How Can Education Policy Improve Income Distribution?: An Empirical Analysis of Education Stages and Measures on Income Inequality

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The Journal of Developing Areas, Volume 43, Number 2, Spring 2010, pp. 51-77 (Article)

Published by Tennessee State University College of Business
DOI: *https://doi.org/10.1353/jda.0.0052*

HOW CAN EDUCATION POLICY IMPROVE INCOME DISTRIBUTION? AN EMPIRICAL ANALYSIS OF EDUCATION STAGES AND MEASURES ON INCOME INEQUALITY

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ABSTRACT

This paper examines the individual effects of primary, secondary and higher education on income distribution, using different measures of investment rates in education: enrollment rates, public expenditures and public expenditures per student, in each education stage. The panel data method is utilized in estimating the effects of different stages and measures of investment rates in education on income inequality across countries and among sample splits for developed and less developed countries since 1960. The results reveal that expenditures per student in primary education highly significantly improve income distribution especially globally and for less developed countries. Moreover, secondary education, for enrollment rates, and public expenditures particularly among already developed countries, has statistically significant equalizing effects. These results imply that education policy would improve income distribution by ensuring that expenditures per student in primary school are kept up with increases in student cohorts, and by promoting enrollment in secondary education.

JEL Classifications: JEL O15, H52, I28
Keywords: Income distribution, income inequality, education, enrollment rates, public education expenditures
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INTRODUCTION

Previous literature explores the effects of each education stage on inequality for enrollment rates (Sylwester, 2003, on the *change* of the GINI coefficient; and Psacharopoulos and Tilak, 1991, on income shares), schooling attainment (Barro, 2000), overall education expenditures as a share of GDP (Sylwester, 2002a), and as a share of GDP per capita among U.S. states (Braun, 1988). This research particularly adds to the literature by examining the separate effects of public expenditures on each education stage as a share of GDP, expenditures per student in each education stage as a share of GDP per capita, and gross enrollment rates, all flow measures of investment in education, on the GINI coefficient. This further explains some ambiguous effects of education on inequality in both the theoretical and empirical literature. The panel data method is utilized in estimating the stages and measures of education on income distribution

worldwide since 1960. The samples are further split into separate panel regressions for developed countries (DCs) and less developed countries (LDCs) to test for nonlinearities.

The paper is organized as follows: The second section discusses the theoretical and empirical results from the literature of how education affects income distribution. The third section addresses the methodology. The regression results, a sensitivity analysis and indirect effects are presented in the fourth section. The fifth section concludes.

EDUCATION AND INCOME DISTRIBUTION IN PREVIOUS LITERATURE

Education and Income Distribution in Theory

As the supply of educated labor rises relative to demand, the wage premium on education decreases, and this "compression" effect outweighs the early "composition" effect's tendency to first increase income inequality when limited labor is educated. Thus, a relative expansion of education reduces inequality (Knight and Sabot, 1983). The human capital approach suggests that while inequality in education's concentration contributes to income inequality, expanding education "of the right type" (e.g., vocational) to the lower income groups increases their productivity and thus wages, thereby improving income distribution, provided the marginal product of labor remains high despite the increased supply of skilled labor (Ahluwalia, 1974b).

Under certain circumstances, expanding education can increase income inequality. Bhagwati (1973) notes in LDCs, if jobs remain unchanged, those educated may receive the better low-income jobs. This might decrease uneducated labor's wages and widen the wage differential or keep the GINI coefficient unchanged. However, a large share of skilled labor eventually raises its wage premium when attracting skill-complementary technological change (Acemoglu, 1998). Inequality in education quality can also increase inequality if this attracts skill-biased technological change (Wälde, 2000). Eckstein and Zilcha (1994) establish a minimum level of compulsory education (publicly financed) reducing income inequality. Public education improves income distribution (Dias, 2005), and Chen (2005) recommends policy raising public-school enrollment rates. Glomm and Ravikumar (1992) determine public education reduces income inequality faster than private, while Dias (2005) finds a combination of public and private education perpetuates income inequality.

However, especially in LDCs, the higher-income groups benefit disproportionately from education expansion and subsidies than the poor because they can take better advantage of attending school, and the higher the education stage, the more disproportionately the students attending belong to groups with above average income and the higher the government rate of subsidization (Bhagwati, 1973; Ahluwalia, 1974b, similarly). Exclusive participation and large education expenditures in higher education occur at the expense of basic education in LDCs because of the top class' dominant political power, while the budget allocation is more balanced in DCs (Su, 2006). Regressive versus progressive public education spending is due to weak versus strong government institutions, the former preventing inequality reduction (Dabla-Norris and Gradstein, 2004). Fernandez and Rogerson's (1995) model indicates an only partially subsidized public education might prevent the poor from participating in the education

they are subsidizing through income taxes. Sylwester (2002b) demonstrates public education does not necessarily equalize incomes and might increase inequality because the opportunity cost of foregone income impedes poor students' attendance. Moreover, for DCs like the U.S., making higher education affordable can increase inequality because unskilled workers' wages fall and the skill premium rises (Hendel, Shapiro, and Willen, 2005).

Education and Inequality: Empirical Evidence

Education is a major determinant of pay (Knight and Sabot, 1983). López-Acevedo (2006) states "education is by far the variable that accounts for the largest share of earnings inequality in Mexico, in terms of both its gross and its marginal contribution", and education's significance has increased over time. Moreover, "changes in the relative earnings among educational groups are always the leading force behind changes in inequality". A higher average education level is generally equalizing, while education inequality is unequalizing.[1] In a large panel of countries, De Gregorio and Lee (2002) find schooling attainment significantly negatively and education inequality positively related to the GINI coefficient, while both are insignificant to income shares.

Both primary and secondary education reduce income dispersion, for schooling attainment, literacy, both human capital stock concepts, and enrollment rates, a flow measure changing human-capital stocks. Barro (2000) demonstrates equalizing effects of primary and secondary schooling attainment. Increasing the literacy rate benefits the lowest income groups while not the wealthiest (Ahluwalia 1976; Psacharopoulos and Tilak, 1991). Primary school enrollment rates are significant to the lowest income bracket (Ahluwalia, 1974a). Secondary enrollment rates significantly increase the middle class' income share, while decreasing that of the highest income group (Ahluwalia, 1974a, 1976).[2] Knight and Sabot (1983) demonstrate an education expansion like the faster expansion of secondary enrollments in Kenya compared to Tanzania compresses the intraurban educational wage structure. Latin America's secondary education expansion has reduced the wages of workers with such schooling, despite demand increasing for skilled workers, because the demand for those with tertiary education increased sharply relative to those with secondary (Manacorda, Sanchez-Paramo, and Schady, 2005).

