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"The Allocation of the Education Budget: Implications for Aggregate Income, Inequality and Growth"

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Abstract

The East Asian "Miracle" has led many observers to believe that concentrating public spending on basic education is a win-win strategy: it both promotes growth and reduces inequality. Based on the East Asian experience, policymakers have recommended the re-allocation of government education expenditures towards the lower grades in Latin America. This paper rigorously examines this recommendation. It analyzes how shifting resources from higher education towards basic education a¤ects aggregate income, inequality and growth. It presents a heterogeneous agent, multi-sector model of endogenous education acquisition, technological progress and government expenditure policy in a small open economy. Contrary to the conventional wisdom, spending more on basic education may involve welfare trade-o¤s: it decreases inequality but, if the government faces a budget constraint, resources are diverted from higher education. Eventually, overall income and growth may fall. The model is calibrated for particular countries in Latin America in order to evaluate whether their allocations of public education spending are beyond the trade-o¤ frontier. While some countries could improve on all measures of welfare by following the traditional recommendation, others would be able to achieve a more equal distribution of earnings only at the expense of a lower rate of technological progress or a reduced level of aggregate income.

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1. Introduction

The successful educational experience of East Asia has encouraged policymakers to recommend the re-allocation of public education expenditures towards the lower grades in Latin America. It is argued that by concentrating government resources on basic schooling the East Asian countries could grow fast and reduce inequality. This paper rigorously examines whether spending more on basic education is in fact a win-win strategy. The potential trade-o¤s are analyzed in terms of three components of long-run welfare: the rate of adoption of new technologies; income inequality as driven by education inequality; and the steady state level of aggregate income.

This paper presents three main contributions. First, it analyzes whether a no trade-o¤ policy in education spending is theoretically feasible. We ...nd that as public education resources are re-allocated towards the lower grades, income inequality declines. However, this policy may decrease the rate of technological progress and the level of aggregate income. Second, the paper studies the e¤ects of an increase in the skill premium. When returns in the higher education sector go up, the trade-o¤ between inequality and income is more likely to occur. The trade-o¤ between inequality and growth, on the other hand, is less likely to occur. Finally, the model is calibrated for three countries in Latin America: Argentina, Mexico and Honduras. These countries are examples of high, middle and low educational attainment in the region, respectively. While shifting resources towards basic schooling would allow Honduras to improve on all measures of economic performance, the recommended policy would imply a reduction in technological progress and aggregate income in Mexico. For the case of Argentina we ...nd that there would be a trade-o¤ between inequality and income, but no trade-o¤ between inequality and growth.

1.1. Background and motivation

Human capital, as measured by the educational attainment of the population, has consistently emerged as an essential factor for economic growth and development. Education contributes to economic performance through several channels.[1] At the micro level, more educated individuals earn more income. Following the human capital approach (Schultz, 1961; Becker, 1993; Mincer, 1974) individual wage regressions have shown a strong positive relationship between education and earnings.[2] At the macro level, endogenous growth theories predict that investments in schooling will promote growth. A larger stock of human capital facilitates the creation and adoption of new technologies (Nelson and Phelps, 1966; Romer, 1990; Galor and Weil, 2000). Education also is seen as a great equalizer: a better distribution of education contributes to a more equal distribution of income and enhances intergenerational mobility (Galor and Zeira, 1993; Owen and Weil, 1997; Galor and Tsiddon, 1997).

Given the multi-dimensional contribution of education to economies, government intervention has existed in most countries of the world, justi...ed by the presence of externalities or redistribution goals.[3] The literature has looked at public education policies from di¤erent perspectives. On one side, several studies focus on how alternative mechanisms for the ...nancing of education a¤ect e¢ciency and inequality (Benabou, 1999 and 1996; Fernandez and Rogerson, 1998; Heckman et Al., 1998; Murray et Al., 1998). On the other side, the issue of public schooling expenditures, relative to private or other government expenditures, has been studied (Glomm and Ravikumar, 1992; Steuerle, 1996; Ortigueira, 1999; Kaganovich and Zilcha, 1999;

[1] Krueger and Lindhal (2000) o¤er a review on the micro and macro approaches to the economics of education.

[2] See Willis (1986) for a review on the United States and Psacharopoulos (1994) for evidence on developing countries.

[3] See Poterba (1996).

Janeba, 2000). Less attention has been paid to the allocation of the education budget among schooling categories,[4] the topic of this paper.

Recent studies have emphasized the importance of the distribution and composition of education for economic performance (Galor and Tsiddon, 1997; Lopez et Al., 1998; Ramcharan, 2000). In line with this body of research, we present a model that highlights the di¤erential contribution of basic and higher education to output, inequality and growth. The main objective is to provide a better understanding of the potential trade-o¤s implied by changing the allocation of the education budget between schooling categories. Is it possible to ...nd an expenditure policy that is bene...cial in all three dimensions of economic performance: income per capita, inequality and growth?

The East Asian experience has encouraged policymakers to advocate a win-win strategy in education policy: spending more on high quality basic education will break the equality-e¢ciency trade-o¤. From 1965 to 1990, the 23 economies of East Asia grew faster than all other regions of the world. This growth was accompanied by declining inequality, challenging the Kuznets' hypothesis.[5] Human capital investment is said to have been one of the key engines of the East Asian "Miracle." By focusing public spending on primary and secondary education, and allowing the demand for tertiary education to be met largely by a self-...nanced private system, governments served segments of the population that otherwise would have lacked access to education. The allocation of public resources to primary and secondary education may have been the major factor determining East Asia's successful educational strategy

[4] An exception is Judson (1998), who estimates the optimal allocation of the education budget implied by the maximization of the aggregate rate of return to education. She calibrates the model using international measures of rates of return to education by Psacharopoulos (1994). This last study ...nds that rates of return are highest at the elementary level. However, recent evidence for many developing countries indicates that higher education entails the highest returns (see for instance IDB, 1999).

[5] Kuznets (1955) proposed an inverted U relationship between income and inequality.

(World Bank, 1993; Birdsall et Al., 1995; Rao Govinda, 1998; Mundle, 1998; Mingat, 1998). Although public expenditures on education as a share of GNP are not higher in East Asia than in other developing countries, the share of public expenditures allocated to the basic level has been consistently higher in East Asia than elsewhere. The share of public spending on tertiary education was about 15 percent during the past three decades. In Latin America, this share was roughly 24 percent.[6]

East Asia's "Miracle" contrasts with the performance of Latin America. Latin America is the most unequal region of the world. In spite of the moderate growth experienced in the region, inequality has been persistent over time and it is as high today as it was two decades ago (IDB, 1999; Londono and Szekely, 2000).[7] Additionally, poverty levels are high, particularly considering the average income of Latin America, falling in the upper-middle range of developing nations. In 1993 annual income was US$ 3000, but about a third of the population was below the poverty line (Berry, 1997). Would the educational strategy of East Asia in the past three decades work for Latin America today? Would shifting public resources away from higher education towards basic education be welfare enhancing?[8]

1.2. Main results

To address these questions we present a heterogeneous agent, multi-sector model of endogenous growth, education acquisition and public expenditure policy in a small open economy. Emphasis is given to the e¤ects of government education spending on the long-run determinants of social welfare, abstracting from intergenerational links, dynamics to the steady state or private expenditures. A single good is pro-

[6] See Tables 1.1 and 1.2 for statistics by country and region.

[7] For example, in 1996, Latin America had a Gini Coe¢cient of 0.52, higher than the world average of 0.40 (Deininger and Squire, 1996).

[8] Birdsall et Al. (1998) and Psacharopoulos (1994) suggest that it is.

duced by two sectors that use di¤erent schooling inputs. There is labor augmenting technological progress that depends on the education composition of the labor force. Individuals live for one period and supply di¤erent units of human capital, which are a function of their formal schooling and their "talent" level.[9] They choose the level of education and sector of employment that maximizes lifetime earnings, given their endowment, private schooling costs and government policy.

The government distributes lump sum schooling subsidies that lower the private fees and promote investment in education. This in turn a¤ects the level and distribution of earnings, and the growth rate.[10] The model then establishes whether shifting resources towards basic schooling, holding ...xed total expenditures on education, can unambiguously improve welfare measured by aggregate "e¤ective" income,[11] inequality and growth. Note that this is the policy recommendation based on East Asia's experience: re-allocating resources towards the basic level will reduce inequality and enhance growth, without having to increase total education spending. We additionally analyze the implications for aggregate income.

Re-allocating resources towards basic education is not a win-win strategy. Spending more on basic education always favors a more equal distribution of earnings. However, as the basic sector expands, the budget constraint forces the government to divert more expenditures from higher education. This lowers private incentives to invest in this level of schooling. If spending on basic education is high enough, the contribution of more workers with low schooling will be smaller than the opportunity

[9] In this model "talent" summarizes di¤erences in ability, access to credit, inherited wealth, family background or any other factor that would drive education investments. See for instance Corbacho (2001) for an analysis of schooling determinants for the case of Argenina.

[10] The budget for education spending is raised through non-distortionary taxation. This causes the results to be driven exclusively by the expenditure policy, which is the main contribution of the paper.

[11] By "e¤ective" income we mean the level of income in any given period, scaled by the growing technology. It is the portion of income that does not grow over time in steady-state.

cost of fewer workers with higher education. When the marginal contribution of di¤erent schooling levels is taken into consideration, changes in the education composition of the work force, driven by changes in government subsidies, can be harmful for the rate of adoption of new technologies and the level of steady-state income.

The paper also analyzes whether changes in the skill premium a¤ect the chances of encountering a trade-o¤ between inequality and income, and inequality and growth. This is particularly important in the context of the Latin American region. While estimates of rates of return to education in the 80's indicate that elementary schooling was the most pro...table investment (Psacharopoulos, 1994), estimates for the 90's suggest that higher education has now the highest returns (IDB, 1999).[12] Comparative statics exercises show that as the premium to higher education increases, the potential trade-o¤ between inequality and income is more likely to occur. This happens because the opportunity cost of subsidizing basic education with relatively lower productivity goes up. On the other hand, the trade-o¤ between inequality and growth is less likely to occur. As the skill premium rises, private incentives to invest in higher education become stronger and individuals are less sensitive to changes in the government subsidies. This increases the scope for redistribution without harming the rate of adoption of new technologies.

Using econometrically estimated parameters, we calibrate the model for the cases of Argentina, Mexico and Honduras in order to evaluate whether their allocations of public education expenditures are beyond the trade-o¤ frontier. Re-allocating resources towards the lower grades would be welfare enhancing in all dimensions in Honduras. Mexico, on the other hand, would be able to achieve a more equal distribution of earnings only at the expense of a lower rate of technological progress and a reduced level of aggregate income. The recommended policy would imply a

[12] See Table 1.3.

trade-o¤ between inequality and income for the case of Argentina, but no trade-o¤ between inequality and growth.

