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

William Blankenau† Kansas State University

Nicole Simpson‡ Colgate University

Marc Tomljanovich§ Colgate University

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Abstract

Empirical studies have been unable to provide a consistent answer regarding the long-run relationship between government education expenditures and per-capita output growth. In this paper, we develop a simple endogenous growth model whereby growth is a function of both government education expenditures and taxation. Using pooled data from 1960 to 2000 for 83 countries, we test our growth equation and find that imposing the government budget constraint is imperative when estimating the relationship between expenditures and growth. Furthermore, we find a robust positive relationship between education expenditures and growth for rich countries when the method of finance is considered but no significant relationship for poor and middle-income countries.

Keywords: *Fiscal Policy and Taxation; Education; Endogenous Growth*

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† Department of Economics, 321 Waters Hall, Kansas State University, Manhattan, Kansas, 66506, (785)532-6340, Fax: (785)532-6919, blankenw@ksu.edu.

‡ Department of Economics, 13 Oak Drive, Hamilton, New York, 13346; (315)228-7991, Fax: (315)228-7033, nsimpson@mail.colgate.edu.

§ Department of Economics, 13 Oak Drive, Hamilton, New York, 13346; (315)228-7537, Fax: (315)228-7033, mtomljanovich@mail.colgate.edu.

1 Introduction

Governments around the world have taken a prominent role in financing education. In developed nations, government education expenditures account for 5.4% of GDP on average. In less developed countries, the commitment is smaller (3.8% on average) but substantial nonetheless. While justifications for government involvement in financing education are varied, a common notion 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 government education expenditures, human capital accumulation and long-run economic growth.[1] While theory assigns expenditures a key role in growth, empirical support of the link is mixed.[2] As highlighted by Blankenau and 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 government education expenditures, a non-monotonic relationship between expenditures and growth can arise. Spending increases growth while taxes may decrease growth, leaving the net effect ambiguous.[3]

Thus economic theory is clear that in order to identify the growth effects of expenditures, one must account for any offsetting effects of the requisite taxation. Consider a simple regression with growth on the left-hand side and government expenditures on the right, perhaps along with some controls. At first glance, a lack of significance on the expenditure coefficient repudiates growth models which rely on government

[1] Examples include Glomm and Ravikumar (1997, 1998), Eckstein and Zilcha (1994), Zhang (1996), Kaganovich and Zilcha (1999), Cassou and Lansing (2003), Zagler and Durnecker (2003) and Blankenau (2005).

[2] Cullison (1993) and Barro and Sala-i-Martin (1999) find a positive relationship between government education spending and growth. In contrast, Easterly and Rebelo (1993) find this relationship only for some specifications while Levine and Renelt (1992) conclude that government education expenditures are not robustly correlated with growth rates. Zhang and Casagrande (1998) find that education subsidies improve growth in a cross-section of developed and developing countries while Landau (1986) and Devarajan, Swaroop and Zou (1996) show that education expenditures are insignificant determinants of growth for developing countries.

[3] Blankenau and Simpson (2004) demonstrate further that the growth maximizing level of expenditures plausibly lies in the range of observed levels, making simple growth regressions particularly misleading.

education expenditures as the growth catalyst. However, if the investigator has not controlled for the offsetting tax effects, this conclusion may be misleading. Rather than finding that expenditures are unimportant for growth, the investigator may have discovered that the tax effect is offsetting the education effect. Similarly, if a growth effect of expenditures is found, the effect is likely understated. The distinction is not merely semantic. The first conclusion implies that if growth outcomes motivate expenditures, such spending is indefensible. Under the second conclusion, there are two separate issues: expenditures and taxation. As governments have a variety of tax instruments at their disposal, each with different distortionary effects, expenditure may increase growth subject to choosing the proper revenue source.

While theory does not miss the link between government expenditure, taxation and growth, much empirical work does. For example, Landau (1986), Levine and Renelt (1992) and Devarajan et al. (1996) do not explicitly control for the method of finance when estimating the relationship between growth and public education expenditures. In contrast to much of the previous work, we make the relationship between expenditures, taxes and growth central to our analysis. To fully specify the relationship, we build an overlapping generations endogenous growth model where human capital accumulation relies on public education spending. In this setting, growth derives from both public education expenditures as a share of output and the distortionary tax rate, providing us with a growth equation to estimate.

We estimate the growth equation for a panel data of 83 countries over the period 1960-2000, using revenue and expenditure data representing all levels of government. We disaggregate our analysis for countries at different stages of development, following Temple's (1999) suggestions. Using pooled estimation techniques, we find a positive relationship between public education expenditures and long–run growth for rich countries. The relationship holds only when controlling for taxation and thus emphasizes the importance of controlling for funding when considering the effect of expenditures. In contrast, public education expenditures in poor and middle-income countries appear to have no effect on long-run growth rates even when controlling for funding.

Our work is related to several other papers that make the relationship between growth, expenditures and taxation more central in their analysis; examples include Helms (1985), Mofidi and Stone (1990), Miller and Russek (1997), Cashin (1995), Kocherlakota and Yi (1997) and Bleaney, Gemmel and Kneller (BGK) (1999, 2001). Of these, the work most closely related to ours is BGK (1999, 2001). BGK argue and demonstrate that models which do not properly account for the government budget constraint give misleading estimates of the growth effects of government spending.

Aside from considering a larger range of counties, our work is different from theirs in four important ways. First, we develop a fully specified theoretical model which makes clear the proper specification for our growth regression.[4] Second, we identify and relax an implicit assumption in the BGK regressions regarding the funding of productive expenditures. Third, we focus on education expenditures while BGK consider a broader class of productive expenditures.[5] Finally, the BGK measure of education expenditures includes only spending at the federal level. Since contributions to education from other levels of government are considerable, they ignore a large part of education expenditures. As they are concerned with a larger aggregate (productive expenditures), this is likely unimportant for their results. However, our focus on education requires us to use a better measure of government involvement; our measure includes education expenditures at all levels of government.

The paper is organized as follows. In Section 2, we develop a simple endogenous growth model while Section 3 describes the resulting empirical specification and relates it to the BGK specification. Section 4 lays out the details of the empirical analysis, including a description of the data and the regression results. We conclude in Section 5.

[4] BGK (2001) use the theoretical framework of Barro and Sala-i-Martin (1992) to arrive at their empirical specification.

