Public education expenditures, taxation and growth: Linking data to theory

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Governments around the world have taken a prominent role in financing education. While justifications for this involvement are varied, a common motivation is that education expenditures are a key to sustained economic growth. Economic theory provides a foundation for this belief. Many papers in the endogenous growth literature have formalized a link between public education expenditures, human capital accumulation and long-run growth.[1]

While theory assigns public education expenditures a key role in growth, empirical support of the link is mixed.[2] As highlighted by William F. Blankenau and Nicole B. Simpson (2004), the disconnect between theory and data can be reconciled by taking a closer look at the theory. In nearly every model where growth is fueled by public education expenditures, a non-monotonic relationship between expenditures and growth can arise. Public education spending increases growth while taxes may decrease growth, leaving the net effect ambiguous.

Thus economic theory shows that to identify the growth effects of expenditures, one must account for any offsetting effects of the requisite taxation. However, most empirical investigations of these effects do not explicitly control for the method of finance.[3] In contrast, we make the relationship between expenditures, taxation and growth central to our analysis. We estimate a growth equation which arises from a fully specified theoretical model where public education expenditures matter for growth. A key innovation is that the regression accounts for the general equilibrium adjustment to the taxes levied in support of education.

Using panel data from 23 developed countries over the period 1960-2000, we find a positive relationship between public education expenditures and long-run growth only when

controlling for the government budget constraint.[4] An interpretation of these results is that studies which fail to control for the method of finance underestimate the role of public education expenditures. A statistically insignificant coefficient in such analyses may indicate a positive growth effect of expenditures that is offset by the negative consequences of taxation.

I. Model

We develop an overlapping generations growth model which shares some features with Gerhard Glomm and B. Ravikumar (1997) and William F. Blankenau and Nicole B. Simpson (2004). A representative three-period-lived agent is born in each period. When young in period *t*, the agent receives an endowment of public education inputs, E_t. Public inputs combine with the human capital of the prior generation, h_t, to create human capital according to

(1) $$h_{t+1} = \xi E_t^{\mu} h_t^{1-\mu}; \ \mu \in [0,1], \xi > 0.$$

As a worker in period *t+1*, the agent receives net labor income equal to $\omega_{t+1} h_{t+1}(1-\tau_i)$ where τ_i is the tax rate on income and ω is the wage for a unit of human capital. The worker saves for old age through capital accumulation. Capital holdings at the end of period *t+1* are K_{t+2}. A unit of capital purchased in period *t+1* returns $r_{t+2}(1-\tau_i)$ units in period *t+2* where r_{t+2} is the rental rate on capital.

A period *t* agent maximizes lifetime utility by choosing consumption in periods *t+1* and *t+2* ($C_{t,t+1}$ and $C_{t,t+2}$) and K_{t+2}. Utility is logarithmic in $C_{t,t+1}$ and $C_{t,t+2}$ and utility in period *t+2* is discounted at the rate of β. Consumption is taxed at the rate τ_c. The agent's budget constraint in period *t+1* is $C_{t,t+1}(1+\tau_c) + K_{t+2} \le w_{t+1} h_{t+1}(1-\tau_i)$ and in period *t+2* is $C_{t,t+2}(1+\tau_c) \le r_{t+2}(1-\tau_i)K_{t+2}$. Solving the agent's problem for optimal savings yields

(2) $$K_{t+2} = \beta(1+\beta)^{-1} \omega_{t+1} h_{t+1}(1-\tau_i).$$

The firm combines physical capital and human capital to generate the final good according to $y_t = Ak_t^{\alpha}$, where y_t is output per unit of human capital and k_t is the ratio of physical capital to human capital used in production. Parameter restrictions are $\alpha \in [0,1]$ and $A>0$. The firm's optimization problem yields $r_t = A\alpha k_t^{\alpha-1}$ and $\omega_t = A(1-\alpha)k_t^{\alpha}$.