The rest of the paper is organized as follows. The next section lays out the basic theoretical framework abstracting from government expenditures, while section 3 introduces government subsidies. Section 4 explores the conditions for the trade-o¤s between inequality and growth, and inequality and income to arise, as resources are shifted towards basic education. Section 5 analyzes the e¤ects of an increase in the return to higher education. The results from the calibration are presented in section 6. The last section concludes.

2. Basic Framework

In this section of the paper, we analyze the model abstracting from government education spending. Schooling expenditures are introduced in the next section.

2.1. Firms

There are two production sectors in the economy using physical and human capital to produce a single good. Physical capital is a perfectly mobile homogenous good. Human capital, on the other hand, is not traded in the world market. Its contribution to output depends on the schooling level and characteristics of the workers. Sector 1 will be designated the traditional sector, and sector 2 the modern sector. To work in the traditional sector a person must have at least basic education, while to work in the advanced or modern sector higher education is necessary. The uneducated do not work.

The production function in sector $j = 1; 2$ is given by:

$$Y_t^j = F(A_t H_t^j; K_t^j) \tag{2.1}$$

F exhibits constant returns to scale, is strictly concave and satis...es boundary conditions. A_t is a labor augmenting technology parameter common across sectors. The growth rate of A_t will be speci...ed later.

Given these assumptions, Y_t^j can be re-written as:

$$Y_t^j = A_t H_t^j f(k_t^j) \tag{2.2}$$

where $f(k_t^j) = F(1; K_t^j/A_t H_t^j)$ and k_t^j is the ratio of physical capital to e¤ective units of human capital in sector j.

Competitive ...rms in each sector choose physical and human capital to maximize pro...ts period by period, given wages and the world interest rate. First order conditions for pro...t maximization imply:

$$f'(k_t^j) = r_t^j \text{ and } [f(k_t^j) - f'(k_t^j)k_t^j]A_t = w_t \tag{2.3}$$

where $f'(k_t^j)$ is the ...rst derivative of the function $f(k_t^j)$, with respect to its argument k_t^j.

It is assumed that the economy is small and open, and faces a constant interest rate, r, determined in the world market. Physical capital ‡ows into the economy until the capital-e¤ective labor ratio in each sector is ...xed in any given period at $[f'(k_t^j)]^{-1} = k_t^j = k^*$. Then the wage rate per unit of e¤ective human capital, w_t, grows at the same rate of A_t. Although there is one common wage rate in the economy, earnings across sectors di¤er because individuals are heterogeneous in their supply of human capital.

The aggregate production function is given by the sum of output in each sector:

$$Y_t = Y_t^1 + Y_t^2 = A_t f(k^{\alpha})(H_t^1 + H_t^2) \qquad (2.4)$$

2.2. Individuals

Individuals live for one period, when they acquire education, work, consume and die. Each period a new generation is born. Population size is normalized to one. Agents are heterogeneous in their "talent", "quality" or "number of e¤ective units" of human capital they supply in the labor market. The underlying "talent" a¤ects the net return to human capital. This is the only source of heterogeneity across workers.[13]

Schooling involves two sets of costs: foregone earnings and ...xed fees. These costs increase with the level of education. To become a basic school graduate and be able to work in sector 1, a person must spend S^1 percentage of their time endowment in school and pay a ...xed fee of F_t^1. To become a college graduate and be able to work in sector 2 a person must ...rst attend basic education. The cost in time of higher education is S^2, with $S^2 > S^1$ and the direct costs are $F_t^2 + F_t^1$.[14] Those individuals that do not acquire any education are not employed in either sector. Uneducated workers are the "poor" of this economy.

Incurring the higher costs of a college degree allows workers to get a higher return. The traditional sector o¤ers a return of $^{-1}$ and the modern sector o¤ers a return of $^{-2} > ^{-1}$. $^{-2}$ and $^{-1}$ will be parameters in this economy.

Let h_{ti}^j be the supply of human capital to sector j of person i in time period t.[15]

[13] The variable "talent" summarizes di¤erences in innate ability, di¤erent access to credit markets for the ...nancing of education or family endowments.

[14] For example, considering a working lifetime of 65 years, $S^1 = 10{=}65$ and $S^2 = 15{=}65$.

[15] Lower case letters correspond to individual quantities while upper case letters denote aggregate quantities of human capital.

It is a function of talent, T_i; and education, S^j, that is quality and quantity of time supplied in the labor market. A simple linear speci...cation is assumed:[16]

$$h^j_{ti} = h^j_{ti}[\text{working-time}^j_{ti}; T_i] = h^j_{ti}[1 \text{ ¡ } S^j; T_i] \quad (2.5)$$

$$= (1 \text{ ¡ } S^j)^{-j} T_i \quad (2.6)$$

Besides the time endowment, individuals have an endowment in kind that is taxed by the government. Each period endowments in kind (and thus government resources) grow at the same rate of the overall economy. In this section of the model, tax revenues are not distributed back to workers.[17] Denote I^j_{ti} individual income net of taxes if employed in sector j at time t. Then:

$$I^j_{ti} = w_t(1 \text{ ¡ } S^j)^{-j} T_i \text{ ¡ } F^j_t \text{ ¡ } (j \text{ ¡ } 1) F^{j\,i\,1}_t \quad (2.7)$$

Further assume that schooling fees grow at the same rate of the economy, the growth rate of A_t. This would be a reasonable assumption if, for instance, the ...xed fees account for wages of those working in the education sector, not modeled here. Let $I^{j\,\alpha}_i = I^j_{ti}=At$, $F^{j\,\alpha} = F^j_t=A_t$ and $w^\alpha = w_t=A_t$. These quantities will remain constant in steady state. Without loss of generality w^α is set equal to 1.[18]

Given her talent level, the worker chooses the sector of employment, and consequently the level of education that maximizes lifetime utility of consumption, subject

[16] This follows Galor and Tsiddon (1997).

The college premium is $[w_t(1 \text{ ¡ } S^2)^{-2} \text{ ¡ } w_t(1 \text{ ¡ } S^1)^{-1}]$, which is constant. Owen and Weil (1998) o¤er a model where returns are determined endogenously instead. In their setup wages for the educated are always higher than wages for the uneducated in equilibrium, but may vary depending on the number of people in each skill category.

[17] The goal is to look for the distribution of education that would prevail abstracting from education subsidies. This allows to pin-down some parameter restrictions that are necessary to guarantee a disitribution of workers across three schooling levels: high, basic and no education.

[18] "¤" will denote quantities scaled by the growing technology throughout the paper. These quantities will remain ...xed in steady state.

to her income budget constraint. That is, the individual will choose $j = 1; 2$ to:

$$\text{Max } U(c_{ti}^j) \text{ subject to } c_{ti}^j = I_{ti}^j \tag{2.8}$$

where c_{ti}^j is individual consumption of a member of generation t if employed in sector j. For any non-decreasing, concave utility function this problem will yield the same result as choosing the education level that maximizes lifetime earnings. This follows the human capital approach in microeconomics.[19]

An individual of talent T_i chooses to get no education if:

$$0 > I_{ti}^1 \tag{2.9}$$

$$0 > w_t(1 - S^1)^{-1}T_i - F_t^1 \tag{2.10}$$

All individuals with talent levels below T^1 will get no schooling, where:

$$T^1 = F^{1a}=(1 - S^1)^{-1} \tag{2.11}$$

It is intuitive that T^1, the minimum talent level that makes investing in basic education worthwhile, be increasing in the ...xed cost of basic education, F^{1a}, increasing in the time cost of basic education, S^1, and decreasing in the return, $^{-1}$.

An individual of talent T_i will choose to get higher education if:

$$I_{ti}^2 > I_{ti}^1 \tag{2.12}$$

$$w_t(1 - S^2)^{-2}T_i - F_t^2 > w_t(1 - S^1)^{-1}T_i - F_t^1 \tag{2.13}$$

[19] See for instance Becker (1993), Schultz (1961) and Mincer (1974).

All workers with talent levels above T^2 will get a college degree, where:

$$T^2 = \frac{F^{2¤}}{(1 ¡ S^2)^{-2} ¡ (1 ¡ S^1)^{-1}} \tag{2.14}$$

As expected, T^2, the minimum talent level of workers in the advanced sector, increases with the college fee, $F^{2¤}$, increases with the time cost of a college degree, S^2, and decreases with the return, $^{-2}$.

Given that the goal is to analyze the e¤ects of education spending across schooling categories, we propose the following assumptions to guarantee the existence of three education sectors: high, basic and no schooling.

Assumptions:

1. T_i is distributed as Uniform [0,1] for each generation.

2. Fees and returns are such that the most talented person invests in higher education:

$$(1 ¡ S^2)(^{-2} ¡ ^{-1}) ¡ ^{-1}(S^2 ¡ S^1) ¡ F^{2¤} > 0 \tag{2.15}$$

   The ...rst term measures extra lifetime gross earnings from the advanced sector for someone of talent level "1." The second term represents foregone earnings of going to college over just going to basic school, and the last term represents the extra direct costs, the college tuition. This condition is derived from $I^2_{ti} > I^1_{ti}$ for talent level "1."

3. The ratio of gross earnings to ...xed costs is higher at the basic school level:

$$\frac{(1 ¡ S^1)^{-1}}{F^{1¤}} > \frac{(1 ¡ S^2)^{-2}}{F^{2¤} + F^{1¤}} \tag{2.16}$$

This condition will be satis...ed if the college tuition is su¢ciently high.[20]

These assumptions imply that $1 > T^2 > T^1 > 0$: The equilibrium without government expenditures is characterized by $1 ¡ T^2$ proportion of people with higher education, $T^2 ¡ T^1$ proportion of people with just basic education and T^1 proportion of people with no education. The total proportion of people with basic education is then: $(1 ¡ T^2) + (T^2 ¡ T^1) = 1 ¡ T^1$:

Figure 2.1 represents lifetime labor earnings pro...les and the cuto¤ values for the underlying distribution of talent across sectors. This chart is valid every period and the distribution of education is stationary.[21]

Note that a decrease in fees for basic education would shift both earnings pro...les in a parallel way, resulting in a larger number of people that get only basic education, but no change in the proportion of people that get higher education (i.e. T^2 does not change but T^1 decreases). This will move people from the "poor" sector into the traditional sector, leaving the number of workers in the modern sector unchanged. The proportion of people with higher education is only determined by the extra costs from attending college, $F^{2¤}$. On the other hand, a decrease in fees for higher education will shift only the earnings pro...les of workers in sector 2. This results in an increase in the total number of people with higher education but no change in the proportion of poor people, unless the decline in $F^{2¤}$ is high enough to violate Assumption 3.[22]

[20] This condition can be re-written as $F^{2¤} > \frac{F^{1¤}[(1 ¡ S^2)^{-2} ¡ (1 ¡ S^1)^{-1}]}{(1 ¡ S^1)^{-1}}$

[21] An additional assumption is implicit in the chart. Income is positive for the most talented person in the economy if employed in the traditional sector, i.e. $(1 ¡ S^1)^{-1} ¡ F^{1¤} > 0$.

