

Are educational policies elitist?*

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Abstract

A recent theoretical and empirical literature has recognized the importance of growth-promoting policies that not only take into account the level but also the distribution of human capital. This paper studies the link between public spending on education and human capital inequality. I build a model of human capital formation where government intervention in education is justified by the existence of credit market imperfections. The framework provides conditions on the level of development of an economy under which the educational policies are elitist, that is increase the spread between the educational achievement of the bright and less bright individuals. The theoretical predictions of the model are tested using the measures of educational inequality recently constructed for both developed and developing countries by Castelló and Doménech (2002). The paper also presents estimates of the effects of public expenditure by education level on human capital inequality.

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1 Introduction

Recently there has been much discussion about the importance of growth-promoting policies that take into account not only the level but also the distribution of human capital. Galor and Tsiddon (1997) show theoretically that the composition of human capital is an important factor in the determination of the pattern of economic development. Castelló and Doménech (2002) find empirical evidence that human capital inequalities negatively affect economic growth rates and provide more robust results than income inequality measures in the estimation of standard growth equations. They also show that this negative effect of human capital inequality on economic growth rates is due to the inefficiency of resource allocation and to a reduction in investment rates. De Gregorio and Lee (2002) measure inequality of schooling as the standard deviation of the educational attainment of the population and find that a more unequal distribution of education plays a significant role in making the income distribution more unequal. Birdsall and Londono (1997) describe the approach reflected in the work of World Bank economists and point out that the long-standing inattention of the World Bank to inequality in the distribution of assets, especially education, has been extremely costly to developing countries.

Using cross-country aggregate data, Castelló and Doménech (2002) find that most countries in the world have tended to reduce educational inequality in the last decades. This has implied a process of convergence in human capital equality. They also show that the variability of human capital inequality has been greater across countries than within each country. Blanden and Machin (2004) study the distributional consequences of UK higher education expansion in the last decades. They report evidence that this higher education expansion has disproportionately benefited children from relatively rich families and has reinforced inequalities in access to higher education. Checchi and García-Peñalosa (2004) find both theoretically and empirically that greater aggregate production risk may be associated with fewer average years of education and greater educational inequality. Hanushek and Wößmann (2006) compare differences in educational outcome between primary

and secondary schools in countries that track students into differing-ability schools by age 10 (e.g. Austria, Germany, Hungary and the Slovak Republic) and in countries that instead keep the lower secondary school system comprehensive. Their difference-in-differences estimates suggest that early tracking increases the standard deviation of scores in international student achievement tests. Kremer (1997) argues that sorting into homogeneous neighborhoods, marriages, schools or workplaces is instead likely to have minor effects on inequality of education.

The public provision of education has been commonly perceived as egalitarian and viewed as a vehicle to achieve equity goals in the economy. For instance, among the justifications for public intervention, Barr (1998) mentions redistributive motives. There are however some exceptions to this common perception. Gradstein (2003) argues that extreme income inequalities may generate a bias in favor of the rich, because richer households are able to exert more political pressure through rent seeking. Su (2004) studies the trade-off between efficiency and equality for the allocation of public funds to basic and advanced education in a hierarchical two-stage model. Her dynamic theoretical framework predicts that an allocation favoring advanced education generates redistribution from bottom to top. In his theoretical analysis of optimal educational policies, De Fraja (2002) shows that when individuals have private information about their ability, this information disadvantage of the government may imply an elitist educational policy, which increases the spread between the educational achievement of the bright and the less bright individuals. The elitist character of the provision of educational subsidies in De Fraja's (2002) model is a consequence of the need to provide high ability individuals with enough incentives to acquire a higher level of education than they would do privately.

The aim of my paper is to study the following research question: How has public education expenditure affected the distribution of human capital? My contribution to the literature is twofold. First, I show theoretically that the relationship between public expenditure on education and human capital inequality may depend on the level of development of the economy. Second, I provide empirical evidence that confirms the theoretical predictions of the model.

In particular, I build a simple model of human capital formation in which individuals differ in their disutility of acquiring human capital. Government

intervention in education is motivated by the presence of credit constraints¹. I compare an economy with and without credit markets. In an economy with credit markets individuals can smooth consumption over time through lending and borrowing. Instead, in the absence of credit markets, agents cannot borrow and cannot save. Borrowing constraints may inhibit human capital formation. Educational choices may also be affected if individuals are restricted to save. For instance, because of the absence of formal financial institutions, people from developing countries may tend to save less than they would have if such institutions were available². My model predicts that public spending on education raises (lowers) human capital inequality in countries with high (low) levels of productivity. Educational policies thus may be elitist (i.e. they may increase the spread between the educational achievement of the bright and less bright individuals) even in the absence of asymmetric information³ or rent-seeking activities of the elites. The reasoning behind this finding is that the level of development of the economy may affect the marginal utility from having recourse to the credit market differently for individuals with different ability.

I test the predictions of the model using the dataset of Castelló and Doménech (2002), who have computed the educational Gini coefficients and the distribution of education by quintiles using the Barro and Lee's (2001) dataset. I find that total public education expenditure as a percentage of GDP is associated with a subsequent decrease in educational inequalities in developing countries through its effect on the relative position of the median human capital investor, while it has exacerbated the differences in human capital investment between the least and the most educated individuals in developed countries. In addition, I provide estimates of the effects of public expenditure by education level on human capital inequality. In developing countries secondary and tertiary public education expenditures have not been

¹See Carneiro and Heckman (2002) and Edmonds (2006) for evidence concerning the important role of liquidity constraints on educational choices.

²Several authors have stressed the inefficiency of some types of informal financial institutions relative to well-developed credit markets (see for instance Besley, Coate and Loury (1994)).

³It is interesting to relax the assumption of asymmetric information, which is one of the main assumptions of De Fraja's (2002) model, because the information advantage enjoyed by the individuals who acquire education is less obvious than in income taxation or other contexts. As reported by De Fraja (2002), this may be due to the fact that there exist tests and exams and the allocation of most scholarships and the admittance to some schools and universities are based on such tests.

effective in shaping the extreme of the distribution of human capital, while primary public education expenditure has reduced educational inequalities. In developed countries public spending on secondary and tertiary education has increased the spread between the educational attainment of the most educated and the least educated individuals.

The paper proceeds as follows. Section 2 presents the theoretical framework. Section 3 describes the data and the methodology. Section 4 presents the estimation results. The last section summarizes the results of the paper.

2 The Model

The model consists of two periods, $t = 1, 2$. There is no discounting of the future.