[5] In a series of robustness tests, BGK (1999) disaggregate to public health and education expenditures as single arguments and find them to be significant in generating growth.

2 Model

In this section we develop a simple overlapping generations model of growth which shares key features with the models in Glomm and Ravikumar (1997) and Blankenau and Simpson (2004). The model is stylized to produce closed-form solutions that yield a growth equation to estimate. Our model economy consists of three-period-lived homogeneous agents, a representative firm producing a single good, a government and a technology for producing human capital.

2.1 The agent's problem

A continuum of agents, normalized to 1, is born each period. Agents within a generation are identical, allowing us to consider the behavior of a single representative agent for each period t. We refer to an agent in the first period of life as a learner, in the second period as an earner and in the final period as old. The initial old agent is endowed with K_0 units of physical capital and the original earner is endowed with h_0 units of human capital. Learners in each generation receive an endowment of public education inputs given by E_t. Public inputs combine with the human capital of the prior generation, h_t, to create period $t+1$ human capital according to

$$h_{t+1} = \xi E_t^{\mu} h_t^{1-\mu} \tag{1}$$

where $\mu \in [0,1]$ and $\xi > 0$. This is the specification used in Glomm and Ravikumar (1997). The parameter μ governs the relative importance of public education expenditures and human capital of the preceding generation in generating human capital.

As an earner in period $t+1$, the agent inelastically supplies her one unit of labor endowment to the representative firm and receives after-tax labor income in proportion to her stock of human capital. That is, net lifetime labor income is 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 to a unit of human capital.[6] The agent uses net wage income to consume and save. Earners

[6] We typically suppress time subscipts on government policy choices to simplify the notation.

save for old age through capital accumulation. The capital holdings for a period t learner at the end of period $t+1$ are $K_{t,t+2}$ where the time subscript emphasizes that the capital is productive in period $t+2$. When old, an agent uses net income from savings to finance consumption spending. A unit of capital purchased in period t returns $r_{t+1}(1-\tau_i)$ units where r_{t+1} is the period $t+1$ rental rate, assuming that capital depreciates fully. Labor and capital income are taxed at the same rate.[7]

We denote consumption in periods $t+1$ and $t+2$ by a period t learner as $C_{t,t+1}$ and $C_{t,t+2}$ and assume that all consumption is taxed at the rate τ_c. When no confusion arises, we suppress the generation specific notation. Preferences are logarithmic in C_{t+1} and C_{t+2} with discount rate $\beta \in (0,1]$. The representative agent's problem is:

$$\max_{C_{t+1},C_{t+2},K_{t+2}} \ln C_{t+1} + \beta \ln C_{t+2} \tag{2}$$

subject to

$$\begin{aligned} C_{t+1}(1+\tau_c) + K_{t+2} &\leq \omega_{t+1} h_{t+1}(1-\tau_i) \\ C_{t+2}(1+\tau_c) &\leq (r_{t+2}(1-\tau_i))K_{t+2} \\ C_{t+j} &\geq 0,\ j=1,2. \end{aligned}$$

Solving the agent's problem for optimal savings yields

$$K_{t+2} = \widetilde{\beta}\left(\omega_{t+1} h_{t+1}(1-\tau_i)\right) \tag{3}$$

where $\widetilde{\beta} \equiv \frac{\beta}{1+\beta}$.

2.2 Firms

A representative firm combines human capital and physical capital to generate a single final good. As is common in the growth literature, we assume that output is a Cobb-Douglas combination of physical and human capital. Letting K_t and L_t be the quantities of physical and human capital employed and $k_t \equiv \frac{K_t}{L_t}$, we have

$$\begin{aligned} Y_t &= AK_t^{\alpha} L_t^{1-\alpha} \\ y_t &= \frac{Y_t}{L_t} = Ak_t^{\alpha} \end{aligned} \tag{4}$$

[7] This assumption is due to data limitations.

where $\alpha \in [0,1]$ and $A > 0$. The markets for inputs and output are competitive. Thus the firm takes prices as given and hires additional inputs until $r_t = A\alpha k_t^{\alpha-1}$ and

$$\omega_t = A(1-\alpha)\, k_t^{\alpha}. \tag{5}$$

2.3 Government

Government spends a share e of output on public education expenditures and these are related to educational inputs by

$$E_t = \tilde{e}Y \tag{6}$$

where $\tilde{e} \equiv \exp(e)$. An additional share of output g is spent by the government, while a share b of output is funded through deficit spending. For simplicity, we do not explicitly model the mechanism through which countries borrow/lend from abroad. Instead, we assume that interest payments are incorporated in g or b.

All expenditures are financed through taxes on labor and capital income, through a consumption tax or through borrowing. Revenues and expenditures must balance in each period. Government policy then is the set $\{\tau_i, \tau_c, e, g, b\}$ where

$$\tau_i \omega_t h_t + \tau_i r_t K_t + \tau_c \left(C_{t-1,t} + C_{t-2,t}\right) = (e+g+b)\, Y_t. \tag{7}$$

2.4 Equilibrium and balanced growth

Definition 1 *A competitive equilibrium in this environment is a sequence of consumption levels and portfolio holdings* $\{C_{t,t+1}, C_{t,t+2}, K_{t,t+2},\}_{t=0}^{t=\infty}$ *chosen by the representative agent of each generation, a sequence of outputs and inputs chosen by the representative firm in each period* $\{Y_t, K_t, L_t\}_{t=0}^{t=\infty}$*, a sequence of government policies* $\{\tau_{i,t}, \tau_{c,t}, e_t, g_t, b_t\}_{t=0}^{t=\infty}$*, a sequence of prices* $\{\omega_t, r_t\}_{t=0}^{t=\infty}$*, and a set of initial conditions* $\{K_0, h_0\}$ *such that*

(i) a period t learner chooses $C_{t,t+1}, C_{t,t+2}$, and $K_{t,t+2}$ to solve the agent's problem taking prices and government policy as given,

(ii) the firm chooses Y_t, K_t and L_t in period t to maximize profits taking prices, government policy and the production possibilities (equation (4)) as given,

(iii) the government chooses $\{\tau_{i,t}, \tau_{c,t}, e_t, g_t, b_t\}_{t=0}^{t=\infty}$ *subject to a balanced budget constraint,*

(iv) the stock of human capital evolves according to equations (1) and (6),

(v) the goods market clears: $Y_t = (e_t + g_t + b_t)\, Y_t + C_{t-1,t} + C_{t-2,t} + K_{(t-1,t+1)}$*,*

(vi) the capital market clears, and

(vii) the labor market clears: $L_t = h_t$*.*

To meet the objectives of this paper it is sufficient to consider balanced growth paths.