Barro (2000) finds attainment in higher education significantly directly related to a higher GINI coefficient. Sylwester (2003) shows the natural log of 1970 tertiary enrollment rates significantly associated with a smaller 1970-1990 difference in GINI coefficient, for a 50-observation sample (average initial years of schooling included are significant to a larger such change). Additionally, education expenditures impact inequality. Schultz (1963) observes higher amounts invested in human capital the most important factor in decreasing inequality. However, several LDCs increasing education resources did not see decreases in inequality (Fields, 1980). Jimenez (1986) shows working-class children benefit less from education subsidies than their white-collar counterparts, especially in Africa. Gunatilaka, Chotikapanich, and Inder (2006) find Sri Lanka's middle class benefiting disproportionately more from education provision and infrastructure than the poor, raising income inequality. The percentage of public education spending accruing to the wealthiest, or the ratio benefiting the wealthiest

quintile relative to the poorest, depend highly significantly negatively on institutional quality (Dabla-Norris and Gradstein, 2004). College subsidies increase the GINI coefficient globally and between LDCs, while insignificantly decreasing it among DCs (Psacharopoulos and Tilak, 1991). The average ratio of education expenditures to GDP reduces the GINI coefficient, but more strongly for OECD countries than LDCs (Sylwester, 2002a). Braun (1988) estimates education expenditures per capita as insignificantly negatively correlated with inequality measures, however, given control variables, turn significantly positive to the coefficient of variation and the Nelson ratio of inequality.

Lower and Higher Education Stages and Inequality

Barro (2000) includes all three stages of schooling as determinants of income inequality. He estimates primary and secondary attainments significantly related to lower inequality, while college attainment significantly associated with a higher GINI coefficient. Sylwester (2003) displays tertiary enrollment rates significantly related to a smaller *change* in GINI coefficient, while primary enrollment rates associated with a smaller and secondary with a larger such change, however, both insignificantly (with average schooling included significantly related to a larger change). Psacharopoulos and Tilak (1991) observe gross secondary enrollment rates significantly increasing the bottom and middle 40 percent income shares, while decreasing that of the top 20 percent. The other two stages are insignificant.

Expenditures Versus Expenditures per Student

Glomm and Ravikumar (1992) note public education quality increasing with tax revenues. Public education expenditures as a share of GDP may increase education quality (Sylwester, 2002a). Birdsall, Ross and Sabot (1997) reveal education expenditures as a percentage of GNP hiding vastly diversed expenditures per eligible child, especially due to economic versus population growth. Countries such as Mexico, Kenya and Pakistan have increased enrollments and GNP shares toward education, with expenditures per student declining. Moreover, Schultz (1996) shows increased enrollment rates, but decreased public education expenditures for all regions, indicating a fall in expenditures *per student*. Expenditures per student as a share of GNP per capita are disproportionately high in non-OECD, especially African, countries. In Malawi, this measure is 9 percent in primary education, 27 percent for secondary, and 1580 percent for higher education. Su (2006) calculates the ratio between secondary and primary education as 3 and between tertiary and primary as a “stunning” 176.

METHODOLOGY

Model Specifications

In examining the three education stages’ effects on income distribution, the updated GINI coefficient from UNU-WIDER’s (2005) *World Income Inequality Database* is utilized.[3] Only nationwide high quality data (categories 1-2 of 4) are included. The GINI

coefficients (Q) are generally from the year of each even decade (1970-2000), with lagged education and control variables averaged over the previous decade. This produces a dynamic estimation of education's effects on income distribution across countries over time. Regressing the education variables, gross enrollment rates (e_i), public expenditures as a share of GDP (p_i), public expenditures per student as a share of GDP per capita (s_i), separately for each individual education stage (i=1,2,3) identifies possible counteracting effects on inequality.[4]

The model specifications are:

$$\mathbf{Q}_{it} = \alpha_0 + \alpha_1 \mathbf{s1}_{i(t-10)} + \alpha_2 \mathbf{s2}_{i(t-10)} + \alpha_3 \mathbf{s3}_{i(t-10)} + \alpha_4 \mathbf{ly}_{i(t-10)} + \alpha_5 \mathbf{(ly)^2}_{i(t-10)} + \mathbf{X} + \varepsilon_{it} \quad \mathbf{(1)}$$

$$\mathbf{Q}_{it} = \alpha_0 + \alpha_1 \mathbf{e1}_{i(t-10)} + \alpha_2 \mathbf{e2}_{i(t-10)} + \alpha_3 \mathbf{e3}_{i(t-10)} + \alpha_4 \mathbf{ly}_{i(t-10)} + \alpha_5 \mathbf{(ly)^2}_{i(t-10)} + \mathbf{X} + \varepsilon_{it} \quad \mathbf{(2)}$$

$$\mathbf{Q}_{it} = \alpha_0 + \alpha_1 \mathbf{p1}_{i(t-10)} + \alpha_2 \mathbf{p2}_{i(t-10)} + \alpha_3 \mathbf{p3}_{i(t-10)} + \alpha_4 \mathbf{ly}_{i(t-10)} + \alpha_5 \mathbf{(ly)^2}_{i(t-10)} + \mathbf{X} + \varepsilon_{it} \quad \mathbf{(3)}$$

where $\mathbf{X} = \alpha_6 \mathbf{ln(f)}_{it} + \alpha_7 \mathbf{Infl}_{it} + \alpha_8 \mathbf{(T/Y)}_{it} + \alpha_9 \mathbf{(I/Y)}_{it} + \alpha_{10} \mathbf{g}_{it} + \alpha_{11} \mathbf{PR}_{it} + \alpha_{12} \mathbf{GC}_{it} + \alpha_{13} \mathbf{D_{(Gross)}}_{it} + \alpha_{14} \mathbf{D_{(Income)}}_{it} + \alpha_{15} \mathbf{D_{(Afr)}}_{it} + \alpha_{16} \mathbf{D_{(LAm)}}_{it}$

In these equations, **ly** is the natural logarithm of GDP per capita, and $\mathbf{(ly)^2}$ its square, **f** the fertility rate, **Infl** the growth of the Consumer Price Index, **T/Y** openness to international trade measured as imports plus exports as a share of GDP, **I/Y** investment as a share of GDP, **g** growth of ln(GDP per capita), **PR** political rights, and **GC** government consumption exclusive of education expenditures as a share of GDP.[5] D_{Gross} and D_{Income} are dummy variables for whether the GINI coefficients for each country and observation are calculated using gross versus net income, and income versus expenditures (like Barro, 2000; De Gregorio and Lee, 2002; and Sylwester, 2002a, 2003).[6] The measurement dummies are expected to indicate higher inequality, with tax systems typically designed to be redistributive, and as people with higher incomes predictably consume a smaller portion. D_{Afr} and D_{LAm} are regional dummy variables for Africa and Latin America, respectively (like Barro, 2000), or alternatively D_{LDCs} for LDCs. Employing regional dummies follows Temple's (1999) recommendation and previous literature. This is a Pooled Least Squares (PLS) panel. Alternative methods are conducted in the sensitivity analysis below. These model specifications pertain also to the DC and LDC sample splits (subsamples recommended by Temple, 1999; and Krueger and Lindahl, 2001, to test for nonlinearities), with the dummies included as appropriate (see Tables 1-9). The income dummy is excluded from the DC sample, where all GINI coefficients are measured by income. The education variables are not regressed together because enrollment rates and public expenditures are collinear.[7] Moreover, public expenditures per student as a share of GDP per capita indicate the relation between expenditures and student amounts.

