HOW DOES STATE AND LOCAL EDUCATION SPENDING AFFECT STATE ECONOMIC GROWTH IN THE LONG RUN?

John Deskins, Creighton University
Brian Hill, Salisbury University
M. H. Tuttle, Sam Houston State University

INTRODUCTION

A LARGE BODY OF LITERATURE HAS INVESTIGATED the effect of public spending for education on U.S. state economic growth (see, for example, Fisher, 1997; Dalenberg and Partridge, 1995; Taylor and Brown, 2006). Theoretically the effect of education spending on state economic growth is ambiguous when financed through own-source revenues since the potentially positive effects of education spending could be outweighed by the negative growth effects generated by own-source revenues. Empirical results vary widely in this literature in terms of magnitude as well as sign. It is crucial to recognize that most of the existing literature on education spending and state economic growth examines the relationship between either (1) the contemporaneous levels of education spending and economic activity, (2) the current level of economic activity and one-year lagged education spending, or (3) economic growth from time t to t+1 (or t+3) and education spending in time t. The literature does not use long-run times-series econometrics methods generally despite the likelihood that an increase in education spending may require several years to translate into the greater human capital which promotes economic activity.

In this study we extend this literature by providing a long-run analysis of the effect of state and local education spending on state economic growth in the United States. We use a panel of state-level data for all U.S. states for the period 1977 through 2003. Our key contribution is that, through the use of dynamic panel estimation techniques, we are able to estimate long-run equilibrium effects of variation in education spending on economic activity, as well as short-run transitional effects. Only one other paper (Tomljanovich, 2004) has been identified that utilizes time-series econometric techniques to analyze the long-run relationship between education spending and economic activity. We build upon Tomljanovich in several ways, such as by investigating the short-run response of state economic growth from changes in education spending. We are careful to control for all elements of the state budget to clearly identify the effect of education spending that is financed thorough own-source revenues and to avoid omitted variable bias, the necessity of which is show in Helms (1985), Dalenberg and Partridge (1995), and others. For robustness, we consider two measures of state economic activity, state gross domestic product (GDP) and total state employment, and we consider combined state and local spending.

Results indicate that, when financed through own-source revenues, education spending exhibits a positive effect on state GDP in the long run, with an estimated elasticity of 0.48. As suggested by theory, this positive response takes place over decades, given a predicted half-life of nearly 18 years. Results also suggest a bi-causal relationship, since education spending responds positively to changes in state income. We find no short-run relationship between education spending and state GDP. In contrast to the GDP results, we find a negative long-run relationship between education spending and employment when financed through own-source revenue.

EXISTING LITERATURE

Fisher (1997) provides a review of 19 studies that investigate the relationship between public education spending and regional economic activity. These studies vary in terms of which education spending and economic activity measures are considered, whether they conduct state-, local-, or metro-area-level analyses, the time period of analysis, and econometric methodology. Results also vary widely in terms of magnitude, and even, sign of the estimated relationship between education spending and economic activity. It is also worth noting that several of the earlier studies fail to control for the general equilibrium effects associated with an increase in public education revenues (i.e., researchers often fail to control for all elements of the state budget) even though a change in education

spending necessarily corresponds to some other change in the government budget.[1]

The wide variation in early statistical results and the availability of stronger econometric techniques has led researchers to conduct several additional studies since 1995.[2] Harden and Hoyt (2003) study the impact of cutting school expenditures on state employment levels. They use statewide data from 1980 through 1994 to jointly estimate employment and revenue within a balanced budget framework. They find that cutting K-12 education expenditures is more detrimental to long-run statewide employment levels than is an equivalent decrease in other state expenditure programs including highways and hospitals. Bensi et al. (2004) use a series of bivariate regression models to examine the direction of causality in the relationship between state-level per pupil expenditures and real personal income. They conclude that when growth and expenditure data are calculated relative to the U.S. average, greater education expenditures cause greater income growth.

