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ESSAYS ON FISCAL POLICY AND ECONOMIC GROWTH

BY

TAMOYA A.L. CHRISTIE

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree
of
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in the
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of
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ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Andrew Young School of Policy Studies of Georgia State University.

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ABSTRACT

ESSAYS ON FISCAL POLICY AND ECONOMIC GROWTH

By

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August 2011

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This dissertation comprises two essays that elaborate on different aspects of the relationship between government expenditure and long-term economic growth. The first essay explores how the size of government, as measured by the level of spending, affects growth. Theoretical models suggest a nonlinear relationship; however, testing this hypothesis empirically in cross-country studies is complicated by the endogeneity of government spending and the accurate identification of turning points. This paper examines the nonlinear hypothesis by incorporating threshold analysis in a cross-country growth regression. The methodology utilizes a sample-splitting framework and follows an objective strategy for identifying and testing changes in the slope. Using a broad panel of countries over the period 1971-2005, the results show evidence in favor of a nonlinear effect, but not of the form predicted by theory. When total government spending is low, there is no statistically significant effect on economic growth. However, after passing a certain threshold (26 percent for developed countries and 33 percent for developing countries) government spending exhibits a negative effect on growth. This pattern remains the same even when productive government spending is singled out.

The second essay develops a dynamic macroeconomic model to explore how variations in the composition and financing of government expenditures affect economic growth in the long-run. The model is used to analyze how public investment spending funded by taxes or borrowing affects long-term output growth. We also examine the effect of varying the composition of public expenditure, shifting between consumption and investment spending, or re-allocating between different types of public investment. In addition, we use alternative parameterizations of the model to explore how the effects on growth change under extreme initial fiscal conditions such as high average tax rates, debt ratios and public consumption spending. The model is calibrated to reflect economic conditions in the seven largest Latin American economies during the period 1990 to 2008. We find that, where tax rates are not already high, funding public investment by raising taxes may increase long-run growth. If existing tax rates are high, then public investment is only growth-enhancing if funded by restructuring the composition of public spending. Interestingly, using debt to finance new public investment compromises growth, regardless of the initial fiscal condition.

INTRODUCTION

The general increase in the average size of government over time has precipitated fears that progressively larger governments will compromise economic growth. This has prompted calls to scale back government activities and cut budgets. However, the areas of government spending which typically end up being cut during fiscal adjustment are categories associated with productive expenditure—public investment in physical infrastructure, education and healthcare, for example. Spending in these areas has been shown to have a positive impact on aggregate production and is considered crucial for long-term growth and development. Policymakers risk doing more harm than good to their economies over the long-run if the appropriate level and composition of public expenditure is not maintained.

Of course, one of the major challenges facing governments is how to finance such expenditures given binding fiscal constraints. Moreover, it has been shown that diverse types of government expenditure may have conflicting effects on growth given different sources of financing. Income taxes tend to be distortionary creating disincentives to saving and investment, while deficit financing may crowd out private investment (Agénor, 2004; Kneller, Bleaney, & Gemmell, 1999). It is therefore also important to know how government spending can be most efficiently allocated and financed to bring about the best growth results, particularly in the context of adverse fiscal conditions such as already high tax rates, large fiscal deficits and growing debt stocks.

This dissertation comprises two essays that examine different aspects of the relationship between government spending and long-term economic growth. The first essay explores the topical issue of size, as measured by the level of government spending (as a share of GDP). The paper empirically tests the validity of existing theory which stipulates there is a nonlinear relationship between government size and economic growth; such that government spending is growth-enhancing at low levels but growth-retarding at high levels, with the optimal size occurring somewhere in between. The second essay complements the first by delving into issues concerning the optimal composition and financing of public expenditures, and how these vary depending on heterogeneous fiscal conditions across countries. The premise is that the appropriate fiscal strategy in one country may not be the same in another where fiscal conditions are more stringent.

In the first essay, the objective of empirically testing the nonlinear hypothesis in cross-country studies is complicated by the endogeneity of government spending and the accurate identification of turning points. We attempt to overcome these problems and in so doing make several contributions to the existing literature. First, in terms of methodology, we incorporate threshold analysis in the cross-country growth regression. This methodology utilizes a sample-splitting framework and follows an objective strategy for identifying and testing changes in the slope. In addition, we apply generalized method of moments (GMM) dynamic panel techniques to address potential endogeneity of government expenditure. Second, with respect to data, we employ an updated data set with a broad cross-section of countries over a long time span. Pulling data from the International Monetary Fund’s (IMF) *Government Finance Statistics* (GFS), the sample contains 136 countries over the period 1971-2005. Most important, this data source offers a more comprehensive measure of government size by using total government expenditure (excluding interest payments) as opposed to government consumption expenditure as the proxy. The consumption measure, though widely used in empirical studies, does not include public capital formation and so cannot fully capture the productivity-enhancing effects of government services. Moreover, the GFS data contain sectoral decompositions of government spending, which allows us to isolate "productive" as opposed to "unproductive" elements of government spending from the total. This enables us to also explore, in broad terms, different effects due to the composition of public spending.

We find evidence to support a nonlinear effect, but not of the form suggested by the nonlinear hypothesis. For total government spending above a critical size threshold, we find a negative effect on growth. However, this effect is negligible for government size below the threshold, and only displays a positive—though not statistically significant—coefficient when productive government spending is distinguished from the total. We also find evidence to suggest that other factors may affect the nature of the relationship between government size and growth. The level of economic development and the quality of government are two such factors. When we analyze developed and developing countries separately, the threshold location is lower for developed countries. In addition, high quality governance mitigated some of the negative effects so that nonlinearities were more pronounced in countries with less effective governments.

The findings of this study have significant public policy implications as they offer some insight to the policy debate about the optimal size of government, and how this varies according to the level of economic development of a country. Indeed, the concern about large governments is not misplaced as several countries have exceeded the critical threshold identified in this study. Further expansion of government will have negative effects on long-run growth in these economies. Fortunately, the evidence also shows that improvements to the quality of government can dampen these negative effects. On another note, the negligible growth effects of government spending below the threshold imply serious offsetting influences, which mitigate the potential benefits from increased public spending. The extent to which the mitigating factors are due to the composition and financing of public expenditures is explored in the second essay.

The second essay of the dissertation develops a two-sector endogenous growth model which is capable of explaining how variations in the composition and financing of government expenditures affect economic growth rates in the long-run. The model is used to analyze how public investment spending funded by taxes (income or consumption) or by borrowing affects long-term output growth. We also examine the effect of varying the composition of public expenditure, shifting the proportions of productive versus unproductive spending, or re-allocating between different types of productive expenditure. In addition, we explore how heterogeneous fiscal conditions affect the implications for growth. Specifically, we use alternative parameterizations of the model to simulate extreme initial fiscal conditions such as high average tax rates, debt stock ratios and government consumption spending. The implications of the model are tested using quantitative methods. The model is calibrated to reflect economic conditions in the seven largest Latin American economies during the period 1990 to 2008. The Latin American countries provide a suitable testing ground given their debt history and diverse fiscal adjustment experiences.

The study makes several contributions to the existing literature. First, we take into account that government expenditure is not homogenous and spending in different sectors will have diverse productivities. Thus, we move beyond the standard practice of broadly categorizing government spending merely as “productive” or “unproductive” and explicitly recognize the heterogeneity within productive government expenditure itself. To do this, we develop a two-sector endogenous growth model in which public investment is divided between physical and human capital, allowing for distinct output effects from each type of spending. Second, the theoretical model moves away from the balanced government budget constraint typical of the literature and opens up the revenue options of the government to include deficit financing. This more realistically captures the actual situation of the majority of economies today and allows us to explore the extent to which variations in the sources of financing affect the relationship between government spending and long-term growth. Third, we pay particular attention to how these effects change under different initial fiscal conditions (such as high tax rates and large debt stocks), an aspect not previously explored in the growth literature.

We find that the effect of productive government spending on growth is not necessarily positive, but varies with the overall structure of total public expenditure, the method of funding and the existing fiscal conditions. This helps to explain the negligible effect of government spending below the threshold found in the first essay. If existing tax rates are high, then funding productive spending by further increases in the tax rate, actually lowers long-run growth. In this case, public investment is only growth-enhancing if financed by restructuring the composition of public spending. Interestingly, using debt to finance new public investment compromises growth in the long-run, regardless of the initial fiscal condition.

The dissertation proceeds with a more detailed discussion of each of the two essays.

ESSAY 1

THE EFFECT OF GOVERNMENT SPENDING ON ECONOMIC GROWTH: TESTING THE NONLINEAR HYPOTHESIS

Introduction

There has been ongoing concern that large and growing governments have deleterious effects on the long-run growth of their economies. The usual policy prescription calls for a scaling back of government activity and budgets, constraining public spending from growing faster than output. In countries facing fiscal imbalances and high debt burdens, this has prompted wide-ranging fiscal consolidation programs to reduce government spending (IMF, 2003). However, parallel to this thrust has been a call for "fiscal space" in which governments argue for room in their budgets to allow for the provision of productive public goods that will foster economic growth (Heller, 2005).[1] These opposing policies are based on conflicting views on the role of government in the development process.

The theoretical literature offers support for both positive and negative effects of government size on economic growth. Government provision of public goods such as infrastructure, rule of law, and protection of property rights—the core areas of government – is thought to be conducive to growth (Aschauer, 1989; Ram, 1986). However, as the size of government increases, distortionary effects of high taxes and public borrowing, diminishing returns to public capital, rent-seeking activities and bureaucratic inefficiencies become more prevalent. Public choice theorists argue that

[1] Productive government expenditure may include, *inter alia*, spending on highways, roads, education, health, national defense or rule of law (Gramlich, 1994). Conversely, unproductive government spending may be regarded as government consumption services like social security and welfare payments.

eventually the latter factors dominate and marginal government expenditure exerts a negative effect on growth (Barth, Keleher, & Russek, 1990; Gwartney, Lawson, & Holcombe, 1998).

These ideas have been formalized in the endogenous growth literature. Barro (1990) introduces a non-monotonic relationship through the rising distortionary effect of increasing tax rates which are required to fund ever larger government expenditure. In the Barro model, when government is relatively small, growth rises with increases in productive government services as the positive effects of more public goods dominates, but beyond some critical point the disincentive effects of higher taxes on savings and investment reduce the growth rate. If the nonlinear hypothesis is valid and the effect of government spending on long-run economic growth does vary with its size, this would not only help to explain the ambiguous findings in the empirical growth literature, but would also offer clearer guidelines on the appropriate fiscal policy prescription for a country of a particular government size. Furthermore, implicit in the nonlinear hypothesis is the existence of some optimal size of government which would maximize economic growth. Having an indication of this hypothetical optimum, and where a country stands relative to it, should be of potential interest to policymakers. It must be noted, of course, that the optimal point is likely to differ for each country depending on various factors which may attentuate or accentuate the break point. Some factors we are able to control for, while others we are not.

This chapter tests the validity of Barro's nonlinear hypothesis on the relationship between government spending and economic growth. Currently, there is no clear consensus in the empirical growth literature on how government spending affects growth.[2] This may be attributable to the fact that the possibility of a nonlinear relationship has been largely ignored. Those studies which have tried to incorporate a possible nonlinear effect have been mainly limited to single-country investigations, using time series data (Chen & Lee, 2005; Grossman, 1988; Mittnik & Neumann, 2003; Vedder & Gallaway, 1998). Among the relatively few cross-country studies that have explored a non-monotonic relationship (Afonso & Furceri, 2010; Kelly, 1997; Park, 2006), the tendency is to include a quadratic term, which usually fails to detect any evidence of nonlinear effects in the relationship. This may be attributable to the fact that a quadratic specification assumes one particular form of nonlinearity, but the true effect may be present in other forms not appropriately modeled by a quadratic term.

Nevertheless, some early evidence in favor of the nonlinear hypothesis using cross-country data has been provided by Sheehey (1993) and Karras (1996). By dividing a broad sample of 102 countries according to the initial size of government, Sheehey finds that increasing the share of government spending to GDP has a positive (negative) effect on growth when the initial government expenditure share is below (above) 15 percent.[3] While these findings are consistent with the nonlinear hypothesis, the choice of a 15 percent government share threshold is arbitrary, which creates uncertainty about the correct identification of the growth-maximizing point. Karras takes a different approach to the nonlinearity question. Although he does not directly test the relationship between government size and growth, his methodology allows him to determine the productivity

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[2] Ram (1986) and Rubinson (1977) are among the few who find clear evidence in favor of a positive relationship. Barro (1989) and Kormendi and Meguire (1986) find no significant relationship. On the other hand, studies which find a negative effect include Afonso and Furceri (2010), Folster and Henrekson (2001), Grier and Tullock (1987) and Landau (1983).

[3] Sheehey (1993) also searches for nonlinearities in government spending on the basis of economic development. He finds that increasing the share of government in low-income countries has a positive effect, but increases in high-income countries have a negative effect.

of government spending and identify whether or not government services are optimally provided.[4] Moreover, he is able to test the relationship between the marginal productivity of government services and government size. He finds this relationship to be negative, implying that the public sector is more productive when small—a feature consistent with the nonlinear hypothesis.[5]

More recently, Varoudakis, Tiongson, and Pushak (2007) also investigate the nonlinear hypothesis for a group of 25 transition economies between 1992 and 2004. Using spline regressions, they experimented with a number of plausible threshold values for government size. They eventually settle on a threshold value of 35 percent, which is approximately equal to the sample median. They find that at expenditure levels of 35 percent of GDP or higher, public spending negatively affects growth. However, at levels below 35 percent, public sector size had no robust measurable effect.

This chapter re-examines the relationship between government size and long-run economic growth, explicitly accounting for the likelihood of a nonlinear effect. We contribute to the literature in a number of ways. First, in terms of methodology, we make improvements to previous empirical studies by applying threshold analysis (Hansen, 2000) to a panel of 136 countries. This technique has been widely used as the preferred method to identify threshold effects (Adam & Bevan, 2005; Chen & Lee, 2005; Falvey, Foster, & Greenaway, 2006; Haque & Kneller, 2009; Khan & Senhadji, 2001), particularly when the variable of interest is observable, but the position of the threshold is not known. The methodology uses a sample-splitting framework and follows an objective

[4] Karras (1996) takes advantage of the "Barro rule" which states that government services are optimally provided when their marginal product equals unity.

[5] Furthermore, he calculates the optimal government size to be 23 percent for the average country in his sample, ranging from 14 percent for the average OECD country, to 33 percent in South America.

strategy for identifying and testing changes in the slope. One important advantage of threshold analysis is that it avoids the *ad hoc*, subjective pre-selection of threshold values—a major critique of previous studies. In addition, we also apply generalized method of moments (GMM) dynamic panel techniques to address potential endogeneity of government expenditure, which is measured as a share of GDP. Second, with respect to data, we employ an updated data set with a broad cross-section of countries over a long time span. Pulling data from the IMF's *Government Finance Statistics* (GFS), our sample contains 136 countries over the period 1971-2005. Most important, this data source offers a more comprehensive measure of government size by using total government expenditure (excluding interest payments) as opposed to government consumption expenditure as the proxy. The consumption measure, though widely used in empirical studies, does not include public capital formation and so cannot fully capture the productivity-enhancing effects of government services. Moreover, the GFS data contain sectoral decompositions of government spending, which allows us to isolate "productive" as opposed to "unproductive" elements of government spending from the total. This enables us to also explore, in broad terms, different effects due to the composition of public spending.

The results of the study suggest evidence in favor of a nonlinear effect, but not as predicted by Barro's nonlinear hypothesis (Barro, 1990). When total government spending is low, we find no statistically significant effect on economic growth. However, after passing a certain threshold (26 percent for developed countries and 33 percent for developing countries) government spending exhibits a strong negative effect on growth. Interestingly, this pattern remains the same even when productive government spending is singled out. The results are qualitatively robust to various specifications and estimation techniques.