[22] Besides labor income, individuals have earnings from the returns to physical capital. The main focus of this study is the understanding of the e¤ects of human capital on aggregate income, growth and inequality and how government spending can alter the microeconomic decision of acquiring education. To make receipts from physical capital irrelevant for the individual sectoral decision it is assumed that they are distributed proportionally to receipts from human capital. For instance, it seems reasonable to think that people with more labor income can buy larger quantities of physical capital. Total earnings for the worker are labor earnings plus physical capital earnings. Let IT^j_{ti} be

3. Government Education Spending

In this section, the government is introduced to the previous framework. The goal is the analysis of the potential trade-o¤s involved in shifting resources towards basic education, while holding the size of the budget constant. The government distributes lump sum subsidies to the private ...xed fees for education, but resources are not enough to subsidize the fees in full for the whole population. This forces the government to choose the allocation of scarce resources across schooling levels. If this constraint were not in place, then the government should spend all the budget in higher education. Workers with higher education contribute marginally more to output and growth than workers with basic education. If the government had enough resources to move all the population into the advanced sector, output and growth would be the highest possible. On the other hand, inequality would be the lowest possible, only driven by di¤erent talent levels, as education inequality would disappear.

Through its spending policy, the government can alter the private incentives to invest in human capital, a¤ecting the number of people in each schooling category, and

total earnings of agent i from sector j. Then:

$$IT_{ti}^{j} = I_{ti}^{j} + eK_{ti}^{j} = (1 + p) I_{ti}^{j} \tag{2.17}$$

where K_{ti}^{j} is the amount of physical capital owned by person i. Since the aggregate level of physical capital per unit of e¤ective labor, $k_t^j = K_t^j = A_t H^j$, is constant over time (equal to k^{π}), K_t^j grows at the same rate of A_t.

A worker will get no education if:

$$0 > (1 + p) I_{ti}^{1} \tag{2.18}$$

or equivalently if:

$$0 > I_{ti}^{1} \tag{2.19}$$

This yields the same distribution of workers between no education and basic education as before, when only labor income was considered. The same applies for the distribution between basic and higher education. Then, all the previous analysis remains unchanged and without loss of generality p is set equal to 0. This implies that A_t is re-scaled to take into account the receipts from physical capital.

consequently the patterns of inequality, income and growth. Workers and ...rms take government policy as given. The government sets the subsidies knowing the private sector's reaction functions, and is constrained to satisfy the budget. The model concentrates on public spending along the balanced growth path, and all variables grow at the same rate, the rate of technological progress.[23]

In the next section we analyze whether, departing from any particular allocation, there are trade-o¤s involved in shifting resources towards basic education.

3.1. The budget constraint

Let G_t^1 be spending per student in basic education and G_t^2 spending per student in college. Then a college graduate receives a total subsidy of $G_t^1 + G_t^2$: As before, quantities indexed by "*" are de‡ated by the growing technology A_t. So, $G^{1\alpha} = G_t^1/A_t$ and $G^{2\alpha} = G_t^2/A_t$. The private fees for basic education are $F^{1\alpha} - G^{1\alpha}$, and for higher education $F^{1\alpha} + F^{2\alpha} - (G^{1\alpha} + G^{2\alpha})$. This setup would correspond to a system of public education were everyone can sign up and be entitled to the government's subsidy.

Recall that the total number of people with basic education is: $(T^{2g} - T^{1g}) + (1 - T^{2g})$, where the g superscripts denote the new cuto¤ values in the economy with the government, given in the next sub-section.

Total expenditures on basic education equal:

$$E^{1\alpha} = (1 - T^{1g})G^{1\alpha} \tag{3.1}$$

while total expenditures on higher education are:

$$E^{2\alpha} = (1 - T^{2g})G^{2\alpha} \tag{3.2}$$

[23] An implicit assumption throughout the paper is that government spending can in fact change private incentives to acquire education. For an empirical assessment see Corbacho et Al. (1999).

The ministry of education is assigned a budget of B_t dollars. This amount is increased every year according to the growth rate of the economy. The implicit assumption is that if the overall budget of the government changes as the distribution of workers (and human capital) change, some other ministry will adjust its spending accordingly.[24] Given that the ministry of education will be assigned a budget every year, the paper studies how the re-allocation of resources within the budget will change aggregate income, inequality and growth.[25]

The budget constraint for the government is then:

$$B^{¤} = (1 ¡ T^{1g})G^{1¤} + (1 ¡ T^{2g})G^{2¤} \tag{3.3}$$

As is apparent from the equation above, the budget constraint is non-linear in $G^{1¤}$ and $G^{2¤}$. Figure 3.1 plots the implicit relationship between subsidies in basic and higher education, for di¤erent sizes of the budget, $B^{¤}$.

3.2. The equilibrium

Under government intervention, ...rms follow the same behavior described in the previous section. The distribution of workers, however, is a¤ected by the subsidies. The

[24] Suppose that as a consequence of the re-allocation of education expenditures total tax collections increase. Then, for example, the ministry of defense will adjust its spending accordingly.

[25] In another version of the model public education spending is ...nanced through a proportional tax, applied on income net of fees payed for schooling (i.e. the worker discounts the ...xed fee minus the subsidy from her tax base). This taxation scheme does not distort private behavior and the budget is endogenous. All the results are qualitatively the same, with no additional insights. The algebra however is unnecessarily more complicated. We chose to present the results from the exogenous budget instead, to highlight the e¤ects of expenditure policies. In essence, the ...xed budget assumes lump-sum taxes on the whole population. Also, it seems a more realistic representation of how budgetary decisions are made in most countries. Once the allocation among broad categories is determined (for example education versus defense), each ministry decides the allocation between categories of its competence (for example higher verus basic education spending). The results with the endogenous budget are available upon request.

cuto¤ values in the model with the government are given by:

$$T^{1g} = \frac{F^{1¤} ¡ G^{1¤}}{(1 ¡ S^{1})^{-1}} \tag{3.4}$$

$$T^{2g} = \frac{F^{2¤} ¡ G^{2¤}}{(1 ¡ S^{2})^{-2} ¡ (1 ¡ S^{1})^{-1}} \tag{3.5}$$

The new equilibrium is described by $T^{2g} ¡ T^{1g}$ proportion of people with just basic education, $1 ¡ T^{2g}$ proportion of people with higher education and T^{1g} of people with no education. Note that an increase in the subsidies decreases the cuto¤ values, encouraging more people to become educated. The e¤ectiveness of spending in changing the allocation depends on the marginal returns.

3.2.1. Aggregate income

Private income (and consumption) equals the sum of output in each sector net of the ...xed investments in education:

$$I_t = A_t^{h} H^{1} + H^{2} ¡ (1 ¡ T^{1g})^{3} F^{1¤} ¡ G^{1¤} ¡ (1 ¡ T^{2g})(F^{2¤} ¡ G^{2¤})^{i} \tag{3.6}$$

with $H^{1} = \frac{(1¡S^{1})^{-1}(T^{2g}+T^{1g})(T^{2g}¡T^{1g})}{2}$ and $H^{2} = \frac{(1¡S^{2})^{-2}(1+T^{2g})(1¡T^{2g})}{2}$.

3.2.2. Income inequality

To assess the degree of income inequality, several alternative measures can be used. The Gini Coe¢cient, the Generalized Gini Coe¢cient and Atkinson's Inequality Index are some of the most popular. In this paper inequality is analyzed via the behavior of the Lorenz Curve, that translates easily to the behavior of the Gini Coe¢cient. The Gini Coe¢cient (Gini) satis...es desirable properties of inequality measures.[26]

[26] Some of these desirable properties are independence of the scale of measurement, Dalton's principle of equal additions, Dalton's principle of proportionate additions of persons, Dalton's principle

The Gini Coe¢cient is measured as one minus twice the area below the Lorenz Curve. Let $L_t^j(p)$ be the Lorenz Curve in period t, corresponding to sector j;where p is the proportion of the population receiving $L_t^j(p)$ share of total income. Since individual income and total income grow at the same rate, income shares and the Lorenz Curve are the same every period. Then $L_t^j(p) = L^j(p)$ and is given by:

$$L^0(p) = 0 \quad \text{for } 0 < p < T^{1g} \tag{3.7}$$

$$L^1(p) = \int_{T^{1g}}^{p} \frac{(1 - S^1)^{-1} T_i \cdot F^{1*}}{I^*} dT \quad \text{for } T^{1g} < p < T^{2g} \tag{3.8}$$

$$L^2(p) = \frac{I^{1*} + \int_{T^{2g}}^{p} (1 - S^2)^{-2} T_i \cdot F^{2*}}{I^*} dT \quad \text{for } T^{2g} < p < 1 \tag{3.9}$$

with $I^* = I_t = A_t$ and $I^{1*} = H^1 \cdot (T^{2g} - T^{1g})(F^{1*} - G^{1*})$:

The Gini Coe¢cient under government intervention is:

$$Gini = 1 - 2 \left[\int_{T^{1g}}^{T^{2g}} L^1(p)dp + \int_{T^{2g}}^{1} L^2(p)dp \right] \tag{3.10}$$

3.2.3. Growth

To specify the growth model, it is necessary to describe the evolution of the technology A_t. We propose a model of absorption of knowledge, where the developing country can use technologies invented abroad, but has to adapt them to local conditions. This adaptation cost slows down technological progress in the less developed country. The domestic growth rate will be that in the knowledge frontier, minus a learning cost. This learning cost declines as the educational attainment of the population improves. This follows Nelson and Phelps (1966), in that production management requires adaptation to change and the more educated the manager the easier it will

of transfers, and symmetry (Kakwani, 1980; Dalton, 1920).

be to introduce new techniques of production. In this sense, education speeds the process of technological di¤usion. Several articles in the growth literature have advocated this hypothesis.[27]

The level of technology A_t is endogenous and a¤ected by the number of people acquiring di¤erent types of education. Let gr(S) be the domestic rate of technological progress, a function of the years of schooling in the population, S. Given that schooling takes only two values in the model, gr(S) depends on the proportion of people in each education category. Then:

$$\frac{(A_t \text{ ¡ } A_{t\text{ ¡ }1})}{A_{t\text{ ¡ }1}} = gr(S) = \text{ , ¡ } I^{h} S^1(T^{2g} \text{ ¡ } T^{1g}) + S^2(1 \text{ ¡ } T^{2g})^{i} \qquad (3.11)$$

where , is the rate of technological progress in the frontier and I(S) is the learning cost, satisfying @I(S)=@S < 0; @²I(S)=@S² > 0; I(0) = 1 and I(1) = 0: Note that since $S^2 > S^1$, more educated workers are faster learners.[28] The constantly improving technology generates permanent growth in the model. Figure 3.2 o¤ers a graphical representation.