There are N households in the economy. Each household is made up of one adult and one child. At time $t = 1$ each parent supplies inelastically one unit of labor. Each child acquires education e at a cost equal to $k\frac{e^2}{2}$. αN children in the economy have high ability. For them the cost to acquire education e_H is equal to $k_H\frac{e_H^2}{2}$. $(1 - \alpha)N$ children have instead low-ability. Their disutility from acquiring human capital is characterized by a parameter k equal to k_L , with $k_L > k_H$. Thus their cost to acquire education e_L is $k_L\frac{e_L^2}{2}$. At time $t = 2$ parents do not work, while children become adults and supply $h(e) = e$ units of labor. Education thus makes individuals more productive and raises income in the second period.

I assume a standard Cobb-Douglas aggregate production function:

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

where, following standard notation, K is the capital stock, L is the number of efficiency units of labor ($L = \alpha N e_H + (1 - \alpha)N e_L$) and A is the level of productivity in the economy. The interest rate r is taken as given by the representative firm, which equates it to the marginal product of capital. Wages per efficiency units are equal to the marginal product of labor and can be written as:

$$w = A^{\frac{1}{1-\beta}}(1 - \beta)\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\beta}} \quad (2)$$

Therefore at time $t = 2$ earnings of high and low-ability agents are respectively $w e_H$ and $w e_L$.

Households may also differ in the parental revenue. At time $t = 1$ the contribution of the parent to the household's budget constraint is denoted as $w_j^P(A)$ and is increasing in the level of development of the economy ($w_j^{P'}(A) > 0$). The contribution of high-income (low-income) parents to the budget constraint is w_H^P (w_L^P). For simplicity and without loss of generality, I assume $w_H^P = Pw$ and $w_L^P = w$, with $P > 1$.

Let c_1 and c_2 be consumption in the first and second period. The household's utility function is separable: $V = U(c_1) + U(c_2)$. I also assume that the function U is logarithmic and that c_1 and c_2 are strictly positive, i.e. $c_1 > 0$ and $c_2 > 0$.

2.1 Human Capital Investment without Credit Constraints

In the first best situation, agents can borrow and lend freely in the credit market at the interest rate R . This allows them to smooth consumption over time. The solution of the maximization problem in (3) represents the optimal children's investment in human capital (e_i^j) and the optimal value of savings (s_i^j) for a household with parental revenue w_j^P ($j = H, L$) and child of type i ($i = H, L$):

$$\begin{aligned} & \max_{e_i^j, s_i^j} \ln(c_1) + \ln(c_2) & (3) \\ \text{s.t. } c_1 & = w_j^P - k_i \frac{e_i^j{}^2}{2} - s_i^j \\ c_2 & = we_i^j + (1 + R)s_i^j \end{aligned}$$

The first order conditions with respect to e and s are respectively⁴:

$$\frac{e_i^j k_i}{w_j^P - k_i \frac{e_i^j{}^2}{2} - s_i^j} = \frac{w}{we_i^j + (1 + R)s_i^j} \quad (4)$$

$$\frac{1}{w_j^P - k_i \frac{e_i^j{}^2}{2} - s_i^j} = \frac{(1 + R)}{we_i^j + (1 + R)s_i^j} \quad (5)$$

⁴The second order conditions for a maximum hold.

Households decide the optimal level of education and the optimal value of s that are reported in (6)-(9):

$$e_H^{H*} = e_H^{L*} = \frac{w}{k_H(1+R)} \quad (6)$$

$$e_L^{H*} = e_L^{L*} = \frac{w}{k_L(1+R)} \quad (7)$$

$$s_H^{j*} = \frac{1}{4} \left(2w_j^P - \frac{3w^2}{k_H(1+R)^2} \right) \quad (8)$$

$$s_L^{j*} = \frac{1}{4} \left(2w_j^P - \frac{3w^2}{k_L(1+R)^2} \right) \quad (9)$$

Given the assumption $k_L > k_H$, it is easy to show that $e_H^{j*} > e_L^{j*}$ and $s_L^{j*} > s_H^{j*}$.

2.2 Human Capital Investment with Credit Constraints

This subsection studies the case in which individuals cannot lend and borrow in the credit market ($s = 0$). This may be related to the idea that in developing countries credit markets work poorly and that in both developed and developing countries human capital provides poor collateral for loans. The impossibility to borrow may inhibit human capital formation. In developing countries the absence of formal financial institutions implies that agents may also be unable to save as much as they would have in the presence of such institutions.

The household's maximization problem is now written as follows:

$$\begin{aligned} & \max_{e_i^j} \ln(c_1) + \ln(c_2) & (10) \\ \text{s.t. } & c_1 = w_j^P - k_i \frac{e_i^j{}^2}{2} \\ & c_2 = we_i^j \end{aligned}$$

The first order condition with respect to e is:

$$\frac{e_i^j k_i}{w_j^P - k_i \frac{e_i^{j^2}}{2}} = \frac{1}{e_i^j} \quad (11)$$

I denote the optimal investment in human capital of high and low-ability children with parental income j ($j = H, L$) when there is no credit market as $e_H^{j^C}$ and $e_L^{j^C}$ (where C is mnemonic for Constrained). The educational choices are:

$$e_H^{j^C} = \sqrt{\frac{2w_j^P}{3k_H}} \quad (12)$$

$$e_L^{j^C} = \sqrt{\frac{2w_j^P}{3k_L}} \quad (13)$$

Comparing households with the same parental income j , the higher disutility of low-ability children from acquiring education ($k_L > k_H$) implies that bright children are more educated than less bright ones ($e_H^{j^C} > e_L^{j^C}$). If income inequality is high ($P > \frac{k_L}{k_H}$), then bright children in low-income households are less educated than less bright children in high-income households ($e_H^{L^C} < e_L^{H^C}$). Everything else equal, a household with high parental revenue is less constrained than a household with low parental income ($e_i^{L^C} < e_i^{H^C}$).

2.3 Introducing Public Educational Subsidies

Credit market imperfections are among the reasons that justify government intervention in education. I now analyze a situation in which the government provides an educational subsidy λ for each unit of human capital e that is acquired at time $t = 1$. This educational subsidy is financed by a lump-sum tax denoted as τ . The households may receive different levels of public subsidies according to the parental income and the children's ability, which is not private information but it is also observed by the government. I make this assumption because the aim of this simple model is to show that public education expenditures may raise educational inequality even in the absence of asymmetric information. As reported by De Fraja (2002), the information advantage enjoyed by the individuals who acquire education is less obvious than in other contexts, for instance income taxation. This may be related

to the existence of tests and exams and to the fact that the allocation of scholarships and the admittance to some schools and universities is based on such tests.