The chapter proceeds as follows. The next section provides a description of the data and the empirical methodology used in the analysis. The results are discussed in the third section. Finally, we summarize the findings and conclude with some policy implications.

Data and Empirical Methodology

Data

This paper incorporates threshold analysis into a standard growth equation to test for a nonlinear relationship between government size and long-run economic growth. As established in the growth literature (Barro & Sala-i-Martin, 1995; Levine & Renelt, 1992), real output per capita growth is modeled as a function of government size (total government expenditure/GDP) and control variables. The set of controls includes initial GDP per capita, the ratio of domestic investment to GDP, the average inflation rate, and openness to trade (as defined by the sum of exports and imports to GDP). The initial level of GDP controls for the convergence effect noted in the Solow-Swan (Solow, 1956; Swan 1956) model.[6] Domestic investment captures the positive effects of physical capital accumulation. The latter variables are controls for the effects of macroeconomic policy. Openness is presumed to affect growth positively, while high inflation adversely affects growth.

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[6] Initial GDP is measured as the value at the start of each five-year period and so varies over time.

The data used for the analysis comprise a panel of 136 countries over the period 1971-2005.[7] The fiscal variables are from the IMF's *Government Finance Statistics* and we use data for the consolidated central government.[8] One advantage of this data source is that it also contains sectoral decompositions of total government spending, which allows us to isolate productive elements of government spending from the total. Using the functional classification of the GFS, we define productive government spending as the sum of expenditure on education, health, housing and transport and communication.[9] The national accounts and inflation variables are obtained from the World Bank's *World Development Indicators (WDI) 2007*. Since the relationship of interest is between long-run growth and government size, in keeping with convention (Bleaney, Gemmell, & Kneller, 2001), we take 5-year averages of the data to smooth out changes due to cyclical effects. This procedure also eliminates potential econometric biases due to endogeneity problems arising from short-run cyclical simultaneity. The averaging operation results in a reconstructed panel of seven observations per country, which gives a potential sample size of 952. However, because of missing data, the usable sample is reduced in various specifications of the model.[10]

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[7] Note, fiscal variables are available since 1972.

[8] The choice to use central government data rather than general government was based on availability. The use of data from the consolidated central government means we are not capturing all government expenditure items in countries with a decentralized system. However, Devarajan, Swaroop, and Zou (1996) using the same data source, conducted robustness checks on a subset of countries which had data available for general government and found results in the two data sets to be consistent.

[9] This definition is reasonably accepted in the literature, variations of which have also been employed by Adam and Bevan (2005), Bleaney et al. (2001), Kneller et al. (1999) and Park (2006). We normalize the variable as a percentage of GDP.

[10] The limitations on the data emanate primarily from the fiscal variables which have a more limited coverage than the WDI. There are also gaps in the early years predominantly from developing countries whose statistical reporting capabilities may not have been well-developed at that time. Given a systematic exclusion of developing country data in the earlier periods, there may be an issue of sample selection bias. We check for this in the sensitivity analysis by running regressions for several time periods.

Table 1 provides summary statistics for the data and defines the variable mnemonics used in the paper. A further breakdown of the sample according to five-year averages is presented in Appendix A (Table A1).[11] For our sample of countries, the overall growth rate averaged 2.1 percent per annum. This masks a wide disparity across countries and across time. While growth in the OECD countries averaged 2.6 percent per annum, the corresponding rate in developing countries was 1.9 percent. Similarly, the average size of government (measured as total expenditure to GDP) was 28.1 percent, but the difference between high-income and low-income countries was stark, averaging 34.1 percent and 25.7 percent, respectively. Figure 1 plots the average government size against average real GDP per capita growth for each country over the period 1970-2005. A preliminary bivariate regression of these cross-sectional data suggests a positive—though not statistically significant (p = .159)—relationship between the two variables of interest.

Model Specification and Estimation

Recall that according to the nonlinear hypothesis, the effect of government expenditure on growth will vary depending on the size of government. We first test for the presence of turning points or thresholds in the relationship between growth and government size by applying the threshold regression model (Hansen, 1996, 1999, 2000). The estimated threshold, provided it exists, is then interacted with government size.

The threshold regression model applied to a standard growth equation for country $i = 1, \ldots, I$ and time period $t = 1, \ldots, T$ takes the following form:

$$GROWTH_{it} = \beta_0 X_{it} + \beta_1 GOV_{it} * I(GOV_{it} \leq \lambda) + \beta_2 GOV_{it} * I(GOV_{it} > \lambda) + u_{it} \ , \qquad (6)$$

[11] A detailed description of all variables used in the estimation is also provided in the Appendix (Table A2).

and $u_{it} = \mu_i + \theta_t + \varepsilon_{it}$,

where X_{it} represents the matrix of control variables, *GOV* denotes government spending as a share of GDP, μ_i is a country-specific fixed effect, θ_t is a time fixed effect and ε_{it} is a normally distributed error term. $I(\cdot)$ is an indicator function which takes the value of one when the condition inside parentheses is satisfied, and λ is the threshold value to be determined within the model. We define $S(\lambda) = \hat{u}(\lambda)'\hat{u}(\lambda)$ as the residual sum of squares of the model in (6) estimated for a threshold level λ. The optimal threshold is then

$$\hat{\lambda} = \arg\min_{\lambda} S(\lambda). \qquad (7)$$

$\hat{\lambda}$ is found by estimating (6) for all values of government size in the range 13-47 percent in one-unit increments.[12]

Having identified a potential threshold, it is important to determine whether the threshold effect is statistically significant. From equation (6), testing for no threshold effects is equivalent to testing the null hypothesis H_0: $\beta_1 = \beta_2$. However, since the null is consistent with any arbitrary value of λ, the threshold cannot be identified using standard methods of inference. Hansen (1996, 1999) suggests a bootstrap method to simulate the asymptotic distribution of the likelihood ratio (LR) test of H_0 based on:

$$LR_0 = \left(S_0 - S_1(\hat{\lambda})\right) / \hat{\sigma}^2 \ , \qquad (8)$$

where S_0 denotes the residual sum of squares for the model with no threshold and $\hat{\sigma}^2$ is the estimated error variance in the presence of the threshold, $\hat{\lambda}$. The asymptotic distribution of LR_0 is non-standard and strictly dominates the χ^2 distribution. The

[12] As recommended by Hansen (1999), we restrict the search to values of λ that allow a minimal percentage of the observations to fall within each regime. Here we exclude values of λ which fall within the top and bottom 5th percentiles of *GOV*.

distribution of LR_0 depends in general on the moments of the sample, thus critical values cannot be tabulated. However, Hansen shows that a bootstrap procedure attains the first-order asymptotic distribution, so p-values constructed from the bootstrap are asymptotically valid.[13]

It is also interesting to know how precisely the threshold has been estimated. The asymptotic confidence interval for $\hat{\lambda}$ can be constructed from the LR_1 statistic

$$LR_1(\lambda) = \left(S(\lambda) - S(\hat{\lambda})\right)/\hat{\sigma}^2 \qquad (9)$$

across the range of values for λ. We note that $LR_1(\lambda)$ is a simple re-normalization of the sequence of sum of squared residuals, $S(\lambda)$, and takes the value of zero at $\hat{\lambda}$. It can be shown that the LR_1 statistic tends in distribution to the random variable ξ with limiting distribution $\Pr(\xi \le x) = (1 - \exp(-x/2))^2$. The inverse of the distribution, $c(\alpha) = -2\log(1 - \sqrt{1-\alpha})$, gives the relevant 100α% critical value.

Once the threshold has been identified and $\hat{\lambda}$ proved statistically significant, we proceed to estimate equation (6) with standard econometric techniques.[14] We rely mainly on fixed effects estimation, controlling for both time-invariant individual country characteristics and time fixed effects.[15] In addition, we use dynamic panel system generalized method of moments (Arellano & Bover, 1995; Blundell & Bond, 1998) estimation to account for the possibility of reverse causality between growth and

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[13] The bootstrap procedure is outlined in Hansen (1999).

[14] Chan (1993) and Hansen (2000) show that the dependence of β_i on the threshold estimate is not of first-order asymptotic importance, so inference on β_i can proceed as if the threshold estimate, $\hat{\lambda}$, were the true value.

[15] We also considered pooled OLS and two-way random effects models. Based on the log likelihood and the adjusted R^2 for the pooled OLS and a rejection of the null hypothesis in the Hausman test between fixed effects and random effects, we choose the fixed effects model as our main method of estimation.

government size under Wagner's law (Easterly & Rebelo, 1993).[16] The panel GMM estimator has been used extensively (Beck & Levine, 2004; Johansson, 2010; Rioja & Valev, 2004) to deal with problems arising from independent variables that are not strictly exogenous. It has the advantage of using internal instruments, formulated from lags of the endogenous variables themselves. Moreover, the system GMM estimator is specifically designed to handle some of the problematic features of panel data such as country-specific fixed effects, heteroskedasticity and autocorrelation within countries.[17]

Results

Threshold Existence

The threshold regression analysis indicates the existence of thresholds in the relationship between growth and government size. Table 2 presents results of the estimated location and significance levels of turning points in various sub-samples of the data. The asymptotic p-values of the LR_0 statistic indicate that the null hypothesis of no threshold effects can be rejected at least at the 5 percent significance level for all three samples.

The overall threshold estimate for the full sample is indicated at 33 percent. Figure 2 illustrates the distribution of observations according to government size and

[16] Wagner's law states that there is a tendency for government expenditure to be higher at higher levels of per capita GDP. On the one hand, Wagner's law may be less of a concern here, since it suggests an association between GDP growth and the growth rate, rather than the level, of government expenditure. However, to the extent that faster growing economies achieve a higher level of GDP, which has been shown to be associated with higher government spending, the possibility of a reverse relationship has to be considered.

[17] The method jointly estimates the regression in first-differences and in levels—with first-differences instrumented by lagged levels of the dependent and explanatory variables and levels instrumented by first-differences of the regressors. The procedure is fully described in Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998).

GDP growth rates. Of the 557 observations in the full sample, 382 (69 percent) fall below the estimated threshold. These observations represent 117 of the 136 countries in the full sample. Figure 3 presents the likelihood ratio (LR_1) statistics and corresponding asymptotic confidence intervals for the threshold estimates.[18] The large confidence interval for the full sample (see panel a), casts doubt on the precision of this estimate. As indicated above, the threshold location is likely to be affected by many things. One such factor may be that the wide disparities among such a broad group of countries are influencing the results (Bose, Holman, & Neanidis, 2007; Gregoriou & Ghosh, 2009; Sheehey, 1993). Allowing for parametric heterogeneity between developed and developing countries, we re-estimate the thresholds distinguishing between the two country groups. This time the results again indicate an expenditure-to-GDP threshold at 33 percent for developing countries, which is highly significant at the one-percent level.[19] More encouragingly, the narrow confidence intervals indicate greater precision of the estimate. The second panel in Figure 3 illustrates that the 5 percent critical value crosses the normalized LR_1 statistic over a narrow range. We can therefore say with 95 percent confidence that the true threshold falls within the interval (29, 36).[20]

For developed countries, Table 2 indicates the presence of threshold effects at 26 percent, which is below the level of developing countries.[21] One explanation for the lower threshold result could be due to the composition of expenditures. We know that

[18] The confidence interval of the threshold estimate of λ consists of those values of government expenditure for which the likelihood ratio statistic is less than the critical value.

[19] For the sample of developing countries, 316 out of 399 observations (79 percent) fall below the threshold ($\lambda = 33$); representing 98 out of 108 countries.

[20] This is consistent with Varoudakis et al. (2007) who found an estimated threshold at 35 percent of total government spending for countries in Europe and Central Asia (ECA). It is notably larger than the average threshold estimates found by Sheehey (1993) and Karras (1996), who both employed consumption expenditure as their measure of government size.

[21] For the sample of developed countries, 41 out of 158 observations (26 percent) fall below the estimated threshold ($\lambda = 26$); comprising 10 of the 28 developed countries in the study.

countries with bigger governments tend to allocate a larger share of total government spending to social welfare and transfer payments (Gray, Lane, & Varoudakis, 2007). In our estimation sample, developed countries allocate roughly 42 percent of total expenditure to unproductive means, [22] compared to 30 percent in developing countries. To the extent that this kind of spending has to be financed by tax revenues, then the lower threshold corresponds to a lower optimal government size predicted by the nonlinear hypothesis (Barro, 1990). We note that while the p-values indicate that the coefficients for the regimes above and below the threshold are statistically different at least at the 5 percent level, the wide confidence intervals again restrict our conclusions about the precision of this estimate.[23]

Threshold Effects

Total government spending.

Table 3 reports the estimated effects of government spending on growth taking into account the thresholds identified in the previous exercise. Results on threshold effects for the full sample are presented in column 3, with the threshold specified at 33 percent. For comparison, we also include results for when the model is estimated without accounting for nonlinearities (column 1) and when nonlinearities take a quadratic form (column 2).[24]

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[22] Defined here as the sum of public spending on social security and welfare, recreation and economic services (Kneller et al., 1999).

[23] We also tested for thresholds on various other sub-samples of the data based on geographical region (Karras, 1996) and income level. The threshold estimates, while varying slightly, are consistent with our main results, though less precisely estimated. More details are provided in Appendix A.

[24] The regressions are estimated by two-way fixed effects using the *xtreg,fe* command in Stata. The reported constant is the average value of the fixed effects, derived from a simple reformulation of the basic fixed effects model.

The main variable of interest is government size, *GOV*, as measured by total government expenditure as a share of GDP. When entered linearly, the coefficient is negative and statistically significant, $p = .018$. A one-percentage point increase in total government expenditure reduces per capita real output growth by 0.07 of a percentage point. Unsurprisingly, consistent with previous studies, the possibility of a nonlinear effect is not captured by a quadratic specification. When a quadratic term on total government spending is included, the model fails to find significance for either of the fiscal variables.

The results for the nonlinear model with a threshold on government spending at 33 percent for the full sample, (column 3) suggest a weak nonlinear effect, but not of the form expected from the Barro nonlinear hypothesis. Instead of displaying a positive relationship with growth when government is small as would be predicted by the theory, the effect of government spending below the threshold is negligible, being neither statistically nor economically significant. Beyond the estimated threshold, the effect of government spending is negative as expected, but only significant at the 10 percent level, $p = .095$. The growth rate falls by 0.045 percentage points for every unit percentage point increase in government size. Standard Wald tests confirm the two coefficients around the threshold to be statistically different, $p = .053$.

Distinguishing between developed and developing countries gives similar results. In developing countries (column 5), there is a significant negative effect only after the threshold has been exceeded. For government size below 33 percent, the growth effect is negligible. Wald tests show the two coefficients around the threshold to be statistically different at a high level of significance, $p = .004$. In developed countries (column 4), we also note significant differences around the estimated threshold of 26 percent. Above this value, larger government size has a deleterious effect on growth but below the threshold, there is no statistically significant effect even though the coefficient is negative.

These results are interesting as they seem to indicate the presence of nonlinearities in the government size – growth relationship, but not in line with an expected inverted U-shape. This would provide one explanation why previous studies using a quadratic specification failed to capture the nonlinear effect. The quadratic model a priori restricts the relationship between government size and long-run growth to a particular functional form, which may or may not be in line with the true data-generating process. The threshold model does not make this assumption but rather allows the data to suggest the model specification. In this case, the data show that the nonlinear effect we investigate does not display a smooth turning point around a defined optimum, but rather takes the form of a kink where there is a distinct change in the slope. The threshold model is better suited than the quadratic model to detect this kind of nonlinearity.

We note that the control variables have the expected signs and are all statistically significant. The negative coefficient on initial GDP confirms the conditional convergence hypothesis within a 5-year time span. Also as expected, increases in inflation reduce growth, but the coefficient is small and weakly significant, $p = .076$. The coefficient on the share of investment as a proportion of GDP is positive and highly significant, $p < .001$. A one-percentage point increase in investment can stimulate long-run growth by 0.2 of a percentage point. This compares favorably with previous studies (Adam & Bevan, 2005; Bose et al., 2007). Finally, openness to trade (*OPEN*) also indicates a positive and statistically significant effect at the five percent level, $p = .034$.

