Education Spending, Inequality, and Economic Growth: Evidence from US States

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Abstract: Education spending and finance in the United States have undergone significant changes over the last several decades. These changes in spending and tax policy may affect economic growth directly as well as indirectly by impacting inequality. Inequality itself may also drive tax and spending changes as part of the political and judicial process. This paper empirically investigates these issues using a panel data set on U.S. states for the years 1973, 1981, 1989, and 1997. The results indicate that education spending has a positive impact on economic growth, while other sorts of spending have a negative or insignificant effect. Education spending is also found to have an indirect impact on economic growth because it is found to reduce inequality. Inequality is initially found be inversely related to growth, but once one controls for the relationship between education and inequality, and a political mechanism in which greater income inequality leads to an increase in income taxation, the direct impact of inequality on growth becomes insignificant. Both personal and corporate income taxes are found to have either a negative or insignificant impact on economic growth.

I. Introduction

Education spending, one of the most important areas of the budget for state and local governments, has undergone significant changes over the past several decades. For instance, Murray, Evans, and Schwab (1998) find that court-ordered school finance reform in many states has significantly reduced within-state variance in education spending, and has led to an overall average increase in spending on education in those states. They also find that this increase in spending on education has been financed in general by increases in state income taxes.

Economic theory indicates that such changes may affect economic growth. This can be expected to occur through three channels. First, a literature on endogenous growth models, such as Barro (1990) and Mankiw, Romer, and Weil (1992), suggests that accumulation of human as well as physical capital is important in understanding economic growth. To the extent that additional spending on education increases human capital, education spending should directly increase growth. [1]

Second, new theories on the relationship between inequality and growth, such as Glomm and Ravikumar (1992), Galor and Zeira (1993), Persson and Tabellini (1994), and Alesina and Rodrick (1994), suggest a negative relationship between inequality and growth. This is in contrast to traditional theories that suggest a positive relationship between inequality and growth because of the bad incentive effects associated with redistribution. To the extent that education expenditures reduce inequality, the theories of Glomm and Ravikumar (1992) and Galor and Zeira (1993) suggest that education spending may have an indirect positive effect on economic growth. In addition, if

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[1] There is some microeconomic evidence that supports the idea that greater education spending increases earnings. See, for instance, Ferguson and Ladd (1996), Murname, Willett, and Levy (1995), and the discussion in Inman (1997).

inequality induces a political reaction toward more redistributive tax policy as suggested by the theories of Persson and Tabellini (1994) and Alesina and Rodrick (1994), inequality may reduce growth through its political impact on public policies.

Third, models such as those of Barro (1990) and Lucas (1990) suggest that tax policies that negatively affect the incentive to invest in human or physical capital can have a detrimental effect on economic growth. Hence, increases in personal or corporate income taxes may reduce growth.

This paper empirically investigates these issues using a panel data set on U.S. states for the years 1973, 1981, 1989, and 1997. The results indicate that education spending has a positive impact on economic growth, while other sorts of spending have a negative or insignificant effect. Education spending is also found to have an indirect impact on economic growth because it is found to reduce inequality, where inequality is measured by the ratio of mean to median income. Support is also found for a political connection between inequality and redistributive tax policy as greater income inequality is found to lead to an increase in income taxation. Inequality is initially found be inversely related to growth, but once one controls for the relationship between education and inequality, the direct impact of inequality on growth is reduced and becomes insignificant once one additionally controls for a political relationship between tax policy and inequality. Both personal and corporate income taxes are found to have either a negative or insignificant impact on economic growth.

The remainder of the paper is organized as follows. Section II reviews the empirical literature and sets the theoretical background for the empirical model. Section III presents the empirical model and data. Section IV presents results, and section V concludes.

II. Literature Review and Theoretical Background

A recent empirical literature on growth has arisen that uses country level data and concentrates on cross-sectional data sets. A good summary of much of the literature is contained in Robert Barro's Lionel Robbins Lectures (1997). It is important to control for country differences, and cross-sectional studies attempt to do this through the inclusion of many control variables. Panel data have more recently been used and fixed effects have been used to control for cross-country differences. However, estimated rates of convergence are much larger with fixed effects in panel data sets, and this has made the use of fixed effects somewhat controversial in this literature.[2] A recent paper that uses fixed effects with country-level panel data for OECD countries is Kneller et. al. (1999). They find that productive expenditures (a category that they define to include education expenditures) positively affect growth and that taxes that negatively affect the decision to invest in human capital have a detrimental effect on growth, but they do not consider the inter-relationship between inequality, education, and taxes.