Another dimension upon which existing research varies relates to the time period of analysis. Generally speaking, earlier results tend to show a positive relationship between education spending and economic activity, while more recent studies more often find a negative relationship. Taylor and Brown (2006) investigate the possibility that the relationship between various types of public expenditures on private sector economics has changed over the past 20 years or so. Earlier papers typically use data from a period of slow growth in government expenditures (late 1970s to the late 1980s). According to Taylor and Brown, the different results found in later papers may be due to the rapid growth in government expenditures (at the combined state and local level) that began in the late 1980s. They hypothesize that the effect of an increase in government spending is significantly impacted by the existing level of government expenditure growth, and further, increases in government spending will have a muted effect on growth in an economy with high existing levels of government expenditure growth. Therefore, they expect government spending in the mid- to late-1990s, during which government expenditures were moderated, to lead to more positive impacts on economic activity relative to a period of rapid spending growth. Their results show, using a 10-year rolling windows approach, that the effect of increased government spending on private employment and private output remains relatively stable and significantly negative throughout the entire period of analysis (although they do find significant changes over time with other types of public spending).

Despite the large number of studies that investigate the relationship between education spending and economic activity, to our knowledge, all have used more traditional, panel data methods or have used first differences. Only one paper (Tomljanovich, 2004) has been identified that uses a time-series approach to investigate this question. Tomljanovich uses a long-run model that allows him to investigate the long-run equilibrium relationship economic activity and education spending among U.S. states. His methodology also allows for the consideration of short-run transitional relationship for some of the fiscal variables he considers and economic activity, but he does not consider such relationships for education spending. Using state-level data for the period 1972 through 1998, Tomljanovich finds a negative long-run relationship between the growth rate of per capita real GDP and education spending as a share of GDP in one specification and fails to find any statistically significant relationship between the two variables in two other specification.

In this analysis, we build upon Tomljanovich (2004) in several important ways. First, we estimate the short-run response of state economic activity from changes in education spending. Second, we measure education spending in per capita terms rather than as a share of state GDP. We feel the per capita measure of education spending is preferred because education spending expressed as a share of GDP is necessarily between zero and one, and thus its variance cannot be a function of time and it cannot explode to infinity as time approaches infinity. In other words, strictly speaking, a share variable cannot have a unit root. Third, we consider private sector employment as an additional measure of state economic activity. And fourth, we consider combined state and local education spending as opposed to only state spending, which we feel is appropriate consider local spending comprises such a large share of total education spending in any state.

EMPIRICAL DESIGN AND DATA

In this study we quantify the effect of public education spending on state economic growth

through the estimation of a series of regression models of state economic activity on state and local education spending and other control variables as appropriate. Our primary contribution, as discussed above, is to utilize dynamic ordinary least squares (DOLS) regression methodology to examine both the long-run relationship between public education spending and economic activity as well as the short-run transitional relationship. All models are estimated using a panel of state-level data for all 50 U.S. states for the years 1977 through 2003, resulting in 1,200 observations. All variables that are measured in dollar terms are adjusted for inflation to the 2004 price level using the consumer price index. See Appendix 1 and Appendix 2 for summary statistics and source notes.

Our dynamic panel regression model to estimate the long-run effect of education spending on state economic activity in equation 1:

$$\textbf{(1)}\quad Ln(y_{it}) = \beta Ln(educ_{it}) + x_{it}^{j}\gamma + \sum_{j=-k}^{k} \rho \Delta Ln(educ_{it-j}) + \sum_{j=-k}^{k} \Delta x_{it-j}^{j}\varphi + \alpha_i + \theta_t + \varepsilon_{it},$$

where y denotes economic activity. Economic activity is measured as non-government state GDP as well as total private sector employment in the state.[3] Existing research has used both of these measures of economic activity, but usually in isolation; we consider both to provide for greater robustness.

On the right-hand side, *educ* is per capita state and local education spending. We combine state government expenditures with all local government expenditures within a state, which we view as most appropriate in the context of education spending. While much of the existing literature has measured education spending as a share of state personal income (SPI) or state GDP, we only use a per capita measure. We feel that an SPI share specification is inappropriate in this dynamic panel context because it takes on values that are necessarily between zero and one, and thus its variance cannot be a function of time and it cannot explode to infinity as time approaches infinity. In other words, strictly speaking, a share variable cannot have a unit root.