In the presence of an educational subsidy, the households solve the following maximization problem:

$$\begin{aligned} & \max_{e_i^j} \ln(c_1) + \ln(c_2) & (14) \\ \text{s.t. } c_1 &= w_j^P - k_i \frac{e_i^j{}^2}{2} + \lambda_i^j e_i^j - \tau_i^j \\ c_2 &= w e_i^j \end{aligned}$$

I denote the optimal human capital investment in the presence of public intervention and the optimal educational subsidies as e_i^{jG} and λ_i^{j*} , respectively. In this subsection I assume that there are no transfers between different types of households. In the appendix I relax this assumption and show that the findings of this paper also hold if government intervention in education is motivated by both credit market imperfections and redistribution purposes. In the absence of transfers between different types of households, the government's budget constraint can be written as $\tau_i^{j*} = \lambda_i^{j*} e_i^{jG}$. For given levels of the educational subsidy λ_i^j , the optimal investments in human capital are⁵:

$$e_H^{jG} = \frac{\lambda_H^j + \sqrt{6k_H w_j^P + \lambda_H^j{}^2}}{3k_H} \quad (15)$$

$$e_L^{jG} = \frac{\lambda_L^j + \sqrt{6k_L w_j^P + \lambda_L^j{}^2}}{3k_L}$$

The government chooses λ_i^j in order to induce the first-best levels of schooling (i.e., $e_H^{HG} = e_H^{LG} = e_H^*$ and $e_L^{HG} = e_L^{LG} = e_L^*$, where e_H^* and e_L^* come from equations (6) and (7)):

⁵The second order condition for a maximum holds.

$$\lambda_H^{j*} = \frac{3w}{2(1+R)} - k_H(1+R)\frac{w_j^P}{w} \quad (16)$$

$$\lambda_L^{j*} = \frac{3w}{2(1+R)} - k_L(1+R)\frac{w_j^P}{w} \quad (17)$$

(16) and (17) show that $\lambda_H^{j*} > \lambda_L^{j*}$. If $\lambda_H^{j*} > \lambda_L^{j*} > 0$, then households with bright children receive more educational subsidies per unit of human capital than households with less bright children, that is the educational policy is input regressive (see Arrow, 1971). For low levels of development in the economy the benefit of acquiring education may be so low that the government optimal policy should be to tax human capital investment, for instance through positive tuition fees or a proportional wage tax⁶. The latter result is due to the fact that individuals may also not be able to save. As reported in the previous subsection, in developing countries the absence of formal financial institutions implies that individuals may also be unable to save as much as they would have in the presence of such institutions. Everything else equal, households with high parental revenue receive less subsidies than households with low income of the parent ($\lambda_i^{L*} > \lambda_i^{H*}$).

2.4 Empirical Implications

To answer this paper's research question, I now compare the difference between the average educational achievement of the bright and less bright individuals under private provision with credit market imperfections ($\bar{e}_H^C - \bar{e}_L^C$) and under government intervention in education ($\bar{e}_H^G - \bar{e}_L^G$). In this subsection I consider the low income inequality case ($1 < P < \frac{k_L}{k_H}$), which implies that bright children in low income households are more educated than less bright children in high income households ($e_H^{L^C} > e_L^{H^C}$). In the appendix I show that results are qualitatively similar when I analyze the high income inequality case, that is if $P > \frac{k_L}{k_H}$ (in this case high-ability children in low-income households are less educated than low-ability children in high-income households). The following proposition holds:

⁶Heckman, Lochner and Taber (1998), and Judd (1998) analyze the impact of tuition and tax policies on human capital formation.

Proposition 1 *Public education expenditure increases (reduces) the difference between the educational achievement of the bright and less bright individuals iff the level of productivity in the economy A is larger (smaller) than $\left(\frac{r}{\beta}\right)^\beta \frac{1}{(1-\beta)^{1-\beta}} \left[\frac{k_H k_L (1+R)}{(k_L - k_H)} (\gamma\sqrt{P} + 1 - \gamma) (\sqrt{\frac{2}{3k_H}} - \sqrt{\frac{2}{3k_L}})\right]^{2(1-\beta)}$.*

Proof. If the share of high-income households is denoted as γ , then in the low income inequality case the average educational achievement of bright individuals is: $\bar{e}_H^C = \gamma e_H^{H^C} + (1 - \gamma) e_H^{L^C}$. The average education level of less bright individuals is $\bar{e}_L^C = \gamma e_L^{H^C} + (1 - \gamma) e_L^{L^C}$. Using $e_H^{H^G} = e_H^{L^G} = e_H^*$, $e_L^{H^G} = e_L^{L^G} = e_L^*$, $w = A^{\frac{1}{1-\beta}} (1 - \beta) \left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\beta}}$ (see (2)), the threshold in Proposition 1 is calculated as follows:

$$\begin{aligned}
\bar{e}_H^G - \bar{e}_L^G &> \bar{e}_H^C - \bar{e}_L^C \iff e_H^* - e_L^* > \gamma(e_H^{H^C} - e_L^{H^C}) + (1 - \gamma)(e_H^{L^C} - e_L^{L^C}) \\
&\iff \frac{w}{k_H(1+R)} - \frac{w}{k_L(1+R)} > \gamma\left(\sqrt{\frac{2Pw}{3k_H}} - \sqrt{\frac{2Pw}{3k_L}}\right) \\
&\quad + (1 - \gamma)\left(\sqrt{\frac{2w}{3k_H}} - \sqrt{\frac{2w}{3k_L}}\right) \\
&\iff \frac{A^{\frac{1}{1-\beta}}(1 - \beta)\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\beta}}}{k_H(1+R)} - \frac{A^{\frac{1}{1-\beta}}(1 - \beta)\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\beta}}}{k_L(1+R)} > \sqrt{w}(\gamma\sqrt{P} + 1 - \gamma) * \\
&\quad * \left(\sqrt{\frac{2}{3k_H}} - \sqrt{\frac{2}{3k_L}}\right) \\
&\iff \frac{A^{\frac{1}{1-\beta}}(1 - \beta)\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\beta}}(k_L - k_H)}{k_L k_H(1+R)} > \sqrt{A^{\frac{1}{1-\beta}}(1 - \beta)\left(\frac{\beta}{r}\right)^{\frac{\beta}{1-\beta}}(\gamma\sqrt{P} + 1 - \gamma) *} \\
&\quad * \left(\sqrt{\frac{2}{3k_H}} - \sqrt{\frac{2}{3k_L}}\right) \\
&\iff A > \left(\frac{r}{\beta}\right)^\beta \frac{1}{(1 - \beta)^{1-\beta}} * \\
&\quad * \left[\frac{k_H k_L (1+R)}{(k_L - k_H)} (\gamma\sqrt{P} + 1 - \gamma) (\sqrt{\frac{2}{3k_H}} - \sqrt{\frac{2}{3k_L}})\right]^{2(1-\beta)}
\end{aligned}$$