4. Shifting Resources Towards Basic Education

The government cares about the welfare of the population. Welfare increases with technological progress and "e¤ective" income per capita, and decreases with inequality. For example, Sen (1974) showed that under certain assumptions on the individual

[27] See for instance Galor and Weil (2000). Barro and Sala-i-Martin (1995), Chapter 6, present a model of adoption of technologies. In their setup the cost of adoption is ...xed, and the bene...ts increase as more workers can buy the new goods. The assumption in this paper would ...t this framework too, as more schooling implies less learning costs, and more aggregate demand.

[28] Bartel and Lichtenberg (1987) provide an empirical assessment of the hypothesis that highly educated workers have a comparative advantage with respect to the adjustment to and implementation of new technologies in the US. Barro and Sala-i-Martin (1995) ...nd in cross-country regressions that the contribution of higher education to growth is larger than that of secondary schooling, which in turn is larger than the contribution of elementary schooling.

utility function, aggregate welfare could be expressed as:

$$W_t = \int_{-\infty}^{z} U(I_{ti})p(I)dI = I_t(1 - kGini) \qquad (4.1)$$

where k measures the degree of "envy" present in the economy and a¤ects the elasticity of welfare with respect to inequality, $p(I)$ is the density function of the income distribution and I_t is aggregate income as before. The Gini Coe¢cient can be interpreted as the average of the depression felt by individuals when comparing their income to that of someone better o¤. As k increases, the depression e¤ect becomes stronger.[29]

In this model this welfare function can be re-written as:

$$W_t = A_t I^{\alpha}(1 - kGini) = A_0[1 + gr(S)]^t I^{\alpha}(1 - kGini) \qquad (4.2)$$

with $gr(S)$ given in 3.11; Gini in 3.10 and $I^{\alpha} = I_t/A_t$ in 3.6.

The objective is to establish whether changing the allocation of the budget towards basic education will always increase welfare, measured by technological progress, "effective" or "base-line" income, I^{α}; and inequality.

The government will be constrained to satisfy the budget. This implies that to

[29] Let the welfare of any pair of individuals be equated to the welfare level of the worst-o¤ person of the two. Then if aggregate welfare is identi...ed with the sum of the welfare levels of all pairs, we get the welfare function underlying the Gini Coe¢cient.

Suppose an individual i with income I_{ti} has the utility function $U(I_{ti};F)$ when $F(I)$ is the income distribution. Let $U(I_{ti};F) = aI_{ti} - bD_F(I)$ with $a;b > 0$ and $D_F(I) = \int_{-\infty}^{\infty} D(I_i;z)f(z)dz$. $D(I_i;z) = z - I_i$ if $I_i < z$ and $D(I_i;z) = 0$ if $I_i \geq z$: $D(x;z)$ measures the individual feeling of deprivation when there are others better o¤ in the economy and $D_F(I)$ measures the average individual depression. Then: $W_t = \int_{-\infty}^{\infty} U(I_i;F)f(I)dI = I_t(1 - kGini_t)$ for $k > 0$. k measures the degree of "deprivation feeling" in the society. If $k > 1$ ($b > a$) the deprivation e¤ect is very strong and a reduction in mean income may be recommended. Note that an individual maximizes its utility function by maximizing its own personal income in this setup, so that the utility maximization process presented in the decentralized equlibrium section remains valid.

Other welfare functions proposed in the literature also increase with income per capita and decrease with inequality. See Lambert (1993) for a more detailed exposition.

increase the share of public spending on basic education, public spending on higher education has to decrease. By total di¤erentiating the budget constraint, the magnitude of this decline is found to be:

$$\frac{dG^{2\alpha}}{dG^{1\alpha}} = -\frac{1 - T^1 + \frac{2G^{1\alpha}}{(1-S^1)^{-T}}}{1 - T^2 + \frac{2G^{2\alpha}}{(1-S^2)^{-2} - (1-S^1)^{-T}}} < 0 \qquad (4.3)$$

This expression is clearly negative, as the proportions of people with basic and higher education were positive in the equilibrium without subsidies. Note that the decline in higher education spending for an additional dollar of spending on basic education depends on the initial allocation of subsidies and workers. The decline will be larger, the larger the initial proportion of people with basic education and the larger the initial subsidy for basic schooling. As the traditional sector expands, the government has to give up larger amounts of spending in the modern sector. As resources are re-allocated towards sector 1, basic education spending becomes more expensive in terms of higher education spending.

4.1. The e¤ects on income inequality

A shift in the allocation of spending towards basic education will have an e¤ect on income inequality measured by:

$$\frac{dGini}{dG^{1\alpha}} = \frac{\partial Gini}{\partial G^{1\alpha}}\Big|_{G^{2\alpha}=\overline{G^{2\alpha}}} + \frac{\partial Gini}{\partial G^{2\alpha}}\frac{dG^{2\alpha}}{dG^{1\alpha}} \qquad (4.4)$$

where the ...rst term is the change in inequality given a change in $G^{1\alpha}$ holding $G^{2\alpha}$ constant, and the second term is the change in inequality induced by a decline in $G^{2\alpha}$, given that the budget constraint has to be satis...ed.

To establish the sign of this expression it is easiest to look at the changes in the Lorenz Curve. Figure 4.1 presents the Lorenz Curve before (solid line) and after

(dashed line) an increase in $G^{1¤}$; adjusted for the corresponding decline in $G^{2¤}$.

Since the dashed line lies above the solid line, we can conclude that inequality will decline and $\frac{dGini}{dG^{1¤}} < 0$. In fact, any inequality measure would give the same result. The new distribution will Lorenz dominate the old one if: (a) more people get basic education (T^{1g} decreases and T^{2g} increases), and (b) the share of income in the traditional sector over total income increases (point $K = I^{1¤}=I^{¤}$ in the graph shifts up and to the right).

An increase in $G^{1¤}$ unambiguously decreases the minimum talent level to enter the traditional sector. Given the increase in $G^{1¤}$, the budget constraint mandates a decline in $G^{2¤}$, and the minimum talent level to enter the modern sector, T^{2g}; goes up. Then condition (a) is satis...ed.

The overall change in K is given by:

$$\frac{dK}{dG^{1¤}} = \frac{@K}{@G^{1¤}}\Big|_{G^{2¤}=\overline{G^{2¤}}} + \frac{@K}{@G^{2¤}}\frac{dG^{2¤}}{dG^{1¤}} \qquad (4.5)$$

It is easy to show that this expression is positive as long as $T^{2g} > T^{1g}$. So if the minimum talent level to enter the traditional sector is lower than that of the modern sector, condition (b) is satis...ed. A policy that favors shifting resources towards basic education will decrease inequality.

If $T^{2g} < T^{1g}$, then the economy will be described by $1 ¡ T^{2g0}$ proportion of people with higher education and T^{2g0} proportion of people with no education, with $T^{2g0} = \frac{F^{1¤}+F^{2¤} ¡ G^{2¤} ¡ G^{1¤}}{(1 ¡ S^2)^{-2}}$ (i.e. there will no workers with just basic education). We consider this the unrealistic case, as no country presents such a distribution. In this situation, an increase in $G^{1¤}$ will have the same impact on inequality as an increase in $G^{2¤}$ (as both policies decrease T^{2g0} by the same amount). A shift in the allocation of spending towards basic education will have no e¤ect on inequality, as the e¤ects of more $G^{1¤}$

and less $G^{2¤}$ compensate exactly. However, if the increase in $G^{1¤}$ (decrease in $G^{2¤}$) is big enough, then we are back in the situation where $T^{2g} > T^{1g}$, and the previous analysis applies.[30]

The intuition for this result is fairly straightforward. An increase in spending in sector 1 gives incentives to invest in basic human capital and moves people out of poverty. As spending in sector 2 decreases, some people are shifted from the high income sector to the traditional sector. Both e¤ects imply a transfer from relatively richer people to the poorest group in the economy. As resources are re-allocated from higher education towards basic education, inequality unambiguously declines.

4.2. The e¤ects on aggregate income

A shift in the allocation of spending towards basic education will have an e¤ect on "e¤ective" income measured by:

$$\frac{dI^{¤}}{dG^{1¤}} = \frac{@I^{¤}}{@G^{1¤}}\Big|_{G^{2¤}=\overline{G^{2¤}}} + \frac{@I^{¤}}{@G^{2¤}}\frac{dG^{2¤}}{dG^{1¤}} \qquad (4.6)$$

The contribution of additional spending in sector 1 towards income equals the number of people with basic education: $\frac{@I^{¤}}{@G^{1¤}} = 1 ¡ T^{1g}$: The contribution of additional spending in sector 2 equals the number of people with higher education: $\frac{@I^{¤}}{@G^{2¤}} = 1 ¡ T^{2g}$: As spending on basic education increases, more and more resources have to be diverted from higher education. There is a point in the budget constraint line, where the extra income from workers with basic education is less than the income given up from fewer worker with higher education. Spending more on basic education will increase aggregate income (i.e. $\frac{dI^{¤}}{dG^{1¤}}$ will be positive) if and only if spending in

[30] $T^{2g} > T^{1g}$ if the subsidy for higher education is small enough $G^{2¤} < \frac{[(1¡S^{1})^{-1}F^{2¤}]¡[(1¡S^{2})^{-2}¡(1¡S^{1})^{-1}][F^{1¤}¡G^{1¤}]}{(1¡S^{1})^{-1}}$.

the basic sector is "small" enough. The threshold value is given by:

$$\frac{G^{1¤}}{G^{2¤}} < \frac{(1 ¡ S^{1})^{-1} ¡ F^{1¤}}{(1 ¡ S^{2})^{-2} ¡ (1 ¡ S^{1})^{-1} ¡ F^{2¤}} = \frac{I^{1\max}}{I^{2\max} ¡ I^{1\max}} \qquad (4.7)$$

where $I^{1\max}$ and $I^{2\max}$ stand for the maximum income of the most talented person in the economy if employed in sectors 1 and 2 respectively, without considering education subsidies.