Endogeneity.

As previously discussed, one concern is that some of the explanatory variables, including our main variable of interest, may not be strictly exogenous thus causing the coefficients to be biased. We account for possible endogeneity issues by applying dynamic panel GMM techniques to equation (6). Given observed differences between developed and developing countries, we reestimate the full sample GMM equation including income-class dummies for each country.[25, 26] The results for the GMM regression on the full sample are presented in Table 4. For comparison, we provide the results of the linear and quadratic models in the first two columns. We also include the Arellano-Bond test for autocorrelation and the Hansen J test of over-identifying restrictions.[27] Both tests support the validity of the model in each regression.

Focusing on the threshold specification, column 3, we note that GMM estimation indicates considerable change in the slope coefficients around the threshold value, but neither side exhibits statistical significance. The negative coefficient above the threshold is consistent with the FE model, but under GMM the standard errors are larger. Interestingly, for government spending below the threshold, the GMM estimation returns a positive coefficient. Not surprisingly, when the model is estimated only for developing countries, column 4, results are more in line with the fixed effects specification, with a weakly significant negative coefficient above the threshold, (p = .070), and no statistically significant effect below. This helps to reassure us that the main results are not

[25] Dynamic panel GMM does not perform well in small samples with many regressors making it unsuitable for estimation of the developed country sub-sample which has only 158 observations (Roodman, 2009b).
[26] We use the World Bank country classification which groups countries into low-income, lower-middle income, upper-middle income and high-income country groups.
[27] The Arellano-Bond test determines whether the differenced error term has first-order or second-order serial correlation. Second-order serial correlation implies that some lags are invalid as instruments. The Hansen J statistic tests the overall validity of the instruments (Roodman, 2009a).

merely an artifact of endogeneity biases. While the coefficients on the control variables are of different magnitudes, the signs are largely as expected with different levels of significance. The only exception is *OPEN* which has an unexpected negative sign. In addition, as in the fixed effects model, when nonlinearities are ignored, the coefficient on the government size variable is strongly negative and significant, $p = .022$. However, under GMM it is about twice the magnitude.

Productive government spending.

Even though the results show that the effect of government spending below the threshold is statistically insignificant, we would have expected the coefficient to at least display a positive sign. One possible explanation for this puzzle is in noting that the theory makes a distinction between productive and unproductive public spending and it is the productive portion which is growth-enhancing, while the unproductive share is theorized to have a negative effect. In analyzing the total spending, we are indeed confounding the two effects, which may have offsetting influences. We therefore try to isolate what may be considered as productive elements of government spending. Using the functional classification of the GFS, we define productive government spending, *PR_GOV*, as the sum of expenditure on education, health, housing, transport and communication, relative to GDP.[28] Similar definitions have been used by Adam and Bevan (2005), Kneller et al. (1999) and Park (2006). We note that more detailed information is required to construct this variable and many missing observations result in a smaller sample size, reducing the number of observations from 557 to 394 in some specifications.

[28] Several empirical studies have shown public spending in these particular areas to be positively associated with economic growth (Aschauer, 1989; Easterly & Rebelo, 1993; Blankenau, Simpson, & Tomljanovich, 2007).

The regression results focusing on productive government spending are presented in Table 5. In column 1, we estimate a linear specification without controlling for total government size. The results are similar to the comparable case using total spending. In column 2 we re-estimate the baseline threshold model (equation 6) replacing total government spending with productive government spending, but maintaining total size as the variable on which the threshold is based.[29] Now, in line with expectations, the coefficients on the fiscal variables change sign around the threshold value. Below the threshold, when total government spending is less than 33 percent, the coefficient on productive government spending is positive, though still not statistically significant. When the total size of government increases beyond the threshold value further increases in productive spending have a negative significant effect on growth, so that even expenditure on productive activities does not translate into long-run growth. In columns 3 and 4, we re-estimate the productive spending models using dynamic GMM to account for endogeneity. We find that the results are consistent with the fixed effects specification.

We also estimated the model separately for developed and developing countries (Table A3 in Appendix A). When focusing on productive expenditure, the government size threshold value for developed countries was higher at 32 percent while that for developing countries remained the same at 33 percent. A statistically significant change in slope was evident around the threshold value in either case, but only the developing countries displayed a change in sign.

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[29] The model estimated was $GROWTH_{it} = \beta_0 X_{it} + \beta_1 PR\_GOV_{it} * I(GOV_{it} \leq \lambda) + \beta_2 PR\_GOV_{it} * I(GOV_{it} > \lambda) + u_{it}$. A new threshold search revealed $\hat{\lambda}$ at 33 percent, consistent with the original sample. Testing the null hypothesis for the difference in slopes gives an LR_0 statistic of 10.968 which is significant at the 1 percent level. Furthermore, 95 percent confidence intervals indicate that the threshold is precisely measured.

Sensitivity Analysis

We test the robustness of the main results under various alternative specifications and sub-samples. The tests give results generally in line with the main findings reported in Tables 3-5, with some caveats.

We first examine how sensitive the results are to alternative combinations of covariates in the control vector. Alternatively excluding *INF*, *INV* and *OPEN* from the main specification in equation (6), we find that both the threshold value and the qualitative effects around the threshold remain consistent with the primary results (see columns 1-3 in Table A4). However, when additional controls are incorporated the results vary. Including average years of schooling to control for the level of human capital (Barro & Sala-i-Martin, 1995; Levine & Renelt, 1992) does not support the existence of a threshold as $\hat{\lambda}$ = 12, the minimum of the range. This would imply that a strictly linear specification of the fiscal variable is more appropriate.

A number of studies have explored the importance of the quality of institutions in the development process (Acemoglu, Johnson, Robinson, & Thaicharoen, 2003; Knack & Keefer, 1995). Following on Varoudakis et al. (2007) who suggest that the quality of government may be an additional source of nonlinearity in the government size – growth relationship, we split the sample in two according to the countries which display high levels of effectiveness in government and those that are less effective.[30] Reestimating the threshold regression on either subsample, we find evidence of thresholds at 30 and 33 percent, respectively. Further, it would appear that the nonlinear effect of government

[30] We determine effectiveness by the Government Effectiveness Indicator (Kaufmann, Kraay, & Mastruzzi, 2009) averaged over time for each country and categorized according to values greater or less than zero. Values greater than zero indicate more effective governments. This variable has been previously used by Gray et al. (2007) and Varoudakis et al. (2007). A full definition is provided in the variables description table in Appendix A.

spending is more dominant in countries with low government effectiveness. On the other hand, highly effective governments seem to be able to offset some of the negative impact of large size. These results for a broad sample of countries are in line with Varoudakis et al. who find similar effects for the transitional economies.

The second set of robustness checks explores how sensitive the main findings are to diverse subsamples of the data. We divide developing countries into four geographical regions (Africa, Latin America, South and East Asia and Europe and Central Asia [ECA]).[31] The estimated threshold values varied between 33 and 41 percent with noticeable variations in the coefficients on either side of the threshold (Table A5). Notably, for developing countries in Asia and the ECA, government expenditure for countries below the threshold had a positive and statistically significant effect. Findings from income-based subgroups also showed variations around the threshold consistent with the main results (Table A6).

In addition, we varied the sample on the basis of time to check for possible sample selection bias introduced by using an unbalanced panel. As we mentioned, data in the earliest years are more prone to missing observations, particularly from the developing countries. As a test we exclude observations from the first decade of our sample, limiting the estimation sample period to 1981-2005. This reduces the number of observations to 447, even though cross-sectionally country coverage is almost unchanged (see column 1 of Table A7). Fixed effects estimation of the threshold model suggests there may be sample selection bias. While the coefficient on government spending above the threshold remains negative and of similar magnitude, the standard errors are larger

[31] Karras (1996) finds that the optimal government size varies across different geographical regions and types of countries.

causing it to lose statistical significance. Likewise, the coefficient on government spending above the threshold is positive, though as in the main analysis, not significant. Notably, the coefficients on the control variables remain largely unchanged, except for openness, which loses significance. Similar effects are found for further variations in the sample period. While sample selection bias may be present in the full panel, the overall results prove to be qualitatively robust over various other subsample specifications.

Conclusion

This paper reexamined the relationship between government spending and long-run economic growth. In light of prevailing theory, which predicts a nonlinear relationship between tax-financed government expenditure and output growth, and in view of inconsistent results from various empirical studies on the subject, we sought to evaluate the Barro hypothesis by explicitly testing for the existence of thresholds in the government size and growth relationship. We applied threshold regression methods developed by Hansen (2000) to a panel of 136 developed and developing countries over the period 1971-2005. Using a comprehensive measure of government spending, we were able to isolate productive elements in various regression specifications. Furthermore, we addressed potential simultaneity biases in the government size – growth relationship by also using GMM dynamic estimation techniques.

We find evidence to support a nonlinear effect, but not of the form suggested by Barro's nonlinear hypothesis. For total government spending above a critical threshold, we find a weakly significant negative effect on growth. However, this effect is negligible for government size below the threshold, and only displays a positive—though not statistically significant—coefficient when productive government spending is distinguished from the total. We also find evidence to suggest that the level of economic development and the quality of government present additional sources of potential nonlinearities. When we analyze developed and developing countries separately, the threshold location is lower for developed countries at 26-32 percent. High quality governance mitigated some of the negative effects so that nonlinearities were more pronounced in countries with less effective governments. Finally, we showed that our results were not driven by endogeneity issues and were generally qualitatively robust to various specifications and estimation techniques.

The findings of this paper have significant public policy implications as they offer some insight to the policy debate about the optimal size of government, and how this varies according to the level of economic development of a country. Indeed, as indicative from the sample of 28 developed countries, almost three-quarters of which have a government size exceeding 30 percent of GDP as of 2001-2005, the concern about large governments is not misplaced. Ever-expanding governments will have negative effects on long-run growth in these economies. Fortunately, the evidence also shows that improvements to the quality of government can dampen these negative effects. On another note, the negligible growth effects of government spending below the threshold imply serious offsetting influences between productive and unproductive expenditure, which mitigate the potential benefits from increased public spending. This points to a necessary restructuring of fiscal budgets towards spending in areas proven to be growth-enhancing. Creating the “fiscal space” to provide productive capital that will engender economic growth should be a critical part of any development agenda.

Of course, the optimal composition and financing of government expenditures matters. While there has been some work on how these aspects of government spending affect its impact on growth, much more work needs to be done in order to arrive at clear, more precise policy guidelines. The next chapter addresses these issues.

ESSAY 2

FINANCING PRODUCTIVE GOVERNMENT EXPENDITURES: THE IMPORTANCE OF INITIAL FISCAL CONDITIONS

Introduction

Endogenous growth theory provides a foundation for the role of productive government spending in fostering long-term economic growth. Government provision of public capital to the production process contributes to growth directly by adding to the existing capital stock, as well as indirectly by raising the marginal productivity of privately supplied factors of production (Barro, 1990; Tanzi & Zee, 1997). While what exactly constitutes productive government spending in practice is debatable,[32] there seems to be consensus that public investment in basic physical infrastructure such as roads, transportation and communication is growth-enhancing. Spending in these areas has been shown empirically to have a positive impact on aggregate production and is considered crucial for long-term growth and development.[33] Likewise, a broader concept of capital to include both physical and human capital (e.g., Garcia-Mila & McGuire, 1992; Mera, 1973) has led to studies which demonstrate that public spending to augment the stock and quality of human capital, such as public investment in education and

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[32] The productivity of public spending may vary according to, *inter alia*, the potential returns on the specific project being funded, how efficiently public funds are used (which may depend on the institutional quality of the government), and the extent of the imbalance in the relative shares between public and private capital, giving rise to diminishing marginal returns.

[33] For a general review of the literature see Tanzi and Zee (1997). Early empirical work by Aschauer (1989) shows a decisive link between government spending on “core” infrastructure and productivity growth in the US economy. Subsequently, Easterly and Rebelo (1993), Canning (1999), Demetriades and Mamuneas (2000) also find a positive association between public investment in infrastructure and economic growth. Positive output growth effects have also been found by Ramirez (2004, 2009, 2010) for Latin America and Chiang, Lo, and Lin (2007) for Asia.

healthcare, also has significant growth effects in the long-run.[34] More recently, it has been shown that complementarities between various types of public capital can generate additional externalities which increase growth (Agénor & Moreno-Dodson, 2006; Agénor & Neanidis, 2006).

Given the potential for productive government expenditure to raise long-term economic growth rates, it is of major concern that in many countries which undergo fiscal adjustments, the first budget items typically slashed are those categories most associated with growth. Latin America has been a particularly extreme case with a history of debt defaults and high debt-to-output ratios. In the 1980s and 1990s, the region engaged in a wave of fiscal adjustment initiatives aimed at scaling back government activity, increasing revenue generation and bringing debt to sustainable levels (Calderòn & Servèn, 2004; Easterly, Irwin, & Servèn, 2008). Declines in fiscal deficits seemed to be largely driven by cuts in public investment. It is estimated that in the five largest economies, infrastructure investment cuts alone contributed at least half of the total fiscal adjustments (Calderòn, Easterly, & Servèn, 2003a,b).

The fallout in productive government expenditure is particularly deleterious in developing countries in general because the state plays a more active role in production, with public capital representing a much larger share of the aggregate capital stock than in

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[34] The empirical evidence for the effect of public investment in education and health is less robust; one reason being the difficulty in distinguishing human investment spending from consumption spending (Gramlich, 1994). Another reason can be attributed to the gestational lags involved in human capital production (Semmler et al., 2007). Baldacci, Clements, Gupta and Cui (2008), exploring the channels linking social spending, human capital and growth, find that both education and health spending have a positive effect on education and health capital, and thus support higher growth. Cullison (1993) and Easterly and Rebelo (1993) find that government spending on education has a positive effect on growth. Blankenau et al. (2007) find a positive relationship between public education expenditures and growth for developed countries, but not for developing. Pradhan (2010), who examines the role of health spending in 11 OECD countries, finds that increased health spending is both a cause and a consequence of economic growth.

industrial countries (Agénor & Montiel, 2008). In Latin America, cuts in public infrastructure investment were not fully offset by private sector investment. As a result, total infrastructure investment fell, reaching well below the level that would be required for sustained growth in the region (Calderòn & Servèn, 2010; Fay & Morrison, 2005). Furthermore, with the phenomenally high degree of inequality in Latin America, shortfalls in public provision of education and healthcare services would have a disproportionate impact on the poor, perpetuating a cycle of low education, low skill and low incomes for a significant fraction of the population, thus severely limiting human capital accumulation (Agénor, 2004).

It is then clear that policymakers in developing countries run the risk of stagnating their economies over the long run if the appropriate level and composition of public investment is not established and maintained. Of course, a major challenge facing governments is how to finance such expenditures given binding fiscal constraints. Moreover, it has been shown that diverse types of government expenditure may have conflicting effects on growth given different sources of financing. Income taxes tend to be distortionary creating disincentives to saving and investment, while deficit financing may crowd out private investment (Agénor, 2004; Kneller et al., 1999). It is therefore important to know how government spending can be most efficiently allocated and financed to bring about optimal growth results, particularly in the context of already high tax rates, large fiscal deficits, and growing debt stocks.

This chapter develops a dynamic macroeconomic model for a representative closed economy to explore how variations in the composition and financing of government expenditures affect economic growth rates in the long run. We use the model to analyze how public investment spending funded by taxes (income or consumption) or by borrowing affects long-term output growth. We also examine the effect of varying the composition of public expenditure, shifting between consumption and investment spending, or re-allocating between different types of public investment. In addition, we explore how heterogeneous fiscal conditions affect the implications for growth. Specifically, we use alternative parameterizations of the model to simulate extreme initial fiscal conditions such as high average tax rates, debt stock ratios and government consumption spending.

