we will use the estimates presented in columns two, four and five.

<sup>17</sup>This notion can also be rationalized from a theoretical point of view if relative endowments of more to less educated people differ across these types of countries. The return to invest in education will be larger in countries with a lower endowment of relatively educated individuals.

<sup>18</sup>See for example Psacharopoulos (1973), Selowsky (1967), Carnoy (1967) and Sorkin (1974). As mentioned before the rate of return to schooling can be written as

$$r = \frac{b}{1 + K/W}$$

Given the empirical findings concerning  $r$  and  $(K/W)$  the implicit value of  $b$  is approximately 0.20.

The ratio of direct costs to foregone income ( $k$ ) lies in the range 0.5 to 1.5.<sup>19</sup> For the purpose of our analysis we will use rather low values of  $k$  namely 0.5 and 0.7. These values will generate a lower bound for the estimate of the economic costs of the misallocation.

## 5.2. Results

This section presents some empirical results in two different forms. First, and making use of the concept of a cohort, it derives values for the incremental value added — induced by different reforms — *as a percentage of the value added of the existing educational system*. Second, it shows the increase in the long run contribution of labor to GNT.

5.2.1. The parameters which have first-order effects on the value added calculations are the ability coefficient ( $c$ ) and the ratio of direct costs to foregone income ( $k$ ). Therefore, the sensitivity analysis concentrates on these two parameters. Table 3 present results of these changes resulting from different reforms and for different country groupings — for alternative values of the coefficients  $c$  and  $k$ .

The structure of the educational system or the relative 'openness' at different levels becomes extremely significant in assessing the impact of alternative reforms. The difference in the contribution of two consecutive reforms measures the impact of extending the reform one further level of schooling.<sup>20</sup> The stronger the lack of openness of that particular level the larger will be the difference in the contribution of the two reforms.

The effect of the structure (or relative openness at different levels) of the system can be illustrated by comparing two extreme types of country groupings, Af 1 and As 2. Af 1 is characterized by an extremely 'strangled' primary education level relative to higher levels of schooling. The reverse is true for As 2.

For Af 1 the first three reforms have a rather small contribution while the last two increase that contribution by a significant amount. The contribution of Reform V (which differs from Reform III by its inclusion of the elementary level of schooling) is approximately seven times larger than the contribution of Reform III. For As 2, the situation is exactly the opposite. The first three reforms represent a large fraction of the total potential gains while the last two have a rather small marginal contribution. Reform V has a contribution only 1.2 times larger than Reform III.

<sup>19</sup>See for example Psacharopoulos (1973).

<sup>20</sup>It can be proved that  $NPV_2 - NPV_1$  reflects the contribution of extending the reform to the second phase of secondary education;  $NPV_3 - NPV_2$  measures the impact of extending the reform to the first phase of secondary education;  $NPV_4 - NPV_3$  reflects the contribution of extending the reform to the second phase of primary education. Finally  $NPV_5 - NPV_4$  reflects the impact of extending the reform to the first phase of primary education.

Table 3  
Increase in the (discounted) value added of the educational system as a percent of the value added of the existing system.<sup>a</sup>