■

For high values of A the marginal utility of borrowing in the first period is higher for high-ability than for low-ability agents. Since the government aims to induce the level of schooling that would be achieved without credit

market imperfections, there is an increase in educational inequality. For low levels of development of the economy high-skilled individuals have a higher marginal utility of saving than low-skilled individuals. This implies that for low values of A government intervention in education instead reduces the spread between the educational attainment of bright and less bright individuals. The level of development of the economy indeed affects the benefit from having recourse to the credit market differently for individuals with different education level.

Credit market imperfections are just one of the reasons for government intervention in education. Public subsidies may also be a tool for redistribution and a vehicle to achieve equity goals in the economy. The appendix shows that the findings presented in this subsection still hold when government intervention in education is motivated by both credit market imperfections and redistribution purposes.

Proposition 1 thus suggests that the total effect of public educational subsidies on human capital inequality differs according to the level of productivity in the economy. The framework predicts that public educational expenditure raises (lowers) educational inequality in countries with high (low) levels of productivity. In particular, A measures how efficiently the economy is turning its inputs into outputs and thus it is close to the conventional concept of total factor productivity. As shown by Islam (1995), higher values of total factor productivity are associated with higher levels of per capita income. To test the theoretical predictions of the model, in the empirical section of the paper I distinguish between two groups of countries: developing and developed countries. Following the classification of the World Bank, “developing countries” are low and middle-income countries, while “developed” countries are high-income countries. Developing countries have lower values of A than developed countries.

3 Data Sources and Empirical Strategy

The human capital inequality measures come from the dataset of Castelló and Doménech (2002). Data on public and private education spending are from World Bank statistics. Data on income inequality are drawn from Deininger and Squire (1996). Data on real GDP per capita and the growth rate of the real GDP per capita are obtained from the Heston-Summers-Aten database (version 6.1). Data on the duration of compulsory education are from the

Unesco Statistical Yearbook (several years). Educational attainment data are from the Barro-Lee's (1993) database.

The following model is estimated:

$$\begin{aligned} \Delta EducInequality_i = & \alpha + \beta EducInequality80s_i + \gamma DC_i + \delta_1 EducSpending_i \\ & + \delta_2 (EducSpending_i * DC_i) + X_i' \eta + \epsilon_i \end{aligned} \quad (18)$$

$\Delta EducInequality$ is the change in the average educational inequality between the 1980s and the 1990s ($\Delta EducInequality = EducInequality90s - EducInequality80s$). A positive number of this variable indicates an increase in human capital inequality.

In particular, I consider three different measures of human capital inequality ($EducInequality$). The first index is the human capital Gini coefficient ($Gini$). Castelló and Doménech (2002) compute it as follows:

$$Gini = \frac{1}{2\bar{H}} \sum_{i=0}^3 \sum_{j=0}^3 |\hat{x}_i - \hat{x}_j| n_i n_j$$

where \bar{H} is the average schooling years of the population, i and j stand for the four different levels of education in the Barro and Lee's dataset (0: no schooling, 1: primary, 2: secondary, 3: higher education), $n_{i(j)}$ is the percentage of population with level of education i (j), and $\hat{x}_{i(j)}$ is the cumulative average schooling years of each educational level (that is $\hat{x}_0 \equiv x_0$ and $\hat{x}_{i(j)} = \hat{x}_{i(j)-1} + x_{i(j)}$ for each $i(j) \neq 0$, where $x_{i(j)}$ is the average schooling years of each educational level $i(j)$). The Gini index is defined in the interval $[0, 100]$. A high Gini coefficient indicates a high level of human capital inequality. The second index is the cumulative share of education attained by the third quintile (Q_3). Since it includes the median, the third quintile allows to study how public spending on education affects the middle of the distribution. As additional index, I consider the ratio of the share of education attained by the bottom quintile to the share of education attained by the top one ($Quintileratio$). This ratio is used to analyze the extremes of the distribution. The distribution of education by quintiles complements the information provided by the human capital Gini coefficient, which is a measure of educational inequality representing the entire distribution of human capital. The latter two indicators are measures of educational equality. For purpose of comparison, I transform these indicators in measures of educational inequality by inverting the sign and multiply them by 100.

The three indicators refer to the population aged 25 and over. Castelló and Doménech (2002) also compute the inequality indicators for the population aged 15 and over. I do not use the latter indicators because my sample also include developed countries and especially in these countries a large portion of the population continues to acquire education while is aged 15-25.

EducInequality80s is the average of each human capital inequality index in the 1980s. It is included in (18) to control for the initial level of educational inequality. A negative sign of the coefficient β implies inequality convergence. *DC* is a dummy variable that is equal to 1 if the country is a developed one, 0 otherwise⁷. *EducSpending* is the average public education expenditure as a percentage of GDP over the period 1970-1989. Since, because of the above explained reason, the inequality indicators refer to the population aged 25 and over, public education expenditure is expected to affect subsequent educational inequality. Ideally I would also have used information on expenditure prior to 1970. Unfortunately these data are unavailable. This represents a minor issue because educational expenditures have been quite stable over time and most of the total variance in the education Gini coefficient has been explained by variation across countries and not over time (see Castelló and Doménech, 2002). As a consequence of this, results are qualitatively similar if public spending on education is considered over the period 1970-1989, 1970-1999 or 1970-1979 (the latter option reduces significantly the number of observations, especially the information on public expenditures by education level).