Government spends a share *e* of output on education expenditures. An additional share of output, *g*, is spent by the government for purposes other than education. Expenditures are financed through taxes on labor and capital income, through a consumption tax, or through borrowing which is proportional to output (Y_t) and given by bY_t. Government policy then is the set $\{\tau_i, \tau_c, e, g, b\}$. These are related through the government budget constraint by

(3) $$\tau_i \omega_t h_t + \tau_i r_t K_t + \tau_c (C_{t-1,t} + C_{t-2,t}) = (e+g+b)Y_t.$$

Expenditures are related to educational inputs by $E_t = \tilde{e} Y_t$ where $\tilde{e} \equiv \exp(e)$. Along a balanced growth, equation (1) reduces to

(4) $$1+\gamma = \xi(\tilde{e} A k^{\alpha})^{\mu}$$

where γ is the growth rate. Substituting equation (1) and wages into equation (2) yields an equation for $k = k(\xi, A, \alpha, \beta, \mu, e, \tau_i)$. Putting this into equation (4), taking the logarithm of each side and using $\ln(1+\mathrm{x}) \approx \mathrm{x}$ gives

(5) $$\gamma \approx \overline{\beta}_0 + \beta_1 e + \beta_2 \tau_i$$

where $\overline{\beta}_0 = \overline{\beta}_0(A, \xi, \alpha, \beta, \mu)$, $\beta_1 = \beta_1(\alpha, \mu)$ and $\beta_2 = \beta_2(\alpha, \mu)$.

To complete the model, we make use of equation (3) to find the relationship between *e* and τ_i. Let $\tilde{C}_t$ represent total consumption. Then equation (3) implies $\tau_i = (e+g+b)/(1+\phi)$

where $\phi = (\tau_c \tilde{C}_t)/(\tau_i Y_t)$ is the ratio of consumption tax revenue to income tax revenue and is constant with balanced growth. Equation (5) then becomes $\gamma \approx \bar{\beta}_0 + \beta_1 e + \beta_2 (g + e + b)/(1 + \phi)$.

Turning to the empirical specification of this relationship, we assume that $\bar{\beta}_0$ can be approximated by a constant β_0 and *m* observable items. We allow for the possibility of convergence by controlling for the level of income in country *n* at time *0*, denoted $y_{n,0}$. We also control for heterogeneity over time and across countries by allowing two-way fixed effects, denoted by δ_t and η_n. To account for measurement error and the stochastic nature of the growth process, we include an error term $u_{n,t}$. Thus our growth regression is

$$(6) \qquad \gamma_{n,t} = \beta_0 + \beta_1 \ln e_{n,t-1} + \beta_2 \left[\frac{g_{n,t} + e_{n,t} + b_{n,t}}{1 + \phi_{n,t}} \right] + \sum_{j=1}^{m} \beta_{j+2} x_{j,n,t} + \beta_{m+3} y_{n,0} + \delta_t + \eta_n + u_{n,t}$$

where $x_{j,n,t}$ is the measure of item x_j of country *n* in period *t*. We lag education expenditures one period (i.e., five years) since it takes time for public education expenditures to impact growth.[5]

Replacing the item following β_2 in equation (6) with actual income taxes gives the analog to the specification in Michael F. Bleaney et al. ((1999); hereafter BGK). There, a one unit increase in e_t would increase predicted growth by β_1. This requires the implicit assumption that increments to education spending are funded from nondistortionary revenue sources. We instead allow for expenditures to be financed by distortionary taxes but assume that revenue shares across the types of taxes are unaffected by e_t; that is, ϕ_t is independent of e_t.[6]

II. Empirical Analysis

We use data from 1960-2000 for a group of 23 developed countries[7]; the data are from the World Development Indicators (WDI) database of the World Bank (unless otherwise noted).

The dependent variable is the five-year average of the annual per capita real GDP growth rate for each country. The independent variables also represent five-year averages and the share variables are expressed as a percentage of GDP.