Definition 2 *A balanced growth path satisfies definition 1 and has the following additional properties:*

(i) government policy is time invariant, $\{\tau_{i,t}, \tau_{c,t}, e_t, g_t, b_t\} = \{\tau_i, \tau_c, e, g, b\}$*;*

(ii) the stock of human capital, the stock of physical capital, consumption by earners, consumption by the old, and output all grow at the same and constant rate, γ*. That is,* $1 + \gamma_t = 1 + \gamma = \frac{h_{t+1}}{h_t} = \frac{K_{t+1}}{K_t} = \frac{C_{t,t+1}}{C_{t-1,t}} = \frac{C_{t,t+2}}{C_{t-1,t+1}} = \frac{Y_{t+1}}{Y_t}$*.*

An implication of definition 2 is that k_t, y_t, ω_t and r_t are stationary. Thus subscripts are dropped and equations (1) and (6) reduce to

$$1 + \gamma = \xi(\tilde{e}Ak^{\alpha})^{\mu} \tag{8}$$

along the balanced growth path. This illustrates that an increase in e can affect the balanced growth rate along several margins. The direct positive effect of an increase in e can be amplified or offset by general equilibrium adjustments to k.

To understand these general equilibrium adjustments, we solve for k as a function of policy instruments and the parameters of the model. Substituting equations (1), (5) and (6) into equation (3) yields:

$$K_{t+2} = \widetilde{\beta}\left(A\,(1-\alpha)\,k_{t+1}^{\alpha}\xi\,(\tilde{e}y_t)^{\mu}\,h_t^{1-\mu}L_t^{\mu}\,(1-\tau_i)\right).$$

Labor market clearing requires $L_t = h_t$ giving

$$k_{t+2} = \widetilde{\beta}\left(A\,(1-\alpha)\,k_{t+1}^{\alpha}\xi\,(\tilde{e}y_t)^{\mu}\,(1-\tau_i)\right).$$

Dropping time subscripts to indicate a steady state and solving for k gives

$$k = \left[\widetilde{\beta} A^{1-\mu} (1-\alpha) \xi \tilde{e}^{\mu} (1-\tau_i)\right]^{\frac{1}{1-\alpha-\alpha\mu}}.$$

Putting this expression in equation (8) and rearranging terms yields

$$1+\gamma = A^{\mu}[A^{1-\mu}\widetilde{\beta}(1-\alpha)]^{\frac{\alpha\mu}{1-\alpha(1+\mu)}} \xi^{\frac{1-\alpha}{1-\alpha(1+\mu)}} \tilde{e}^{\frac{\mu(1-\alpha)}{1-\alpha(1+\mu)}} (1-\tau_i)^{\frac{\alpha\mu}{1-\alpha(1+\mu)}}. \tag{9}$$

To arrive at a simple expression for growth, we take the natural logarithm of each side and use the approximations $\ln(1+\gamma) \approx \gamma$ and $\ln(1-\tau_i) \approx -\tau_i$ to arrive at

$$\gamma \approx \bar{\beta}_0 + \beta_1 e + \beta_2 \tau_i \tag{10}$$

where

$$\beta_1 = \tfrac{\mu(1-\alpha)}{1-\alpha(1+\mu)}, \quad \beta_2 = -\tfrac{\alpha\mu}{1-\alpha(1+\mu)} \tag{11}$$

and $\bar{\beta}_0 = \ln\{A^{\mu}[A^{1-\mu}\widetilde{\beta}(1-\alpha)]^{\frac{\alpha\mu}{1-\alpha(1+\mu)}} \xi^{\frac{1-\alpha}{1-\alpha(1+\mu)}}\}$.

To complete the model, we make use of the government budget constraint to find the relationship between e and τ_i. Equation (7) implies

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

which can be rewritten as:

$$\tau_i + \tau_c \frac{\tilde{C}_t}{Y_t} = (e+g+b) \tag{12}$$

where $\tilde{C}_t$ is total consumption in period t. This implies

$$\tau_i = \frac{e+g+b}{1+\frac{\tau_c}{\tau_i}\frac{\tilde{C}_t}{Y_t}}.$$

The item $\frac{\tau_c \tilde{C}_t}{\tau_i Y_t}$ is the ratio of consumption tax revenue to income tax revenue and is constant in balanced growth. We denote this by ϕ to arrive at

$$\tau_i = \frac{e+g+b}{1+\phi}. \tag{13}$$

Finally, substituting equation (13) into equation (10) gives

$$\gamma \approx \bar{\beta}_0 + \beta_1 e + \beta_2 \frac{g+e+b}{1+\phi}. \tag{14}$$

3 Empirical Model

In this section we discuss the empirical specification implied by our theoretical model. The parameter $\bar{\beta}_0$ is a function of unobservable items including A and ξ. We assume there are m items that can be used to approximate $\bar{\beta}_0$. That is,

$$\bar{\beta}_0 \approx \beta_0 + \sum_{j=1}^{m} \beta_{j+2} x_{j,n,t} + \bar{u}_{n,t} \tag{15}$$

where $x_{j,n,t}$ is the measure of item x_j of country n in period t and $\bar{u}_{n,t}$ is an error term. 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 area, the stochastic nature of the growth process and $\bar{u}_{n,t}$, we include an error term $u_{n,t}$. Substituting equation (15) into equation (14) gives our growth regression:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \beta_2 \left[\frac{g_{n,t} + e_{n,t} + b_{n,t}}{1 + \phi_{n,t}} \right] + \sum_{j=1}^{m} \beta_{j+2} x_{j,n,t} + \beta_{m+3} y_{n,0} + \delta_t + \eta_n + u_{n,t}. \tag{16}$$

Notice that we consider the growth effects of lagged education expenditures based on the assumption that it takes time for government education expenditures to impact growth. We discuss this assumption further in the next section.