A second empirical literature has developed around the question of inequality and growth. The data again is mainly country level, and summaries can be found in Benabou (1996), Perroti (1996), and Aghion, Caroli, and García-Peñalosa (1999). This literature finds a negative relationship between growth and inequality when cross-sectional data is used, although this relationship often is not robust to the inclusion of fixed effects in panel data. This again has made the use of fixed effects somewhat controversial in this literature. A negative relationship between inequality and growth is in stark contrast to traditional theories, as discussed in Aghion, Caroli, and García-Peñalosa (1999).

Several theories have been proposed to explain the cross-sectional negative relationship

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[2] See, for example, the discussion in Barro (1997, pp. 41-42).

between inequality and growth. Two theories are most relevant to spending on education and inequality, the subject of the present paper. The first is that of Galor and Zeira (1993), which concentrates on the effect of inequality on credit constraints. The second is embodied in the models of Persson and Tabellini (1994) and Alesina and Rodrick (1994) and focuses on politics.

In the model of Galor and Zeira (1993), investment in human capital increases as equality increases because borrowing constraints are less binding as equality increases. Hence, if spending on education has significantly reduced within-state variance in education spending, and has led to an overall average increase in spending on education as Murray, Evans, and Schwab (1998) find, education spending may itself reduce borrowing constraints and increase investment in human capital, and thereby have a direct impact on growth. In addition, if education spending also decreases inequality, it may also have an indirect impact on growth as it further decreases borrowing constraints. Although there is little empirical evidence concerning inequality, credit constraints, and education, one related study is Fernandez and Rogerson (1998). They find in simulation results that a centralized system of finance results in greater spending on education and a higher average income in the long run.

A second theory that suggests an inverse relationship between inequality and growth is that of Alesina and Rodrick (1994) and Persson and Tabellini (1994). Their models suggest that lower inequality leads to lower spending on redistributive programs which are assumed to be growth-retarding. They find empirical support using country-level data. Partridge (1997) uses state-level panel data and finds contradictory evidence. He finds a positive relationship between inequality and growth, although his specifications do not include fixed effects.

Finally, an early paper on economic growth that uses fixed effects with panel data on U.S.

states is Helms (1985). Helms constructs a careful specification that takes into account the government's budget constraint identity, but since current growth theories had not been written at the time, his specification does not include the initial income level, which is now standard, and does not investigate the inter-relationship between income inequality and growth.

The results of this paper are consistent with the results of Helms (1985) and Kneller et. al. (1999) in finding a positive impact of education on growth. Unlike these studies, however, we model education spending as endogenously determined and instrument for it. In addition, new evidence of the interrelationship between income inequality, education, and growth is found. Inequality is found to be negatively related to economic growth in fixed effects regressions. This is consistent with evidence from cross-sectional country-level data (but contrary to country-level regressions that include fixed effects) and contrary to the results of Partridge (1997) that exclude fixed effects from state-level regressions. Education spending is also found to decrease inequality; education spending thus has an indirect effect on growth as well as a direct impact. Support is found for political explanations of the connection between inequality and growth, but the political connection appears to run through changes in the tax system: inequality is found to induce a future increase in income taxes. Income tax increases are found to negatively affect growth, consistent with the findings of Helms (1985), Kneller et. al. (1999), and Mendoza et. al. (1997).

III. Empirical Framework and Data

Standard growth models suggest that growth should depend on the initial and steady-state income levels:

$$Dy = f(y_0, y^*) \qquad\qquad (1)$$

where Dy is the growth rate, y_0 is the initial income level, and y* is the steady-state level of income. The typical empirical growth specification is of this general form, although different factors are used to proxy for differences in the steady-state income level.

As argued above, two important factors that are likely to affect the steady-state level of income are government spending and tax policies. Spending on education, which presumably directly increases human capital, can be expected to have a positive impact on growth. Tax policies that negatively affect the incentive to invest in human and physical capital can be expected to have a negative impact on growth.

As discussed above, a third factor that has been suggested as possibly affecting the steady-state is the distribution of income. For example, to the extent that borrowing constraints are less binding as equality increases, equality of incomes may positively affect growth. Moreover, to the extent that spending on education leads to lower inequality, education spending may indirectly increase growth as it lowers inequality and makes borrowing constraints less binding. Political motivations may also link inequality and growth. Both Persson and Tabellini (1994) and Alesina and Rodrick (1994) develop median voter models in which inequality leads to the adoption of growth-retarding policies; hence, inequality and growth are predicted to be negatively related.