The right hand side can be interpreted as the ratio of the maximum extra earnings from basic education to the maximum extra earnings from higher education. It is a bit more intuitive to analyze this condition for average extra earnings. This provides only a su¢cient test.[31]

Let $\overline{I}^{1}$ be the average income in sector one and $\overline{I}^{2}$ the average income in sector 2, without education subsidies. Then:

$$\overline{I}^{1} = \frac{I^{2\min} + I^{1\min}}{2} \text{ and } \overline{I}^{2} = \frac{I^{2\max} + I^{2\min}}{2} \qquad (4.8)$$

where $I^{1\min} = 0$, since the marginal person in sector 1 earns no income, and $I^{2\min}$ is the income of person with talent T^{2}:

Spending more on basic education will be bene...cial for aggregate income if:

$$\frac{G^{1¤}}{G^{2¤}} < \frac{I^{1\max}}{I^{2\max} ¡ I^{1\max}} < \frac{I^{2\min}}{I^{2\max} + I^{2\min} ¡ I^{2\min}} = \frac{\overline{I}^{1}}{\overline{I}^{2} ¡ \overline{I}^{1}} \qquad (4.9)$$

As education subsidies in the traditional sector increase, more people invest in basic education. As education subsidies in the modern sector decrease, fewer people invest in higher education. This forces total income in sector one to increase and total income in sector 2 to decrease. The size of these e¤ects becomes larger as the

[31] If the test holds, we can conclude there will be no trade-o¤. Otherwise, the test renders inconclusive.

traditional sector expands, given the non-linear budget constraint. Overall income will increase if expenditures in the traditional sector are not "too" high relative to expenditures in the modern sector. The threshold is given by the average gains in private earnings from sector 1 relative to the average gains from sector 2. The conclusion is that only when the ratio of extra earnings in sector 1 to sector 2 exceeds the ratio of spending on basic education to higher education, the proposed policy would increase e¤ective aggregate consumption and lower inequality.

4.3. The e¤ects on growth

A shift in the allocation of spending towards basic education will have an e¤ect on growth measured by:

$$\frac{dgr(S)}{dG^{1¤}} = \frac{@gr(S)}{@G^{1¤}}\Big|_{G^{2¤}=\overline{G^{2¤}}} + \frac{@gr(S)}{@G^{2¤}}\frac{dG^{2¤}}{dG^{1¤}} \tag{4.10}$$

One more dollar of expenditures on basic education subsidies will increase the rate of adoption of new technologies (i.e. $\frac{dgr}{dG^{1¤}}$ will be positive) if and only if:

$$-\frac{dG^{2¤}}{dG^{1¤}} < \frac{\frac{S^1}{(1¡S^1)^{-1}}}{\frac{S^2¡S^1}{(1¡S^2)^{-2}¡(1¡S^1)^{-1}}} \tag{4.11}$$

The left hand side is the slope of the budget line in absolute value. It measures the amount of resources that have to be diverted from the modern sector as one more dollar is spent on basic education. This amount increases as the traditional sector expands. When this amount is "too" high, one more dollar of spending on basic education will slow down the rate of adoption of new technologies. The threshold is given by the contribution to growth of one more dollar of spending on basic education relative to the contribution to growth of one more dollar of spending on higher education. If the resources diverted from higher education exceed the

bene...ts in growth from basic education, a decline in technological progress should be expected and a trade-o¤ between inequality and growth arises.

4.4. Discussion

The previous exercise has shown that changing the allocation of the budget towards basic education and away from higher education, will have a favorable e¤ect on the distribution of income. However, there will be potential trade-o¤s with respect to the growth rate and the level of aggregate income. Trade-o¤s are more likely to arise as spending on basic education rises relative to spending on higher education. The threshold value that determines the existence of a trade-o¤ between inequality and aggregate income depends on the relative gains in earnings from sector 1 to sector 2. The threshold value that determines the existence of a trade-o¤ between inequality and growth depends on the contribution to growth of spending in sector 1 relative to sector 2.

In the next section, we evaluate whether trade-o¤s are more likely to arise as the skill premium increases. There is ample evidence that the returns to skill have risen considerably in the past decade in Latin America.[32] Does this change the way we should think about the potential trade-o¤s between inequality, growth and aggregate income?

[32] See Machin et Al. (1998) and IDB (1999) for evidence on OECD and Latin American countries respectively. Corbacho (2001) provides estimates for the case of Argentina in 1985-1997. This analysis is particularly critical for the case of Latin America, where contrary to the evidence in developed countries, rates of return to education are convex (i.e. the return to one more year of tertiary schooling is larger than the return to one more year of basic schooling).

5. An Increase in the Skill Premium

Particularly interesting is the analysis of the e¤ects of the rise in the skill premium that took place in the 90's. In the context of this model, this shift would be represented by an increase in $^{-2}$.[33]

When $^{-2}$ increases, earnings functions in sector 2 become steeper and more people ...nd it pro...table to invest in higher education. At the initial allocation of education subsidies, T^{2g} decreases and the proportion of college graduates goes up (see Figure 5.1). As Figure 5.2 shows, the implied e¤ect on the budget line is a rotation to the left at the original levels of educational expenditures. The slope is ‡atter at every point, as indicated by equation 4.3. When $^{-2}$ is higher, the change in the number of college graduates for a given change in higher education subsidies is smaller, as the e¤ect of private incentives is stronger relative to the e¤ect of public incentives. Then the amount of resources that have to be diverted from sector 2 for an extra dollar of spending in sector 1 is smaller when the returns to skill increase.

5.1. The trade-o¤ between inequality and aggregate income

As explained in the previous section, the trade-o¤ between inequality and income arises if the ratio of spending in sector 1 to sector 2 exceeds the ratio of extra earnings of sector 1 to sector 2, that is:

$$\frac{G^{1\alpha}}{G^{2\alpha}} > \frac{I^{1\max}}{"I^{2\max} \; ¡ \; I^{1\max}} +$$

When $^{-2}$ increases, the right hand side becomes smaller, as the earnings in the advanced sector increase with respect to earnings in the basic sector. When the

[33] The assumption throught the exercise is that the increase in $^{-2}$ is not big enough to eliminate the basic education sector.

returns in the modern sector increase, the trade-o¤ between inequality and income is more likely to occur. The intuition for this result is quite clear. As workers in the modern sector become more productive, spending one more dollar on basic education has a higher opportunity cost in terms of overall income.

5.2. The trade-o¤ between inequality and growth

The trade-o¤ between inequality and growth arises if the amount of resources diverted from higher education are higher than the ratio of bene...ts in growth from basic education spending to higher education spending. The contribution of higher education spending to growth is smaller for a higher $^{-2}$: This happens because public incentives to invest in higher education become weaker compared to the returns in the market. For the same change in $G^{2¤}$; the proportion of workers that would move in and out of sector 2 is now less signi...cant. Basic education spending becomes relatively more e¢cient at producing growth. For the same reason, the amount of resources diverted from higher education as the traditional sector expands are not as high. Therefore as the return to skill increase, shifting resources towards basic schooling implies relatively more bene...ts in growth via sector 1 and less costs in resources via sector 2. Both e¤ects go in the same direction, implying that the trade-o¤ between inequality and growth is less likely to occur:

$$+\frac{dG^{2¤}}{dG^{1¤}} < \frac{\frac{S^1}{(1+S^1)^{-1}}}{\frac{S^2 * S^1}{"(1+S^2)^{-2} * (1+S^1)^{-1}}} *$$

When returns to higher education rise, there is more scope for redistribution without hurting the rate of adoption of new technologies, given that the private incentives to invest in higher education become stronger.

6. An Application to Latin America

As described in the previous sections, a re-allocation of public education expenditures towards the lower grades would enable countries to achieve a more equal distribution of earnings. However, this policy may come at the expense of a lower rate of technological progress or a reduced level of aggregate income. The model is calibrated for the cases of Argentina, Honduras and Mexico in the mid 90's to evaluate if their current allocations of education expenditures are beyond the trade-o¤ frontier.

Argentina, Honduras and Mexico constitute interesting examples. They di¤er in their educational attainment, level of development and allocations of public education expenditures. While Argentina has the highest average in years of education (9.5 years), Honduras has the poorest educational attainment in Latin America (4.7 years).[34] Mexico is in the middle range (with 6.2 years). The same ranking applies to levels of GDP per capita. Concerning public education spending, Honduras spends nearly seven times more per student at the higher level than at the basic level. Mexico and Argentina on the other hand, spend only three times and one and a half times more respectively. Of the three countries, Mexico has the highest income inequality, with a Gini Coe¢cient of 0.57. Only Brazil, Chile and Paraguay have higher indices.[35] Mexico is followed by Honduras with a coe¢cient of 0.53 and then by Argentina, with a fairly equal distribution of earnings in the Latin American context.[36]

To evaluate whether a particular country is beyond the trade-o¤ frontier, the key parameters to take into consideration are the returns to basic and higher education ($^{-1}$ and $^{-2}$), the distribution of workers across schooling categories ($1 ¡ T^{1g}$ and $1 ¡ T^{2g}$);

[34] These numbers correspond to 25 year olds. Data sources are given later in the paper.

[35] See IDB (1999).

[36] The Gini Coe¢cient for Argentina is 0.47, one percentage point higher than that of Costa Rica and Peru (the most equal countries of the region).

the ...xed private fees (F_t^1 and F_t^2), the allocation of public education expenditures per student (G_t^1 and G_t^2) and the time costs (S^1 and S^2). S^1 and S^2 are set at 10/65 and 15/65 respectively.[37] Public expenditures on education are taken from UNESCO statistics for Mexico and Honduras, and from the Ministry of Education and Ministry of Economics for Argentina. The returns to education and the distribution of workers across schooling categories are estimated using household survey data. Data for Argentina corresponds to "Encuesta Permanente de Hogares", October, 1997.[38] Data for Mexico corresponds to "Encuesta Nacional de Ingreso Gasto de los Hogares", Third Quarter 1996, and data for Honduras corresponds to "Encuesta Permanente de Hogares de Propósitos Múltiples", September 1997, both of national coverage.[39] The ...xed private fees are estimated as a residual to match the observed distribution of workers, given the returns and government education spending.