The model is calibrated to reflect economic conditions in the seven largest Latin American economies during the period 1990 to 2008. The Latin American countries provide a suitable testing ground for the implications of the model given their debt history and diverse fiscal adjustment experiences. We find that, when tax rates are not already high, funding public investment by raising taxes may increase long-run growth. If existing tax rates are high, then public investment is only growth-enhancing if funded by restructuring the composition of public spending. Interestingly, using debt to finance new public investment compromises long-run growth, regardless of the initial fiscal condition.

The paper contributes to the existing literature in a number of ways. First, we take into account that government expenditure is not homogeneous and spending in different sectors will have diverse productivities (Feltenstein & Ha, 1995). Thus, we move beyond the standard practice of broadly categorizing government spending merely as “productive” or “unproductive” and explicitly recognize the heterogeneity within productive government expenditure itself. To do this, we develop a two-sector endogenous growth model in which public investment is divided between physical capital and human capital, allowing for distinct output effects from each type of spending. In this way, we are able to draw some policy conclusions about the most appropriate allocation of public investment from a growth maximization point of view. Additionally, distinguishing between productive sectors allows us to capture complementarities and tradeoffs between the various kinds of spending thus contributing to a burgeoning area of the literature not yet well explored (Monteiro & Turnovsky, 2008).

Second, the theoretical model moves away from the balanced government budget constraint typical of the literature and opens up the revenue options of the government to include deficit financing. This more realistically captures the actual situation of the majority of economies today and allows us to explore the extent to which variations in the sources of financing affect the relationship between government spending and long-term growth. To this extent, we are able to explore revenue from taxation (both income and consumption), in addition to revenue from debt financing. Surprisingly few studies have taken a comprehensive look at how the effect of government spending on growth changes with variations in the financing despite the overwhelming theoretical evidence (Kellermann, 2007; Turnovsky, 2004).

Third, we pay particular attention to how these effects change under different initial fiscal conditions (such as high tax rates and large debt stocks), an aspect not previously explored in the growth literature. The fiscal idiosyncrasies of developing countries, in general, and Latin American economies in particular, make this a very important issue in determining the extent to which adequate productive government spending is even fiscally feasible under tight budgetary constraints.

The rest of the chapter is organized as follows. The next section briefly reviews the existing literature on the role of productive public expenditure for economic growth. This is followed by the presentation of the theoretical model, which is then calibrated and solved in the fourth section. The results from numerical simulations of policy experiments are presented in the fifth section and the last section concludes.

Literature Review

The traditional approach in endogenous growth models to analyzing the composition of government spending has been to divide it into two broad categories designated as productive and unproductive (Barro, 1990; Turnovsky & Fisher, 1995). Productive government expenditures are by definition complementary to the production process: raising the marginal productivity of private factors of production and thus stimulating growth. Unproductive public expenditures, on the other hand, do not directly affect production, but have to be financed from tax revenues, and are a drain on the economy.[35] The obvious conclusion from this categorization is that government spending should be allocated away from unproductive and towards productive expenditures. However, productive government expenditure is not a homogeneous grouping and theories that only distinguish government spending on such a broad basis provide little guidance on the issue of allocating among the most growth-enhancing expenditures.

An early attempt to differentiate between the types of productive public spending analytically is provided by Devarajan, Swaroop, and Zou (1996), who distinguish

[35] Various empirical studies confirm the negative (positive) growth effects of unproductive (productive) government expenditures including Afonso and Gonzalez Alegre (2008), Barro (1991), Barro and Sala-i-Martin (1992) and Gupta, Clements, Baldacci, and Mulas-Granados (2005).

between government spending on the basis of output elasticities.[36] The model shows that the growth-maximizing allocation of public expenditure is achieved by equating the ratio of output elasticities with the ratio of initial spending shares, so that seemingly productive expenditures could become unproductive if used in excess.

More recent analyses seek to decompose productive government spending according to economic sectors. Traditional analytical models of endogenous growth simplify the economy to only one productive sector, which does not facilitate the study of reallocating among different types of public investment.[37] Subsequently, the extension to multi-sector endogenous growth models has allowed public investment expenditure to be differentiated across sectors with diverse output elasticities. Glomm and Ravikumar (1997), in a review of the literature on the influence of productive government spending on growth, focus on government expenditures that enter as inputs into the production function for final output and those that enter as inputs in investment technologies. They conclude that government expenditures on infrastructure to enhance physical capital, and alternatively on education and health to enhance human capital, have large impacts on growth.[38] Agénor and Neanidis (2006) study the optimal allocation of government spending among health, education and infrastructure, taking into account complementarities among the three sectors whereby one type of spending affects production outcomes in all three sectors. They find that the degree of complementarity

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[36] In their model, two types of government spending enter the production function of final output differentiated by the size of their output elasticities and their initial shares relative to total government spending.

[37] Examples of traditional one-sector endogenous growth models include Barro (1990), Devarajan et al. (1996), Futagami, Morita, and Shibata (1993), Glomm and Ravikumar (1999), Greiner and Hanusch (1998) and Turnovsky (2004).

[38] Various empirical studies support this finding. See, for example, Aschauer (1989), Easterly and Rebelo (1993), Blankenau et al. (2007) and Pradham (2010). Garcia-Mila and McGuire (1992) include human capital in their empirical analysis; Mera (1973) includes health.

and the parameters characterizing the health and education technologies play a key role. Semmler, Greiner, Diallo, Rezai, and Rajaram (2007), who also model productive spending in these three areas, conclude that when the model is calibrated for a set of low- and middle-income countries, the growth-maximizing allocation of public investment directed towards public infrastructure and that which supports the provision of health and education is two to one. Bayraktar and Pinto Moreira (2007) disaggregate government spending even further, incorporating into the analysis public spending on maintenance and security as well as investment in education, health and core infrastructure. They find that various policy experiments have differential effects on growth. Monteiro and Turnovsky (2008) and Rioja (2005) examine how shifts away from public investment in infrastructure towards investment in education affect the long-run growth rate. They find such re-allocations to be growth-enhancing.

None of the foregoing studies evaluates the growth effect of productive government spending according to its source of financing. However, theory suggests that the net effect of productive government expenditures will vary depending on how it is financed. Barro (1990), Blankenau and Simpson (2004) and Cashin (1995) show that when spending is financed by distortionary taxes such as taxes on capital and labor income, there is a nonmonotonic effect on long-run growth. At low levels, increases in productive public spending will enhance growth as the positive externalities from public investment outweigh the negative disincentives from higher tax rates. However, after some critical point, the negative growth effects from higher taxes dominate and the net effect of public investment on growth becomes negative. Empirical evidence supporting the hypothesis that income taxes are detrimental for growth has been provided by

Easterly and Rebelo (1993) and King and Rebelo (1990), among others. The nonmonotonic hypothesis is hard to test empirically, but some support in its favor has been provided by Blankenau et al. (2007), Chen and Lee (2005), Karras (1996, 1997) and Sheehey (1993).[39]

In terms of using public debt to finance productive expenditures, there are several conflicting possibilities emerging from the theoretical literature. Turnovsky (1995) proposes that an increase in public investment financed by higher public debt unambiguously raises the balanced growth rate. However, the model treats debt as a flow rather than a stock, using (negative) lump-sum taxes or transfers as a measure of current fiscal imbalance. The analysis, therefore, does not incorporate feedback effects of debt servicing. Greiner and Semmler (2000), modeling debt as a stock and accounting for feedback effects find that debt-financed public investment can promote economic growth, but only under certain conditions. These conditions were subsequently refuted by Minea and Villieu (2010) so that it would appear that under the Greiner-Semmler framework, debt financing always reduces growth. Futagami, Iwaisako, and Ohdoi (2008), assuming that the debt-to-GDP ratio must not exceed a certain threshold, show that borrowing may raise or lower growth depending on a high or low steady-state level. A number of studies find that using debt may increase growth in the short-run when public capital stock is low, but is counterproductive in the long-run (Aizenman, Kletzer, & Pinto, 2007; Glomm & Rioja, 2005; Greiner, 2007, 2008; Kellermann et al., 2007; Minea & Villieu, 2009). Empirically, Adam and Bevan (2005) find for a set of 45 developing countries that a

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[39] The previous chapter in this dissertation also finds support for a weak nonmonotonic relationship between government spending and economic growth in a panel of 136 developed and developing countries.

large fiscal deficit (as a share of GDP) will retard growth, but for low levels of the deficit (less than 1.5 percent), there is no effect on growth.

An early study which examines similar issues as those raised in this paper is Corsetti and Roubini (1996). They analyze optimal spending and financial policies (including taxes and debt) in models of endogenous growth where public spending is productive. They employ a three-sector endogenous growth model with a human capital accumulation sector, a final output sector and home production sector. Public spending may be allocated to either human capital accumulation or final output production, but not both; thus they do not explore optimal composition issues. A major finding of their analysis is that when the set of tax instruments available to the policymaker is sufficiently large, public debt is redundant as a policy tool. However, when there are constraints on the set of tax instruments available to the policymaker (e.g., when the income from human capital and the income from physical capital cannot be taxed separately as in the case with income taxes) public debt may be appropriate.

It has been suggested that the appropriate fiscal strategy to fund productive government spending might be expected “to vary across countries, depending on the volume of their revenues, the level and composition of their expenditures, their level of indebtedness, their endowments of public capital, their fiscal institutions, and a variety of other country-specific factors” (Easterly, Irwin, & Servèn, 2007, p.13). While it is reasonable to expect that the appropriate strategy to finance productive public spending might vary according to a country’s existing fiscal conditions, not much work has been done by way of theory or empirical analysis to examine the issue. Bose et al. (2007) investigate how the level of economic development in general affects the optimal financing strategy when deciding between taxation and seigniorage. Their theoretical analysis suggests that in the presence of capital market imperfection and liquidity shocks, the detrimental effect of inflation on growth is stronger at lower levels of economic development so that income taxation is relatively less distortionary than seigniorage for low-income countries. They provide empirical support in favor of this hypothesis for a panel of 61 developed and developing countries observed over the period 1972–1999. In the same vein, work by Futagami et al. (2008) suggests that when restricted by a budgetary rule which requires a constant level of government debt relative to the size of the economy, less developed countries should use bond financing rather than tax financing to raise the growth rate, with the converse applying to developed countries.

Moving away from broad generalizations about the level of development, Aizenman et al. (2007) evaluate optimal public investment and fiscal policy for countries where distortions and limited enforceability result in limited tax and debt capacities. They show how persistent differences in growth rates across countries could stem from differential public finance constraints. They conclude that if public spending finances investment in the stock of public infrastructure, then relaxation of a debt limit can raise welfare by increasing growth rates in transition to the steady state. However, this higher debt is associated with lower long-run growth rates.

The Theoretical Model

We extend the theoretical model developed by Greiner and Semmler (2000) to determine how the composition and financing of public expenditure affect long-term economic growth. This model is appealing because it moves away from the balanced government budget assumption typical of the fiscal policy and growth literature and allows governments to use bond-financing in addition to taxes, as long as long-term debt sustainability is maintained. Such a formulation more realistically captures the financing practices of the Latin American economies under study. We extend the Greiner-Semmler model by distinguishing between different types of public capital, allowing for heterogeneity in their output elasticities. This is done within the context of a two-sector endogenous growth model in which intermediary human capital and a final market good are produced. The government is assumed to supply public capital complementary to the production process in either sector. In contrast to previous models that work with expenditure flows (Agénor & Yilmaz, 2006; Agénor & Neanidis, 2006), we follow the tradition of Futagami et al. (1993), Greiner (2008) and Turnovsky (2004) by developing a model with stocks. All variables are in per capita form and we define public capital as non-excludable but subject to congestion. The model is calibrated to represent the seven largest economies in Latin America.

Households

The economy is inhabited by infinitely-lived identical households who supply labor, L, inelastically. To simplify the model, we abstract from population growth and normalize the number of households to unity. The representative household derives utility from private consumption, $C(t)$, and preferences are given by the inter-temporal iso-elastic utility function

$$U(C) = \int_0^\infty e^{-\rho t}\left(\frac{C^{1-\sigma}-1}{1-\sigma}\right)dt, \quad \sigma \neq 1, \tag{10}$$

where the time argument has been suppressed.[40] $\rho \in (0,1)$ denotes the pure rate of time preference and σ is the inverse of the inter-temporal elasticity of substitution in consumption.[41] Wage income is earned from the share of effective labor used in private production, uHL, where $0 < u < 1$ is exogenously given and H is the stock of human capital per capita. Household income also comes from returns to wealth, $W \equiv B + K$, which is equal to public debt, B, and private physical capital, K. Income is spent on private consumption and new investments in physical capital, $\dot{K}$, and government bonds, $\dot{B}$, where the dot gives the derivative with respect to time. The government levies flat rate taxes, τ_K and τ_L, on income earned from capital and labor, respectively. There is also an *ad valorem* tax, τ_C, on private consumption. Normalizing labor to one, the representative household's budget identity is thus written as

$$(1+\tau_C)C + \dot{W} + \delta_K K = (1-\tau_L)wuH + (1-\tau_K)(rK + r_B B), \qquad (11)$$

where $\delta_K \in (0,1)$ is the depreciation rate of physical capital, w denotes the real wage rate, r is the real return to physical capital and r_B is the interest rate on government bonds. A no-arbitrage condition requires that the return to physical capital equals the return to government bonds yielding $r_B = r-\delta_K/(1-\tau_K)$.[42] Thus, the budget identity of the household can be re-written as

$$\dot{W} = (1-\tau_L)wuH + (1-\tau_K)rW - \delta_K W - (1+\tau_C)C. \qquad (11a)$$

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[40] This specification is widely accepted in the literature with variants used by Barro (1990), Bruce and Turnovsky (1999) and Corsetti and Roubini (1996). For ease of exposition, we omit the time argument *t*, unless doing so would cause ambiguity.

[41] For $\sigma = 1$ the utility function is replaced by the logarithmic function $U(\cdot) = \ln C$.

[42] Since both are taxed at rate τ_K, it follows that $(1-\tau_K)\, r_B = (1-\tau_K)\, r-\delta_K$, which implies that $r_B = r-\delta_K/(1-\tau_K)$.

To allow the analysis to be more tractable, we abstract from depreciation (i.e., set $\delta_K = 0$) so that the household's budget constraint is more simply written as

$$\dot{W} = (1-\tau_L)wuH + (1-\tau_K)rW - (1+\tau_C)C. \tag{11b}$$

The problem for the representative household is to maximize the discounted stream of utility, defined in (10), over an infinite time horizon subject to its budget constraint in (11b), taking factor prices as given. The current-value Hamiltonian is

$$J = \frac{C^{1-\sigma}-1}{1-\sigma} + \lambda[(1-\tau_L)wuH + (1-\tau_K)rW - (1+\tau_C)C], \tag{12}$$

where λ is the co-state variable for the shadow price of wealth.

By dynamic optimization, the necessary optimality conditions are obtained as:

$$C^{-\sigma} = \lambda(1+\tau_C), \tag{13}$$

$$\dot{\lambda} = \lambda\rho - \lambda(1-\tau_K)r. \tag{14}$$

Equation (13) equates the marginal utility of consumption to the individual's tax-adjusted shadow value of wealth, while (14) is the standard Keynes-Ramsey consumption rule, equating the rate of return on consumption to the after-tax rate of return on capital. If the transversality condition $\lim_{t\to\infty} e^{-\rho t}\lambda W = 0$ holds, which is fulfilled for a time path on which assets grow at the same rate as consumption, the necessary conditions are also sufficient.

Producers

The economy is assumed to have two sectors, producing two kinds of goods: a final private market good and intermediary human capital—a portion of the latter being used in the production of the former. While public capital is assumed complementary to the production of both goods, we distinguish between the types of public capital that enter each stage of the process. To this end, productive government spending is divided into investment in core public infrastructure assets (such as transport and communications systems, energy, water supply and sanitation) and public investment to enhance education and health services that increase the stock of human capital. As noted by Semmler et al. (2007), decomposing the productive capacity of public capital in this way more realistically captures the longer gestation lag in creating human capital relative to typical physical infrastructure. Even more importantly for the purposes of this paper, the decomposition allows us to isolate the effects of different kinds of government spending.