Sylwester (2002a) suggests researching the effects of public expenditures as a share of GDP per education stage on inequality. This measure is used in growth regressions for East Asia (McMahon, 2000), Asia (Keller, 2006b) and worldwide (Keller, 2006a). Braun (1988) includes per capita education expenditures on U.S. inequality, while this study employs expenditures *per student* in each education stage as a share of GDP per capita, utilized by Keller (2006a; 2006b) for growth regressions. Resources per student promote completion rates and are included as a constant policy

variable in growth simulations (McMahon, 2000; Appiah and McMahon, 2002). McMahon (2000) discerns expenditures per student as a percentage of GNP per capita as costs per student reflecting quality or inefficiency, predominantly determined by average teacher salaries and the inverse of the student-teacher ratio. Teachers' wages are the main recurrent education costs and expenditures per child depend positively on teacher costs to income per working-age adult, and income per adult, while negatively on cohort size (Schultz, 1996). Like teacher costs to income per working-age adult, expenditures per student to GDP per capita measure a worker's opportunity cost to educate a child. This variable indicates costs per student relative to a country's standard of living.[8]

RESULTS OF PANEL REGRESSIONS

Global Results

The regressions explain up to 73 percent of variation in income inequality between countries over time. If subsequent stages' enrollment rates are held constant, primary-school enrollment rates increase income inequality, thus expanding enrollment rates at this lowest education stage alone perpetuates inequality (Table 1). Evidently, students also need secondary education to close the income gap. Notably for primary education, expenditures per pupil (Table 2) are significantly equalizing at the 1 or 5 percent level. Conversely, p_1 is insignificant (Table 3). The p_1 variable does not account for student amounts, but shows the allocation toward primary education out of national income. The likely explanation is when resources are spread thin, they produce low quality education that does not provide enough skills to sufficiently raise incomes to improve income distribution. In a poor country with high fertility rates, a large share allocated toward primary education may still not suffice in providing quality education. The s_1 variable, however, shows the share of income per capita allocated toward each primary school pupil. A large s_1 already accounts for the cohort size. Increased student cohorts may not inherently impair income distribution if the students are adequately educated to be productive in the workplace.

Secondary education is equalizing and statistically significant at the 1 or 5 percent levels for enrollment rates (Table 1), and for public expenditures (Table 3) before including the noneducation control variables. Secondary enrollment rates lose significance once including the Latin American dummy variable (they are highly significantly negatively related to the Latin American and African dummies). Thus, secondary education, especially enrollment rates, plays a major role in determining why some countries have more equal income distributions than others. Conversely, tertiary enrollment rates are significantly unequalizing.

TABLE 1. GROSS STUDENT ENROLLMENT RATES ON INEQUALITY: GLOBALLY

Dependent Variable: GINI coefficient

	(1a)	(1b)	(1c)	(2)	(3)	(4)	(5)	(6)
e_1				0.153	0.190	0.139	0.116	0.139
				[4.169]***	[4.305]***	[4.036]***	[3.808]***	[4.013]***
e_2		-0.195		-0.281	-0.230	-0.089	-0.032	-0.082
		[12.979]***	[10.390]***	[8.037]***	[2.319]**	[0.896]	[2.197]**	
e_3			-0.266	0.123	0.165	0.159	0.132	0.143
			[8.015]***	[2.514]**	[3.619]***	[3.331]***	[3.009]***	[3.087]***
ly					-0.022	0.112	0.063	0.061
					[4.224]***	[3.445]***	[2.118]**	[1.677]*
$(ly)^2$						-0.008	-0.005	-0.004
						[3.740]***	[2.717]***	[1.575]'
ln(fertility)						0.130	0.089	0.128
						[6.606]***	[4.777]***	[6.554]***
Inflation						0.004	0.002	0.004
						[1.982]**	[0.985]	[1.887]*
Intl.Trade GDP						0.055	0.042	0.047
						[5.665]***	[5.213]***	[4.297]***
Investment GDP						-0.102	0.008	-0.090
						[1.026]	[0.099]	[0.924]
Growth ly						-0.315	-0.066	-0.305
						[1.508]'	[0.364]	[1.477]'
Pol.Rights						-0.033	-0.015	-0.023
						[1.302]'	[0.674]	[0.878]
Government					-0.226	-0.165	-0.209	GDP
						[2.322]**	[1.877]*	[2.043]**
D_{Gross}						0.006	0.018	0.004
						[0.372]	[1.336]'	[0.274]
D_{Income}						0.110	0.106	0.107
						[7.125]***	[7.518]***	[6.802]***
D_{Africa}							0.089	
							[6.404]***	
$D_{LatinAmerica}$							0.092	
							[6.718]***	
D_{LDCs}								0.053
								[2.469]**
Adj.R^2		0.309	0.136	0.364	0.401	0.642	0.726	0.650
F-statistics		135.425***	48.571***	58.150***	48.595***	31.673***	40.552***	30.570***
Obs.		301	303	301	285	240	240	240
Countries		99	99	99	98	97	97	97

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively. Model (1a) is omitted because of having a negative adjusted R^2, thus lacking explanatory power.