Our model suggests that taxation can alter the positive growth effects from increased public education expenditures. We therefore run a series of regressions using ordinary least squares (OLS) in which we compare the estimated growth effects of public education expenditures with and without τ_i.[8] We control for other variables that potentially affect the relationship between growth and public education expenditures. The initial level of economic development (y_0) is often considered to impact how fast countries grow (Robert J. Barro and Xavier Sala-i-Martin (1999)); we use 1960 per capita GDP as a proxy for y_0. There is evidence supporting the inclusion of government spending net of education (g) and the federal government budget surplus (b) in the growth regression as additional regressors (William Easterly and Sergio Rebelo (1993) and BGK (1999)). Also, a large literature suggests educational outcomes are important determinants of growth.[9] We control for gross enrollment ratios for primary schooling (S), as reported in the World Bank's EdStats. We also include country- and time-specific fixed effects (where appropriate).

First, we consider the basic relationship between public education expenditures and growth when not controlling for taxation, by estimating equation (6) but setting $\beta_k = 0$ for $k > 1$ (Regression 1). This specification does not consider the growth effects of other fiscal factors, nor does it address how public education spending is funded. We then re-estimate equation 1 but set $\beta_k = 0$ for $k > 2$, thus allowing for the revenue side of fiscal policy to impact growth rates (Regression 2). Table 1 reports the estimation results. Regressions 1 and 2 indicate that public

education spending does not significantly influence long-run growth, even when we control for crowding-out effects in Regression 2.

Next, we include the full set of control variables as described above and estimate the model without taxes (Regression 3) and with taxes (Regression 4). Regression 3 yields similar results as in Regressions 1 and 2; public education expenditures do not affect growth. However, Regression 4 shows that when crowding-out effects are considered along with our controls, public education expenditures positively affect growth. A one percentage point increase in public education expenditures results in a 0.201 percentage point increase in growth. In addition, lower distortionary tax rates are found to permanently increase growth rates, with a one percentage point drop in τ_i resulting in a 0.099 percentage point increase in a country's per capita growth rate. That is, the growth effects of public education expenditures may not be significant unless the method of finance is taken into consideration. This finding is robust to several other specifications (which are available upon request). Our result stresses the importance of imposing the government budget constraint when estimating growth effects of government spending, similar to the findings of BGK (1999), and may also explain why the empirical findings on the relationship between growth and public education expenditures are mixed.

Lastly, we run the BGK regression where we include actual income taxes in the regression such that increments to public education expenditures are implicitly financed by nondistortionary taxation. Neither public education expenditures nor income taxation have significant growth effects. This lack of significance on the expenditure coefficient might be taken as evidence that expenditures do not matter for growth. However, since the regression does not control for the offsetting effect of the distortionary tax, this conclusion is misleading. Rather than

finding that expenditures are unimportant for growth, it demonstrates that the negative tax effect is offsetting the positive education expenditures effect.

Some of our control variables are significantly correlated with growth. The coefficients on initial per capita real GDP (y_0) are negative and significant, indicating that richer countries grow at slower rates than poor countries. In addition, the lending position of a country (b) has significant positive growth effects. However, government spending net of education (g) and gross enrollment ratios for primary schooling (S) are not significant predictors of growth.

A key implication of our findings is that including both sides of the government budget sheet is essential when estimating long-run growth effects. Public education expenditures improve long-run growth in rich countries, as long as crowding-out effects are taken into consideration, via the imposition of the government budget constraint and the inclusion of initial per capita GDP and other controls.

III. Conclusion

This study considers the links between public education expenditures and long-run growth. After developing a theoretical model that yields a specific growth equation to estimate, we find that a positive relationship exists between public education expenditures and growth for developed countries. However, this relationship is sensitive to the imposition of the government budget constraint. For example, we find no significant growth effects of public education expenditures when crowding-out effects are not properly taken into consideration. Our work suggests that the inability of some studies to find a robust relationship between public education spending and growth may reflect a failure to properly account for the method of finance.

References

Barro, Robert, and Xavier Sala-i-Martin. 1999. *Economic Growth*. Cambridge, Massachusetts: MIT Press.

Blankenau, William F. 2005. "Public Schooling, College Subsidies, and Growth." *Journal of Economic Dynamics and Control*, 29(3): 487-507.

Blankenau, William F., and Nicole B. Simpson. 2004. "Public Education Expenditures and Growth." *Journal of Development Economics*, 73(2): 583-605.