		Country groupings							
Educational reforms	I (La 1)	II (La 2)	III (Af 1)	IV (Af 2)	V (Af 3)	VI (Me 1)	VII (As 1)	VIII (As 2)	
$(b=0.20; \rho^*=0.10; c=0.0042)$									
$k=0.5$									
I	0.8%	3.2%	0.9%	0.9%	0.1%	2.9%	2.7%	7.7%	
II	3.6%	8.5%	5.1%	4.2%	2.5%	10.1%	9.4%	13.6%	
III	8.0%	17.3%	8.9%	11.0%	7.6%	18.4%	14.0%	33.0%	
IV	18.9%	34.3%	19.9%	20.0%	15.4%	35.7%	32.3%	34.5%	
V	27.8%	41.0%	63.3%	36.4%	25.8%	52.4%	49.7%	40.2%	
$k=0.7$									
I	1.8%	20.9%	2.1%	2.4%	0.1%	.. <sup>b</sup>	35.7%	--	
II	7.8%	56.0%	11.3%	10.6%	5.9%	--	125.5%	--	
III	17.3%	113.7%	20.0%	27.8%	17.8%	--	189.2%	--	
IV	40.9%	225.6%	44.6%	50.6%	35.8%	--	432.1%	--	
V	60.2%	269.7%	141.4%	91.6%	59.8%	--	665.9%	--	
$(b=0.20; \rho^*=0.10; c=0.0076)$									
$k=0.5$									
I	1.7%	6.2%	1.9%	1.9%	0.1%	5.7%	5.2%	15.0%	
II	7.0%	16.3%	9.4%	8.1%	5.1%	19.1%	17.9%	25.6%	
III	15.4%	32.9%	17.1%	21.5%	15.2%	34.3%	26.7%	59.4%	
IV	36.9%	65.7%	38.9%	39.1%	30.3%	66.4%	61.2%	62.2%	
V	54.4%	78.4%	124.1%	70.7%	50.0%	97.3%	94.1%	72.2%	
$k=0.7$									
I	3.5%	37.8%	4.1%	4.8%	0.3%	--	54.4%	--	
II	15.0%	99.7%	20.7%	20.3%	11.6%	--	185.8%	--	
III	32.9%	201.4%	37.8%	53.4%	35.0%	--	277.4%	--	
IV	79.1%	402.2%	85.8%	97.5%	69.7%	--	635.9%	--	
V	116.4%	480.2%	274.0%	176.0%	114.6%	--	976.4%	--	
$(b=0.20; \rho^*=0.10; c_0=c_3=c_6=0.0032; c_9=0.004; c_{12}=0.01; c_{17}=0.011)$									
$k=0.5$									
I	2.8%	10.2%	3.1%	3.2%	0.5%	9.3%	8.6%	30.4%	
II	15.9%	34.3%	15.2%	18.3%	12.9%	42.6%	39.5%	61.4%	
III	27.9%	63.0%	32.6%	39.4%	28.3%	67.8%	53.5%	123.0%	
IV	50.9%	105.5%	58.0%	54.1%	38.4%	110.0%	102.4%	131.3%	
V	61.4%	114.5%	103.3%	73.8%	48.7%	141.7%	131.1%	145.1%	
$k=0.7$									
I	5.8%	57.7%	6.8%	7.8%	1.3%	--	66.2%	--	
II	33.6%	193.4%	33.0%	44.7%	29.2%	--	302.8%	--	
III	59.0%	355.1%	70.8%	96.2%	64.2%	--	410.8%	--	
IV	107.6%	595.0%	125.8%	132.3%	86.9%	--	785.7%	--	
V	129.7%	645.5%	224.1%	180.5%	110.2%	--	1005.7%	--	

<sup>a</sup> $\rho^*$  is the discrete discount rate. It is equivalent to an instantaneous rate of 0.095.

<sup>b</sup>Empty spaces reflect a negative initial value added of the educational system.

In general, we can conclude that the contribution of the reforms are extremely significant. For a value of  $k=0.5$  — which represents a lower bound for this parameter — the contribution of a full reform ranges from 26% to 63%, from 50% to 124% and from 49% to 145% for different values of the ability coefficient. These contributions are significantly larger for  $k=0.7$ . The conclusion is that for a wide variety of cases the full reform will more than double the value added of the educational system.

5.2.2. A second (and perhaps more illustrative) form of presenting the impact of the reforms is in terms of their effect on the contribution of labor to the economy. We can ask ourselves the following question: What will be the increase in the long run contribution of labor to the economy once all of the effects of a continuing full reform have taken place?

If enrolment, completion and progression rates remain constant over time, the educational structure of the *labor force* will tend to approach the educational distribution of the flows of students leaving the educational system. In this context, we can define the long run as that run where the educational distribution of the labor force becomes equal to the distribution of the streams of students leaving the schooling system.

Table 4 presents the change in the long-run contribution of labor to the economy of a fully reformed system relative to the contribution that would have existed in the absence of such reform.<sup>21</sup> Such changes are presented in column (1). Column (2) shows the long-run effect on GNP.

Except for the last country grouping, the results are fairly constant. This is despite the fact that we are comparing groups of countries with wide differences in their degree of 'educational openness'.

Table 4  
Long-run changes induced by a fully reformed educational system.  
( $b=0.20$ ;  $c=0.0076$ ).

Country group	On the wage bill (1)	On GNP (labor share=0.5) (2)
La 1	11.2%	5.6%
La 2	13.4%	6.7%
Af 1	11.1%	5.5%
Af 2	11.8%	5.9%
Af 3	10.2%	5.1%
Me	11.5%	5.7%
As 1	12.9%	6.4%
As 2	6.0%	3.0%

<sup>21</sup>The expression for the contribution of labor input is presented in the appendix.