TABLE 2. PUBLIC EXPENDITURES PER STUDENT (SHARE OF GDP PER CAPITA) ON INEQUALITY: GLOBALLY

Dependent Variable: GINI coefficient

	(1a)	(1b)	(1c)	(2)	(3)	(4)	(5)	(6)
s_1	-0.422			-0.458	-0.347	-0.197	-0.131	-0.209
	[4.664]***			[4.444]***	[4.802]***	[3.513]***	[2.253]**	[3.845]***
s_2		0.075		0.074	0.068	0.081	0.039	0.079
		[2.157]**		[1.313]'	[1.238]	[1.836]*	[0.651]	[1.758]*
s_3			0.009	0.006	-0.002	-0.001	-0.003	-0.0004
			[2.645]***	[1.466]'	[0.689]	[0.347]	[1.421]'	[0.153]
ly					-0.034	0.150	0.041	0.098
					[6.639]***	[3.823]***	[1.091]	[2.459]**
$(ly)^2$						-0.010	-0.004	-0.006
						[3.994]***	[1.518]'	[2.272]**
ln(fertility)						0.112	0.051	0.108
						[5.730]***	[2.547]**	[5.291]***
Inflation						0.007	0.004	0.007
						[2.361]**	[1.495]'	[2.387]**
Intl.Trade GDP						0.036	0.029	0.030
						[2.371]**	[1.994]**	[1.899]*
Investment GDP						-0.053	0.117	-0.043
						[0.430]	[1.076]	[0.355]
Growth ln(y)						-0.390	-0.139	-0.346
						[1.523]'	[0.620]	[1.349]'
Pol.Rights						0.004	0.006	0.009
						[0.096]	[0.162]	[0.202]
Government					-0.323	-0.179	-0.305	GDP
						[2.410]**	[1.469]'	[2.168]**
D_{Gross}						0.025	0.030	0.025
						[1.231]	[1.586]'	[1.195]
D_{Income}						0.103	0.084	0.098
						[4.245]***	[3.598]***	[3.886]***
D_{Africa}							0.107	
							[3.797]***	
$D_{LatinAmerica}$							0.116	
							[5.885]***	
D_{LDCs}								0.057
								[2.372]**
Adj.R^2	0.104	0.015	0.054	0.174	0.356	0.608	0.704	0.619
F-statistics	21.996***	4.510**	15.429***	12.744***	23.525***	17.519***	23.109***	17.109***
Obs.	181	225	252	168	164	150	150	150
Countries	86	90	93	83	83	81	81	81

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively.

TABLE 3. PUBLIC EDUCATION EXPENDITURES (SHARE OF GDP) ON INEQUALITY: GLOBALLY

Dependent Variable: GINI coefficient

	(1a)	(1b)	(1c)	(2)	(3)	(4)	(5)	(6)
p_1	-3.064 [3.099]***			-1.219 [0.964]	0.044 [0.046]	-0.164 [0.236]	0.036 [0.057]	0.001 [0.001]
p_2		-4.552 [5.368]***		-5.895 [3.858]***	-3.131 [2.464]**	0.670 [0.702]	0.106 [0.094]	1.080 [1.160]
p_3			-4.951 [3.634]***	0.741 [0.472]	2.863 [2.502]**	1.650 [1.368]'	0.323 [0.230]	1.040 [0.843]
ly					-0.035 [6.227]***	0.204 [3.862]***	0.123 [2.695]***	0.160 [3.163]***
$(ly)^2$						-0.015 [4.175]***	-0.009 [2.902]***	-0.011 [3.206]***
ln(fertility)						0.098 [3.949]***	0.069 [2.907]***	0.095 [3.667]***
Inflation						0.021 [0.805]	0.009 [0.422]	0.010 [0.331]
Intl.Trade GDP						0.041 [3.447]***	0.020 [1.759]*	0.030 [2.302]**
Investment GDP						0.114 [0.774]	0.154 [1.173]	0.108 [0.748]
Growth ln(y)						-0.649 [1.823]*	-0.022 [0.065]	-0.632 [1.715]*
Pol.Rights						-0.008 [0.200]	-0.003 [0.083]	-0.002 [0.045]
Government					-0.144 [0.815]	-0.036 [0.244]	-0.187 GDP [0.939]	
D_{Gross}						0.001 [0.053]	0.030 [1.550]'	-0.002 [0.106]
D_{Income}						0.153 [7.050]***	0.120 [5.218]***	0.153 [6.943]***
D_{Africa}							0.080 [3.318]***	
$D_{LatinAmerica}$							0.123 [5.326]***	
D_{LDCs}								0.058 [1.683]*
Adj.R^2	0.038	0.122	0.041	0.125	0.318	0.647	0.732	0.653
F-statistics	7.181***	24.784***	8.384***	8.219***	18.737***	19.443***	25.043***	18.724***
Obs.	156	172	173	153	153	142	142	142
Countries	51	56	56	51	51	50	50	50

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively.

Less Developed Countries

The LDC sample show similar patterns to the global regressions. They indicate somewhat lower explanatory power, explaining up to 64 percent of variation in income inequality. The p_1 variable has a large unequalizing coefficient highly significant at the 1 percent level (Table 6). LDCs spending a large part of their GDP on primary education

likely do this because high fertility rates increase student cohorts, but expanding public expenditures at a lower rate would decrease per student resources. If consequently education quality declines, students will not obtain high enough productivity and incomes to decrease the wage gap to secondary and higher education graduates. Moreover, an expansion of primary education may decrease its wage premium, hence increasing income inequality (Bhagwati, 1973). This is supported by e_1's significantly unequalizing effect. Conversely, s_1 is significantly equalizing at the 1 percent level (Table 5), until adding the Latin American dummy (which is significantly positively related to s_1). Thus, when considering *per student* expenditures, primary education reduces income inequality. Enrollment rates in secondary education are also equalizing among LDCs (Table 4), although adding control variables reduces the statistical significance. Thus, for LDCs with diverse secondary enrollment rates, those countries expanding such enrollment rates have more equal income structures.

LDCs have a low percentage of students attending college and such enrollment rates appear unequalizing holding the other education stages constant, but are insignificant at standard levels once controlling for income levels. College expenditures turn significantly equalizing once the Latin American dummy is held constant, while expenditures per student are statistically insignificant.

Developed Countries

The DC regressions (Tables 7-9) explain up to 57 percent of variation in income inequality, generally less than for the global or LDCs samples. Primary enrollment rates also increase inequality among DCs (Table 7), perhaps because of near universal enrollment, with most students attending high school. Gross primary enrollment rates are over 100 percent for countries catching up (from lower more unequal levels of GDP per capita as predicted by Kuznets, 1955). Primary school expenditures overall and per pupil, however, are equalizing. The former are significantly equalizing among DCs in contrast to globally or between LDCs, perhaps indicating DCs' overall primary-school expenditures are adequately providing the resources and quality education the students need for success in the market place. The basic versus higher education budget allocations are more balanced in DCs than LDCs (Su, 2006).

All three measures of secondary education indicate equalizing effects among DCs (Tables 7-9) and secondary education expenditures overall are statistically significant at the 1 or 5 percent levels with a large coefficient of -2.87. Secondary enrollment rates lose significance at standard levels once including income levels. DCs have near universal secondary enrollment and over this period on average a third of students attended college. Tertiary enrollment rates and p_3 are unequalizing. However, s_3 is significantly equalizing at the 1 or 5 percent levels, hence those DCs with higher expenditures per college student have lower income inequality.