Market good.

Production of market goods, *Y*, is carried out by many identical firms which can be represented by one firm which behaves competitively and which maximizes static profits. The production function is given by a Cobb-Douglas technology[43]

$$Y = AK^{1-\alpha-\beta}(uH)^{\alpha}(vK_G)^{\beta}, \qquad (15)$$

[43] The Cobb-Douglas functional form has been criticized for its restrictiveness. It imposes a unitary elasticity of substitution between factors of production which does not hold up in reality. Nevertheless, the Cobb-Douglas production function is widely used in theoretical models precisely because of this mathematical simplification which makes it more analytically tractable. For a discussion of more flexible production forms see Bom, Heijdra and Ligthart (2010), who present the constant elasticity of substitution case.

where A is a productivity parameter and K_G represents the stock of public capital. $u,v \in$ (0,1) represent the respective shares of human capital and public capital used in the production of market goods. The remaining portions are used to build human capital and thus influence production indirectly. α, $\beta \in (0,1)$ denote output elasticities so that production displays constant returns to scale in all factors together.[44]

Human capital accumulation.

Human capital production can be thought of as a non-market, tax-free activity (Mendoza, Milesi-Ferretti, & Asea, 1997), which uses a Cobb-Douglas technology similar to the final market good such that

$$\dot{H} = Q[(1-u)H]^{1-\varepsilon}[(1-v)K_G]^{\varepsilon}, \qquad (16)$$

where Q is the productivity parameter and $\varepsilon \in (0,1)$ represents the elasticity of the production of human capital with respect to public capital stock in education and health facilities. Thus, the technology is again assumed to have constant returns to scale in all factors together. Similar representations for human capital formation have been used by Agénor and Neanidis (2006), Bayraktar and Pinto Moreira (2007), and Monteiro and Turnovsky (2008). The share of public capital stock employed in private production, v, can be used as a policy variable to analyze how variations in the allocation of productive government spending affect growth.

Assuming competitive markets, it must hold that the cost of capital, r, and the wage rate, w, are equal to their marginal products, respectively. This gives

[44] The constant returns to scale assumption is restrictive but is a necessary condition to obtain a constant endogenous growth path in the long run and to ensure the existence of a competitive equilibrium (Minea & Villieu, 2009).

$$w = \alpha(uH)^{-1}Y, \tag{17}$$

$$r = (1-\alpha-\beta)K^{-1}Y. \tag{18}$$

The Government

The government in this economy has a range of financing options and is not constrained to run a balanced budget in each period. However, it must repay all its debt at the end of time, such that $\lim_{t\to\infty} B(t)\exp\left(-\int_0^t (1-\tau_K)(r(s))ds\right) = 0,$ must hold. That is, the government is not allowed to run a Ponzi game; discounted debt converges to zero asymptotically. The government receives tax revenues from income and consumption taxes and can raise additional revenues from issuing government bonds. Note that Ricardian equivalence fails due to the presence of distortionary income taxes. Government expenditure is split between public consumption, C_p, investment in public capital, I_p, and (net) debt servicing, rB.

The accounting identity describing the accumulation of public debt in continuous time is given by:

$$\dot{B} = rB + C_p + I_p - T, \tag{19}$$

where T denotes total tax revenue such that $T = \tau_L wuH + \tau_K rK + \tau_K rB + \tau_C C$. Public consumption[45] expenditure is assumed not to affect productivity, but has to be financed through taxes and constitutes a certain share of tax revenue, $C_p = a_1 T$, $0 < a_1 < 1$. The government is allowed to borrow to finance productive expenditures which will yield

[45] Here public consumption refers to social transfers and expenditure with public goods characteristics, which do not affect production but may enter into household preferences (such as public parks, civic facilities and consumption transfers).

returns in the future, but must finance public consumption expenditures and interest payments from current tax revenue so that $C_p + rB = b_1T$, $0 < b_1 < 1$. This formulation approximates the golden rule of public finance – a fiscal rule that allows the government to borrow only for investment but not to fund current spending (Buiter, 2001; Her Majesty's Treasury, 1997).[46] The remaining tax share allotted to public investment would thus be $I_p=b_2(1 - b_1)T$, where $b_2 > 1$ implies debt financing. Variations in the fiscal policy parameter b_2 allow us to explore the effect of debt financing on growth. Rewriting (19), the accumulation of public debt becomes

$$\dot{B} = T(1-b_1)(b_2-1), \tag{19a}$$

where T is as defined above.

Ignoring depreciation, the differential equation describing the evolution of public capital may therefore be written as

$$\dot{K}_G = I_p = b_2(1-b_1)T. \tag{20}$$

Equilibrium Conditions and the Balanced Growth Path

Equilibrium conditions.

An equilibrium allocation for this economy is defined as a sequence of variables $\{C(t), K(t), H(t), K_G(t), B(t)\}_{t=0}^{\infty}$ and a sequence of factor prices $\{w(t), r(t)\}_{t=0}^{\infty}$ such that, given prices and fiscal parameters, the firm maximizes profits, the household solves (10) subject to (11b) and the budget identity of the government (19a) is fulfilled.

[46] The original conceptualization of the golden rule makes a distinction between current and capital expenditures. Here, we make the distinction between unproductive and productive expenditures broadly defined, so that the latter may include recurrent expenditures that contribute to the stock of human capital, such as spending on education and health, and so may be considered productive.

Using (13), (14), (15) and (18), which must hold in equilibrium, equation (13) can be rewritten as

$$C = (\lambda(1+\tau_C))^{-1/\sigma} .$$

Taking logs of this expression and differentiating with respect to time yields the growth rate of consumption

$$\frac{\dot{C}}{C} = \frac{1}{\sigma}\left((1-\tau_K)(1-\alpha-\beta)AK^{-\alpha-\beta}(uH)^{\alpha}(vK_G)^{\beta} - \rho\right), \tag{21}$$

which is equal to the growth rate of the economy, γ, in steady-state. For the evolution of private capital, we combine the definition of $\dot{B}$ in (19) with the individual consumer's budget constraint given in (11b) to obtain

$$\frac{\dot{K}}{K} = (1-\beta)\frac{Y}{K} - \frac{C}{K} - (a_1 + b_2(1-b_1))\frac{T}{K}. \tag{22}$$

Thus, in equilibrium the economy is completely described by (16), (19a), (20), (21) and (22) plus the limiting transversality condition of the household.

The balanced growth path.

We restrict the analysis to the steady-state where we assume that all the variables in the economy grow at their long-run growth rate. For our purposes, we define a balanced growth path (BGP) as a path such that the economy is in equilibrium and such that consumption, private physical capital, human capital, public capital and government debt grow at the same strictly positive constant growth rate; that is, $\dot{C}/C = \dot{K}/K = \dot{H}/H = \dot{K}_G/K_G = \dot{B}/B = \gamma$, $\gamma > 0$ and is constant. To analyze the model around the BGP we define the new variables $c \equiv C/K$, $h \equiv H/K$, $g \equiv K_G/K$, $b \equiv B/K$.

Differentiating these variables with respect to time leads to a four-dimensional system of differential equations given by

$$\begin{aligned}
\frac{\dot{c}}{c} &= \frac{\dot{C}}{C} - \frac{\dot{K}}{K} = 0, \\
\frac{\dot{h}}{h} &= \frac{\dot{H}}{H} - \frac{\dot{K}}{K} = 0, \\
\frac{\dot{b}}{b} &= \frac{\dot{B}}{B} - \frac{\dot{K}}{K} = 0, \\
\frac{\dot{g}}{g} &= \frac{\dot{K}_G}{K_G} - \frac{\dot{K}}{K} = 0,
\end{aligned} \tag{23}$$

where

$$\frac{\dot{C}}{C} = \frac{1}{\sigma}\left((1-\tau_K)(1-\alpha-\beta)\frac{Y}{K} - \rho \right),$$

$$\frac{\dot{H}}{H} = Q(1-u)^{1-\varepsilon}(1-v)^{\varepsilon}\left(\frac{H}{K}\right)^{-\varepsilon}\left(\frac{K_G}{K}\right)^{\varepsilon},$$

$$\frac{\dot{B}}{B} = \frac{T}{B}(1-b_1)(b_2-1),$$

$$\frac{\dot{K}_G}{K_G} = \frac{T}{K_G}(1-b_1)b_2$$ and

$$\frac{\dot{K}}{K} = \left[(1-\beta) + (1-\alpha-\beta)\frac{B}{K} \right]\frac{Y}{K} - \frac{T}{K}(1+(1-b_1)(b_2-1)) - \frac{C}{K}, \tag{24}$$

with $\frac{Y}{K} = A\left(u\frac{H}{K}\right)^{\alpha}\left(v\frac{K_G}{K}\right)^{\beta}$, $\frac{T}{K} = \tau_L\alpha\frac{Y}{K} + \tau_K(1+\frac{B}{K})(1-\alpha-\beta)\frac{Y}{K} + \tau_C\frac{C}{K}$ and

$$b_1 = a_1 + (1-\alpha-\beta)\frac{Y}{K}\frac{B}{T}.$$

A solution $\dot{c} = \dot{h} = \dot{g} = \dot{b}$ with respect to *c*, *h*, *g*, *b* gives a balanced growth path for the model and corresponding ratios *c**, *h**, *g**, *b** on the balanced growth path. The high dimension of the dynamic system makes it analytically intractable. We therefore rely on numerical simulations to establish the existence and stability of the steady-state equilibrium.

Model Calibration and Solution

The model is calibrated for the seven largest economies in Latin America to correspond to average economic performance during 1990-2008. Table 6 gives some selected economic data for these countries. Over the study period, the average annual growth rate of GDP per capita was 2.3 percent. The average size of government (as measured by government spending to GDP) was 20.8 percent. Of this, the greater share was spent on public consumption (12.7 percent of GDP), while 5.1 percent of GDP went to public investment. The remainder went to debt servicing and other expenses. Public spending was financed by revenue from taxation and other sources, as well as debt. On average, total revenue was about 21.3 percent of GDP, with tax revenue constituting the largest share.[47] The average stock of debt per country was 34.6 percent of GDP with Argentina, Brazil, Chile and Peru having debt stocks above the average. The benchmark parameters of the model are chosen to reflect these statistics.

Table 7 presents the values of parameters used in the benchmark model representing the average data for the region (“Region Average”). The rate of time preference, ρ, is set at 0.04 which is in line with conventions in the literature (Bayraktar & Pinto Moreira, 2007; Rioja, 2005). This leads to a discount factor of approximately 0.96. We set the inverse of the intertemporal elasticity of substitution, σ, to 2. This value

[47] Other sources of revenue include royalties from natural resource extraction which vary across countries according to the level of production in the mineral sector and the extent to which tax incentives are used to attract foreign investors (OECD, 2008).

is lower than what is typically used for industrial country studies and is consistent with evidence indicating that the intertemporal elasticity of substitution tends to be low at low levels of income (Bayraktar & Pinto Moreira, 2007). The share of human capital employed in private production is set to 0.9, which is the average between values used by Bayraktar and Pinto Moreira (2007) for Haiti and Semmler et al. (2007) for a set of middle- and low-income countries.

We set the elasticity of output with respect to public capital in infrastructure, β, to 0.15. This is close to the 0.138 estimated by Calderòn and Servèn (2003) for the elasticity of GDP to infrastructure for a group of countries in Latin America, as well as to the 0.147 estimate used by Suescun (2005) for Colombia. The value for the elasticity of output with respect to human capital, α, is put at 0.3 which is the average of the estimates used by Bayraktar and Pinto Moreira (2007), Rioja (2005) and Semmler et al. (2007). The constant returns to scale technology used in the model, thus, implies that the output elasticity of private capital is 0.55. This is larger than the 0.33 typically found in OECD countries, but close to the value of 0.60 estimated by Elias (1992) for the group of Latin American countries under study.

For the production of human capital, the elasticity of public capital stock in education and health, ε, is set at 0.30. This value is larger than the 0.10 used by Rioja (2005) and the econometric estimate obtained by Blankenau et al. (2007) for the elasticity of the public capital stock in education only. Since the model combines public capital in both education and health for human capital production, we use a higher value to take into account externalities from complementarities between the two forms of spending.[48] Our estimate is close to that used by Semmler et al. (2007).

Since a fraction of public capital is used to produce human capital – itself an input factor in private market production – the final output elasticity of total public capital is derived from the model as $\varepsilon\alpha + \beta$. Given the selected parameters, the size of the output elasticity of total public capital is thus 0.24. This value is consistent with the 0.268 estimated by Bom and Ligthart (2009) in a meta-analysis on the output elasticity of public capital for a sample of 67 studies. The remaining parameters—the shift factors and fiscal policy variables—are fixed as to achieve a baseline growth rate consistent with the data for the seven Latin American countries of interest.

The calibrated model provides a fair representation of the average Latin American country, as defined by the data. The steady-state results of the numerical simulation are presented in Table 8.We use these results as the benchmark for various fiscal policy experiments.

Policy Experiments

As a starting point, we first simulate the long-run growth effects for the region as a result of the fiscal adjustment policies enacted in the 1990s. As previously discussed, Latin American countries attempted to cut their fiscal deficits by reducing expenditure on public infrastructure—to as little as one percent of GDP in some countries. We use the

[48] Agénor and Neanidis (2006) provide several examples of the interaction between health and education to improve the quality of human capital. Healthier students are more likely to participate and do better in school. Among the examples cited, Baldacci et al. (2008) show that health capital has a statistically significant effect on school enrollment rates. Simultaneously, the evidence shows that higher education levels can improve health. Smith and Haddad (2000) report that improvements in female secondary school enrollment rates during 1970-1995 accounted for 43 percent of the total reduction in the child underweight rate of developing countries.

model to analyze the long-term effects of this policy by simulating a reduction in the deficit brought about by a cut in public investment from 4.6 percent of GDP (the benchmark) to one percent. The effect is to successfully lower the debt stock to 10.7 percent of GDP, but at the cost of dramatically reducing the growth rate to 0.6 percent in the steady-state. The model results thus underscore the concern that growth is potentially stagnated in the long run when fiscal adjustment policies disproportionately target public investment spending.

Given the importance of public investment to growth, we next use numerical simulations to explore how variations in the composition and financing of public investment expenditure affect the steady-state growth rate. We conduct four types of fiscal policy experiments: (a) increase public investment financed by new debt issues, (b) increase public investment financed by raising taxes (income or consumption), (c) increase public investment by re-allocating spending away from public consumption, and (d) re-allocating public investment in infrastructure toward education and healthcare. We first examine the case for the average Latin American country and then examine how the growth effects vary when initial fiscal conditions are more extreme. Three scenarios are investigated: (a) when both the existing debt ratio and tax rates are high ("High Debt, High Tax" scenario); (b) when the debt ratio and tax rates are low ("Low Debt, Low Tax" scenario); and (c) when the debt ratio is high, but tax rates are low ("High Debt, Low Tax" scenario).[49]

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[49] A fourth possible case "Low Debt, High Tax" might also be of interest. However, simulating this scenario in the current model involves altering more than just the relevant policy variables; significant adjustments to the baseline parameters are also required. Such changes would substantially alter the underlying structure of the original simulated economy, limiting our ability to make cross-scenario comparisons. Therefore, only the first three scenarios are considered.

The Region Average

Financing increased public investment by issuing new debt.

Financing public investment through increased borrowing is detrimental to growth (see top panel of Table 9). When b_2 is increased from 2 to 2.5, the steady-state growth rate falls from 2.50 percent in the benchmark case to 2.36 percent. The policy causes debt to increase from 36.7 to 41 percent, which is similar to going from a debt level as in Argentina to a debt level as in Brazil. The new borrowing has two effects: (a) It increases the debt stock ratio, which then translates into higher debt repayments; and (b) It also raises interest rates (the marginal cost of borrowing) so that repayments are even larger. The higher debt-servicing costs eventually crowd out spending on public investment so that instead of increasing, the ratio of public investment to GDP actually falls from 4.59 to 4.17 percent in the steady state. The elevated interest rate will also discourage private investment causing an additional crowding-out effect.