3.1 Relationship with BGK regression.

It is instructive to compare regression equation (16) with a similar regression in the spirit of BGK. From equation (12), the government budget constraint in each period requires

$$e_t - \tau_{i,t} - \tau_{c,t} \frac{\tilde{C}_t}{Y_t} + g_t + b_t = 0. \tag{17}$$

Suppose the following regression is run to discern the overall effect of fiscal policy on growth:[8]

$$\gamma_t = \theta_0 + \theta_1 e_t + \theta_2 \tau_{i,t} + \theta_3 \tau_{c,t} \frac{\tilde{C}_t}{Y_t} + \theta_4 g_t + \theta_5 b_t + u_t. \tag{18}$$

[8] Here we ignore control variables and country specific notation for expositional clarity.

BGK (1999) point out that to avoid multicollinearity in this regression one of the fiscal policy instruments must be eliminated. Consider the case where item $\tau_{c,t}\frac{\tilde{C}_t}{Y_t}$ is excluded by subtracting $\theta_3\tau_{c,t}\frac{\tilde{C}_t}{Y_t}$ from each side of equation (18). Using equation (17) and rearranging terms, it is clear that the true regression being estimated is then

$$\gamma_t = \theta_0 + (\theta_1 + \theta_3)\, e_t + (\theta_2 - \theta_3)\, \tau_{i,t} + (\theta_4 + \theta_3)\, g_t + (\theta_5 + \theta_3)\, b_t + u_t.$$

A key point in BGK (1999) is that the regression will give the proper estimate of θ_1 and other coefficients only if the excluded item has no growth effect; i.e. only if θ_3 is zero.

Our regression equation (equation (16)) avoids the problem exposed by BGK. Our theoretical model identifies $\tau_{c,t}\frac{\tilde{C}_t}{Y_t}$ as an item to be plausibly excluded from the regression as it has no growth effect ($\theta_3 = 0$). Thus our regression is analogous to

$$\gamma_t = \theta_0 + \theta_1 e_t + \theta_2 \tau_{i,t} + \theta_4 g_t + \theta_5 b_t + u_t. \tag{19}$$

where g_t and b_t are items in equation (15).

By the BGK argument, this is properly specified. However we take the argument one step further. In equation (19), an increase in e_t by one unit would yield an increase in predicted growth equal to θ_1. The effect of financing the revenue increase is not considered. This is proper if the required revenue arises from nondistortionary taxes. Thus this interpretation of θ_1 in equation (19) requires the implicit assumption that increments to education spending are funded from nondistortionary revenue sources. We instead assume that revenue shares across the different types of taxes are unaffected by e_t; that is, $\phi = \frac{\tau_c}{\tau_i}\frac{\tilde{C}_t}{Y_t}$ remains constant. To insure this, we impose the relationship arising in equation (13) to get

$$\gamma_t = \theta_0 + \theta_1 e_t + \theta_2 \frac{g_t + e_t + b_t}{1 + \phi_t} + \theta_4 g_t + \theta_5 b_t + u_t.$$

From this, equation (16) is simply a generalization.[9]

To reiterate, the BGK regression assumes that increments to education are funded by nondistortionary taxes while our main regression assumes that they are funded in

[9] We avoid the multicollinearity problem without excluding an item by lagging expenditures.

part by distortionary taxes. A possible extension is to assume that education funding comes *only* from income taxes while other sources fund other expenditures so that $e_t = \tau_{i,t}$. Putting this into equation (19) gives

$$\gamma_t = \theta_0 + (\theta_1 + \theta_2)\, e_t + \theta_4 g_t + \theta_5 b_t + u_t.$$

Running this regression clearly gives the proper estimate of θ_1 only if $\theta_2 = 0$. Thus this regression is generally misspecified. We have excluded an item from the regression that has no growth effect so the source of the misspecification is different than in the BGK criticism. Here the problem arises because we are trying to capture two effects, the growth effect of education expenditures and the crowding out effect of the requisite taxation, by a single parameter. The different effects are not identifiable and we can only estimate the sum of the two effects. Of particular importance is the notion that the coefficients on e_t may be zero even if $\theta_1 > 0$.

3.2 Technology parameters.

Before estimating the model, we point out that our mapping from theory to an empirical specification allows us to identify point estimates of several important technology parameters. Specifically,we can use equation (11) to find

$$\mu = \tfrac{\beta_1}{1-\beta_2}, \quad \alpha = \tfrac{\beta_2}{\beta_2-\beta_1} \quad . \tag{20}$$

The estimate for μ could prove useful for researchers who need to calibrate similar models. The estimate of α, capital's share of output, will gauge the extent to which the model yields reasonable predictions.

4 Empirical Analysis

4.1 Data

To estimate the model, we use annual data from 1960-2000 for a group of 83 countries; the data are from the World Development Indicators (WDI) database of the World Bank. In our sample, rich countries are those that had more than $4000 in real per capita GDP in 1960 (in 1995 $), upper middle-income countries had between $2000 and $4000 in real GDP, lower-middle income countries had between $800 and $2000 in real GDP, and poor countries had less than $800 in real GDP. Our sample includes 23 rich countries, 9 upper-middle income countries, 20 lower-middle income countries, and 30 poor countries; the list of countries is in Appendix A.1. From the annual data, we construct five-year averages for all of the variables. This construction serves two purposes. First, since we are interested in the relationship between long-run growth and fiscal policy, using five-year averages reduces the impact of short-run (annual) fluctuations. Second, the issue of endogeneity, while not completely eliminated, is reduced since the variable of interest for all of our regressions is the one-period lag of public education expenditures. This method helps deflect the criticism that lower growth rates may in turn alter education spending rates in a given time period. By lagging public education expenditures, we analyze how higher spending will impact future growth rates.[10]

The dependant variable is the five-year average of the annual per capita GDP growth rate for each country, with the averages having been compiled for years that have as final digits 0-4 and 5-9. The fastest growing countries are the upper-middle income group with a growth rate of 2.9% per year, while the lower-middle income and poor countries are the slowest growing, both at 2.1% per year on average (refer to Table 1).

The World Bank reports total public education expenditures for all levels of government as a percentage of GDP. Two important distinctions must be made with respect to our data. First, our measure of government spending on education is relative to total output rather than total government expenditures (which is used in Devarajan et al. (1996), for example). We consider the former since we focus on the role of a specific type of expenditure (i.e., education) in increasing growth rather than the mix of government expenditures. Second, our expenditure data represent all lev-

[10] A lag of two periods was also considered, with similar qualitative results. Results available upon request.

els of government, compared to Devarajan et al. (1996) and BGK (1999, 2001) who use expenditure data for only the central government. At least in most developed countries, a majority of public education expenditures come from local and state governments rather than the central government. Devarajan et al. (1996) find some support of this in developing countries as well.