TABLE 4. GROSS STUDENT ENROLLMENT RATES ON INEQUALITY: LDCS

Dependent Variable: GINI coefficient

	(1a)	(1b)	(1c)	(2)	(3)	(4)	(5)
e_1				0.179	0.179	0.157	0.123
				[4.478]***	[3.728]***	[4.115]***	[3.582]***
e_2		-0.164		-0.268	-0.250	-0.095	-0.023
		[8.153]***		[7.522]***	[6.540]***	[1.713]*	[0.409]
e_3			-0.263	0.155	0.137	0.145	0.124
			[5.262]***	[1.912]**	[1.621]'	[1.388]'	[1.311]'
ly					0.003	0.142	0.112
					[0.329]	[3.049]***	[2.674]***
$(ly)^2$						-0.010	-0.009
						[2.970]***	[2.992]***
ln(fertility)						0.136	0.099
						[5.246]***	[4.119]***
Inflation						0.003	0.001
						[1.530]'	[0.640]
Intl.Trade / GDP						0.071	0.059
						[4.834]***	[4.769]***
Investment / GDP						-0.182	-0.084
						[1.478]'	[0.753]
Growth ln(y)						-0.239	0.042
						[1.083]	[0.214]
Pol.Rights						-0.026	-0.013
						[0.996]	[0.570]
Government / GDP						-0.115	-0.058
						[1.014]	[0.600]
D_{Gross}						-0.001	0.014
						[0.046]	[0.967]
D_{Income}						0.117	0.111
						[7.297]***	[7.519]***
D_{Africa}							0.083
							[5.877]***
$D_{LatinAmerica}$							0.089
							[6.075]***
Adj.R^2		0.202	0.084	0.290	0.255	0.470	0.596
F-statistics		56.799***	21.456***	30.945***	18.481***	11.431***	16.240***
Obs.		221	223	221	205	166	166
Countries		77	77	77	76	75	75

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively. Model (1a) is omitted because of having a negative adjusted R^2, thus lacking explanatory power.

TABLE 5. PUBLIC EXPENDITURES PER STUDENT (SHARE OF GDP PER CAPITA) ON INEQUALITY: LDCS

Dependent Variable: GINI coefficient

	(1a)	(1b)	(1c)	(2)	(3)	(4)	(5)	
s_1	-0.262			-0.339	-0.396	-0.198	-0.111	
	[3.249]***			[3.661]***	[4.137]***	[2.665]***	[1.461]'	
s_2		0.053		0.102	0.090	0.041	0.008	
		[1.585]'		[1.752]*	[1.606]'	[0.800]	[0.118]	
s_3			0.004	0.001	0.0003	0.0003	-0.002	
			[1.511]'	[0.228]	[0.090]	[0.091]	[0.919]	
ly					0.003	0.208	0.098	
					[0.329]	[2.925]***	[1.441]'	
$(ly)^2$						-0.014	-0.008	
						[2.737]***	[1.575]'	
ln(fertility)							0.133	0.071
							[5.102]***	[2.612]**
Inflation						0.006	0.003	
						[1.650]'	[1.094]	
Intl.Trade GDP						0.052	0.048	
						[2.176]**	[1.711]*	
Investment GDP						-0.072	0.097	
						[0.424]	[0.587]	
Growth ln(y)						-0.222	-0.015	
						[0.745]	[0.051]	
Pol.Rights						0.011	0.010	
						[0.232]	[0.256]	
Government GDP						-0.217	-0.106	
						[1.093]	[0.624]	
D_{Gross}						0.019	0.028	
						[0.841]	[1.327]'	
D_{Income}						0.111	0.089	
						[4.126]***	[3.463]***	
D_{Africa}							0.098	
							[3.221]***	
$D_{LatinAmerica}$							0.109	
							[4.717]***	
Adj.R^2	0.039	0.010	0.016	0.085	0.107	0.415	0.547	
F-statistics	5.901**	2.464'	3.845*	4.416***	4.188**	5.806***	8.165***	
Obs.	122	152	173	111	107	96	96	
Countries	65	69	71	62	62	60	60	

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively.

TABLE 6. PUBLIC EDUCATION EXPENDITURES (SHARE OF GDP) ON INEQUALITY: LDCS

Dependent Variable: GINI coefficient

	(1a)	(1b)	(1c)	(2)	(3)	(4)	(5)	
p_1	3.441			5.684	5.544	3.794	4.788	
	[1.866]*			[2.632]**	[2.503]**	[1.752]*	[2.860]***	
p_2				-1.656	-1.474	0.697	0.681	
				[0.958]	[0.819]	[0.549]	[0.480]	
p_3				2.345	-3.016	-2.788	-9.276	
				[0.897]	[0.996]	[1.079]	[3.241]***	
ly					0.003	0.051	0.025	
					[0.329]	[1.634]’	[0.944]	
$(ly)^2$						-0.004	-0.002	
						[1.532]’	[0.711]	
ln(fertility)							0.090	0.085
						[2.226]**	[2.466]**	
Inflation						0.027	0.030	
						[0.771]	[1.247]	
Intl.Trade / GDP						0.059	0.029	
						[2.235]**	[1.159]	
Investment / GDP						0.071	0.248	
						[0.256]	[1.055]	
Growth ln(y)						-0.792	-0.101	
						[1.972]*	[0.243]	
Pol.Rights						0.018	0.011	
						[0.398]	[0.310]	
Government / GDP						0.238	0.012	
						[0.890]	[0.061]	
D_{Gross}						-0.017	0.029	
						[0.711]	[1.399]’	
D_{Income}						0.167	0.112	
						[7.130]***	[4.408]***	
D_{Africa}							0.068	
							[2.317]**	
$D_{LatinAmerica}$							0.152	
							[5.777]***	
Adj.R^2	0.027			0.027	0.018	0.387	0.644	
F-statistics	3.424*			1.820’	1.409	4.889***	10.636***	
Obs.	90			88	88	81	81	
Countries	33			33	33	32	32	

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ‘ for the 1, 5, 10 and 20 percent levels respectively. Models (1b) and (1c) are omitted because of having negative adjusted R^2s, thus lacking explanatory power.

TABLE 7. GROSS STUDENT ENROLLMENT RATES ON INEQUALITY: DCS

Dependent Variable: GINI coefficient						
	(1a)	(1b)	(1c)	(2)	(3)	(4)
e_1	0.142			0.093	0.045	0.219
	[2.085]**			[1.250]	[0.607]	[3.332]***
e_2		-0.050		-0.113	-0.068	-0.003
		[1.984]*		[2.958]***	[1.655]'	[0.083]
e_3				0.116	0.112	0.057
				[2.879]***	[2.577]**	[1.563]'
ly					0.003	-0.755
					[0.329]	[1.908]*
$(ly)^2$						0.038
						[1.888]*
ln(fertility)						0.029
						[1.577]'
Inflation						0.068
						[0.402]
Intl.Trade / GDP						-0.004
						[0.273]
Investment / GDP						-0.514
						[3.386]***
Growth ln(y)						-0.229
						[0.600]
Pol.Rights						0.113
						[1.919]*
Government / GDP						-1.187
						[6.805]***
D_{Gross}						-0.011
						[1.570]'
Adj.R^2	0.040	0.033		0.143	0.176	0.566
F-statistics	4.308**	3.680*		5.402***	5.233***	8.329***
Obs.	80	80		80	80	74
Countries	22	22		22	22	22

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively. Model (1c) is omitted because of having a negative adjusted R^2, thus lacking explanatory power.