I now describe the control variables of vector X . *GiniIncome* is the average income Gini coefficient in the 1970s and 1980s. On the one hand, higher income inequality may inhibit access to schooling and exacerbate the differences in human capital investment between individuals. On the other hand, a more unequal distribution of income may be associated with more incentives to acquire higher levels of education. Following Checchi and García-Peñalosa (2004), I also control for output volatility: *SdGDP* is the average of 3-year moving standard deviation of growth rate of GDP over the period 1970-1989. Greater volatility is expected to increase educational inequality. *EducAttainment* is the average years of education in the 1970s and 1980s. It is included as explanatory variable to check whether educational expansion

⁷I use the classification of the World Bank, which uses the term “developing country” to refer to low and middle-income countries.

raises schooling inequality. *CompulsoryEduc* denotes the average years of compulsory schooling over the time period 1970-1989. The government may also shape the educational choices of individuals through the duration of compulsory schooling, but countries may differ in the level of enforcement of compulsory education laws⁸. *RealGDPpc* is the logarithm of real GDP per capita (average over the period 1970-1989). This variable allows to control for the fact that income per capita may also widely vary within the two groups of interest (developing and developed countries). *PrivateEducSpending* is private education expenditure as a percentage of GDP. Unfortunately aggregate data on private expenditure are only observed from 1990 onwards. I only use the least recent information, that is data for 1990 or the closest following year if the data for 1990 are not available. Private spending on education is added as a control variable because it may affect both public expenditure and subsequent educational inequality. In all regressions I also include regional dummy variables for developing countries in Sub-Saharan Africa, Latin America and the Caribbean, East Asia and Pacific, Europe and Central Asia, Middle East and North Africa (World Bank classification).

Table 1 presents summary statistics for the estimation sample. The negative mean value for the change in the average educational inequality variables between the 1990s and the 1980s suggests that countries tended to reduce educational inequality in the last two decades. Looking at the educational Gini index, the country that was the most successful in reducing human capital inequality was Jordan. The least successful was Indonesia, where educational inequality was higher in the 1990s than in the 1980s. The average total public education expenditure (over the period 1970-1989) was 4.2 percent of GDP. The minimum value (1% of GDP) was the average total public spending on education in Ecuador, while the maximum values were observed in Sweden and Algeria. On average, governments of countries in the sample spent more money for primary education than for other education levels. The minimum value of public spending on tertiary education as a percentage of GDP was the expenditure level in Peru. The average private expenditure on education was more than 3 times smaller than public spending. Minimum and maximum values of private spending on education were observed in Italy and Egypt, respectively.

⁸See Bellettini e Berti Ceroni (2004) for a theoretical analysis of how the possibly imperfect enforcement of compulsory schooling laws may affect educational choices in developing countries.

Table 1: Descriptive statistics

| | <i>Mean</i> | <i>Median</i> | <i>Std. Dev.</i> | <i>Min</i> | <i>Max</i> |
|-------------------------------|-------------|---------------|------------------|------------|------------|
| $\Delta Gini$ | -5.14 | -3.96 | 6.18 | -21.06 | 9.89 |
| ΔQ_3 | -3.8 | -2.27 | 6.13 | -20.77 | 12.45 |
| $\Delta Quintileratio$ | -2.28 | 0 | 5.33 | -17.79 | 6.02 |
| <i>Gini80s</i> | 42.72 | 37.42 | 22.46 | 9.89 | 93.07 |
| Q_380s | -28.51 | -33.6 | 17.66 | -53.09 | 0 |
| <i>Quintileratio80s</i> | -13.89 | 0 | 18.99 | -60.29 | 0 |
| <i>DC</i> | .29 | | | | |
| <i>EducSpending</i> | 4.20 | 4.33 | 1.60 | 1 | 7.5 |
| <i>Secondary EducSpending</i> | 1.15 | 1.07 | 0.67 | 0.17 | 3.07 |
| <i>Tertiary EducSpending</i> | 0.71 | 0.66 | 0.43 | 0.08 | 2.26 |
| <i>PrivateEducSpending</i> | 1.3 | 0.79 | 1.56 | 0.03 | 7.89 |
| <i>GiniIncome</i> | 41.62 | 41.9 | 9.69 | 22.56 | 62.3 |
| <i>SdGDP</i> | 2.92 | 2.44 | 1.73 | 0.97 | 10.25 |
| <i>EducAttainment</i> | 4.62 | 4.05 | 2.74 | 0.32 | 10.86 |
| <i>CompulsoryEduc</i> | 7.79 | 8 | 1.56 | 5 | 10.8 |
| <i>RealGDPpc</i> | 7156.04 | 4740.75 | 6035.6 | 655.18 | 21779.52 |

3.1 Econometric Issues

This paper’s empirical strategy aims to estimate the long-run effects of public education expenditure on human capital inequalities.

Several reasons motivate the choice of a single cross-section of countries using long time spans in this context⁹. In particular, in this subsection I explain why I rely on the OLS estimator applied to a single cross-section using variables averaged over time (the “between” estimator) rather than on alternative estimators, such as the “fixed effects” estimator. First, a simple ANOVA analysis shows that about 95% of the total variance in the education Gini coefficient can be explained by variation across countries, while only about 2.3% of the total variance is due to variation over time. A fixed effects estimator would thus be of little use in studying these differences between countries because it only uses the time variation within each cross-section. Second, the timing with which public expenditure on education affects educational inequality may be subject to several lags. The inequality

⁹Edwards (1997) and Savvides (1998) use a similar empirical strategy in their analysis of the relationship between income inequality and trade policies.

indicators that I have used refer to the population aged 25 and over, consequently public spending on education does not affect educational inequality contemporaneously. The government expenditure on education of each year instead affects subsequent human capital inequality for several years. The fixed effects estimator would produce inconsistent estimates of the long-run relationship between the variables if an inappropriate lag structure of the explanatory variable is specified. Baltagi and Griffin (1984) and Pesaran and Smith (1995) analyze the consequences of the estimation of misspecified dynamic error components models and find that the cross-section regressions when based on long time averages produce consistent estimates of the average long run coefficients. Pirotte (1999) shows that if the true specification is a general dynamic error components model, then the probability limit of the between estimator of a static relation converges, whatever the time dimension, to the long run effects. An additional advantage of taking averages of the variables is that it reduces possible measurement error problems. For instance, the Monte Carlo simulations of Hauk and Wacziarg (2006) show that for growth regressions the between estimator is the one that performs best when measurement errors of the regressors and country effects that are correlated with the regressors are accounted for.

A possible source of bias due to this empirical strategy may be related to the impossibility to control for unobserved heterogeneity. For this reason, in addition to several control variables I include regional dummies in all the regressions.