The model shows that for countries already using deficit financing, and which have average debt stock ratios around 35 percent of GDP, such as Argentina, it is better to reduce the amount of deficit-financing being used. Reducing b_2 slightly to 1.9 (i.e., lowering the debt stock by about one percent of GDP) is shown to increase the growth rate by 0.04 percentage points. In this case, the share of public investment now actually increases by 0.12 percentage points to 4.71 percent of GDP, since debt repayments are reduced and more money is made available for investment. The implication is that the existing debt burden in Latin America may already be too high so that financing additional public investment by further increasing the debt stock is counterproductive.

Financing increased public investment by raising taxes.

Increasing tax rate on capital and labor income.

Public investment financed by higher income taxes raises the steady-state growth rate (see middle panel of Table 9). The higher income tax rates increase the amount of tax revenue generated and thus enlarge the potential pool of funds available for public expenditure. A one-percentage-point change from 15 to 16 percent in the tax rate causes a corresponding rise in tax revenue to GDP (23.54 to 24.41percent). This in turn increases public investment spending to 4.72 percent of GDP, which raises the public capital stock and subsequently the growth rate by 0.02 percentage points to 2.52 percent. Similar growth effects are experienced if the income tax rate is further increased to 17 percent. However, for any higher increases the model becomes unsolvable. This may be an indication that the extent to which the tax rate can be used to finance higher expenditure is limited and is consistent with endogenous growth theories which predict a nonmonotonic relationship between growth and the tax rate (Barro, 1990; Blankenau and Simpson, 2004).[50] Conversely, reducing the income tax rate reduces available funds for public investment and reduces the growth rate.

Increasing tax rate on consumption taxes.

We alternatively try to achieve an increase in tax revenue using the consumption rather than the income tax (see middle panel of Table 9). Raising the consumption tax rate from 20 to 21 percent increases the tax revenue relative to GDP to 23.96 percent,

[50] It must be noted that the tax increase is not exclusively spent on public investment; it is spread across consumption spending and debt repayment as well. This has to do with how the model is formulated, making public consumption spending and debt repayments positive linear functions of tax revenue. In practical terms, this can be interpreted as representing fungibility in the use of public funds (Erekson, DeShano, Platt, & Ziegert, 2002; Lago-Penas, 2006).

stimulating an increase in public investment spending to 4.67 percent and raising the growth rate to 2.53 percent. It is interesting to note that a one-percentage-point increase in the consumption tax rate generated slightly less revenue (relative to GDP) than a similar increase in the income tax rate, but had a greater effect on growth. This may be due to the less distortionary impact of consumption taxes on investment and saving decisions relative to the capital income tax, which reduces the net rate of return to private capital and thus causes disincentives to investment. Therefore, if the choice is between an increase in the income or the consumption tax, the preference with respect to growth should fall on the consumption tax.[51] Again, it must be noted that taxes cannot be raised indefinitely and for values higher than $\tau_C = 0.22$ the model fails to arrive at a steady-state solution.

It must be stressed that the tax rates used in the simulations are chosen so as to replicate the average tax revenue as a share of GDP, and do not reflect actual tax rates in the Latin American economies. Marginal tax rates in these countries are, in fact, higher with top marginal rates for corporate and individual income taxes ranging between 35 and 40 percent. Tax theory tells us that the efficiency loss from a tax increases exponentially with the tax rate. Therefore, we may expect smaller improvements in the equilibrium growth rate if higher marginal tax rates are actually taken into account.

Further, the model abstracts from several things, including tax evasion. Our simplified representation assumes that increases in the tax rate translate fully into corresponding increases in tax revenue. However, the tax literature shows that as the

[51] There may be other factors to take into consideration such as the higher burden a consumption tax places on the poor (Vasquez, 1987). Nevertheless, because of high informality and difficulty in capturing the tax base, consumption taxes are used more predominantly in developing countries, including Latin America (Bird & Gendron, 2007).

marginal rate increases, we might expect to see greater incidence of tax evasion (Alm, 1999), so that later tax increases may not be as effective in generating additional revenue. This possibility weakens the case for funding additional public investment through raising tax rates.

Restructuring public spending.

Re-allocating spending from public consumption to investment.

Shifting expenditure away from public consumption toward public investment increases the steady-state growth rate (see bottom panel of Table 9). This finding is consistent with the consensus in the growth literature. However, doing quantitative analysis in a fully specified general equilibrium macroeconomic model allows us to determine just how potentially stimulating even a slight restructuring of public expenditure can be. Lowering public consumption to GDP by about one percentage point (from 14.12 in the baseline scenario to 13.05; achieved by reducing a_1 to 0.55) increases public investment to 5.23 percent of GDP and increases the growth rate to 2.7 percent. Re-allocating an additional percent (lowering a_1 to 0.50) further increases the growth rate to 2.89 percent.

While it is obvious that a restructuring of public spending away from unproductive toward productive expenditure is growth-enhancing, such a policy may be politically difficult to implement. This is particularly true for Latin American countries where there has been a long history of populist governments (Conniff, 1999; Ronchi, 2007). This phenomenon would help explain why capital rather than current expenditures were disproportionately cut during the fiscal adjustment episodes. Given the difficult political challenge to cut consumption expenditures, it is necessary to explore alternative shifts in spending which may be more politically feasible.

Re-allocating between infrastructure and human capital spending.

One advantage of the model is that it allows for heterogeneity among different forms of productive public expenditure. Shifting the emphasis of public investment away from infrastructure and towards public capital which more specifically supports human capital formation is growth-enhancing. Changing the allocation by just five percentage points ($v = 0.85$) increases the steady-state growth rate from 2.5 to 2.9 percent, the most significant increase of all the policy experiments. The higher growth rate comes about through the following channel: more spending in the human capital sector raises the ratio of human capital to private capital, h^*, from 0.123 in the benchmark case to 0.149. Human capital, being the limiting factor, has a higher marginal productivity so that any given increase generates more output than a similar increase in physical capital and thus stimulates the growth rate more. Further shifts in public investment spending ($v = 0.8$) that bring the human/private capital ratio to 0.171 cause the growth rate to increase to 3.19 percent.

We note that these results may be dependent on the specific parameter values assigned to the output elasticities for public capital spent on human capital accumulation and private market output, respectively. Robustness checks are therefore carried out with alternative parameters (within the purview of the literature) to see how results vary. Simulations, reported in Appendix B, show that the effects on growth are not qualitatively different. Our findings are consistent with Rioja (2005) who explores similar shifts between infrastructure and education spending for the same group of countries; and Montiero and Turnovsky (2008) who calibrate a similar model for the United States. Re-allocating spending to the most productive uses will generate the best returns on public investment and give the strongest boost to growth. Productivity of the factor in relatively short supply is higher and public capital to boost this factor will have greater returns.

Fiscal Strategy under Different Initial Fiscal Conditions

"High Debt, High Tax" scenario.

Of the seven Latin American countries under study, the "High Debt, High Tax" scenario (henceforth abbreviated to HDHT) might represent Chile which has tax and debt ratios above average. The steady-state results for the HDHT scenario are presented in Table 10. The new benchmark from which policy experiments are simulated is achieved by increasing the tax and debt parameters as indicated at the bottom of the table. In the HDHT baseline solution (presented in bold type), tax revenue to GDP is approximately 30 percent and the debt stock ratio is about 51 percent. The corresponding growth rate is 2.44 percent, which is lower than in the scenario representing the region average.

When the fiscal policy experiments are simulated, the results show that financing increased public investment by issuing new debt reduces growth, which is the same effect as in the average case. Increasing b_2 raises the debt ratio, lowers public investment to GDP and eventually lowers the steady-state growth rate.

Using higher income taxes to fund public investment clearly demonstrates a nonmonotonic relationship between the tax rate and growth in the HDHT case. Initially raising the income tax rate from 20 to 22 percent, and then 24 percent, increases public investment and stimulates a rise in the growth rate from 2.44 to 2.5 percent. However, further increasing the income tax rate beyond 24 percent has a deleterious effect on growth, which starts to fall even as the share of public investment to GDP continues to rise. The HDHT scenario clearly demonstrates the nonmonotonic growth effect when public spending is financed by distortionary taxes. This implies that when initial tax rates are already high, there is little room for further income tax rate increases to support the budget. Increasing the consumption tax rate instead of the income tax rate shows no evidence of a nonmonotonic effect, but rather consistently increases growth. Interestingly, in the HDHT case it is possible to raise consumption tax rates over a considerable range (τ_C goes up to 33 percent) before a steady-state solution does not exist.

The remaining policy experiments have qualitatively similar growth effects as in the region average case. Shifting spending from public consumption to investment is growth-enhancing, while re-allocating from public investment in infrastructure toward education and health also stimulates higher growth. Changing the allocation to infrastructure by just five percentage points ($v = 0.85$) increases the steady-state growth rate from 2.44 to 2.84 percent.

“Low Debt, Low Tax” scenario.

In the “Low Debt, Low Tax” (LDLT) scenario, funding public investment by raising either income or consumption taxes has the potential for considerable improvement to growth. The steady-state results are shown in Table 11. The respective benchmark tax and debt-to-GDP ratios are 17.8 and 29.86 percent, respectively, which roughly approximates the fiscal situation in Mexico during the study period. The results demonstrate that when tax rates are initially low, there is room for substantial increases before the negative financing effects outweigh the positive impact of public investment. In the simulations, increasing income tax rates from 11 to 22 percent results in consistently higher growth rates.

The qualitative growth effects from the other policy experiments are similar to the region average. Despite a lower initial debt ratio, issuing public debt to fund public investment is harmful to growth, with the growth rate declining to 2.02 percent when debt is raised from 30 to 35 percent (achieved by increasing b_2 from 2 to 2.8). On the other hand, re-allocating public expenditure away from consumption and emphasizing investment in education and healthcare bring the greatest improvements to the growth rate.

“High Debt, Low Tax” scenario.

The previous results carry over to the “High Debt, Low Tax” (HDLT) scenario, which is roughly representative of the Peruvian economy during 1990-2008. Table 12 provides the steady-state results in which the benchmark tax and debt ratios are 18.36 and 46.32 percent, respectively.[52] It is interesting to note that in this extreme scenario where such a large debt burden is underpinned by low tax revenue, a steady-state equilibrium which supports additional borrowing (i.e. increasing b_2 beyond 2.95) does not exist. In this extreme case, debt financing public investment is not an option if the economy is to reach equilibrium in the long run. On the other hand, reducing the usage of debt

[52] It must be noted that in order to simulate this scenario, the share of tax revenue allocated to public consumption expenditure, a_1, also had to be adjusted.

considerably improves the growth rate, which rises to 2.6 percent when the debt level is lowered from 46 to 44 percent. The growth effects of the remaining policy experiments are qualitatively similar to the region average and do not need to be discussed further.

To summarize, regardless of the initial fiscal condition, for the Latin American economies under consideration, financing additional public investment by debt will compromise growth in the long run. Where tax rates are not already high, funding public investment by raising taxes, in particular consumption taxes, may be a viable option to support long-run growth. If, however, tax rates are already high or other constraints to raising tax revenue exist, then public investment should be funded by restructuring the composition of public spending. This may be accomplished by lowering the share of public consumption expenditure in favor of investment in public capital. In addition, even greater growth benefits can be achieved when public investment is carefully allocated to those sectors where its marginal productivity is largest. In our simplified model, re-allocating public investment from the final output sector toward intermediary human capital production enhances long-run growth.

Conclusion

In this paper we develop a dynamic micro-founded macroeconomic model to explore how variations in the composition and financing of government expenditures affect economic growth in the long run. The model is used to analyze how public investment spending funded by taxes or borrowing affects long-term output growth. We also examine the effect of varying the composition of public expenditure, shifting between consumption and investment spending, or re-allocating between different types of public investment. In addition, we use alternative parameterizations of the model to explore how the effects on growth change under extreme initial fiscal conditions such as high average tax rates and debt ratios. The model is calibrated to reflect economic conditions in the seven largest Latin American economies during the period 1990 to 2008.

With respect to financing productive government expenditures, the simulation results show that when the choice is between taxes and borrowing, the better fiscal strategy is to raise taxes. For the Latin American economies under consideration, which already have sizeable debt ratios, issuing new debt earmarked even for productive expenditures which have expected future returns is harmful to long-run growth. This finding is consistent with several other studies which do not advocate deficit-financing as an effective fiscal strategy to fund public spending and still achieve long-term growth. The negative growth impact of debt-financed public investment is robust to different initial fiscal conditions, that is, whether the economy in question has a high or low existing debt stock. In either circumstance, borrowing to finance public investment not only raises the debt stock, but also increases domestic interest rates, thereby raising debt servicing and crowding out domestic private investment. The simulations show that in the steady-state, financing public investment by new debt issues actually leads to less public investment in the long run and a lower level of public capital stock because a larger share of public spending is redirected to future debt servicing.

On the other hand, productive government expenditures financed by raising taxes can increase the long-run growth rate as long as the optimal tax level has not been exceeded. The simulations show results consistent with the nonmonotonic effect of tax-financed government spending. For the “Region Average” and “Low Tax” scenarios, increasing tax rates stimulated growth, with increases in the nondistortionary consumption tax rate having a greater positive effect than increases in the tax on capital and labor income. For the “High Debt, High Tax” scenario, raising taxes was only stimulative to a point, after which further increases caused the growth rate to fall. This implies that for countries where the level of taxation is already high (e.g., Chile and Colombia), tax increases are not a good option for funding public investment. In this case the distortionary effect of higher taxes totally offsets any productivity gains from higher public capital in the production process.

The analysis also underscores previous work which shows that public consumption expenditure has a negative effect on growth so that reallocating away from consumption towards public investment can have tremendous positive growth effects in the long run. In the model, such reallocations bring about some of the most significant increases in the growth rate in all scenarios. More important, the model formulation allows us to take the analysis a little further to show that reallocations amongst public investment itself toward the most productive sectors can have sizeable growth effects. By allowing for heterogeneity within government spending on two levels, the model shows that not only reallocation away from consumption to productive expenditure is viable, but also shifting among various types of public investment projects. In the simulations, shifting spending from investment in infrastructure to investment in education and health facilities to promote human capital accumulation enhanced long-run growth.

This result has tremendous implications for countries facing binding fiscal constraints and which find it politically infeasible to significantly cut public consumption expenditure. More careful selection of the most rewarding public projects can raise public capital across multiple sectors, stir private and human capital accumulation and promote growth. Moreover, this strategy is viable regardless of the initial fiscal conditions, as growth was stimulated in every scenario. The challenge now is to determine those types of public investment with the highest future returns. To this end, there is a pressing need for more accurate estimates of production elasticities for public capital used in various sectors in order to refine future dynamic models.

Other interesting areas for future work would be to extend the current model to a (small) open economy which can borrow from abroad at world interest rate (plus a country premium). Less crowding-out effects from reduced domestic borrowing may allow for positive growth effects of specific debt-financed public investment (Glomm & Rioja, 2005). Another potentially worthwhile extension would be to account for the possibility of tax evasion which prevents increases in tax rates from translating into commensurate increases in tax revenue, thus limiting the effectiveness of tax policy to fund public investment.

CONCLUSION

This dissertation reexamined the role of fiscal policy in promoting long-run economic growth. Specifically, we focused on the impact of government expenditures and showed that the relationship is not only dependent on the level of expenditures, but also on its structure and financing. The interplay of these and other factors is instructive. The size of government does not seem to matter until it passes some critical threshold. The location of this threshold is itself dependent on various factors, the level of economic development and composition of financing being two salient ones. Moreover, the analysis shows that the growth effect of government spending targeted towards seemingly productive sectors is not necessarily positive, but varies with the overall structure of total public expenditure, the method of funding, the effectiveness of government and the existing fiscal conditions. The interaction of all these factors, plus other relevant but unobservable ones, may be such that the overall effect of government spending is offset and not easily discerned in empirical analyses.