TABLE 8. PUBLIC EXPENDITURES PER STUDENT (SHARE OF GDP PER CAPITA) ON INEQUALITY: DCS

Dependent Variable: GINI coefficient	(1a)	(1b)	(1c)	(2)	(3)	(4)
s_1	-0.229 [2.842]***			-0.215 [2.300]**	-0.148 [1.457]'	-0.139 [1.505]'
s_2		-0.110 [1.231]		-0.093 [0.766]	0.038 [0.286]	-0.024 [0.165]
s_3			-0.076 [3.133]***	-0.075 [2.544]**	-0.091 [3.066]***	-0.118 [3.107]***
ly					0.003 [0.329]	-0.655 [1.600]'
$(ly)^2$						0.033 [1.543]'
ln(fertility)						0.060 [2.618]**
Inflation						-0.051 [0.326]
Intl.Trade / GDP						-0.001 [0.053]
Investment / GDP						-0.500 [3.019]***
Growth ln(y)						-0.710 [1.714]*
Pol.Rights						0.079 [1.236]
Government / GDP						-0.787 [3.899]***
D_{Gross}						-0.025 [3.476]***
Adj.R^2	0.131	0.008	0.051	0.203	0.227	0.477
F-statistics	9.737***	1.553	5.183**	5.751***	5.105***	4.723***
Obs.	59	73	79	57	57	54
Countries	21	21	22	21	21	21

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively.

TABLE 9. PUBLIC EDUCATION EXPENDITURES (SHARE OF GDP) ON INEQUALITY: DCS

Dependent Variable: GINI coefficient						
	(1a)	(1b)	(1c)	(2)	(3)	(4)
p_1	-1.362			-2.053	-1.810	-1.061
	[2.815]***			[2.980]***	[2.758]***	[1.866]*
p_2				-3.953	-3.194	-2.866
				[4.679]***	[3.008]***	[2.254]**
p_3				2.850	2.813	1.150
				[2.477]**	[2.501]**	[1.011]
ly					0.003	-0.889
					[0.329]	[2.297]**
$(ly)^2$						0.044
						[2.246]**
ln(fertility)						-0.007
						[0.203]
Inflation						-0.146
						[0.631]
Intl.Trade						-0.016
GDP						[1.273]
Investment						-0.579
GDP						[3.780]***
Growth ln(y)						-0.009
						[1.020]
Pol.Rights						0.079
						[1.369]’
Government						-0.800
GDP						[3.567]***
D_{Gross}						-0.014
						[1.419]’
Adj.R^2	0.057			0.218	0.226	0.452
F-statistics	4.915**			6.953***	5.672***	4.810***
Obs.	66			65	65	61
Countries	18			18	18	18

Notes: Each regression estimated with common constant (not reported). Estimated coefficient stated for each variable with absolute value of t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix utilized. Statistical significance indicated by ***, **, * and ‘ for the 1, 5, 10 and 20 percent levels respectively. Models (1b) and (1c) are omitted because of having negative adjusted R^2s, thus lacking explanatory power.

The Control Variables

Income per capita and its square take on opposite signs, indicating the effect of income per capita on inequality is nonlinear, signifying a Kuznets curve relationship of inequality increasing in an early stage of development and later decreasing still remains without being fully explained by these education and control variables. The variables frequently show significance to inequality, but less for the sample splits.

The fertility rate significantly increases inequality, except tends to lose significance for DCs. The unequalizing effect is likely because high fertility rates are more common among lower income classes and more people then share the lower income groups' part of national income. Inflation is generally insignificantly related to inequality once the regional dummies included, or in the sample splits. Openness to international trade is significantly unequalizing globally and among LDCs, however, loses some significance in the sample splits and turns insignificantly equalizing for DCs. Investment in physical capital is insignificant globally and in the LDC sample, but indicates significantly equalizing effects at the 1 percent level among DCs. The GDP per capita growth rate is generally negative to inequality, however at most significant at the 10 percent level.

Political rights are generally equalizing globally, while unequalizing for the sample splits, although with little statistical significance. Government spending exclusive of education expenditures improves equality among DCs and globally, among the former significantly at the 1 percent level. Alternative controls are insignificant (see endnote 5). The dummy indicating the GINI coefficient is calculated using income rather than expenditures is significantly positive to income inequality, as expected. The dummy indicating gross versus net income is usually statistically insignificant. Africa and Latin America, traditionally with high inequality, have significantly positive dummy variables.

Sensitivity Analysis

To verify whether outliers drive the results, outliers are tested for and robust regressions employed. Outliers are not found a problem in this sample. To determine if DC drive the global results, separate LDC regressions are conducted. Robust estimation techniques are employed, reducing the influence of potential outliers. Least median of squares (LMS) regressions are performed for all regressions on the best subset.[9] Weighted Least Square (WLS) regressions are performed on these smaller best subsets.[10] Least absolute value (LAV), or least absolute deviation, regressions are performed, using the full samples but reducing the influence of potential outliers.[11] In these various robust regressions, the size, signs and statistical significance of the coefficients are generally similar to the results presented. Notably, s_1 is consistently significantly equalizing at the 1 percent level, here also once all control variables are added for DCs and LDCs (LDCs with regional dummies only for LAV). In WLS regressions, p_2, p_1 and s_2 are consistently of even higher statistical significance to DCs, and e_2 is highly significant for LDCs with non-regional controls added. Thus, the robust regressions corroborate our results with even higher statistical significance that public expenditures especially per student in primary education are equalizing and overall public expenditures on the lower stages are equalizing among DCs.

Period-fixed, country-fixed or random effects are alternatively included, with similar coefficients, signs and statistical significance to those presented, although somewhat lower significance with country-fixed dummies.[12] Barro (1997) cautions country-fixed effects eliminate the cross-country differences, which provide the principal strength of cross-country data, and instead rely on the within-country time-series aspect. Instead, Temple (1999) advocates employing regional dummies. Colonial times exacerbated inequality justifying utilizing regional dummy variables following previous

literature. Applying period-fixed and random effects (for the Wansbeek and Kapteyn estimator of component variances), secondary enrollment rates are significant at the 10 percent level globally adding regional dummy variables. Secondary enrollment rates are insignificant for LDCs with regional dummies, while excluding those, they are significant at least at the 5 percent level.