Educational inequalities might affect the educational policies of the government. There are two reasons why it is not very likely that reverse causation is driving the relationship between public spending and human capital inequalities. First, in the estimated equation educational expenditures affect subsequent human capital inequality. Second, as dependent variable I consider the change in educational inequality between two decades.

I also run all the regressions without one outlier (Rwanda), which is detected using the Hadi's (1992) criterion with significance level of 0.01. This procedure recursively computes the distance of an observation from a cluster of observations in the model. Unlike standard regression diagnostic tools (such as Cook's distances), this criterion is effective in dealing with masking (outliers are falsely identified as nonoutliers) and swamping (non-outliers are falsely identified as outliers) problems.

4 Estimation Results

Table 2 presents the estimation results from the regressions with total public education expenditure and its interaction with the dummy DC as main explanatory variables. The even columns in the table show the results from the regressions without the outlier Rwanda. In this first set of regressions I do not include the control variable $PrivateEducSpending$, because there are few data on private education expenditure and the inclusion of this variable reduces the sample size. Estimates of (18) with the inclusion of this additional control variable are presented in table 3.

In developing countries public spending on education has reduced subsequent educational inequality. Column 1 of table 2 shows that devoting an additional percentage point of GDP to public education is associated with a 1.36 point drop in the human capital Gini coefficient. This result seems to be due to the fact that public education expenditure has improved the relative position of the median human capital investor (from the third and fourth column). In developed countries¹⁰ public education expenditure has exacerbated the differences in human capital investment between the least and the most educated individuals. In particular, it has increased the inequality measure built using the ratio of the share of education attained by the bottom and top quintiles. These findings are in line with the theoretical predictions of the model, which shows that public spending on education raises (lowers) human capital inequality in countries with high (low) productivity (see section 2). In particular, the theoretical framework has shown how the level of development of the economy may affect the incentive to have recourse to the credit market differently for individuals with different education level.

Moreover, the coefficient β is statistically significant and negative. This shows evidence of educational inequality convergence. As expected, table 2 shows that developed countries have a more equal distribution of human capital than developing countries (negative effect of DC on $\Delta EducInequality$ computed at the average value of $EducSpending$, i.e. $\gamma + \delta_2 E(EducSpending)$ from the estimated equation (18), or at its median value). All columns of table 2 show that a higher level of the population's educational attainment is associated with lower subsequent educational inequality. This result does not depend on how the human capital inequality is measured. In the third

¹⁰All the tables also report the p-value of the null hypothesis $\delta_1 + \delta_2 = 0$ (see the estimated equation (18)) to analyze the statistical significance of the explanatory variable of interest ($EducSpending$) in developed countries.

and fourth column, *GiniIncome* has a negative and statistically significant effect on subsequent educational inequality, as measured by the indicator Q_3 . This finding may be related to the association between income inequality and returns to education. A more unequal distribution of income may imply more incentives to acquire higher levels of education for lowly educated than for highly educated individuals, and through this mechanism reduce human capital inequality. The third and fourth columns confirm Checchi and García-Peñalosa's (2004) finding that greater output volatility may increase educational inequality.

In table 3 I show estimates from regressions similar to the ones whose results are reported in the previous table, but with the inclusion of the variable *PrivateEducSpending* and an interaction term *PrivateEducSpending*DC*. Since there is no information on private education expenditure in Rwanda (the outlier), the table only presents coefficients from 3 regressions rather than 6 like in table 2. I also report p-values of the null hypotheses: $\delta_{EducSpending} + \delta_{EducSpending*DC} = 0$ and $\delta_{PrivateEducSpending} + \delta_{PrivateEducSpending*DC} = 0$ to analyze the statistical significance of the public and private education expenditure variables for developed countries. Table 3 shows that private education expenditure has not affected subsequent educational inequality. A plausible reason that explains the non-significant impact of private expenditure on subsequent human capital inequality is that average private spending on education was much smaller than public spending. The inclusion of *PrivateEducSpending* and the interaction term only reduces the sample size. Results for the coefficients of *EducSpending* and *EducSpending * DC* are qualitatively similar to the results presented in table 2 and discussed above.

Table 4 shows the results from the regressions in which I use the information on the composition of public education expenditure. Differently from the model whose results are reported in table 2, I now include two additional variables, *Secondary EducSpending* and *Tertiary EducSpending*, and their interaction terms with the dummy *DC*. *Secondary EducSpending* and *Tertiary EducSpending* refer to public expenditures on secondary and tertiary education, respectively. Thus in these regressions the coefficients of *EducSpending* and *EducSpending * DC* capture the effect of primary education expenditure on the human capital inequality indicators. In developing countries higher primary public education expenditures are associated with future reductions in the educational Gini coefficient and with the improvement of the relative position of the median human capital investor. The effectiveness of primary public education expenditure in devel-

oping countries is extremely important in the light of the imperfect enforcement of compulsory schooling laws in these countries. Public spending on secondary and tertiary educational institutions instead seem to have been ineffective in raising the educational attainment and in the last decades have not affected the distribution of human capital in developing countries. The second and third columns of table 4 instead show that in developed countries public expenditures on secondary and tertiary education may have increased human capital inequality (see p-values of the null hypotheses: $\delta_{SecondaryEducSpending} + \delta_{SecondaryEducSpending*DC} = 0$ and $\delta_{TertiaryEducSpending} + \delta_{TertiaryEducSpending*DC} = 0$).

5 Concluding Remarks

Educational policies should take into account both the level and the distribution of human capital. This paper has studied the relationship between public education expenditure and human capital inequality.

I have built a simple model where credit market imperfections justify the provision of educational subsidies. The model predicts that public spending on education raises (lowers) human capital inequality in countries with high (low) productivity. The level of development of the economy may indeed affect the incentive to have recourse to the credit market differently for individuals with different education level.

To test the theoretical predictions of the model, I have used the measures of human capital inequality of the Castelló and Doménech's (2002) dataset. In developing countries total public spending on education has reduced subsequent human capital inequality, by improving the relative position of the median human capital investor. This finding stands out in the light of the ongoing debate in which, due to rent-seeking activities of the elites, public education expenditure in developing countries is presented as far from being egalitarian (see Gradstein, 2003). In these countries public secondary and tertiary education expenditures have failed to affect the extreme of the distribution of human capital. Public primary education expenditure has instead been effective in reducing educational inequalities. This negative effect of public primary education expenditure on subsequent human capital inequality is extremely important because in developing countries compulsory schooling laws are often imperfectly enforced. In developed countries total public

spending on education has increased the spread between the educational attainment of the most educated and the least educated individuals. The latter finding is due to the effectiveness of public expenditures on secondary and tertiary education in these countries.