Bleaney, Michael F., Norman Gemmell, and Richard Kneller. 1999. "Fiscal Policy and Growth: Evidence from OECD Countries." *Journal of Public Economics*, 74(2): 171-90.

Devarajan, Shantayanan, Vinaya Swaroop, and Heng-fu Zou. 1996. "The Composition of Public Expenditure and Economic Growth." *Journal of Monetary Economics*, 37(2): 313-44.

Easterly, William, and Sergio Rebelo. 1993. "Fiscal Policy and Economic Growth." *Journal of Monetary Economics*, 32(3): 417-458.

Eckstein, Zvi, and Itzhak Zilcha. 1994. "The Effects of Compulsory Schooling on Growth, Income Distribution and Welfare." *Journal of Public Economics*, 54(3): 339-59.

Glomm, Gerhard, and B. Ravikumar. 1997. "Productive Government Expenditures and Long-Run Growth."*Journal of Economic Dynamics and Control*, 21(1): 183-204.

Krueger, Alan B., and Mikael Lindahl. 2001. "Education for Growth: Why and for Whom?" *Journal of Economic Literature*, 39(4): 1101-36.

Levine, Ross, and David Renelt. 1992. "A Sensitivity Analysis of Cross-Country Growth Regressions." *American Economic Review*, 82(4): 942-63.

Zhang, Jie, and Richard Casagrande. 1998. "Fertility, Growth, and Flat-Rate Taxation for Education Subsidies." *Economics Letters*, 60(2): 209-16.

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[1] Examples include Gerhard Glomm and B. Ravikumar (1997), Zvi Eckstein and Itzhak Zilcha (1994), and William F. Blankenau (2005).

[2] See Ross Levine and David Renelt (1992), William Easterly and Sergio Rebelo (1993), Shantayanan Devarajan et al. (1996), Jie Zhang and Richard Casagrande (1998), and Robert J. Barro and Xavier Sala-i-Martin (1999) for contrasting findings.

[3] One exception is Michael F. Bleaney et al. (1999).

[4] In a longer version of this paper (available upon request), we find that public education expenditures in poor countries have no effect on growth even when controlling for funding.

[5] To avoid multicollinearity in a regression of growth on fiscal policy instruments, one policy instrument must be eliminated, as discussed in Michael F. Bleaney et al. (1999). In our regression, the consumption tax (which is growth-neutral) drops out in deriving equation (6).

[6] A regression of e_t against ϕ_t (available upon request) demonstrates this independence.

[7] Countries in the sample are: Argentina, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom and United States.

[8] Our main findings are robust to applying GMM dynamic estimators.

[9] See Alan B. Krueger and Mikael Lindahl (2001) for a comprehensive review.

Table 1. OLS Estimates of the Growth Effects of Public Education Expenditures

Regression	**#1**	**#2**	**#3**	**#4**	**BGK**
e_{t-1}	0.134	0.175	0.105	*0.201	0.128
	(0.192)	(0.186)	(0.107)	(0.114)	(0.110)
τ_i	-	-0.074	-	**-0.099	-0.029
		(0.091)		(0.044)	(0.031)
S	-	-	-0.019	-0.022	-0.020
			(0.018)	(0.018)	(0.018)
y_0	-	-	**-0.141	**-0.150	**-0.146
			(0.035)	(0.035)	(0.036)
b	-	-	**0.083	**0.128	**0.087
			(0.039)	(0.042)	(0.039)
g	-	-	-0.035	0.0002	-0.027
			(0.036)	(0.038)	(0.037)
Adjusted R^2	0.293	0.291	0.244	0.266	0.243
Observations	137	137	137	137	137

Note: The dependent variable is the five-year average of the annual per capita real GDP growth rate. Standard errors are in parentheses. * (**) represents significance at the 10% (5%) level. Regressions 1-2 include two-way fixed effects, while regressions 3-4 include fixed effects over time; none of which are reported. In the BGK regression, τ_i is replaced with actual income taxes. Standard errors and covariance are corrected for cross-sectional heteroskedasticity.