Workers are sorted out in three categories: low schooling, basic schooling and high schooling. The basic schooling category includes workers with some or complete secondary education. The high schooling category includes workers with some or complete tertiary education. The returns are estimated via a Maximum Likelihood Heckman model that controls for self-selection, using dummies for the level of education.[40] Low schooling is the left out category. Then the coe¢cients on the education dummies measure how much a worker with basic or tertiary schooling earns over a worker with low schooling. The regressions control for experience in the labor market, experience squared,[41] size of the ...rm, industry and occupation e¤ects,

[37] Other speci...cations yielded the same results.

[38] This survey covers "Gran Buenos Aires", which includes the Capital District and 19 counties of the Province of Buenos Aires, concentrating over one third of the total population of Argentina.

[39] The statistics centers that collect these data sets are INDEC, INEGI and INE for Argentina, Mexico and Honduras respectively.

[40] This model is also called "Generalized Tobit." Details of the estimation model and results are provided in the appendix. Self-selection is signi...cant in the Argentine and Honduran cases, but not in the Mexican one. The returns to education are robust to di¤erent speci...cations.

[41] Experience is calculated as age minus years of education minus six, as is standard in labor

gender and civil status. The regressions for Argentina and Honduras also control for tenure in the job.[42]

Table 6.1 presents the parameters used in the calibration. In Argentina, a worker with basic schooling earns 20% more than a worker with low schooling. A worker with higher education earns 55% more. Di¤erences in returns are less signi...cant in Honduras, mostly due to a higher return to basic education. This is probably explained by the unequal distribution of workers across education sectors, with a low proportion in the basic school category.[43] Di¤erences in returns are striking in Mexico. A worker with basic schooling earns 55% more than a worker with low schooling, while a worker with higher education earns 133% more.[44]

Table 6.2 reports the calibration results. The top part of the table presents the conditions for the trade-o¤ between inequality and aggregate income to arise. The line for spending corresponds to the ratio of public education expenditures per student in the basic level to the higher level. The line for income corresponds to the ratio of lifetime extra earnings in the basic sector to the advanced sector. A trade-o¤ between inequality and income arises if the ratio of expenditures exceeds the ratio of earnings.

A re-allocation of public resources towards the lower grades would reduce inequality and increase steady-state income for the case of Honduras. This result is not surprising. On the one hand, Honduras spends a large share of the budget in higher education. On the other hand returns to higher education are not very large, at least in the Latin American context. These two facts go in the same direction making the

economics.

[42] The survey for Mexico does not include this information.

[43] In Honduras, there is a fairly low percentage of workers with basic schooling ($1 ¡ T^{1g} = 0{:}29$) and a large percentage of workers with higher education ($1 ¡ T^{2g} = 0{:}20$).

[44] Other studies have also found this result. Another feature to notice is that marginal returns per year of education are increasing in these three countries, as is the case for the whole Latin American region (IDB, 1999).

trade-o¤ between inequality and income not likely to occur. However, a re-allocation towards the lower grades would imply a trade-o¤ for the Argentine and Mexican cases. Although these countries do not spend as much in tertiary education, returns at this level are high enough to induce a large opportunity cost of subsidizing the lower productivity sector.

The bottom part of Table 6.2 presents the results for the trade-o¤ between inequality and growth to occur. The line for spending corresponds to the slope of the budget constraint, given the allocation of expenditures and the distribution of workers. Recall that as subsidies and returns to basic education increase, and more workers invest in basic schooling, more resources have to be diverted from higher education (i.e. the slope of the budget constraint becomes steeper).[45] The line in the table for growth corresponds to the ratio of the contributions of basic education and higher education. This ratio is larger, the larger the return to higher education. The trade-o¤ between inequality and growth arises if the resources diverted from higher education exceed the gains in growth.

A re-allocation of resources towards the basic level would reduce inequality and increase the rate of adoption of new technologies for the case of Honduras. Both the low concentration of workers and expenditures at the basic level imply that Honduras is positioned on the ‡atter part of the budget constraint. Then, the amount of resources diverted from higher education for an extra dollar of spending in the basic sector is not very large. In fact, the relative gains in growth from basic schooling exceed the costs in resources. Then the recommended policy would be welfare enhancing in all dimensions in Honduras. The trade-o¤ between inequality and growth does not occur for the case of Argentina either. Argentina spends relatively

[45] In the previous section it was shown that as the return in the higher education sector goes up, the slope of the budget constraint ‡attens. The opposite occurs if the return in the basic education sector goes up.

more in basic education and has a larger proportion of basic education workers than Honduras. This positions the country on the relatively steeper part of the budget constraint. Although Argentina would have to give up more resources in higher education for an extra dollar of spending on the lower grades, the larger returns to higher education imply that expenditures on this level are relatively less e¢cient at producing growth.[46] The Mexican case is di¤erent. Spending more on basic education would reduce inequality at the expense of a lower rate of technological progress. The allocation of workers and expenditures implies that Mexico would have to give up the largest amounts of resources in higher education of the three countries under analysis. The relative gains in growth, however, seem not to be enough to compensate for this loss.[47]

The cases under study show that while Honduras could increase welfare by spending more on the lower grades without encountering any trade-o¤s, Mexico would be able to improve the distribution of earnings only at the expense of a lower growth rate and income level. In Argentina, on the other hand, there is scope for reducing inequality and promoting technological progress, but the government faces a trade-o¤ in terms of steady-state income. The empirical analysis shows that the conventional wisdom would not apply in all countries. Each case should be analyzed in detail, as the particularities of the education and labor markets, and the distribution of expenditures, play a key role in determining the relative bene...ts and costs of education spending policies.

[46] Recall that as the return to higher education goes up, public incentives to invest in this level of education become relatively weaker. Then the same dollar of subsidies in the advanced sector contributes less to growth when the returns in this sector are high.

[47] In Table 6.2, returns and expenditures correspond to the same period. Returns to education today are the best proxy one can use to estimate returns in the future. However, to consider the possibility of lagged e¤ects, the analysis was also performed matching previous allocations of public education spending to current returns. Although countries have changed their allocations over time, these changes have not been very signi...cant and the conclusions remain unchanged. These results are available upon request.

7. Final Comments

The conventional recommendation for public expenditure policy is to re-allocate resources from higher education towards basic education in order to allow countries to grow faster and to reduce inequality. This paper provides a critical assessment of whether spending more at low levels of schooling is in fact a win-win policy. The potential trade-o¤s are analyzed in terms of three components of long-run welfare: the rate of adoption of new technologies; inequality of earnings as driven by inequality in educational attainment; and the "base-line" level of income.

We present a simple two-sector model of heterogeneous agents, endogenous schooling acquisition and government education expenditures in a small open economy. The traditional sector employs workers with basic schooling while the advanced sector employs college graduates. Individuals have to forego earnings while in school and pay a direct private fee. These two costs are higher at the higher education level. Agents sort themselves into education categories according to their endowments of "talent" or human capital "quality." The government subsidizes the private education fees, ...nanced through a lump-sum budget. Education expenditures provide incentives for individuals to invest in education, altering the distribution of education, and consequently the patterns of inequality, growth and overall income.

As the allocation of government education subsidies is more concentrated on the basic sector, the budget constraint mandates further declines in higher education spending. If basic education expenditures are high enough relative to expenditures on higher education, then further re-allocations towards low levels of schooling may slow technological progress and decrease the level of aggregate income in the steady state. This happens because fewer people invest in higher education as subsidies at this level decrease. Given that the marginal contribution of higher education

to growth and income is higher than that of basic education, the opportunity cost of having fewer workers with high skills eventually overcomes the bene...ts of having additional basic school graduates. However, inequality of earnings always declines as the traditional sector expands. This implies that if re-allocations towards the basic schooling sector are too high, there will be a trade-o¤ between inequality and growth and inequality and income.

The paper also studies the e¤ects of an increase in the skill premium. As returns in the higher education sector rise, more people will invest in this type of education. Government subsidies at the college level may become less e¤ective in moving workers in or out of the advanced sector. This gives the government more scope for redistribution without hurting the rate of adoption of new technologies; and, the trade-o¤ between inequality and growth is less likely to arise. However, re-allocating resources towards the basic sector is more likely to decrease the level of overall income because the opportunity cost of subsidizing a sector with relatively lower productivity increases.

Using econometrically estimated parameters, we calibrate the model for three countries in Latin America: Argentina, Mexico and Honduras. These countries have high, middle and low educational attainment, respectively. While the proposed policy would allow Honduras to increase welfare in all dimensions, Mexico would be able to reduce inequality only at the expense of a lower rate of technological progress and a reduced level of aggregate income. Argentina would not encounter a trade-o¤ between inequality and growth, but would encounter a trade-o¤ between inequality and income.

This research can be extended in di¤erent directions. From a theoretical perspective, there are several issues that are not addressed. For instance, it would be interesting to analyze shocks to terms of trade, by classifying sectors as import or

export oriented. The framework also abstracts from the relationship between private and public expenditures.[48] From an applied perspective, the model provides a rule-of-thumb for the analysis of speci...c allocations of education expenditures that can be applied to other examples.

8. Appendix: Estimation of Returns

As explained in section 6, returns were estimated using a Heckman Maximum Likelihood procedure to control for self-selection bias.[49] This appendix provides details for this model.

Let Ψ_i be the "latent" variable corresponding to net earnings of person i, and E_i a dummy variable equal to one if the person is employed in the labor market. If $\Psi_i > 0$; the market wage exceeds the reservation wage for person i: Then $\Psi_i = Y_i$ is observed and $E_i = 1$. If $\Psi_i < 0$; the person does not participate in the labor market and only $\Psi_i = 0$ is observed. This implies $E_i = 0$:

Let X be the matrix of variables a¤ecting individual earnings in the labor market and ¼ the corresponding e¤ects. X typically includes education, experience, tenure, occupation and industry e¤ects, etc. Let Z be the matrix of variables a¤ecting labor force participation and ° the corresponding e¤ects. Z may include the same variables in X or others, like number of children, civil status and non-linear functions of human capital variables.

The model is:

selection mechanism: If $\Psi_i = Z_i° + \cdot_i > 0$ then $E_i = 1$ and 0 otherwise.

regression model: $Y_i = X_i¼ + "_i$ is observed only if $E_i = 1$:

[48] Other interesting extensions include the incorporation of distortionary taxation, that would force the government to weight the bene...ts of subsidizing education against the costs of distortions, and the analysis of short-run versus long-run e¤ects.

[49] Heckman (1979 and 1990).