Given the above discussion, estimation of equation (1) should include three factors that may affect the steady-state: spending, taxes, and the distribution of income. Hence, a modified estimating equation is:

$$Dy = b_0 + b_1 y_0 + b_2 IN + \sum_{i=1}^{k} \beta_i T_i + \sum_{j=1}^{l} \gamma_j S_j + e_{it} \qquad (2)$$

where IN is a measure of inequality, T_i is tax i, and S_j is spending category j. State-level fixed effects are included to control for differences between states that do not change over time.

As discussed in some detail in Helms (1986) and Kneller et. al. (1999), spending and taxes are connected through a budget constraint identity, so all spending and taxes cannot be included. One way to deal with this problem is to omit one item of the budget; the estimated coefficients are then interpreted as resulting from an increase in the relevant budget item financed by a decrease in the omitted budget item. It is convenient for interpretation to omit a category that is expected to have a zero coefficient. For this reason, property and sales taxes will be used as the omitted category.

A panel data set was constructed for U.S. states for 1973, 1981, 1989, and 1997. Most of the data comes from *State Government Finances* for the respective years, with some variables coming from the *Bureau of Economic Analysis*. Summary statistics for the variables used in the regressions are given in Table 1.

Income. The initial income variable is the log of state mean income as downloaded from the *Bureau of Economic Analysis*. The growth rate is measured as the average annual real per-capita growth rate computed using fairly long nine year intervals in order to mitigate business cycle influences.[3] Three growth rates for each state can be constructed with the four years, which leaves

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[3] The use of long time intervals is standard in the growth literature, although there is some variation in the length of interval chosen.

room for fixed effects to be included.

Spending. As this study concentrates on education spending, this category of spending is separated from other spending. Data on spending is collected from *State Government Finances*.

Education spending may be endogenously determined, which will bias the regression results. To obtain consistent estimates, one must account for this endogeneity by, for instance, instrumenting. To instrument for education, we rely on the large literature that estimates the demand for education; a somewhat dated but still useful survey is Inman (1979). A starting point for this literature is the median voter model, and important explanatory variables include the median voter's income and tax-price. In addition, a large literature on the flypaper effect suggests that grants are an important determinant of education spending. Education spending will therefore be instrumented as follows:

$$ED \; = \; b_0 \; + \; b_1 y_{med} \; + \; b_2 \frac{E}{N} \; + \; b_3 G \; + \; \epsilon_{it} \tag{3}$$

where ED is education spending per pupil, y_{med} is median income, E/N is enrollment divided by population, a proxy for price, and G is grants per capita. Fixed effects will also be included. This model includes a political element to it, albeit one that operates through a quite different channel than that envisaged by Persson and Tabellini (1994) and Alesina and Rodrik (1994). Here, a higher income level for the median voter stimulates greater education spending (rather than lower spending on redistribution) and thereby greater growth.

Inequality. Inequality will be measured by the ratio of median to mean income, which is essentially the skew of the distribution. Other studies have often used the Gini coefficient, but this is unavailable as a time series for states.

Inequality may be endogenously determined and education spending may itself impact

inequality. For instance, the reduction in within-state variance in education spending found in Murray, Evans, and Schwab (1998) may overcome borrowing constraints or translate directly to a reduction in within-state variance in incomes, lowering income inequality and enhancing growth. Inequality therefore will be instrumented using a poverty index and education spending; the inclusion of the latter is of interest in itself to see if education spending and inequality are related. Hence, a predicted value for inequality is estimated from:

$$IN = b_0 + b_1 P + b_2 ED + \epsilon_{it} \qquad (4)$$

where P is the poverty index and fixed effects are included.

Taxes. Theory suggests that the most important taxes for economic growth are income and capital taxes, so these two categories will be separately considered. These are measured as per-capita tax revenues as a proportion of mean income and are collected from *State Government Finances*.

The income tax and inequality may be related. Simple median voter political models such as those of Persson and Tabelini (1994) and Alesina and Rodrik (1994) suggest that greater inequality will increase redistributive pressures and thereby lead to higher income taxes. Since inequality is measured at the beginning of the nine-year period and the income tax is an average of present and future income taxes, one might suspect that the income tax itself is endogenous. To account for this possibility, some specifications will instrument for the income tax using inequality as one of the explanatory variables. In particular, a predicted value for the income tax will be estimated from:

$$T_I = b_0 + b_1 P + b_2 IN + b_3 T_S + \epsilon_{it} \qquad (5)$$

where T_I is the income tax, T_S is the sales tax, and fixed effects are included.

IV. Results

The results are presented in Tables 2 to 5. I first describe the general pattern of the results and follow this with a more detailed discussion.

Education spending is found to have a positive impact on economic growth in all specifications. Other spending is found to have a negative impact on economic growth in all specifications.