To calculate τ_i, we use the following data, which are expressed as a percentage of GDP: government spending net of education (g), the government budget surplus (b), consumption tax revenues ($\tau_c \tilde{C}$) and income tax revenues ($\tau_i Y$). For income and consumption taxes, we use the World Bank's taxation on income, profits, and capital gains and taxation on goods and services, respectively, which represent all levels of government and are reported as a percentage of current tax revenue. We transform our tax measures relative to GDP using total tax revenues as a percentage of GDP. For g and b, we obtain data from the WDI. The WDI reports total government consumption as a percent of GDP, and we subtract government spending on education (as a percent of GDP) from it. The data indicate a considerable difference in non-education government spending across country types (Table 1): rich countries spend an average of 14.2% of GDP over the time span, middle-income countries spend 9.7% of GDP, and poor countries spend 10.7% of GDP. Budget deficits range from 2% of GDP (for upper middle-income countries) to 4% of GDP (poor countries) in our sample. We then compute τ_i for each country in every period using equation (13). On average, τ_i represents 8.65% of GDP for rich countries and a much lower percentage for poor and middle-income countries (5-6% of GDP).

The level of economic development is often considered to impact how fast countries grow. As Barro (1991) shows using cross-sectional data, historically rich countries tend to grow at a slower rate than poor countries, *ceteris paribus*. Easterly and Rebelo (1993) find that their results are sensitive to inclusion of initial GDP whereas BGK (1999) do not. Among the various specifications we consider, per-capita real GDP in 1960 for each country is included to see if convergence factors alter the relationship between growth, spending and taxation. Table 1 illustrates the stark differences in the initial levels of GDP across the groups of countries.

In our regression analysis, we control for other variables that potentially affect the relationship between growth and fiscal policy (see equation (15)). We use the existing empirical growth literature to provide some guidance as to which variables are important to include as controls. Government spending net of education (g) is important for calculating τ_i, but there is also evidence supporting its inclusion in the growth regression as an additional regressor. Landau (1986) and Easterly and Rebelo (1993) find that real government consumption net of education and defense significantly lowers growth. BGK find that expenditures other than education expenditures can increase growth. In our data, these items are mostly contained in g. Thus we have no a priori argument that g is growth neutral and by the BGK argument, it should be included. The federal government budget surplus (b) is likewise included in our set of independent variables. Several empirical papers document an important role for public deficits: Easterly and Rebelo (1993) and BGK (1999, 2001) find the budget surplus to be a significant, robust and positive determinant of growth.

There is a large literature that suggests educational outcomes are important determinants of growth.[11] In the context of our model, with education spending fueling growth, it is particularly relevant to control for enrollment.[12] It is difficult to obtain reliable estimates of educational attainment for a cross-section of rich and poor countries. The World Bank's EdStats provides the most comprehensive database.[13] It reports gross enrollment ratios at various levels of schooling (pre-primary, primary, secondary and tertiary), where the gross enrollment ratio for primary schooling, for example, is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the primary level of education.[14] We use pri-

[11] See Krueger and Lindahl (2001) for a comprehensive review.

[12] There is some evidence that enrollment ratios alter growth: Landau (1986) finds that higher enrollment ratios are positively correlated with higher growth rates, even though public education expenditures are not.

[13] It is located at: http://www1.worldbank.org/education/edstats/index.html

[14] Note that this calculation often leads to enrollment rates that are greater than 100% since the number of children enrolled in certain grade levels is frequently larger than the population size that corresponds to the official age group for those grade levels.

mary enrollment ratios since those data are most complete. Comparing mean gross primary enrollment ratios across groups of countries, we find that primary school enrollment ratios range from 87% to 107%.

4.2 Results

In this section we estimate the empirical relationship between public education expenditures, tax policy and GDP growth for various specifications. For specifications that do not include initial GDP as a regressor, we consider two-way fixed effects, allowing for heterogeneity across countries (η_n) and over time (δ_t). In regressions that include initial GDP, we consider fixed effects over time (since initial GDP levels are capturing cross-country differences). Before these equations were estimated, a battery of panel unit root tests were run on each of the variables to determine their stationarity properties; none of the series were found to be nonstationary.[15]

The theoretical model outlined in section 2 suggests that taxation can alter the positive growth effects from increased public education expenditures. Therefore, we run a series of regressions in which we directly compare the estimated growth effects of public education expenditures with and without the income tax rate (τ_i). We consider three such pairs of regressions (with and without τ_i), and run the same set of regressions for each group of countries. A complete list of regression specifications can be found in Appendix A.2.

First, we consider the basic relationship between government education expenditures and growth when not controlling for taxation. That is, we estimate equation (16) but set $\beta_k = 0$ for $k > 1$ (call this Regression #1). This simplistic specification does not consider the growth effects of other fiscal factors, nor does it address the issue of how these public education spending projects are funded. Nonetheless, many authors have used variants of this regression, including Easterly and Rebelo (1993) and Devarajan et al. (1996). We then estimate equation (16) but set $\beta_k = 0$

[15] We use panel unit root tests proposed by Levin, Lin, and Chu (2002) and Im, Pesaran, and Shin (2003). A key difference between the two sets of tests is that the former assumes a common unit root process, while the latter assumes an individual unit root process.

for $k > 2$, thus allowing for the revenue side of fiscal policy to impact growth rates; we refer to this as Regression #2. As stated above, Regressions #1 and #2 include two-way fixed effects (time- and country-specific).

Next, we consider the following set of regressors: initial GDP (y_0), primary school enrollment ratios (S), the government budget surplus (b) and time-specific fixed effects (δ_t). Again, we estimate the model without taxes (Regression #3) and with taxes (Regression #4). The inclusion of initial GDP allows us to test the effects of education spending and distortionary taxes on growth after controlling for the potential β-convergence tendencies predicted by exogenous growth models. A negative coefficient implies that initially rich countries grow at slower rates, ceteris paribus, than initially poor countries. In addition, the gross enrollment ratio for primary schooling is a proxy for the productivity parameters and may affect the relationship between expenditures and growth. The expected sign on enrollment rates is ambiguous. Certainly, countries that have higher enrollment rates have higher aggregate levels of human capital, so that long-run growth increases. However, higher enrollment rates (particularly in rich countries) imply less expenditure per student, so that growth may fall in enrollment rates. This effect may be non-trivial since we include current rather than lagged enrollment rates. The anticipated growth effects of b are positive. Higher budget surpluses are typically associated with periods of economic growth as tax revenues rise and/or domestic savings increase.