The constancy of this type of contribution across countries is the result of two forces working in opposite directions. The stronger the lack of openness of the system the larger are the induced changes in mean abilities and the larger the contribution of the reforms. However, given the size of the educational system, the larger the lack of openness of the system the smaller will be the relative number of individuals with relatively high levels of schooling that are affected by the reforms.

The results of table 4 show that the long-run effects on GNP of having a fully reformed educational system are substantial, at least if compared with other misallocation estimates.<sup>22</sup> Harberger's (1959) estimates of the cost of the misallocation of capital and labor, under extremely large assumption concerning distortions in the Chilean economy, yield values between 9% and 15% of GNP. Balassa et al. (1971) obtain values up to 2.4% of GNP for the welfare loss due to trade protection in selected developing countries. Dougherty and Selowsky's (1973) estimates of the welfare cost of the misallocation of labor across sectors in the urban economy of Colombia yielded values of less than 2% of the urban GNP.

**Appendix**

Denoting  $\rho$  as the discount rate and  $\dot{A}_i$  as the change in the mean ability of individuals with  $i$  years of schooling induced by the reform, the expressions for NPV and MPV can be written as

$$\begin{aligned}
 NPV = & CW_0 \left( - (k+1)e^{-\rho} \left( E_p \sum_{i=0}^2 e^{i(b-\rho)} + E_p C_p \sum_{i=3}^5 e^{i(b-\rho)} \right. \right. \\
 & + E_p C_p \Pi_p \sum_{i=6}^8 e^{i(b-\rho)} + E_p C_p \Pi_p C_s \sum_{i=9}^{11} e^{i(b-\rho)} \left. \right) \\
 & + E_p C_p \Pi_p C_s \Pi_s \Pi'_s (k e^{C[A_{12} - A_0]} + e^{C[A_{17} - A_0]}) \sum_{i=12}^{16} e^{i(b-\rho)} \\
 & + e^{ln'} (E_p (1 - C_p) e^{3(b-\rho)} - e^{-3\rho}) \\
 & + E_p C_p (1 - \Pi_p) (e^{6(b-\rho)} - e^{-6\rho}) + E_p C_p \Pi_p (1 - C_s) \\
 & \quad \times (e^{9(b-\rho)} - e^{-9\rho}) \\
 & + E_p C_p \Pi_p C_s (1 - \Pi_s \Pi'_s) (e^{12(b-\rho) + C_{12} - A_0} - e^{-12\rho}) \\
 & + E_p C_p \Pi_p C_s \Pi_s \Pi'_s (e^{17(b-\rho) + C_{17} - A_0} - e^{-17\rho}), \tag{A.1}
 \end{aligned}$$

<sup>22</sup>Notice however that the implementation of the reforms could imply important administrative costs. In those circumstances we can not conceive such reforms as completely costless.

$$\begin{aligned}
MPV = & CW_0(e^{n\rho}((1-E_p)(e^{cA_0}-1)+E_p(1-C_p)e^{3(b-\rho)} \\
& \times (e^{cA_3}-1)+E_pC_p(1-\Pi_p)e^{6(b-\rho)}(e^{cA_6}-1) \\
& +E_pC_p\Pi_p)(1-C_s) \\
& \times e^{9(b-\rho)}(e^{cA_9}-1)+E_pC_p\Pi_pC_s(1-\Pi_s\Pi'_s)e^{12(b-\rho)+c(A_{12}-A_0)} \\
& \times (e^{cA_{12}}-1)+E_pC_p\Pi_pC_s\Pi_s\Pi'_se^{17(b-\rho)+c(A_{17}-A_0)}(e^{cA_{17}}-1)),
\end{aligned}
\tag{A.2}$$

The change in the contribution of labor to output ( $\Delta$ ) induced by a reformed educational system can, in the long run, be written as

$$\begin{aligned}
\Delta = & LW_0[(1-E_p)e^{cA_0}+E_p(1-C_p)e^{3b+cA_3}+E_pC_p(1-\Pi_p)e^{6b+cA_6} \\
& +E_pC_p\Pi_p(1-C_s)e^{9b+cA_9} \\
& +E_pC_p\Pi_pC_s(1-\Pi_s\Pi'_s)e^{12b+c(A_{12}-A_0)+cA_{12}} \\
& +E_pC_p\Pi_pC_s\Pi_s\Pi'_se^{17b+c(A_{17}-A_0)+cA_{17}}],
\end{aligned}
\tag{A.3}$$

where  $L$  represents the size of the labor force and  $W_0$  the wage of a worker with no education and an ability level equal to the population mean.

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