The results on inequality are more complex. Inequality is initially found to have a negative impact on economic growth, but education spending is found to have a negative impact on inequality. Once the relationship between inequality and education is accounted for, the estimated impact of inequality on growth is reduced, but remains negative and significant. If the average income tax over the period is assumed to be influenced through a political mechanism by the initial inequality measure, and this is accounted for by further instrumenting for the income tax measure, inequality is found to have a significant positive impact on the income tax, but no significant impact on economic growth. This suggests that the sources of the negative relationship between inequality and growth are the impact of education spending on inequality and the impact of inequality on the political choice concerning the use of the income tax.

The income tax is found to have either a negative or no impact on economic growth and the corporate tax is also found to have either no impact or a negative relationship. These results depend to some extent on the method of estimation. Instrumental variable methods tend to indicate a

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negative impact of the income tax and no impact for the corporate tax. Two-stage and three-stage least squares methods with the income tax treated as endogenous find an insignificant coefficient for the income tax and a significant negative coefficient for the corporate tax.

Looking in more detail at the results, Table 2 gives the results of five estimation methods. Each takes the growth rate as the dependent variable, and include the initial income level, an inequality measure, per-pupil education spending level and the per-capita level of other spending, and an average measure of the income and corporate tax rates over the period as dependent variables. Fixed effects are included in all specifications to control for between state differences that do not change over time. The first column gives the results from ordinary least squares, the second through fourth columns give the results from instrumental variable estimations, and the fifth column gives the results for two-stage least squares. The first instrumental variables estimation, IV-1, instruments for education, the second, IV-2, instruments for education and inequality, and the third, IV-3, instruments for education, inequality, and the income tax. The underlying regressions used to determine predicted values are detailed in Table 3.

The coefficient on the initial income variable indicates evidence of conditional income convergence, as in cross-country growth regressions. Education spending is consistently positively related to growth and other spending negatively related to growth. The income tax is fairly consistently negatively related to growth, though not significantly in the two-stage least squares estimation. The corporate tax is insignificant except for the negative relationship found in the two-stage least squares approach. Inequality is negatively related to growth initially, but its coefficient and significance level is reduced when it is instrumented in IV-2, and it becomes insignificant once the income tax is instrumented in IV-3 and in the two-stage least squares results.

Table 3 reinforces the reasons for the insignificance of inequality in the last specifications. Education spending is found to be negatively related to inequality, and inequality is positively related to the future level of income tax. Once these relationships are accounted for, inequality itself is no longer related to economic growth.

Tables 4 and 5 re-run specifications corresponding to IV-2 and IV-3 using three-stage least squares. Table 4, which corresponds to IV-2, confirms the IV specification results with the exception of the income tax, which is marginally insignificant. Education spending is again found to be positively related to economic growth and negatively related to inequality. Table 5, which corresponds to IV-3, also confirms the IV results with the exception of the tax variables. In this specification, the income tax is found to be insignificant while the corporate tax is found to have a negative and significant effect on economic growth. Education spending is again found to positively impact economic growth and negatively impact inequality.

V. Conclusion

Education spending and finance have undergone significant changes in the past several decades. Endogenous growth models and new theories on the link between growth and inequality suggest that these changes may impact economic growth. Endogenous growth models suggest that government spending that increases human capital can be expected to increase growth, while taxes that decrease the incentive to invest in human or physical capital can be expected to decrease growth. One new theory on the link between growth and inequality suggests a positive relationship between education and inequality, while another suggests that inequality may drive political decisions on

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redistributive policy.

The results of this paper are supportive of all of these links. Education spending is found to positively affect growth, while income and corporate taxes are found to either decrease or have no effect on growth. Education spending is found to decrease inequality, and inequality is found to have a positive effect on future redistributive taxes. When these two forces are accounted for, inequality is found to have no effect on economic growth, rather than a negative effect that is found without accounting for the interrelationships between inequality and education and tax policy.

The results of this paper are also consistent with certain results of previous studies, and hence bring together several different empirical strands of literature. In particular, the finding of a positive impact of education on growth is consistent with the results of Helms (1985) and Kneller et. al. (1999). The initial finding that inequality is negatively related to economic growth in fixed effects regressions is consistent with evidence from cross-sectional country-level data (but contrary to country-level regressions that include fixed effects) and contrary to the results of Partridge (1997) that exclude fixed effects from state-level regressions. The finding that income tax increases negatively affect growth is consistent with the findings of Helms (1985), Kneller et. al. (1999), and Mendoza et. al. (1997).

There is much future work to do on this topic. In particular, we have not exploited here differences in the timing and character of educational reforms across states. Such differences should allow a more detailed examination of the impact of different types of educational reforms on growth rates in future research.