Next, we build on Regressions #3 and #4 by including one additional proxy: government spending net of education (g). Again, only time-specific fixed effects are considered. Regression #5 does not control for taxation, but Regression #6 does. Higher government spending in other areas could increase or decrease growth depending on the extent to which these expenditures are productive or distortionary.

Finally, to demonstrate the importance of controlling for crowding out, we estimate a version of the model where increments to public education expenditures are implicitly financed by nondistortionary taxation. Since this regression excludes only nondistortionary government budget items and ignores the relationship expressed in equation (13), it is similar to equation (19); we refer to it as Regression 'BGK'. It is not, however, the same regression run by BGK due to the differences in focus and data between our paper and theirs.

4.2.1 Rich Countries

Table 2 reports the estimation results for our group of rich countries. First, consider the results from Regressions #1 and #2. We find that public education spending does not significantly influence long-run growth, even when we control for crowding-out effects (i.e., τ_i is included in the regression).

The inclusion of additional controls in Regressions #3 yields similar results: public education spending does not significantly affect growth when enrollment ratios, initial GDP and the government budget surplus are included in the right-hand side of the regression. However, Regression #4 yields a different finding. When crowding-out effects are considered (in addition to the aforementioned controls), we now find that public education expenditures positively affect growth. A one percentage point increase in public education expenditures results in a 0.202 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 the income tax share resulting in a 0.099 percentage point increase in a country's per-capita growth rate.

The coefficients on initial per-capita real GDP are negative and significant in Regressions #3 and #4, showing that richer countries within the set of developed countries are growing at a slower rate than initially less rich countries. In addition, the international lending position of a country has significant growth effects: growth increases by 0.095 and 0.128 percentage points, respectively, when the budget surplus increases by one percentage point.

Regressions #5 and #6 support our findings from Regressions #3 and #4. Upon the inclusion of g as an additional control, we find that public education expenditures do not significantly affect growth when the government budget constraint is not imposed (i.e., τ_i is not included as a regressor, Regression #5). However, if we control for the method of finance (Regression #6), the coefficient on public education spending becomes significant once again. That is, the growth effects of education expenditures may not be significant unless the method of finance is taken into consideration. This result stresses the importance of the government budget constraint when estimating the empirical growth effects of government spending. It also may explain why the empirical findings on the relationship between growth and public education expenditures are mixed.

In addition, Regressions #5 and #6 indicate that government spending net of education is also a significant determinant of growth. Growth falls by 0.016 and 0.012 percentage points when other government expenditures increase by one percentage point. Note that we include the contemporaneous five-year average of other government spending rather than lagging spending, as done with education expenditures. We feel this specification is more reasonable since the growth effects of many other types of spending (specifically, unproductive spending) may be felt quickly, while the growth effects of education spending may take time to materialize.

In Table 3, we compare our estimates from Regressions #5 and #6 with estimates from the BGK regression. In the BGK regression, we include actual income taxes in the regression and ignore the relationship given in equation (13). By assuming that public education expenditures are financed by nondistortionary taxation, we get different growth implications. In the BGK regression, 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 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 effect.

In our theoretical model, expenditures matter for growth only if $\mu > 0$. In fact, all models which rely on government education expenditures as an engine of growth require a positive value for an analogous parameter. Using equation (20), we see that when taxes are excluded from the regression, and even when they are included as in the BGK regression, μ cannot be confidently considered to exceed 0. As such, the engine of growth in these endogenous growth models is stalled. However, using our results from Regressions #4 and #6 in equation (20), we find that μ lies in the range of 0.18 to 0.22. Previous calibrations of endogenous growth models typically use values of μ closer to 0.1 (see, for example, Glomm and Ravikumar (1998) and Blankenau and Simpson (2004)). This small value is partly in deference to work which finds little effect of education expenditures on educational outcomes. Our estimates indicate that this value is at least supported and is likely too conservative. We can also use equation (20) to find that α is between 0.27 and 0.33. Our estimates for α are consistent with observed values for the U.S. capital share, providing support to our methods.

A key implication of these 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 GDP and other fiscal variables as regressors.

4.2.2 Middle Income Countries

We run the same set of regressions for our set of 9 upper-middle income countries; results are reported in Table 4. In Regressions #3 and #5, when τ_i is not included as a regressor, we find that public education significantly lowers growth, with estimated coefficients of -1.117 and -1.129, respectively. However, when crowding-out effects are considered in Regressions #4 and #6, we find that this effect disappears, with no significant relationship between growth and public education spending. Instead, the estimated coefficients on τ_i are negative and significant, indicating that the crowding-out effects of government spending have important implications on long-run growth. This result suggests that countries at this stage of development will not necessarily lower growth by spending more on education. Nonetheless, they should carefully consider the method of finance. The sensitivity of the growth-expenditure relationship to crowding-out effects may at least partially explain why the empirical results have been mixed. The only other significant coefficient is initial GDP, which is robust across specifications. Our results again indicate that initially wealthier countries grow at slower rates.

The group of lower-middle income countries in our sample is quite heterogeneous with respect to development experiences. It it likely due to this heterogeneity that we find very few significant predictors of long-run growth, in Table 5. The only significant coefficient is the government budget surplus. Our results indicate that an increase in the government budget surplus leads to increases in growth for this set of countries.

4.2.3 Poor Countries

Lastly, we estimate the relationship between growth and public education expenditures for our sample of poor countries. Table 6 illustrates that public education expenditures and taxation have no significant impact on long-run growth across all model specifications. In fact, all of the coefficients on public education expenditures are negative though insignificant, indicating that poor countries are potentially hurt (or at least unaffected) by increased public education expenditures, no matter how they are financed. Our findings are similar to estimates in Devarajan et al. (1996). When controlling for other government spending and the budget surplus (Regressions #3-6), we discover a few noteworthy findings. First, growth improves as enrollment ratios rise, indicating that educational outcomes are important for growth (or vice versa) in poor countries. In addition, larger budget surpluses may lead to more growth, suggesting that countries that borrow less from abroad are faster-growing. In Regression #5, we find some evidence that increases in government spending in other areas are associated with higher growth rates. Since we use contemporaneous spending levels (rather than lagged levels), the causality is unclear.