6 Appendix

6.1 Educational Subsidies and Redistribution

In this appendix I solve the model in the case of possible transfers between households (that is, I relax one of the assumptions of subsection 2.3). The government intervention in education is now motivated by both the lack of credit markets and redistribution purposes. I compute the optimal subsidies λ_i^{j*} and lump sum taxes τ_i^{j*} that induce the first best level of human capital investment ($e_H^{H*} = e_H^{L*} = e_H^*$ and $e_L^{H*} = e_L^{L*} = e_L^*$ from (6) and (7)) and an equal level of consumption for high and low income households in the first period (with an intertemporal budget constraint it would be possible to equalize levels of consumptions in both periods. The main result still would hold). To simplify the notation, I assume that there is an equal number of high and low income households (i.e., $\gamma = \frac{1}{2}$). The maximization problem is similar to (14). The government's budget constraint is now written as:

$$\tau_i^{H*} + \tau_i^{L*} = (\lambda_i^{H*} + \lambda_i^{L*})e_i^*$$

There is an additional constraint that equalizes consumption of the two types of households in the first period ($c_1^H = c_1^L$):

$$w_H^P - k_i \frac{e_i^{H*2}}{2} + \lambda_i^{H*} e_i^* - \tau_i^{H*} = w_L^P - k_i \frac{e_i^{L*2}}{2} + \lambda_i^{L*} e_i^* - \tau_i^{L*}$$

The optimal mix of educational subsidies and taxes are found by solving the following system of equations:

$$\frac{e_i^* k_i - \lambda_i^{H*}}{w_H^P - k_i \frac{e_i^{H*2}}{2} + \lambda_i^{H*} e_i^* - \tau_i^{H*}} = \frac{1}{e_i^*}$$

$$\frac{e_i^* k_i - \lambda_i^{L*}}{w_L^P - k_i \frac{e_i^{L*2}}{2} + \lambda_i^{L*} e_i^* - \tau_i^{L*}} = \frac{1}{e_i^*}$$

$$\tau_i^{H*} + \tau_i^{L*} = (\lambda_i^{H*} + \lambda_i^{L*})e_i^*$$

$$w_H^P - k_i \frac{e_i^{H*2}}{2} + \lambda_i^{H*} e_i^* - \tau_i^{H*} = w_L^P - k_i \frac{e_i^{L*2}}{2} + \lambda_i^{L*} e_i^* - \tau_i^{L*}$$

$$e_H^{H*} = e_H^{L*} = \frac{w}{k_H(1+R)}$$

$$e_L^{H*} = e_L^{L*} = \frac{w}{k_L(1+R)}$$

If transfers between the two types of households are feasible, then the government can induce the first best level of schooling and obtain redistribution by choosing the following educational policy:

$$\lambda_i^{H*} = \lambda_i^{L*} = \frac{3w}{2(1+R)} - \frac{k_i(1+R)(P+1)}{2} \quad (19)$$

$$\tau_i^{L*} = \frac{3w^2}{2k_i(1+R)^2} - Pw \quad (20)$$

$$\tau_i^{H*} = \frac{3w^2}{2k_i(1+R)^2} - w \quad (21)$$

It is easy to show that $\lambda_H^{j*} > \lambda_L^{j*}$. Therefore bright individuals may receive more educational subsidies than less bright ones, that is the educational policy may be input regressive. Moreover, high income households are more taxed than low income ones ($\tau_i^{H*} > \tau_i^{L*}$).

The government thus can still induce the first best levels of human capital formation given by (6) and (7) even if the educational policies are also designed for redistribution purposes. Therefore the main findings of the paper presented in proposition 1 of subsection 2.4 still hold when government intervention in education is motivated by both credit market imperfections and redistribution purposes.

6.2 Solving the model in the high income inequality case

In the high income inequality case (i.e., if $P > \frac{k_L}{k_H}$) high ability children in low income households are less educated than low ability children in high income households ($e_H^{L^C} < e_L^{H^C}$). The most educated individuals have high ability and are born in high income households. The educational achievement of these individuals is: $e_H^{H^C}$. Assuming that there is an equal number of high and low ability children, the average education level of the individuals who are not among the most educated ones is $\frac{\gamma e_L^{H^C} + (1-\gamma)(e_H^{L^C} + e_L^{L^C})}{2-\gamma}$. It is possible to show that the result presented in Proposition 1 still holds. In the high income inequality case the threshold value is written as follows:

$$\Leftrightarrow A > \left(\frac{r}{\beta}\right)^\beta \frac{1}{(1-\beta)^{1-\beta}} * \\ * \left[\frac{k_H k_L (1+R)}{(k_L - k_H)} \left(\sqrt{\frac{2P}{3k_H}} - \frac{\gamma \sqrt{\frac{2P}{3k_L}} + (1-\gamma) \left(\sqrt{\frac{2}{3k_H}} + \sqrt{\frac{2}{3k_L}} \right)}{2-\gamma} \right) \right]^{2(1-\beta)}$$

6.3 List of Countries

For the estimation of (18) (see also table 2), I have observations for the following countries: Algeria, Australia, Bangladesh, Barbados, Belgium, Bolivia, Botswana, Cameroon, Canada, Central African Republic, Chile, China, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Finland, France, Ghana, Greece, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Italy, Jamaica, Japan, Jordan, Korea, Lesotho, Malawi, Malaysia, Mali, Mauritius, Mexico, Nepal, Netherlands, New Zealand, Niger, Norway, Panama, Peru, Philippines, Poland, Portugal, Rwanda, Senegal, South Africa, Spain, Sri Lanka, Sweden, Thailand, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States, Venezuela, Zambia and Zimbabwe.