Indirect Effects

As with economic growth (e.g., Bleaney and Nishiyama, 2002; McMahon, 2000; and Barro, 1997), noneducation variables important to income distribution might channel indirect effects of education, if determined by education. López-Acevedo (2006) states "'indirect' effects are becoming more important", regarding inequality in Mexico. Similar to Keller (2006a, 2006b), regressions are conducted for indirect effects (Tables 10-12), however here for total (market and nonmarket) effects of education on the control variables, rather than nonmarket effects alone. The dependent variables are decade averages regressed on education variables that are lagged by one decade.[13]

Enrollment rates in primary, secondary and higher education each highly significantly decrease fertility rates (Table 10), and as high fertility rates generally are highly significantly increasing income inequality (Tables 1-9), this also indirectly improves income distribution. Enrollment rates explain 73 percent of variation in fertility rates. While the direct effects of enrollment rates in primary education increase income inequality, they have some additional equalizing indirect effects through improving growth (and investment among DCs). Thus, it seems that the indirect effects of primary enrollment rates are overall more important in improving income distribution, as opposed to the variable's counteracting effects on inequality though other variables (the level of income, trade, and for DCs political rights) of lower statistical significance. Similarly, enrollment rates in secondary education are of higher significance to the variables that decrease inequality (fertility rates, government spending, and in DCs investment and the level of income), thus the variable's indirect effects are rather reinforcing its direct effects of improving income distribution. Nevertheless, it has some counteracting effects of increasing inequality (through the level of income and trade, as well as in DCs political rights). Enrollment rates in higher education improves income distribution indirectly through lowered fertility rates, as well as through trade. However, it has indirect effects that increase inequality such as through the level of income, and in DCs investment and political rights.

TABLE 10. INDIRECT EFFECTS OF ENROLLMENT RATES: GLOBALLY

Dependent Variable:	ly	ln(fertility)	Investment GDP	Pol.Rights	Govt. GDP	Trade GDP	Inflation	Growth
e_1	0.864	-0.299	0.074	0.100	-0.001	0.146	0.626	0.029
	[3.203]***	[4.682]***	[3.243]***	[1.948]*	[0.066]	[1.771]*	[1.623]'	[2.737]***
e_2	2.636	-1.044	0.072	0.186	0.049	0.832	-0.746	-0.010
	[6.440]***	[9.778]***	[2.933]***	[2.179]**	[2.832]***	[6.230]***	[1.279]	[0.882]
e_3	1.708	-0.737	-0.134	0.915	-0.021	-1.794	2.334	-0.019
	[1.848]*	[3.137]***	[2.922]***	[4.566]***	[0.670]	[5.237]***	[1.525]'	[0.789]
R^2 adj.	0.537	0.726	0.147	0.320	0.044	0.157	0.0002	0.032
F-statistics	134.113***	362.484***	23.033***	62.676***	6.363***		24.733***	1.030
	4.959***							
Obs.	345	411	385	395	354	382	384	366
Countries	144	154	152	153	148	151	153	146

Notes: Each regression is estimated with a common coefficients not reported. For each variable are stated the estimated coefficient and the absolute value of the t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix is used. Statistical significance is indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively.

Public expenditures per student in primary school generally decrease income inequality directly, but additionally have indirect effects that enhance this effect, through its reducing of fertility rates and being associated with subsequent government spending that are equalizing (Table 11). Some counteracting effects emerge though increasing the level of income, as that worsens inequality, similarly for political rights among DCs. The indirect effects of expenditures per student in secondary school are rather equalizing, mainly through reduced inflation rates, as well as political rights among DCs. However, large expenditures per student in secondary school are likely associated with a lower level of income with few students enrolled. The variable is also associated with high fertility rates which increase inequality. Similar effects are seen for expenditures per college student. In addition, high such expenditures suppress growth rates and so indirectly raise inequality. Among DCs, such an indirect effect takes place through less investment.

TABLE 11. INDIRECT EFFECTS OF PUBLIC EXPENDITURES PER STUDENT (SHARE OF GDP PER CAPITA): GLOBALLY

Dependent Variable:	ly	ln(fertility)	Investment GDP	Pol.Rights	Govt. GDP	Trade GDP	Inflation	Growth
s_1	6.295	-1.742	-0.072	0.605	0.239		-0.409	-0.027
	[3.783]***	[3.270]***	[1.426]'	[1.878]*	[3.491]***		[0.287]	[1.181]
s_2	-1.684	0.856	-0.002	-0.228	0.029		-0.834	0.010
	[3.250]***	[6.206]***	[0.076]	[2.644]***	[1.489]'		[2.203]**	[0.944]
s_3	-0.107	0.025	-0.002	-0.018	-0.002		-0.011	-0.001
	[3.129]***	[2.713]***	[1.759]*	[3.777]***	[1.622]'		[1.298]'	2.465]***
R^2 adj.	0.391	0.398	0.023	0.233	0.135		0.002	0.016
F-statistics	30.966***	34.683***	2.143*	16.274	8.328***		1.115	1.762'
Obs.	145	154	148	152	142		152	143
Countries	77	82	80	82	77		81	76

Notes: Each regression is estimated with a common coefficients not reported. For each variable are stated the estimated coefficient and the absolute value of the t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix is used. Statistical significance is indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively. The model for International Trade is omitted because of having a negative adjusted R^2, thus lacking explanatory power.

Public expenditures on primary education overall have little indirect effects on income distribution through control variables, although are associated with increased government spending in the subsequent decade (Table 12), which in turn is equalizing. This effect is similar for public expenditures on secondary education. The other indirect effects are all unequalizing, through the level of income, trade and fertility rates, as well as among DCs through investment and political rights. The indirect effects of expenditures on higher education are similarly unequalizing.

TABLE 12. INDIRECT EFFECTS OF PUBLIC EXPENDITURES (SHARE OF GDP): GLOBALLY

Dependent Variable:	ly	ln(fertility)	Investment GDP	Pol.Rights	Govt. GDP	Trade GDP	Inflation	Growth
p_1	-15.395	2.729	0.877	-3.414	1.510	5.420		
	[0.963]	[0.501]	[1.273]	[1.248]	[3.130]***	[1.386]'		
p_2	97.573	-29.077	1.877	10.781	2.353	19.629		
	[4.913]***	[4.254]***	[2.316]**	[2.829]***	[4.307]***	[3.367]***		
p_3	50.001	-9.069	-1.172	14.683	-0.349	-15.457		
	[1.783]*	[0.947]	[1.202]	[2.758]***	[0.322]	[1.486]'		
R^2 adj.	0.155	0.103	0.024	0.096	0.150	0.041		
F-statistics	12.631***	8.633***	2.580*	7.951***	11.948***	3.688**		
Obs.	191	200	193	198	187	192		
Countries	73	75	73	74	72	72		

Notes: Each regression is estimated with a common coefficients not reported. For each variable are stated the estimated coefficient and the absolute value of the t-statistic in brackets. White's heteroskedasticity-consistent covariance matrix is used. Statistical significance is indicated by ***, **, * and ' for the 1, 5, 10 and 20 percent levels respectively. The models for Inflation and Growth are omitted because of having negative adjusted R^2s, thus lacking explanatory power.