Our results indicate that in poor and middle income countries education expenditures do not seem to be a viable candidate for increasing growth. These results contrast with our sample of rich countries where we find a robust positive relationship between public education expenditures and growth. The differences between the country groups could be attributable to several causes. First, the enabling devices are substantially different across these groups of countries. In richer countries, one can be reasonably certain that public funds earmarked for education are used for that purpose. However, in poor countries the money allotted for public education expenditures may not actually be used, for example, to buy new books and pay teachers' salaries, due to corruption and graft at national or local levels. Thus for developing countries, education expenditures as a percentage of GDP has the potential to be much lower than the official figures suggest. Mauro (1998) provides support of this: he finds corruption to have a significant impact on the composition of government expenditures for a cross-section of developing countries. Second, population movements may play a significant role, since educated citizens in poor countries may choose to emigrate to more developed nations (the brain drain phenomenon). Finally, our empirical results could indicate shortcomings of the model for sufficiently low levels of physical and human capital that are prevalent in poor countries.

5 Conclusion

This study considers the theoretical and empirical links between government education expenditures and long-run economic growth. We first develop a theoretical model that yields a specific growth equation to estimate. Using pooled estimation techniques, we find that a positive relationship exists between government public education expenditures and growth for rich 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 taken into consideration. Thus fiscal policy aimed at increasing human capital has the ability to profoundly affect a country's growth trajectory, a finding that supports endogenous growth theory in general and our model in particular.

For middle-income countries, we find some evidence that disregarding taxation in the growth regression yields inaccurate predictions regarding growth and public education expenditures. Finally, for poor countries, there appears to be no correlation between public spending rates on education and long-run growth. However, educational outcomes are positively associated with higher growth rates. Thus, poor countries can improve their long-run economic situation by allocating resources in a way that guarantees increases in school enrollment ratios.

A Appendix

A.1 List of Countries by Group

A.1.1 Developed Countries (23):

Argentina, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, United States

A.1.2 Upper-Middle Income Countries (9):

Barbados, Cyprus, Portugal, Seychelles, Singapore, South Africa, St. Kitts and Nevis, Uruguay, Venezuela

A.1.3 Lower-Middle Income Countries (20):

Bolivia, Bulgaria, Chile, Colombia, Costa Rica, Hungary, Iran, Jamaica, Jordan, Korea, Malaysia, Malta, Mauritius, Mexico, Panama, Paraguay, Peru, Romania, Swaziland, Turkey

A.1.4 Poor Countries (30):

Bangladesh, Botswana, Burkina Faso, Burundi, Cameroon, China, Congo, Cote d'Ivoire, Dominican Republic, Egypt, Ethiopia, Ghana, India, Indonesia, Kenya, Lesotho, Madagascar, Malawi, Morocco, Myanmar, Nepal, Nicaragua, Pakistan, Philippines, Sri Lanka, Syria, Thailand, Tunisia, Zambia, Zimbabwe

A.2 Regression Specifications and Results

Regression #1:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \eta_n + \delta_t + u_{n,t}$$

where $\gamma_{n,t}$ is the average annual growth rate, $e_{n,t-1}$ is public education expenditures as a % of GDP, η_n and δ_t respectively reflect country and time fixed effects and $u_{n,t}$ represents the error term.

Regression #2:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \beta_2 \tau_{i,n,t} + \eta_n + \delta_t + u_{n,t}$$

where $\tau_{i,n,t} = \frac{e_{n,t}+g_{n,t}+b_{n,t}}{1+\phi_{n,t}}$ and $\phi_{n,t} = \frac{\tau_{c,t}}{\tau_{n,t}} \frac{\tilde{C}_t}{Y_t}$.

Regression #3:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \beta_3 S_{n,t} + \beta_4 y_{n,0} + \beta_5 b_{n,t} + \delta_t + u_{nt}$$

where $S_{n,t}$ is the gross enrollment ratio for primary schooling, $y_{n,0}$ is initial GDP (rescaled to be consistent with other variables) and $b_{n,t}$ is the government surplus as a percent of output. There are no country-specific fixed effects since initial GDP is included.

Regression #4:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \beta_2 \tau_{i,n,t} + \beta_3 S_{n,t} + \beta_4 y_{n,0} + \beta_5 b_{n,t} + \delta_t + u_{nt}$$

Regression #5:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \beta_3 S_{n,t} + \beta_4 y_{n,0} + \beta_5 b_{n,t} + \beta_6 \log(g_{n,t}) + \delta_t + u_{nt}$$

where $g_{n,t}$ is government spending net of education as a percent of output.

Regression #6:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \beta_2 \tau_{i,n,t} + \beta_3 S_{n,t} + \beta_4 y_{n,0} + \beta_5 b_{n,t} + \beta_6 \log(g_{n,t}) + \delta_t + u_{nt}$$

Regression BGK:

$$\gamma_{n,t} = \beta_0 + \beta_1 e_{n,t-1} + \beta_2 \widetilde{\tau}_{i,n,t} + \beta_3 S_{n,t} + \beta_4 y_{n,0} + \beta_5 b_{n,t} + \beta_6 \log(g_{n,t}) + \delta_t + u_{nt}$$

where $\widetilde{\tau}_{i,n,t}$ represents actual income taxes (rather than income taxes implied by equation (13)).

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B Tables

Variable	Rich	Upper-Middle Income	Lower-Midd Income
(Annual) growth rate of per-capita real GDP (γ), %	2.41 (1.64)	2.88 (3.56)	2.11 (3.28)
Education expenditures (e), % of GDP	5.45 (1.42)	4.18 (1.27)	4.19 (1.44)
Government expenditures net of education (g), % of GDP	14.24 (4.53)	9.67 (3.01)	9.70 (4.08)
Central government budget surplus (b), % of GDP	-3.31 (4.17)	-1.95 (4.63)	-2.89 (3.49
τ_i, % of GDP	8.65 (3.77)	6.53 (3.41)	5.31 (3.90)
Initial GDP levels (y_0), 1995 U.S. $	10,618 (4661)	3181 (506)	1429 (381)
Enrollment ratio for primary schooling (S), %	101.7 (8.35)	106.6 (11.74)	103.7 (9.33
Sample size	23	7	20

Table 1: Descriptive Statistics. Means (standard deviations) are reported.