The vector x represents other control variables including the other elements of the state budget. We control for all elements of the state budget to obtain an unbiased estimate of the effect of education spending. More specifically, we include total non-education government expenditures, federal transfers, and the total budget surplus. We omit one element of the government budget to avoid perfect multi-collinearity. The choice of which variable to omit is arbitrary. We choose to omit total own-source revenue such that our results can be interpreted as a change in education spending financed through own-source revenues (since own-source revenue is the only other budgetary element allowed to vary in our econometric model). We feel this approach is appropriate since the policy debate often takes this point of view. We also control for population density in all models. These variables are also measured in natural logs. We also control for the natural log of state population density.

Other researchers have used a specification similar to equation (1) to examine the impact of taxes on gross state product growth.[4] Equation (1) employs a parametric correction for endogeneity and serial correlation, as suggested by Stock and Watson (1993). In equation (1), this parametric correction is provided by the k first-differenced leads and lags of the right-hand side variables.[5] Further, White's (1980) correction is employed, as suggested by Karras (1999) and Tomljanovich (2004). In equation (1), β represents the estimated long-run elasticity of state GDP growth with respect to state and local education spending.

Following estimation of equation (1), the short-run, dynamic adjustment of state GDP and employment associated with changes in education spending are examined via an error-correction model (ECM). Equation (2) provides an overview of the ECM specification. The ECM includes the vector z, which includes the lagged first-difference of the variables in vector x in equation (1).

$$\textbf{(2)}\quad \Delta Ln(y_{it}) = \mu ect_{it-1} + \eta \Delta Ln(educ_{it-1}) + z_{it}^{j}\delta + \pi_i + \tau_t + \varepsilon_{it}.$$

The long run adjustment of state GDP and employment are represented by μ. If state GDP and employment responds to changes in state and local educational spending, then the parameter μ should be negative and fall between zero and negative one. Specifically, the parameter μ is the adjustment or, more precisely, the percent of long-run disequilibrium that is eliminated in each year. This parameter, μ, conveys the speed of the response of state GDP, given by the parameter β in equation (1), to education spending. The error-correction term

(ECT) is derived from equation (2). Equation (3) presents the ECT calculation.

(3) $Ln(y_{it}) - \beta Ln(educ_{it}) - x_{it}^{j}\gamma = ect_{it}$.

RESULTS AND DISCUSSION

Next we turn to results from the dynamic OLS models (corresponding to equation 1 above), which are reported in Table 1. The first column is the long-run results for state per capita GDP and the second column are the results for private sector employment. Most importantly, the long-run elasticity of per capita state GDP, with respect to state per capita education financed by an equal increase in own taxes is estimated to be 0.479. Therefore, the long-run impact of education spending is positive, overcoming any potential negative effects from an increase in taxes. This finding of a positive effect over the long run, of course, stands in large contrast to much of the recent research on the topic, which uses models similar to those in the first part of our analysis that analyze short-run growth in economic activity.

Statistically, the effect of education spending is equal to non-education spending. The elasticity of per capita state GDP with respect to state per capita non-education spending is slightly smaller, equaling 0.414. However, a test of equality between the two fails to reject the null with an associated *p*-value of 0.35.

The second column of Table 1 provides the results for the long-run response of private sector employment. Interestingly, the elasticity of employment with respect to education spending is negative. This result may not be surprising if the benefits of education are revealed through increased productivity rather than an increase in the number of jobs. Further, this effect is of the same size but the direction of the effect is opposite that of non-educational spending per capita.

Short-Run Estimates

In Table 2 we present the results from the error-correction model represented by equation (2). Our estimates indicate that state per capita GDP and private sector employment respond to changes in state educational spending in the short run. The error-correction parameter is the percentage of a short-run disequilibrium that is removed each year. For example, from Table 1, a 1 percent increase in education spending increases state per capita GDP by 0.48 percent. The value of the error-correction parameter suggests that half of this increase takes place after 6½ years and three-quarters of

Table 1
Long-Run Regression Results - Economic Activity on Education Spending

Variable	*Ln(State GDP)*	*Ln(Private Sector Employment)*
Education Spending per Capita	0.479***	-0.088***
	(0.043)	(0.027)
Non-Education Spending per Capita	0.414***	0.084***
	(0.037)	(0.024)
Federal Grants per Capita	-0.131***	-0.039**
	(0.810)	(0.016)
Total Budget Surpus per Capita	0.003	-0.001
	(0.010)	(0.004)
Population Density	1.191***	0.893***
	(0.040)	(0.025)
Constant	13.610***	16.336***
	(0.138)	(0.072)
R-squared	0.998	0.999

Entries are regression coefficients with standard errors in parentheses.

*, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels.

Education spending variables are measured in hundreds. All other government expenditure variables are measured in thousands.

All variables measured in dollars are adjusted for inflation to the 2004 price level.

Table 2
Short-Run Regression Results - Economic Activity on Education Spending

Variable	*Change in Change in State GDP* $_{t/t-1}$	*Private Sector Employment* $_{t/t-1}$
Error Correction Term $_{t-1}$	-0.038	-0.118***
	(0.024)	(0.016)
Change in Education Spending per Capita $_{t-1/t-2}$	-0.024	-0.006
	(0.055)	(0.014)
Change in Non-Education Spending per Capita $_{t-1/t-2}$	0.038	-0.018
	(0.033)	(0.014)
Change in Federal Grants per Capita $_{t-1/t-2}$	-0.011	0.007
	(0.019)	(0.007)
Change in Total Budget Surpus per $_{t-1/t-2}$	0.002	0.001
	(0.005)	(0.001)
Change in Populat ion Density $_{t-1/t-2}$	0.171	0.062
	(0.331)	(0.088)
Change in State GDP $_{t-1/t-2}$	0.302***	-
	(0.085)	-
Change in Private Sector Employment $_{t-1/t-2}$	-	0.461***
	-	(0.039)
Constant	0.550*	1.953***
	(0.327)	(0.269)
R-squared	0.443	0.709

Entries are regression coefficients with standard errors in parentheses.

*, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels.

Education spending variables are measured in hundreds. All other government expenditure variables are measured in thousands.

All variables measured in dollars are adjusted for inflation to the 2004 price level.

the effect occurs after 12 years.[6] Therefore, the error-correction results suggest that the effects of educational spending occur across generations. Educational spending per capita does not appear to have an immediate impact on state incomes, since the parameter is statistically insignificant. Non-educational spending has a small, immediate impact on state GDP (Table 2) and a larger, long-run impact (Table 2). The opposite is true of federal grants, given the results in Tables 1 and 2.

The long-run effect of educational spending on employment is negative from the results in Table 1, and the effect takes many years; the estimated half-life is 15 years. Interestingly, non-educational spending has a negative, immediate effect (from Table 2), but the long-run elasticity is positive (and economically small). The effect of population density follows the same pattern as non-educational spending.

CONCLUSIONS

In this paper we return to the large literature that examines the relationship between public education spending and state economic activity. We contribute to an already sizeable literature on the subject by using time-series analysis to address the question, rather than more standard cross-section or panel data econometric methods. This approach allows us to examine the long-run relationship between education spending and economic growth, as well as the short-run transitional relationship.

Results indicate that, when financed through own-source revenues, education spending exhibits a positive effect on state GDP in the long run, with an estimated elasticity of 0.48. As suggested by theory, this positive response takes place over decades, given a predicted half-life of nearly 18 years. Results also suggest a bi-causal relationship, since education spending responds positively

to changes in state income. We find no short-run relationship between education spending and state GDP. In contrast to the GSP results, we find a negative long-run relationship between education spending and employment when financed through own-source revenue.

Notes

[1] See Helms (1985) and Mofidi and Stone (1990) for examples of studies that do properly control for all budgetary elements.

[2] See also Bartik (1994).

[3] We focus on private sector economic growth but all of the estimations below were also performed on total economic growth. These estimations resulted in very similar results compared to those that use private-sector economic growth and are available from the authors upon request.

[4] See Karras (1999) or Tomljanovich (2004).

[5] In all estimations of equation (1), k is equal to one.

[6] The percent of disequilibrium removed in each period is $1-(1+\mu)^t$.