Table 1

Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
growth rate	0.010473	0.009746	-0.02373	0.036207
log of initial income	9.401787	0.174642	8.993092	9.927669
inequality	2.552463	0.299477	2.002429	3.296375
education spending	2804.83	1014.839	1172.91	8115.203
other spending	1043.586	568.3903	441.3601	5121.515
income tax	0.017657	0.011938	0	0.054063
corporate tax	0.00605	0.009932	0	0.092635
median income	30978.37	4189.98	22643.56	43621.62
E/N	0.190731	0.028693	0.135639	0.261811
grants	356.5553	294.1572	87.25603	3154.968
poverty	13.096	4.41188	2.9	29.2
sales tax	0.037166	0.01976	0.004932	0.09445

Data sources: *State Government Finances* (various years), *Bureau of Economic Analysis* (various years), and *Statistical Abstract of the United States* (various years).

Table 2
Regression Results
Dependent variable: growth rate

	OLS	IV-1	IV-2	IV-3	2SLS
constant	0.924 (9.12)	1.058 (10.3)	1.025 (8.9)	1.003 (9.02)	1.327 (7.28)
initial income	-0.089 (-8.14)	-.107 (-9.35)	-.105 (-8.31)	-.104 (-8.64)	-.144 (-6.52)
inequality	-0.027 (-5.65)	-.024 (-5.5)	-.017 (-2.75)	-.004 (-.609)	.0067 (.653)
education spending	.000004 (1.61)	0.000011 (3.7)	0.000014 (4.12)	0.000012 (3.86)	0.00003 (3.49)
other spending	-.000012 (-2.67)	-.0000009 (-2.63)	-.000014 (-3.16)	-.00001 (-2.36)	-.00003 (-3.78)
income tax	-.378 (-2.44)	-.247 (-1.67)	-.509 (-3.32)	-1.37 (-4.37)	-1.14 (-1.50)
corporate tax	-.111 (-.724)	.011 (.075)	-.094 (-.585)	-.054 (-.35)	-.43 (-1.80)
state fixed effects included	yes	yes	yes	yes	yes
R^2	.58	.62	.54	.57	.07

Notes for Table 2: IV-1 uses predicted values of column 1 of table 3 to instrument for education, IV-2 use the same instrument for education as IV-1 and column 2 of table 3 to instrument for inequality, and IV-3 uses the same instruments for education and inequality as IV-2 and column 3 of table 3 to instrument for income tax.

Table 3
Underlying Instrument Regressions for Table 2

	dependent variable		
	education	inequality	income tax
constant	4067 (8.00)	3.98 (26.4)	-0.019 (1.47)
median income	0.072 (5.13)		
E/N	-19272 (-11.8)		
grants	.5149 (3.33)		
poverty		-.029 (-3.1)	-.0004 (-1.25)
education spending		-.00037 (-14.9)	
sales tax			-.060 (-.884)
inequality			.018 (4.33)
state fixed effects included	yes	yes	yes
R^2	.73	.69	.47

Table 4

3 SLS Regression Results: Income tax predetermined

| | dependent variable | | |
	growth rate	education spending	inequality
constant	0.917 (5.2)	5467 (15.3)	4.122 (35.2)
initial income	-0.100 (-4.53)		
inequality	-0.0024 (-0.242)		
education spending	0.00002 (2.25)		
other spending	-.0000009 (-1.27)		
income tax	-0.255 (-1.65)		
corporate tax	-0.0025 (-0.013)		
median income		0.031 (3.09)	
E/N		-19736 (-17.0)	
grants		0.358 (3.5)	
education spending			-.000047 (-21.5)
poverty			-.018 (-2.62)
state fixed effects included	yes	yes	yes
"R^2"	0.25	.70	.63

Table 5
3 SLS Regression Results: Income tax endogenous

	dependent variable			
	growth rate	education spending	inequality	income tax
constant	1.23 (8.17)	5562 (15.5)	4.11 (35.0)	-0.024 (-2.46)
initial income	-0.140 (-7.37)			
inequality	0.0049 (0.419)			0.019 (5.90)
education spending	0.00003 (4.96)			
other spending	-.000015 (-2.15)			
income tax	0.302 (0.514)			
corporate tax	-0.409 (-2.21)			
median income		0.032 (3.15)		
E/N		-20244 (-17.3)		
grants		0.307 (3.1)		
education spending			-.0004 (-21.7)	
poverty			-0.017 (-2.53)	-.00027 (-1.13)
sales tax				-.070 (-1.31)
state fixed effects included	yes	yes	yes	yes
"R^2"	-.35	.70	.63	.47

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