Regression	#1	#2	#3	#4	#5	#6
e	0.330	0.175	0.180	*0.202	0.185	**0.241
	(0.257)	(0.189)	(0.114)	(0.121)	(0.114)	(0.119)
τ_i	-	-0.074	-	**-0.099	-	*-0.087
		(0.080)		(0.045)		(0.046)
S	-	-	-0.019	-0.022	-0.015	-0.019
			(0.021)	(0.018)	(0.017)	(0.017)
y_0	-	-	**-0.130	**-0.150	**-0.151	**-0.167
			(0.041)	(0.036)	(0.036)	(0.035)
b	-	-	**0.095	**0.128	*0.066	**0.109
			(0.045)	(0.037)	(0.036)	(0.038)
g	-	-	-	-	**-0.016	**-0.012
					(0.006)	(0.006)
$\overline{R}^2$	0.215	0.291	0.189	0.272	0.289	0.339

Table 2: Growth Regressions, Rich Countries.

Dependent variable for all regressions is the five-year average of annual per capita GDP growth rate. Standard errors are in parentheses.
* (**) represents significance at the 10% (5%) level, using student's t critical values. Regressions 1-2 include two-way fixed effects, while regressions 3-6 include fixed effects over time; none of which are reported. Standard errors and covariance are corrected for cross-sectional heteroskedasticity.

Regression	#5	#6	BGK
e	0.185	**0.241	0.174
	(0.114)	(0.119)	(0.116)
τ_i	-	*-0.087	-0.031***
		(0.046)	(0.034)
S	-0.015	-0.019	-0.018
	(0.017)	(0.017)	(0.017)
y_0	**-0.151	**-0.167	**-0.167
	(0.036)	(0.035)	(0.036)
b	*0.066	**0.109	**0.078
	(0.036)	(0.038)	(0.035)
g	**-0.016	**-0.012	**-0.015
	(0.006)	(0.006)	(0.006)
$\overline{R}^2$	0.289	0.339	0.321

Table 3: Growth Regressions, Rich Countries - BGK.

Dependent variable for all regressions is the five-year average of annual per capita GDP growth rate. Standard errors are in parentheses.
* (**) represents significance at the 10% (5%) level, using student's t critical values. Regressions 1-2 include two-way fixed effects, while regressions 3-6 include fixed effects over time; none of which are reported. Standard errors and covariance are corrected for cross-sectional heteroskedasticity.
*** τ_i is replaced with actual income taxes in the BGK regression.

Regression	#1	#2	#3	#4	#5	#6
e	0.019	0.895	*-1.117	-0.448	*-1.129	-0.260
	(0.418)	(0.552)	(0.428)	(0.430)	(0.391)	(0.542)
τ_i	-	*-0.271	-	**-0.495	-	*-0.640
		(0.155)		(0.221)		(0.353)
S	-	-	*-0.082	-0.080	-0.096	-0.101
			(0.043)	(0.061)	(0.064)	(0.078)
y_0	-	-	*-3.715	**-4.141	*-3.615	*-3.837
			(1.646)	(1.663)	(1.978)	(1.897)
b	-	-	-0.062	0.217	0.002	0.385
			(0.164)	(0.238)	(0.158)	(0.271)
g	-	-	-	-	0.017	0.027
					(0.013)	(0.021)
$\overline{R}^2$	0.687	0.755	0.278	0.278	0.233	0.314

Table 4: Growth Regressions, Upper-Middle Income Countries.

Dependent variable for all regressions is the five-year average of annual per capita GDP growth rate. Standard errors are in parentheses.
* (**) represents significance at the 10% (5%) level, using student's t critical values. Regressions 1-2 include two-way fixed effects, while regressions 3-6 include fixed effects over time; none of which are reported. Standard errors and covariance are corrected for cross-sectional heteroskedasticity.

Regression	#1	#2	#3	#4	#5	#6
e	-0.244	-0.206	0.097	0.052	0.129	0.067
	(0.324)	(0.373)	(0.283)	(0.317)	(0.278)	(0.301)
τ_i		0.127	-	0.043	-	0.138
		(0.180)		(0.151)		(0.188)
S	-	-	-0.026	-0.025	-0.028	-0.036
			(0.034)	(0.037)	(0.042)	(0.038)
y_0	-	-	-0.900	-0.713	-0.965	-0.519
			(0.985)	(1.026)	(0.977)	(1.027)
b	-	-	**0.321	**0.306	**0.311	0.254
			(0.112)	(0.141)	(0.117)	(0.154)
g	-	-	-	-	-0.003	-0.012
					(0.010)	(0.010)
$\overline{R}^2$	0.311	0.336	0.155	0.142	0.142	0.141

Table 5: Growth Regressions, Lower-Middle Income Countries.

Dependent variable for all regressions is the five-year average of annual per capita GDP growth rate. Standard errors are in parentheses.
* (**) represents significance at the 10% (5%) level, using student's t critical values. Regressions 1-2 include two-way fixed effects, while regressions 3-6 include fixed effects over time; none of which are reported. Standard errors and covariance are corrected for cross-sectional heteroskedasticity.

Regression	#1	#2	#3	#4	#5	#6
e	-0.020	-0.246	-0.047	-0.169	-0.186	-0.192
	(0.218)	(0.265)	(0.151)	(0.172)	(0.179)	(0.185)
τ_i	-	-0.061	-	**0.101	-	0.064
		(0.121)		(0.044)		(0.101)
S	-	-	*0.023	*0.025	**0.027	**0.026
			(0.012)	(0.013)	(0.013)	(0.010)
y_0	-	-	*-3.136	**-3.226	**-3.184	**-3.200
			(1.603)	(1.611)	(1.582)	(1.356)
b	-	-	**0.168	0.115	**0.214	0.149
			(0.063)	(0.096)	(0.063)	(0.109)
g	-	-	-	-	**0.013	0.006
					(0.006)	(0.010)
$\overline{R}^2$	0.327	0.307	0.101	0.126	0.135	0.121

Table 6: Growth Regressions, Poor Countries.

Dependent variable for all regressions is the five-year average of annual per capita GDP growth rate. Standard errors are in parentheses.
* (**) represents significance at the 10% (5%) level, using student's t critical values. Regressions 1-2 include two-way fixed effects, while regressions 3-6 include fixed effects over time; none of which are reported. Standard errors and covariance are corrected for cross-sectional heteroskedasticity.