The most important indirect effects are primary, secondary and higher education enrollments, all highly significantly decreasing fertility rates (and explaining 73 percent thereof), which in turn are highly significant in reducing income inequality. Public expenditures per student in primary school have the same effects of highly significantly reducing fertility rates and thus inequality. Primary school enrollment rates increase growth, which improve income distribution. Enrollment rates in primary and secondary education raise investment, which is equalizing among DCs. The indirect effects from expenditures overall and per student at the higher stages are rather unequalizing. The indirect effects are often reinforcing the direct effects of education, however, there are frequently counteracting effects as well through education's effects on the control variables. Once the control variables are held constant, the indirect effects are also held constant and only the variables' direct effects are displayed in the regression results. The indirect effects are likely the reason why a few of the education variables lose statistical significance once the control variables are included.

CONCLUSION

This research estimates the effects of different measures of investment rates in primary, secondary and higher education on income distribution globally, and separately for LDCs and DCs. While enrollment rates in the different stages are examined in previous studies for effects on the *change* in the GINI coefficient (Sylwester, 2003), and income shares (Psacharopoulos and Tilak, 1991), they are here important determinants of the GINI coefficient. This study especially adds to the literature by researching the effects of public expenditures per student as a share of GDP per capita, and public expenditures as a share of GDP, each for the different education stages, on income inequality. Enrollment rates and overall public expenditure on primary education are not sufficient to decrease

inequality, but are frequently unequalizing, except among DCs such expenditures are statistically significantly improving income distribution perhaps because adequately providing quality education. Expenditures per primary-school student, however, are significantly equalizing across samples. The global regressions estimate a country augmenting public expenditures per primary-school student as a share of GDP per capita by one standard deviation (0.09), experiences a decrease in its GINI coefficient by 1.2 percentage points. Gross enrollment rates in secondary education are significant and increasing them (standard deviation 0.312) provide similar improvements. Secondary education expenditures are equalizing, especially for DCs. College enrollment rates are worsening inequality globally, while expenditures per student are equalizing among DCs. The regressions explain much of income inequality among the samples and sample splits. Additional regressions for indirect effects show that enrollment rates in primary, secondary and higher education, as well as expenditures per primary school student, reduce fertility rates, which in turn decrease income inequality.

As a policy recommendation, this study shows that income distribution improves by ensuring that expenditures per primary-school student are adequately kept up with increases in cohort size to prevent education quality from deteriorating. Importantly, improving the quality of primary education would benefit most of the population and reduce inequality. Moreover, expanding secondary enrollment rates and expenditures improves income distribution. While this research focuses on the supply of education, especially public resources, demand for education and private education resources would also be important for human capital accumulation and income distribution. Additionally important for education to improve wage rates and income distribution is labor demand (e.g., Birdsall, Ross and Sabot, 1997; Manacorda, Sanchez-Paramo, and Schady, 2005). This study uses the GINI coefficient for income inequality and research based on income shares could further test the results obtained. By considering expenditures per student in different education stages, this research hints toward the importance of education quality for income distribution. Resources may not necessarily provide quality education, yet quality education is considered to require resources. With scarce resources, further research about how to utilize them most effectively to enhance skills, wages and income distribution would be welcome.

ENDNOTES

[*] I am grateful to Amitava K. Dutt, Jaime Ros, Kwan S. Kim and Kajal Mukhopadhyay for valuable feedback. Conference participants at Yaroslavl State University, Russia, provided useful remarks. Helpful reviewer comments are appreciated. The usual caveat applies.

[1] E.g., Chiswick (1971); Marin and Psacharopolous (1976); Psacharopoulos (1977); Winegarden (1979); Park (1996); and Li, Squire, and Zou (1998) for 1960 secondary schooling. However, Ram (1989) finds low statistical significance.

[2] See also Bourguignon and Morrisson (1990). Combined primary and secondary enrollment rates are equalizing (Papanek and Kyn, 1986, using GINI coefficients; Chenery and Syrquin, 1975, and Adelman and Morris, 1973, for income shares).

[3] Updated from Deininger and Squire (1996). GINI coefficients based on gross income are 0.10-0.15 points lower (on a 0-1 scale) than from wage earnings (Deininger and Squire, 1996). In high-

income countries, pay inequality form two-thirds of income inequality (Birdsall, Ross and Sabot, 1997). Whenever possible, the GINI coefficients are of the same measurement and source. Alternatively using the change of the GINI coefficient (like Sylwester, 2002a, 2003) reduces the adjusted R^2.

[4] Gross enrollment rates comprise all students (publicly or privately) enrolled, including those older than the standard age group, as a share the respective age group per education stage. Primary enrollment rates sometimes exceed 1 (100%) for countries catching up by enrolling students above the age group, expected to be equalizing. Observations not available in WDI (2003), but in WDI (2001) are included for enrollment rates. Expenditures per student as a share of GNI from WDI (2001) included when no observation as a share of GDP available from WDI (2003) for that decade. Public expenditures as a share of GDP are from WDI (1997).

[5] The data are from WDI (2003), except as noted. Political Rights are from Freedom House (2004), except 1960s values from Bollen (1990). Real GDP per capita measures are in constant 1995 $U.S. When CPI data unavailable, the GDP deflator is used for that decade. Political Rights and Rule of Law are converted to 0-1 scales, 1 being the most favorable, similar to Barro (1997). Alternative controls are excluded from the general analysis if insignificant and/or of limited data availability. The square of political rights, rule of law (Knack and Keefer, 1998), the blackmarket premium (Barro and Lee, 1994) are alternatively included, and from WDI (2003): life expectancy, its square, debt service, terms of trade adjustment, research and development and military expenditures, the two latter as GDP shares.

[6] Deininger and Squire (1996) observe the differences from calculating the GINI coefficient based on personal or household data, or income gross or net of taxes, are minor, but the difference between using income or expenditures is significant and systematic. A dummy alternatively used for per person data is insignificant.

[7] Found collinear by education stage in McMahon (2000), and multicollinear by the Belsley, Kuh, and Welsch (1980) method. The models used in this study do not indicate multicollinearity.

[8] Using expenditures per student produce qualitatively similar results to the GDP per capita ratios.

[9] LMS regressions minimize the median of ordered squares of residuals by omitting observations considered outliers (Rousseeuw, 1984).

[10] WLS estimations minimize the weighted residual sum of squares. Weights proportional to the reciprocals of the error variances lessen the weight of observations with larger errors.

[11] LAV procedures minimize the sum of absolute errors.

[12] Using Wansbeek and Kapteyn, Wallace and Hussain, and Swamy and Arora estimators of component variances for the random effect model.

[13] For these indirect-effects regressions, Sudan and Nicaragua are excluded from the public expenditures per student regressions, as they here have outlying data points of s_i, with standardized values (z-scores) more than three standard deviations above the sample mean.

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