("¡; ·¡)~bivariate normal [0,0,1,¾"; ½]

The expected value of observed earnings equals:

$$E(Y_i = E_i = 1) = X_i¼ + E("_i = \cdot_i > ¡ Z_i°) = X_i¼ + ½¾" ¸(Z_i°) \qquad (8.1)$$

where ¸(:) are the "inverse Mills' Ratios."[50]

An OLS regression of X on Y will yield unbiased estimators for ¼ only if the last term in 8.1 is zero. This term arises from the use of a "non-random" sample of workers (i.e. a sample of workers that "select" themselves into the labor market). There will be no self-selection bias if the participation and earnings equations are independent (½ = 0):

The model in 8.1 is estimated via Maximum Likelihood. The results are given in Table 8.1.[51] The Wald Test of Independent Equations indicates that while the hypothesis of no self-selection is rejected for the cases of Argentina and Honduras, it is not rejected for the case of Mexico. This result is somewhat expected given the larger employment rate in Mexico.[52]

[50] ¸(Z_i°) = Á(Z_i°)=©(Z_i°); where Á(:) is the Normal density function and ©(:) is the cumulative Normal disitrbution.

[51] Since the inverse Milll's Ratios are non-linear functions of Z, Z and X could in theory be the same. It is better, however, to have identifying restrictions on the earnings and partipation equations to reduce the degree of multicollinearity between X and ¸(:): See the table for details.

[52] Employment rates can be calculated as the ratio of censored observations to total observations in the sample. This ratio is 65% for Mexico, 58% for Argentina and 49% for Honduras.

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Table 1.1 Spending on Higher Education
(as a share of total education spending)

East Asia		Latin America	
Examples:		Examples:	
Indonesia	0.18	Mexico	0.14
Malaysia	0.17	Colombia	0.17
Thailand	0.17	Argentina	0.17
Korea	0.08	Chile	0.20
		Ecuador	0.23
		Brazil	0.26
		Venezuela	0.35
Average for the whole region	0.15	Average for the whole region	0.22

Source: Birdsall et Al. (1998)

Table 1.2: Spending on Education
(as a share of GNP)

	Total % of GNP		Per student % of GNP p/capita			
			Primary		Tertiary	
East Asia	1980	1997	1980	1997	1980	1997
Korea	3.7	3.7	10.6	18.8	16.1	6.0
Malaysia	6.0	4.9	12.0	11.1	148.9	57.3
Thailand	3.4	4.8	8.8	12.5	60.1	26.7
Singapore	2.8	3.0	6.8	7.8	40.6	28.0
Average	2.5	2.9				
Latin America	1980	1997	1980	1997	1980	1997
Argentina	2.7	3.5	6.5	8.3	29.3	19.9
Chile	4.6	3.6	9.6	11.1	112.0	21.1
Colombia	1.9	4.1	5.3	10.3	43.8	35.4
Mexico	4.7	4.9	4.4	11.8	26.4	46.8
Venezuela	4.4	5.2	5.7	2.1	71.1	
Average	3.8	3.6				

Source: World Development Indicators (1998)

Table 1.3 Returns to Education in Latin America

Level	1980's	1990's
Primary	26%	10%
Secondary	18%	11%
Higher	16%	18%

Source: Psacharopoulos (1994) & IDB (1999)