The findings of this study have significant public policy implications as they offer some insight to the policy debate about the optimal size of government. Indeed, the concern about large governments is not misplaced as several countries have exceeded the critical threshold identified in this study. Further expansion of government will have negative effects on long-run growth in these economies. Fortunately, the evidence also shows that improvements to the quality of government can dampen these negative effects. On another note, the negligible growth effects of government spending below the threshold imply serious offsetting influences, which mitigate the potential benefits from increased public spending.

This complex interplay of factors led us to develop a more comprehensive two-sector endogenous growth model capable of explaining how various fiscal strategies influence the growth outcome for a country in the long run. We find that, where tax rates are not already high, funding public investment by raising taxes may increase long-run growth. If existing tax rates are high, then public investment is only growth-enhancing if funded by restructuring the composition of public spending. Interestingly, using debt to finance new public investment compromises growth, regardless of the initial fiscal condition.

Future work in this area will rely on accurate estimates of relevant parameters, such as the production elasticities of public capital, to calibrate more sophisticated dynamic models. Furthermore, the extension of the current closed economy model to an open economy which can access external debt at world interest rate is potentially interesting. Another worthwhile extension would be to account for the possibility of tax evasion which prevents increases in tax rates from translating into commensurate increases in tax revenue.

TABLES AND FIGURES

Table 1

Descriptive Statistics, 1971-2005

Variable	Mnemonic	Mean	Std. Dev.	Min	Max	Obs.
Annual average growth in GDP per capita	*GROWTH*	2.1	3.3	-16.8	15.1	557
Total central government expenditure as % of GDP	*GOV*	28.1	10.8	7.2	79.4	557
Productive central government expenditure as % GDP	*PR_GOV*	8.0	3.9	0.1	23.0	394
Log initial GDP per capita (constant 2000 $US)	*LINI_GDP*	7.9	1.5	4.4	10.8	557
Inflation rate (%)	*INF*	40.7	310	-1.6	6517	557
Investment as % of GDP	*INV*	22.0	6.7	5.5	60.9	557
Exports + Imports as % of GDP	*OPEN*	77.4	43.8	9.9	405	557
Average years of schooling	*SCH*	5.7	2.8	0.0	12.2	438
Government effectiveness indicator	*GOV_EFF*	34.8	101	-178	229	557

Variable Correlations

	GROWTH	*GOV*	*PR_GOV*	*LINI_GDP*	*INF*	*INV*	*OPEN*	*SCH*	*GOV_EFF*
GROWTH	1.000								
GOV	-0.048	1.000							
PR_GOV	0.008	0.621	1.000						
LINI_GDP	0.074	0.703	0.482	1.000					
INF	-0.072	-0.296	-0.070	-0.138	1.000				
INV	-0.024	0.320	0.132	0.343	0.224	1.000			
OPEN	-0.108	0.053	-0.108	-0.042	-0.144	-0.041	1.000		
SCH	0.364	0.152	0.275	0.212	-0.007	0.001	-0.078	1.000	
GOV_EFF	0.115	0.356	0.565	0.229	0.094	0.154	-0.151	0.241	1.000

Note. The table gives descriptive statistics for the variables used in the regressions.

Table 2

Threshold Identification and Inference

Sample	Threshold estimate $\hat{\lambda}$	LR_0	p-value
All countries	33	5.528	0.015
Developed countries	26	3.647	0.000
Developing countries	33	11.603	0.005

Note. p-values determined from 200 bootstrap repetitions for full sample and developing countries; 50 bootstrap repetitions for developed countries.

Table 3

Baseline Regression Results (Total Government Spending)

Estimation technique: 5-year averages, two-way FE
Dependent variable: Real GDP p.c. growth

	Full sample			Developed countries	Developing countries
Variable	Linear	Quadratic	λ=33	λ=26	λ=33
	(1)	(2)	(3)	(4)	(5)
GOV	-0.066	-0.059			
	(0.018)	(0.463)			
GOV^2		-0.000			
		(0.910)			
*GOV*I(GOV≤λ)*			-0.009	-0.012	-0.001
			(0.788)	(0.748)	(0.986)
*GOV*I(GOV>λ)*			-0.045	-0.059	-0.072
			(0.095)	(0.067)	(0.058)
LINI_GDP	-7.452	-7.459	-7.538	-5.519	-9.049
	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
INF	-0.001	-0.001	-0.001	0.001	-0.001
	(0.082)	(0.082)	(0.076)	(0.816)	(0.119)
INV	0.198	0.198	0.201	0.160	0.283
	(0.000)	(0.000)	(0.000)	(0.049)	(0.000)
OPEN	0.030	0.030	0.029	0.035	0.030
	(0.037)	(0.038)	(0.034)	(0.030)	(0.063)
Constant	54.56	54.51	54.06	49.28	58.63
	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)
Observations	557	557	557	158	399
Number of countries	136	136	136	28	108
R-squared	0.390	0.390	0.398	0.549	0.466
Wald test $\beta_1=\beta_2$ (p-value)			0.053	0.012	0.004

Note. Robust p-values in parentheses. Time dummies included but not reported. Constant term represents the average value of the fixed effects.

Table 4

GMM Estimation to Address Endogeneity

Estimation method: One-step system GMM

Dependent variable: Real GDP p.c. growth

Variable	Full sample: Linear	Full sample: Quadratic	Full sample: λ=33	Developing countries: λ=33
	(1)	(2)	(3)	(4)
GOV	-0.135	-0.264		
	(0.022)	(0.112)		
GOV^2		0.002		
		(0.394)		
*GOV*I(GOV≤λ)*			0.007	-0.029
			(0.924)	(0.693)
*GOV*I(GOV>λ)*			-0.061	-0.108
			(0.245)	(0.070)
LINI_GDP	-3.470	-3.430	-3.482	-2.806
	(0.000)	(0.000)	(0.000)	(0.000)
INF	-0.002	-0.002	-0.002	-0.002
	(0.090)	(0.094)	(0.099)	(0.079)
INV	0.263	0.264	0.26	0.288
	(0.000)	(0.000)	(0.000)	(0.000)
OPEN	-0.019	-0.020	-0.019	-0.017
	(0.095)	(0.081)	(0.067)	(0.136)
Lower middle income	7.718	7.872	8.059	6.124
	(0.002)	(0.002)	(0.001)	(0.004)
Upper middle income	15.18	15.38	15.14	12.62
	(0.000)	(0.000)	(0.000)	(0.000)
High income	21.25	21.35	21.16	18.59
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	15.27	16.68	12.29	11.21
	(0.006)	(0.013)	(0.004)	(0.007)
Observations	557	557	557	396
Number of countries	136	136	136	107
Wald test $\beta_1=\beta_2$ (p-value)			0.074	0.024
AR(2) test (p-value)	0.135	0.117	0.231	0.171
Hansen test (p-value)	0.248	0.236	0.413	0.635
Number of instruments	108	108	120	107

Note. Robust p-values in parentheses. Time dummies included but not reported. Time and income class dummies entered as exogenous; *LINI_GDP* entered as predetermined; all other variables entered as endogenous with maximum lags 4.

Table 5

Productive Government Spending (Linear and Non-linear)

Estimation methods: Two-way FE and GMM

Dependent variable: Real GDP p.c. growth

Variable	(1)	(2)	(3)	(4)
PR_GOV	-0.194		-0.265	
	(0.037)		(0.052)	
PR_GOVI(GOV≤33)		0.022		0.001
		(0.850)		(0.996)
PR_GOVI(GOV>33)		-0.161		-0.233
		(0.074)		(0.072)
LINI_GDP	-8.014	-8.198	-2.863	-2.793
	(0.000)	(0.000)	(0.012)	(0.009)
INF	-0.001	-0.001	-0.002	-0.003
	(0.521)	(0.513)	(0.202)	(0.243)
INV	0.208	0.214	0.316	0.336
	(0.001)	(0.000)	(0.000)	(0.000)
OPEN	0.018	0.017	-0.027	-0.0361
	(0.327)	(0.327)	(0.118)	(0.078)
Lower middle income			6.848	6.950
			(0.016)	(0.014)
Upper middle income			14.35	13.26
			(0.004)	(0.006)
High income			17.46	18.06
			(0.003)	(0.002)
Constant	59.80	59.93	9.773	7.991
	(0.000)	(0.000)	(0.132)	(0.177)
Observations	394	394	394	394
Number of countries	103	103	103	103
R-squared	0.394	0.42		
Wald test β_1=β_2 (p-value)		0.004		0.017
Number of instruments			101	93
AR(2) test (p-value)			0.377	0.601
Hansen test (p-value)			0.281	0.417

Note. Robust p-values in parentheses. Time dummies included but not reported. Columns (3)-(4) estimated by GMM. Time and income-class dummies entered as exogenous; *LINI_GDP* entered as predetermined; all other variables entered as endogenous using all available lags.

Table 6

Selected Economic Indicators 1990-2008

Economic indicator	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	Average
Revenue (% GDP) [a]	20.0	21.3	24.4	29.3	16.0	15.1	23.2	21.3
Tax revenue (% GDP) [a]	14.3	16.7	17.8	13.1	11.1	13.2	13.1	14.2
Government expenditure (% GDP) [a]	19.0	15.6	18.9	30.6	22.8	14.4	24.7	20.8
Government consumption (% GDP) [b]	11.2	19.5	11.2	16.3	10.6	9.5	10.8	12.7
Public investment (% GDP) [c]	1.7	4.5	4.9	7.2	3.6	3.8	9.9	5.1
Public debt (% GDP) [a]	36.2	41.8	38.7	27.5	24.4	42.4	31.1	34.6
GDP p.c. growth (%) [b]	3.0	1.2	3.9	1.8	1.7	2.7	1.5	2.3
Private consumption (% GDP) [b]	68.1	61.9	61.7	66.2	67.8	70.6	58.3	64.9
Domestic investment (% GDP) [b]	18.2	18.0	23.6	20.2	23.4	20.6	21.9	20.8
Trade (% GDP) [b]	28.0	21.4	64.5	35.7	52.8	35.5	52.3	41.5
Capital-output ratio [d]	1.9	1.9	2.2	2.0	2.2	2.5	2.1	2.1
GDP p.c. (2000 US$) [b]	7580	3717	4735	2483	5654	2082	5037	4470
GDP p.c. PPP (2005 intl $) [b]	10128	7954	10163	6757	11500	5600	9998	8871

[a] Official statistics from public sector agencies in each country. [b] Data sourced from World Bank's World Development Indicators.
[c] Public investment in infrastructure 2001-2006 from Calderòn and Servèn (2010). [d] Author's calculations.

Table 7

Benchmark Parameters for Region Average

Parameter	Value	Definition
ρ	0.04	Rate of time preference
σ	2.00	Inverse of the inter-temporal elasticity of substitution in consumption
u	0.90	Share of human capital employed in private production
α	0.30	Elasticity of output, *Y*, w.r.t. educated labor (human capital)
β	0.15	Elasticity of output, *Y*, w.r.t. public capital in infrastructure
ε	0.30	Elasticity of the production of human capital w.r.t. public capital stock in education and health
A	0.85	Shift factor in final market production
Q	0.50	Shift factor in human capital production
		Fiscal Policy Variables
τ_K	0.15	Tax rate on capital income
τ_L	0.15	Tax rate on labor income
τ_C	0.20	Tax rate on consumption
v	0.90	Share of public capital stock employed in private production (public infrastructure)
a_1	0.60	Share of total tax revenue used to finance public consumption
b_2	2.00	Extent to which new bond issues are used to finance public investment. b_2 >1 implies the use of debt financing.

Table 8

Benchmark Solution for Model Calibrated to Region Average

Economic indicator	LAC-7 average	Model
Revenue (% GDP)	21.3	23.5
Tax revenue (% GDP)	14.2	23.5
Government expenditure (% GDP)	20.8	18.7
Government consumption (% GDP)	12.7	14.1
Public investment (% GDP)	5.1	4.6
Public debt (% GDP)	34.6	36.7
GDP p.c. growth (%)	2.3	2.5
Private consumption (% GDP)	64.9	48.6
Domestic investment (% GDP)	20.8	22.3
Capital-output ratio	2.1	2.8

Note. The underlying equilibrium solutions are c = 0.1715, b = 0.1295, g = 0.2590, h = 0.1230, and b_1 = 0.9026.

Table 9

Steady-State Results for Policy Experiments on the Region Average

Policy variable	γ	I_p/Y	C_p/Y	rB/Y	B/Y	T/Y
b_2						
1.9	2.54	4.71	14.09	6.91	35.45	23.48
2.0	**2.50**	**4.59**	**14.12**	**7.12**	**36.68**	**23.54**
2.1	2.47	4.48	14.15	7.30	37.75	23.58
2.5	2.36	4.17	14.23	7.82	40.97	23.72
$\tau_K = \tau_L$						
0.13	2.45	4.32	13.08	6.56	34.80	21.80
0.14	2.48	4.45	13.60	6.84	35.75	22.67
0.15	**2.50**	**4.59**	**14.12**	**7.12**	**36.68**	**23.54**
0.16	2.52	4.72	14.65	7.41	37.60	24.41
0.17	2.54	4.85	15.17	7.69	38.51	25.29
τ_C						
0.18	2.44	4.41	13.60	6.86	35.59	22.66
0.19	2.47	4.50	13.86	6.99	36.14	23.10
0.20	**2.50**	**4.59**	**14.12**	**7.12**	**36.68**	**23.54**
0.21	2.53	4.67	14.38	7.25	37.21	23.96
0.22	2.56	4.76	14.63	7.37	37.73	24.39
$a_{\square}$						
0.50	2.89	5.89	11.97	9.02	44.38	23.94
0.55	2.70	5.23	13.05	8.06	40.54	23.73
0.60	**2.50**	**4.59**	**14.12**	**7.12**	**36.68**	**23.54**
0.65	2.28	3.95	15.17	6.19	32.77	23.34
0.70	2.04	3.34	16.21	5.28	28.81	23.16
v						
0.80	3.19	4.65	14.06	7.05	33.49	23.44
0.85	2.90	4.63	14.08	7.08	34.75	23.47
0.90	**2.50**	**4.59**	**14.12**	**7.12**	**36.68**	**23.54**
0.95	1.84	4.51	14.19	7.20	40.33	23.65

Note. Benchmark case in bold type.

Table 10

Steady-State Results for "High Debt, High Tax" Scenario

Policy variable	γ	I_p/Y	C_p/Y	rB/Y	B/Y	T/Y
benchmark	**2.44**	**4.73**	**18.02**	**10.44**	**50.99**	**30.04**
b_2						
3.1	2.42	4.68	18.01	10.50	51.39	30.02
3.5	2.37	4.53	18.02	10.72	52.81	30.04
$\tau_K = \tau_L$						
0.22	2.45	4.92	19.13	11.11	52.87	31.88
0.24	2.50	5.10	20.30	11.80	54.70	33.80
0.26	2.45	5.25	21.40	12.52	56.47	35.66
0.28	2.44	5.40	22.56	13.24	58.17	37.60
τ_C						
0.26	2.48	4.87	18.50	10.71	52.07	30.84
0.28	2.52	5.00	18.97	10.98	53.12	31.62
0.30	2.56	5.12	19.42	11.24	54.14	32.37
0.32	2.59	5.24	19.87	11.50	55.12	33.11
0.33	2.61	5.30	20.08	11.62	55.60	33.47
a_1						
0.50	2.80	5.99	15.02	13.03	60.95	30.04
0.55	2.63	5.36	16.52	11.73	56.04	30.04
v						
0.80	3.14	4.84	18.02	10.40	46.83	30.04
0.85	2.84	4.80	18.02	10.42	48.48	30.04

Note. The following parameters were changed to achieve the "high debt, high tax" benchmark: $\tau_K = \tau_L = 0.20$; $\tau_C = 0.24$; $b_2 = 3$. The underlying equilibrium solutions are $c = 0.1698$, $b = 0.1898$, $g = 0.2846$, $h = 0.1399$ and $b_1 = 0.9475$.