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Table 2: The effect of public education expenditure (all levels) on educational inequality. $\Delta EducInequality$ as dependent variable

| | <i>Gini</i> | <i>Gini</i> | Q_3 | Q_3 | Q_3 | <i>Quintileratio</i> | <i>Quintileratio</i> |
|---|--------------------|--------------------|--------------------|--------------------|---------------------|----------------------|----------------------|
| <i>EducInequality80s</i> | -0.26*** (0.08) | -0.26*** (0.08) | -0.41*** (0.1) | -0.41*** (0.1) | -0.21*** (0.07) | -0.21*** (0.07) | -0.22*** (0.07) |
| <i>DC</i> | -7.79* (4.14) | -7.79* (4.27) | -10.83** (4.92) | -10.83** (4.94) | -13.38*** (4.47) | -13.38*** (4.4) | -13.33*** (4.4) |
| <i>EducSpending</i> | -1.36** (0.54) | -1.33** (0.53) | -1.51*** (0.58) | -1.5*** (0.57) | -0.84 (0.56) | -0.84 (0.57) | -0.86 (0.57) |
| <i>EducSpending * DC</i> | 1.56** (0.77) | 1.61** (0.78) | 1.66** (0.81) | 1.66** (0.82) | 2.5*** (0.81) | 2.5*** (0.8) | 2.47*** (0.8) |
| <i>GiniIncome</i> | -0.05 (0.1) | -0.1 (0.11) | -0.17* (0.09) | -0.18* (0.1) | 0.01 (0.06) | 0.01 (0.09) | 0.03 (0.09) |
| <i>SdGDP</i> | 0.05 (0.38) | 0.31 (0.37) | 0.66* (0.35) | 0.71* (0.4) | -0.3 (0.38) | -0.3 (0.38) | -0.41 (0.55) |
| <i>EducAttainment</i> | -1.22* (0.63) | -1.27** (0.64) | -1.68** (0.71) | -1.68** (0.71) | -1.26** (0.52) | -1.26** (0.52) | -1.26** (0.52) |
| <i>CompulsoryEduc</i> | 0.82 (0.61) | 0.72 (0.62) | 0.34 (0.62) | 0.32 (0.63) | 0.78 (0.48) | 0.78 (0.5) | 0.82 (0.5) |
| <i>RealGDPpc</i> | 0.7 (1.72) | 0.79 (1.71) | 0.66 (1.78) | 0.68 (1.79) | -1.28 (1.45) | -1.28 (1.48) | -1.32 (1.48) |
| <i>Intercept</i> | 6.85 (16.79) | 8.2 (16.84) | -2.05 (14.23) | -1.83 (14.37) | 9.97 (10.67) | 9.97 (10.61) | 9.52 (10.61) |
| <i>RegionalDummies</i> | <i>yes</i> | <i>yes</i> | <i>yes</i> | <i>yes</i> | <i>yes</i> | <i>yes</i> | <i>yes</i> |
| H0: $\delta_1 + \delta_2 = 0$ (p-value) | 0.7 | 0.61 | 0.81 | 0.79 | 0.01*** | 0.01*** | 0.02** |
| Number of countries | 68 | 67 | 68 | 67 | 68 | 67 | 67 |
| R ² | 0.52 | 0.52 | 0.51 | 0.51 | 0.46 | 0.46 | 0.46 |

Heteroscedasticity-consistent standard errors in parentheses. *significant at 10%, **significant at 5% and ***significant at 1%. In the second, fourth and sixth columns the regressions omit one outlier (Rwanda).

All regressions include regional dummies (Sub-Saharan Africa, Latin America and the Caribbean, East Asia and Pacific, Europe and Central Asia, Middle East and North Africa)

Table 3: The effect of public and private expenditure on educational inequality. $\Delta EducInequality$ as dependent variable

| | <i>Gini</i> | Q_3 | <i>Quintileratio</i> |
|--|-------------------|------------------|----------------------|
| <i>EducSpending</i> | -2.38** (0.93) | -1.72* (0.87) | -0.6 (1.04) |
| <i>EducSpending * DC</i> | 3.82** (1.41) | 2.53** (1.1) | 2.79** (1.13) |
| <i>PrivateEducSpending</i> | 0.34 (0.98) | 0.71 (0.84) | -0.05 (0.73) |
| <i>PrivateEducSpending * DC</i> | 3.44 (3.21) | 2.69 (2.71) | 1.08 (3.62) |
| <i>Control variables and Regional dummies</i> | <i>yes</i> | <i>yes</i> | <i>yes</i> |
| H0: $\delta_{EducSpending} + \delta_{EducSpending*DC} = 0$ (p-value) | 0.25 | 0.33 | 0.01*** |
| H0: $\delta_{PrivateEducSpending} + \delta_{PrivateEducSpending*DC} = 0$ (p-value) | 0.3 | 0.27 | 0.88 |
| Number of countries | 41 | 41 | 41 |
| R ² | 0.66 | 0.63 | 0.59 |

Heteroscedasticity-consistent standard errors in parentheses. *significant at 10%, ** significant at 5% and ***significant at 1%. All regressions include regional dummies (Sub-Saharan Africa, Latin America and the Caribbean, East Asia and Pacific, Europe and Central Asia, Middle East and North Africa)

Table 4: The effect of public expenditure by education level on educational inequality. $\Delta EducInequality$ as dependent variable

| | Gini | Q ₃ | Quantileratio |
|--|------------------|------------------|-----------------|
| <i>EducSpending</i> | -1.43* (0.83) | -1.61* (0.84) | -0.62 (0.6) |
| <i>EducSpending * DC</i> | 0.75 (1.23) | 0.77 (1.22) | 1.26 (1.53) |
| <i>Secondary EducSpending</i> | -1.36 (1.9) | -0.9 (1.88) | -0.04 (2.28) |
| <i>Secondary EducSpending * DC</i> | 3.01 (2.09) | 1.77 (2.06) | 4.13 (2.56) |
| <i>Tertiary EducSpending</i> | 4.23 (3.38) | 2.8 (2.83) | 3.53 (2.63) |
| <i>Tertiary EducSpending * DC</i> | -1.16 (3.58) | 1.03 (3.21) | -0.24 (4.47) |
| <i>Control variables and Regional dummies</i> | <i>yes</i> | <i>yes</i> | <i>yes</i> |
| H0: $\delta_{EducSpending * DC} = 0$ (p-value) | 0.34 | 0.27 | 0.62 |
| H0: $\delta_{SecondaryEducSpending} + \delta_{SecondaryEducSpending * DC} = 0$ (p-value) | 0.19 | 0.49 | 0.01*** |
| H0: $\delta_{TertiaryEducSpending} + \delta_{TertiaryEducSpending * DC} = 0$ (p-value) | 0.16 | 0.07* | 0.32 |
| Number of countries | 57 | 57 | 57 |
| R ² | 0.56 | 0.48 | 0.57 |

Heteroscedasticity-consistent standard errors in parentheses. *significant at 10%, ** significant at 5% and ***significant at 1%. All regressions include regional dummies (Sub-Saharan Africa, Latin America and the Caribbean, East Asia and Pacific, Europe and Central Asia, Middle East and North Africa)