Figure 2.1: The Allocation of Talent across Sectors

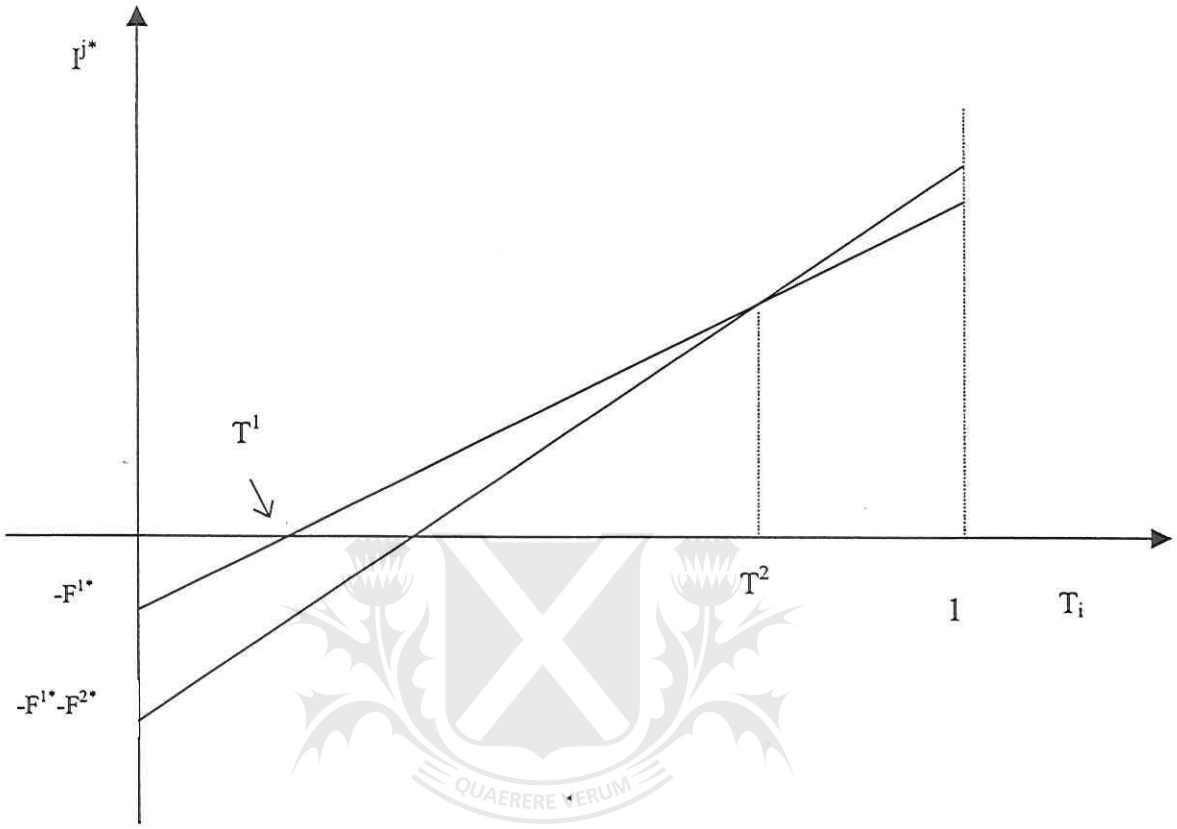

Figure 3.1: The Budget Constraint

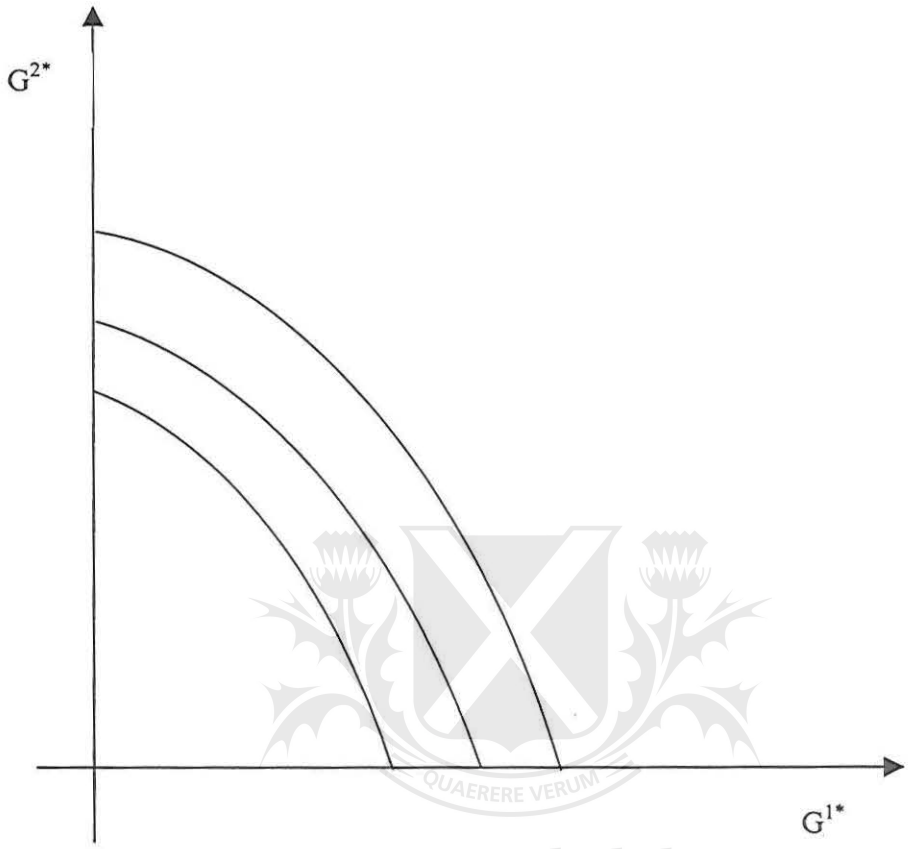

Figure 3.2: Technological Progress

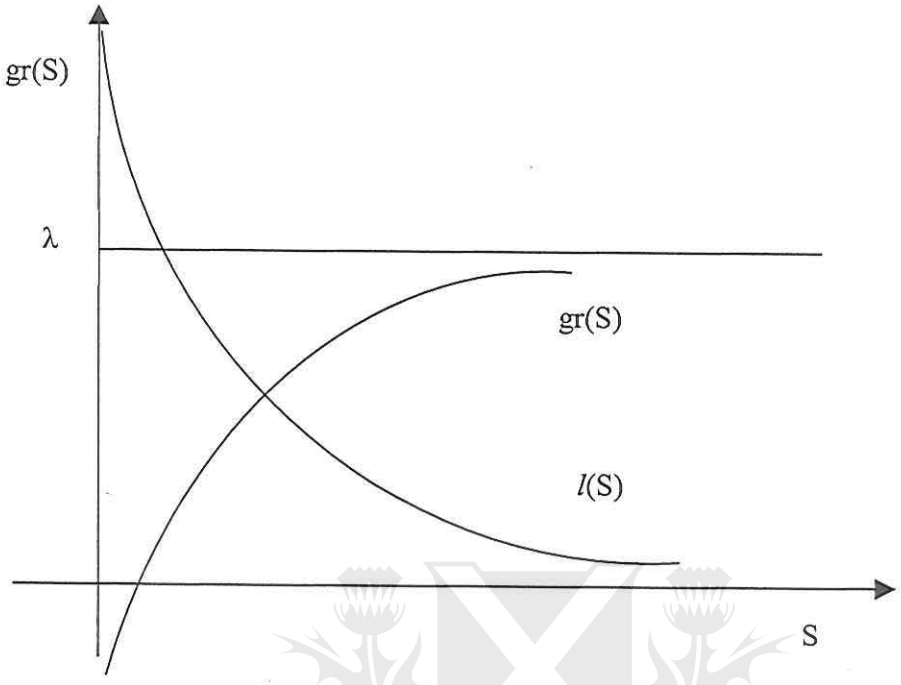

Figure 4.1: The Lorenz Curve after a Change in G^{1*}

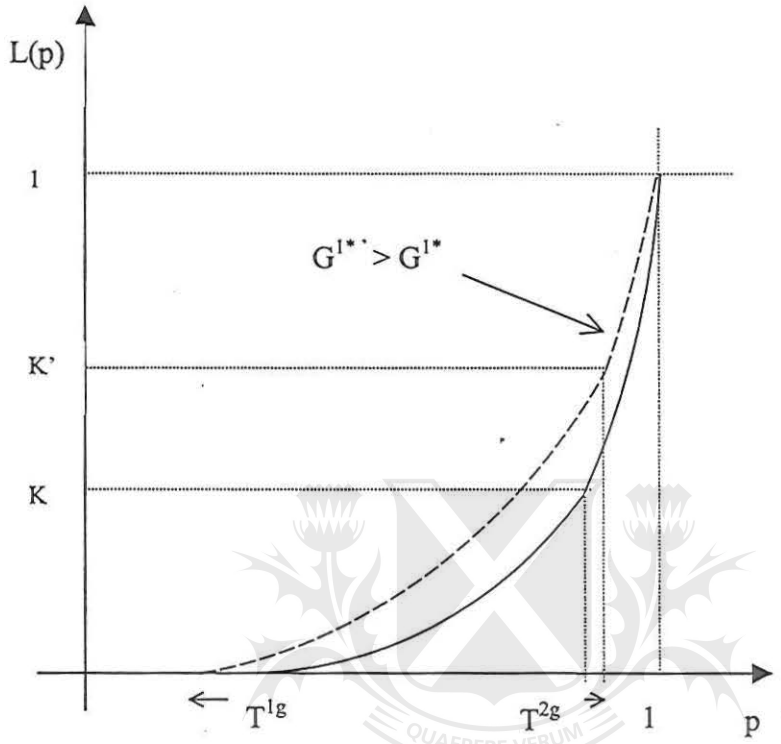

Figure 5.1: A Rise in the Skill Premium and Earnings Functions

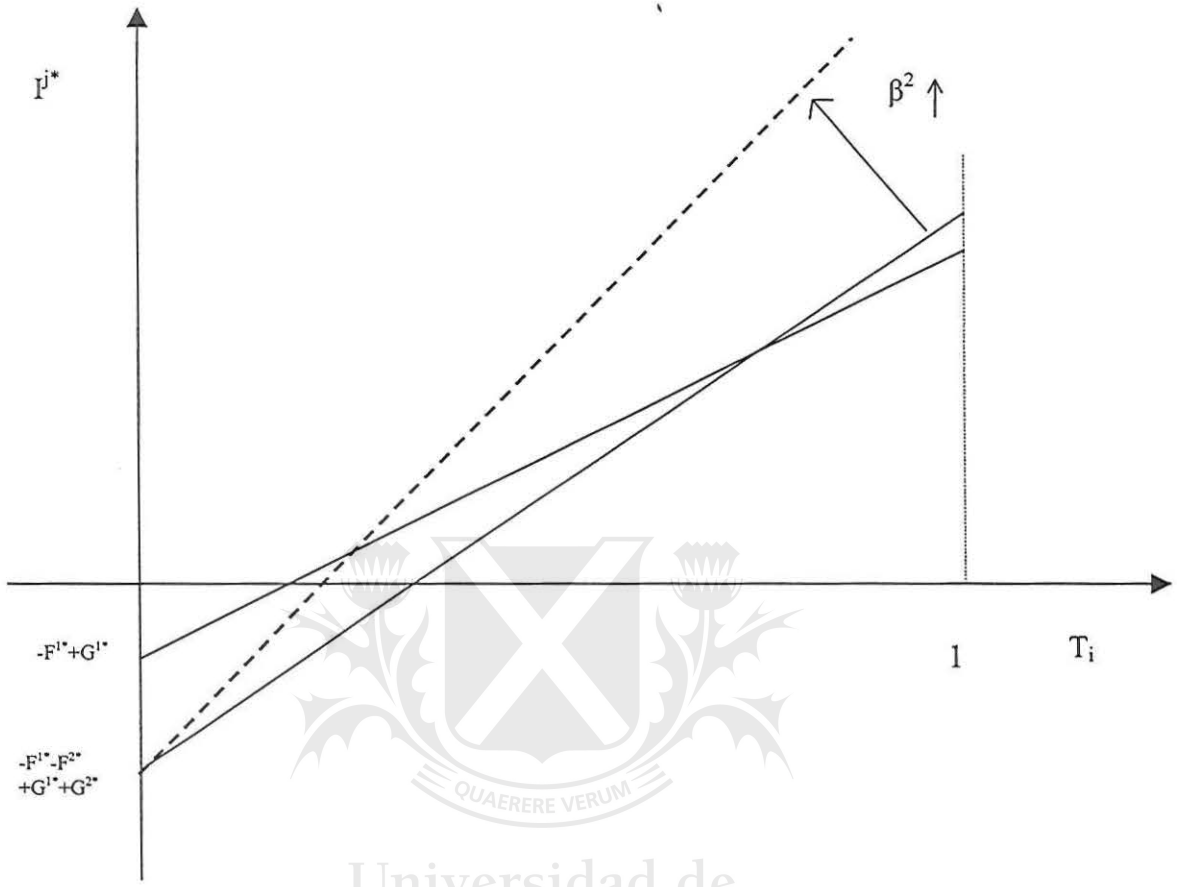

Figure 5.2: A Rise in the Skill Premium and the Budget Constraint

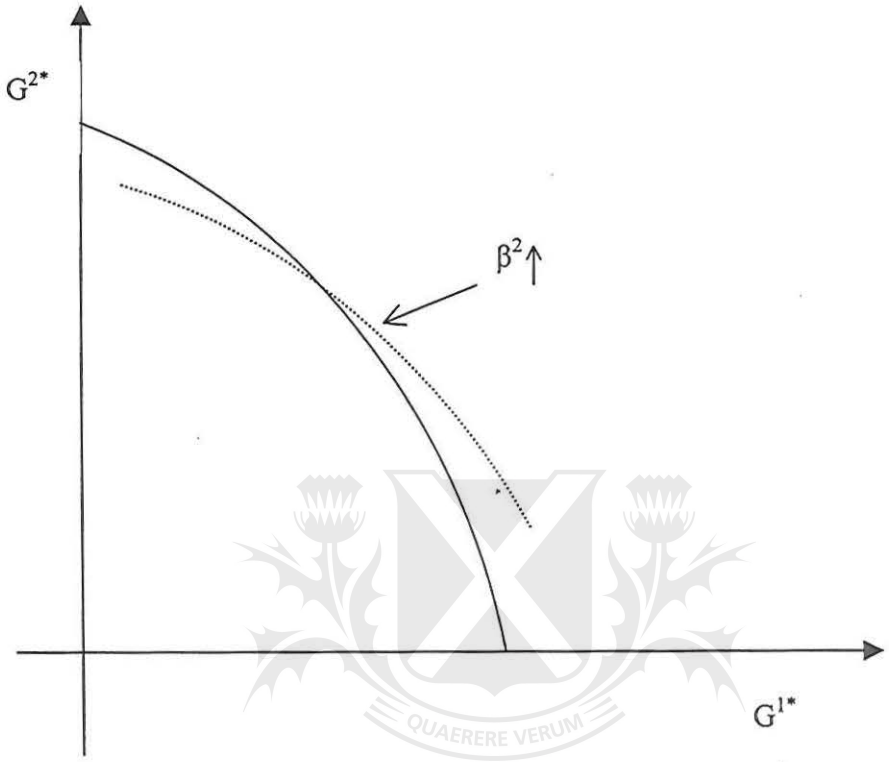

Table 6.1 Parameters Used in the Calibration

Basic Parameters	Argentina 1997	Honduras 1997	Mexico 1996
GDP p/capita PPP terms	10300	2220	7990
Avg. years of education (25 year olds)	9.44	4.74	6.23
Gini Coefficient	0.47	0.53	0.57
Distribution of workers			
Basic Education	0.61	0.29	0.46
Higher Education	0.23	0.20	0.12
Public Expenditures p/student (US$)			
Basic Education	1092.00	62.27	466.65
Higher Education	1477.00	423.55	1401.91
Returns			
Basic Education	0.20	0.30	0.55
Higher Education	0.60	0.59	1.33
Private Fees p/student (US$)			
Basic Education	1195.75	64.12	572.88
Higher Education	2184.61	426.83	1814.41

Sources:

GDP: World Development Indicators

Expenditures: Argentina: Ministry of Economics
Mexico and Honduras: UNESCO Statistics

Rest: Own calculations based on Household Surveys

Expenditures for Honduras correspond to the year 1994

Table 6.2: Trade-Offs

	Argentina 1997	Honduras 1997	Mexico 1996
Trade-Off Inequality & Income			
Spending	0.74	0.15	0.33
Income	0.21	1.42	0.29
Conclusion	YES	NO	YES
Trade-Off Inequality & Growth			
Spending	2.64	0.39	3.06
Growth	3.45	1.58	2.40
Conclusion	NO	NO	YES

Table 8.1: Returns to Education

Dependent Variable: Log real hourly wage	Argentina 1997	Honduras 1997	Mexico 1996
Basic Education	0.20 **	0.30 **	0.56 **
	[0.02]	[0.05]	[0.02]
Higher Education	0.55 **	0.59 **	1.33 **
	[0.04]	[0.05]	[0.03]
Experience	0.01 **	0.00	0.03 **
	[0.00]	[0.00]	[0.00]
Experience Squared (coefficient x 1000)	-0.18 **	0.04	-0.52 **
	[0.00]	[0.00]	[0.00]
Other Controls			
Tenure	yes	yes	no
Occupation	yes	yes	yes
Industry	yes	yes	yes
Size of the firm	yes	yes	yes
Region	no	yes	no
Gender	yes	yes	yes
Married	yes	yes	yes
Wald Test (Overall Sig.)	2116.24 **	2595.43 **	6306.96 **
Total Observations	6078	11256	34967
Censored	3541	5581	22871
Uncensored	2537	5675	12096
Wald Test (Independent Eq.)	7.29 **	173.4 **	1.06

The estimation is via a Maximum Likelihood Heckman selection model

Variables in participation equation: years of education squared, age, age squared, female and married

** significant at the 1% level

Robust standard errors in brackets