References

Bartik, Timothy J. Jobs, Productivity, and Local Economic Development: What Implications Does Economic Research Have For The Role of Government? *National Tax Journal*,47 (December 1994): 847-861.

Bensi, Michelle T., David C. Black, and Michael R. Dowd. The Education/Growth Relationship: Evidence from Real State Panel Data. *Contemporary Economic Policy* 22 (April 2004): 281-298.

Dalenberg, Douglas R., and Mark D. Partridge. The Effects of Taxes, Expenditures, and Public Infrastructure on Metropolitan Area Employment. *Journal of Regional Science* 35 (November 1995): 617-640.

Fisher, Ronald C. The Effects of State and Local Public Services on Economic Development. *New England Economic Review* (March/April 1997): 53-82.

Harden, J. William, and William H. Hoyt. Do States Choose Their Mix of Taxes to Minimize Employment Losses? *National Tax Journal* 56 (March 2003): 7-26.

Helms, L. Jay. The Effect of State and Local Taxes on Economic Growth: A Time Series-Cross Section Approach. *Review of Economics and Statistics* 72 (November 1985): 574-582.

Karras, Georgios. Taxes and Growth: Testing the Neoclassical and Endogenous Growth Models. *Contemporary Economic Policy* 17 (April 1999): 177-188.

Mofidi, Alaeddin and Joe A. Stone. Do State and Local Taxes Affect Economic Growth? *Review of Economics and Statistics* 72 (November 1990): 686-691.

Stock, James A. and Mark W. Watson. A Simple Estimation of Cointegrating Vectors in Higher Order Integrated Systems. *Econometrica* 61 (July 1993): 783-820.

Taylor, Lori L. and Stephen P. Brown. The Private Sector Impact of State and Local Government: Has More Become Bad? *Contemporary Economic Policy* 24 (October 2006): 548-562.

Tomljanovich, Marc. The Role of State Fiscal Policy in State Economic Growth. *Contemporary Economic Policy* 22 (July 2004): 318-330.

White, Halbert. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica* 48 (May 1980): 817-838.

Appendix 1
Summary Statistics

	1985		*2003*	
Mean	*Mean*	*Std.Dev.*	*Mean*	*Std.Dev.*
Private Employment Growth (%)	1.792	2.758	0.566	1.069
Non-Government Gross State Product Growth (%)	3.019	8.917	7.423	2.485
Education Spending per Capita (hundreds)	0.852	0.265	2.146	0.314
Education Spending/SPI (%)	6.112	1.522	7.124	1.020
Federal Grants per Capita (thousands)	0.466	0.132	1.454	0.462
Non-Education Spending per Capita (thousands)	2.004	0.991	5.092	1.267
Total Budget Surplus per Capita (thousands)	0.302	0.455	-0.011	0.477
Population Density	0.160	0.228	0.187	0.256

All dollar amounts are expressed as current year dollars.

Appendix 2
Data Descriptions and Source Notes

Variable	*Definition*
Private Employment Growth (%)	Growth rate private state employment from t to t+1. (1)
Non-Government Gross State Product Growth (%)	Growth rate of non-government Gross State Product from t to t+1. (2)
Education Spending per Capita	Total state and local government spending on education divided by state population. (3)
Non-Education Spending per Capita	(Total government spending - total education spending)/ population. (3 and 4)
Total Federal Transfers to per Capita	Total federal transfers/population. (3 and 4)
Total Budget Surplus per Capita	(Total government revenues - total government spending)/population. (3 and 4)
Population Density	Population/square miles in a state. (5)

Source Notes:

1. Author's calculations based on data from Employment and Wages, Bureau of Labor Statistics, various years,
2. Author's calculations based on data from Regional Economic Accounts, Bureau of Economic Analysis, various years.
3. Author's calculations based on data from State Government Finances, U.S. Census Bureau, various years.
4. Author's calculations based on data from State Government Finances, U.S. Census Bureau, various years, and Regional Economic Accounts,Bureau of Economic Analysis, various years.
5. Author's calculations based on data from Statistical Abstract of the United States, U.S. Census Bureau, various years.