Table 11

Steady-State Results for "Low Debt, Low Tax" Scenario

Policy variable	γ	I_p/Y	C_p/Y	rB/Y	B/Y	T/Y
benchmark	**2.21**	**3.56**	**10.68**	**5.34**	**29.86**	**17.80**
b_2						
2.1	2.18	3.48	10.70	5.48	30.74	17.83
2.5	2.08	3.24	10.75	5.87	33.37	17.91
2.8	2.02	3.12	10.77	6.07	34.74	17.96
$\tau_K = \tau_L$						
0.13	2.28	3.85	11.72	5.89	31.89	19.53
0.14	2.32	3.99	12.25	6.17	32.89	20.41
0.15	2.35	4.13	12.78	6.45	33.87	21.29
0.18	2.42	4.53	14.39	7.32	36.76	23.98
0.20	2.46	4.79	15.48	7.92	38.62	25.80
0.22	2.49	5.04	16.59	8.54	40.43	27.65
τ_C						
0.18	2.33	3.85	11.52	5.75	31.71	19.20
0.20	2.40	4.04	12.06	6.02	32.88	20.10
0.22	2.46	4.22	12.58	6.28	34.00	20.97
0.25	2.55	4.49	13.34	6.65	35.61	22.23
0.26	2.58	4.58	13.58	6.77	36.13	22.64
a_1						
0.50	2.58	4.55	9.01	6.73	35.98	18.02
0.55	2.40	4.05	9.85	6.03	32.94	17.91
v						
0.80	2.87	3.61	10.63	5.28	27.27	17.72
0.85	2.60	3.59	10.65	5.31	28.29	17.76

Note. The following parameters were changed to achieve the "low debt, low tax" benchmark: $\tau_K = \tau_L = 0.11$; $\tau_C = 0.15$. The underlying equilibrium solutions are c = 0.1705, b = 0.0971, g = 0.1942, h = 0.1081 and b_1 = 0.9.

Table 12

Steady-State Results for "High Debt, Low Tax" Scenario

Policy variable	γ	I_p/Y	C_p/Y	rB/Y	B/Y	T/Y
benchmark	**2.52**	**4.40**	**8.26**	**8.61**	**46.32**	**18.36**
b_2						
2.5	2.60	4.63	8.23	8.20	43.72	18.28
$\tau_K = \tau_L$						
0.13	2.60	4.76	9.10	9.51	49.54	20.23
0.15	2.67	5.12	9.96	10.44	52.69	22.13
0.18	2.75	5.63	11.28	11.88	57.29	25.06
0.20	2.79	5.96	12.18	12.87	60.26	27.07
0.25	2.86	6.74	14.54	15.48	67.42	32.30
0.28	2.88	7.17	16.02	17.14	71.51	35.59
τ_C						
0.20	2.72	5.01	9.36	9.75	51.18	20.81
0.25	2.90	5.59	10.39	10.80	55.61	23.09
0.30	3.05	6.14	11.35	11.80	59.68	25.23
0.35	3.18	6.65	12.26	12.73	63.43	27.24
a_1						
0.35	2.82	5.32	6.53	10.31	53.57	18.64
0.40	2.67	4.85	7.40	9.46	49.95	18.50
v						
0.80	3.22	4.47	8.23	8.54	42.37	18.28
0.85	2.93	4.44	8.24	8.57	43.93	18.32

Note. The following parameters were changed to achieve the "high debt, low tax" benchmark: $\tau_K = \tau_L = 0.11$; $\tau_C = 0.15$; $a_1 = 0.45$; $b_2 = 2.95$. The underlying equilibrium solutions are $c = 0.1818$, $b = 0.1566$, $g = 0.2368$, $h = 0.1113$ and $b_1 = 0.9189$.

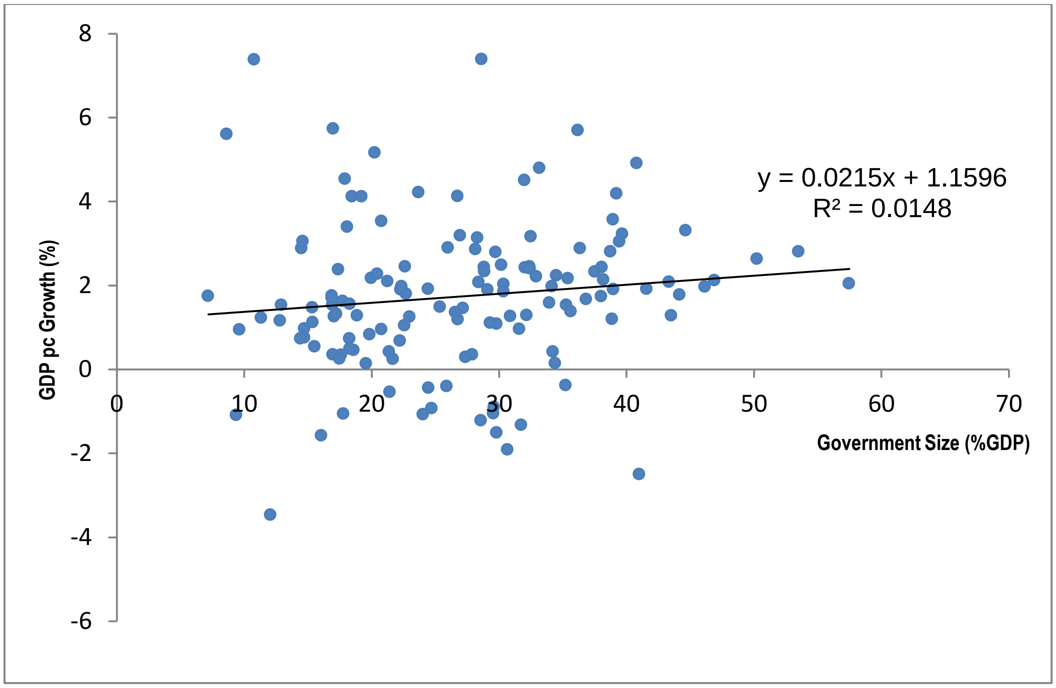

Figure 1. Over time averages of government size relative to GDP per capita growth by country.

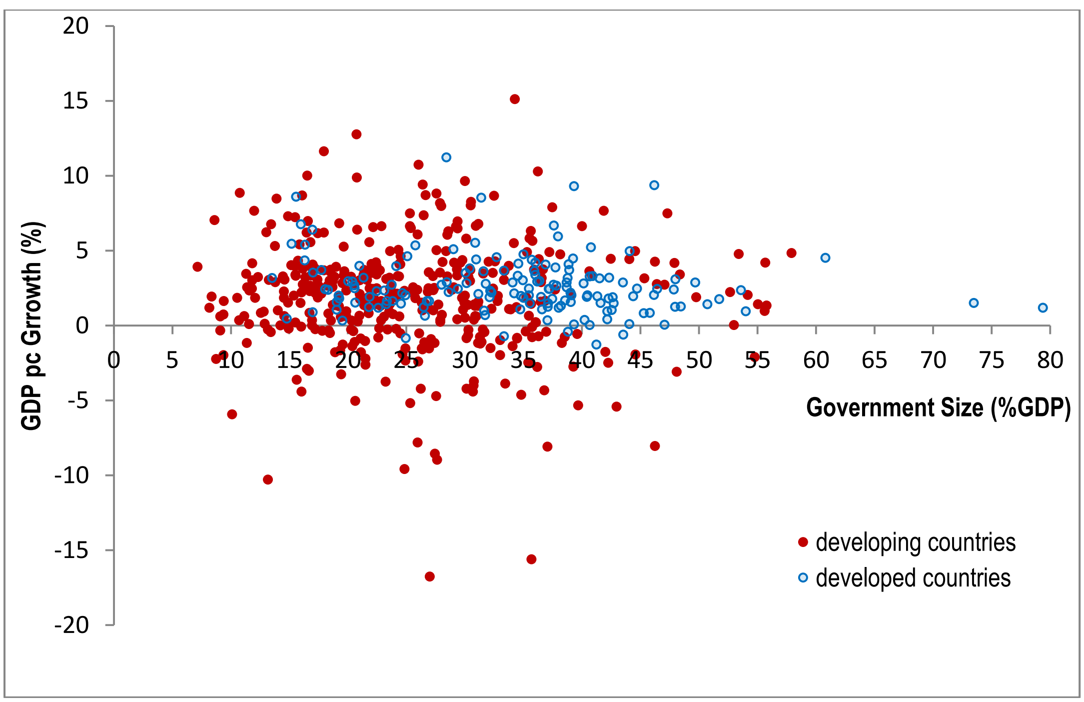

Figure 2. Distribution of estimation observations according to government size and GDP Growth.

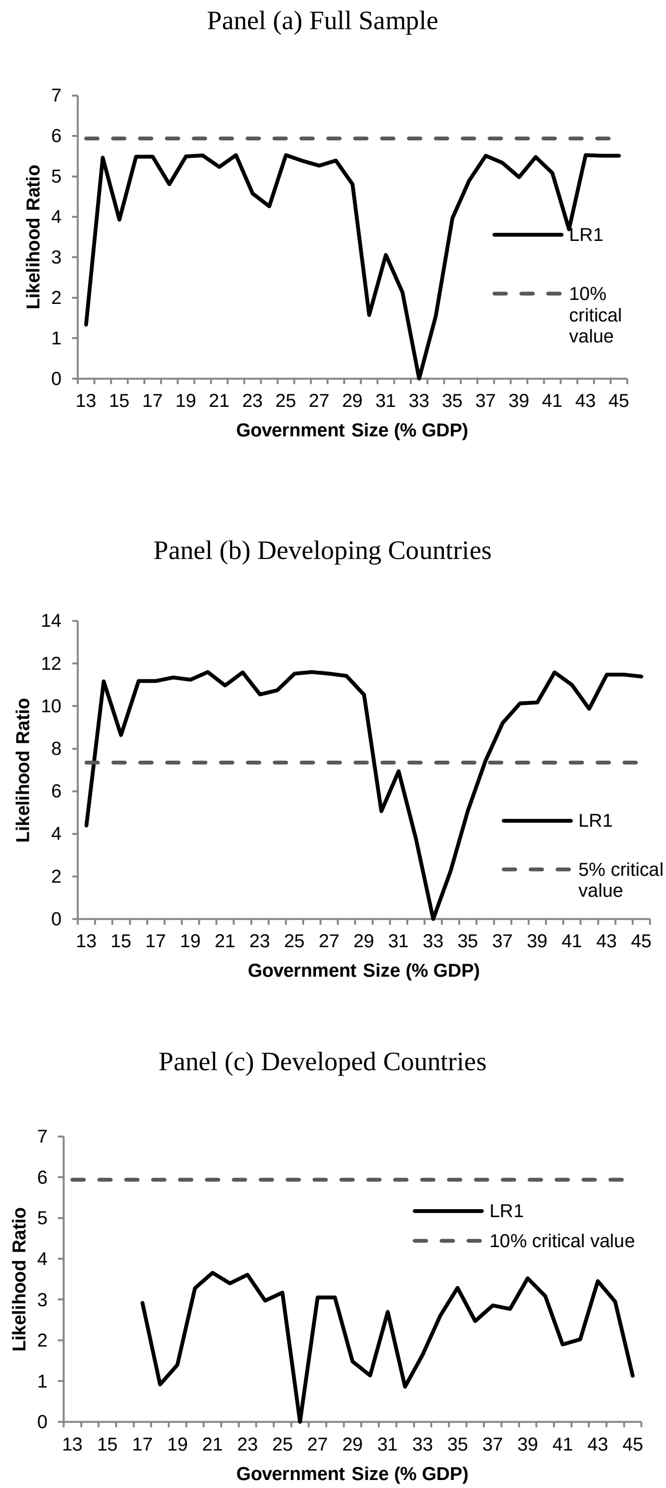

Figure 3. Likelihood ratio (LR_1) statistics and confidence intervals for threshold inference. The confidence interval of the threshold estimate consists of those values of government size for which the LR_1 statistic is less than the critical value.

APPENDIX A

Country Sets

Developed Countries (28): Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Republic of Korea, Singapore, Spain, Sweden, Switzerland, United Kingdom, and United States of America.

Developing Countries[53] *(108):* Africa - Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Cote d'Ivoire, Democratic Republic of the Congo, Egypt, Ethiopia, Gabon, Gambia, Ghana, Kenya, Lesotho, Mali, Mauritius, Morocco, Namibia, Niger, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Togo, Tunisia, Uganda, Zambia, Zimbabwe. Americas - Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Trinidad and Tobago, Uruguay, Venezuela. Asia - Bahrain, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Iran, Jordan, Kuwait, Lebanon, Macao , Malaysia, Mongolia, Nepal, Oman, Pakistan, Philippines, Sri Lanka, Syria, Thailand, Yemen. Europe and Central Asia - Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Poland, Moldova, Romania, Russian Federation, Slovakia, Turkey, Ukraine. Oceania - Fiji, Papua New Guinea, Tonga, Vanuatu.

Table A1

Descriptive Statistics over time Averages

Variable	1971-2005	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
GROWTH	2.1	2.7	2.9	1.0	2.1	0.6	2.3	3.1
GOV	28.1	25.4	28.0	30.9	28.6	29.4	27.6	26.8
PR_GOV	8.0	7.7	8.5	8.9	8.4	8.0	7.2	7.1
LINI_GDP	7.9	7.9	7.9	8.0	7.8	8.0	7.9	7.9
INF	40.7	17.7	15.2	17.0	57.5	139.3	16.1	5.9
INV	22.0	21.4	23.5	22.8	22.0	22.2	21.2	21.8
OPEN	77.4	57.3	68.5	73.2	74.3	77.2	82.3	92.4
SCH	5.7	4.7	4.7	5.4	5.2	6.0	6.3	6.5
GOV_EFF	34.8	58.2	43.9	45.7	28.4	32.0	26.2	27.4

[53] Decomposition by geographical region based on data from the United Nations Statistics Division.

Table A2

Data Sources and Variables Description

Variable	Mnemonic	Description
IMF, *Government Finance Statistics*		
Total central government expenditure	*GOV*	Total government expenditure for the consolidated central government net of interest payments (% GDP).
Productive central government expenditure	*PR_GOV*	Sum of expenditure on education, health, housing and transport and communication as defined using the functional classification of the GFS. Measured as % GDP.
World Bank, *World Development Indicators*		
Annual average growth in GDP p.c.	*GROWTH*	Annual percentage growth rate of GDP p.c. based on constant local currency.
Log initial GDP p.c. (constant 2000 $US)	*LINI_GDP*	Logarithmic transformation of initial GDP p.c. in constant 2000 U.S. dollars. Initial GDP is measured as the value at the start of each five-year period.
Inflation rate (%)	*INF*	Based on annual percentage change in consumer price index.
Investment	*INV*	Gross capital formation as % of GDP.
Exports + Imports as % of GDP	*OPEN*	Sum of exports and imports of goods and services.
Barro and Lee (2001)		
Average years of schooling	*SCH*	Average schooling years in the total population at the end of each preceding 5-year period.
World Bank, *Worldwide Governance Indicators*		
Government effectiveness indicator	*GOV_EFF*	Captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Higher values correspond to more effective government.

Table A3

Productive Government Spending Sub-samples

Estimation technique: Two-way FE

Dependent variable: Real GDP p.c. growth

	Developed		*Developing*	
Variable	(1)	(2)	(3)	(4)
PR_GOV	-0.186		-0.240	
	(0.004)		(0.080)	
PR_GOVI(GOV≤32)		-0.077		
		(0.299)		
PR_GOVI(GOV>32)		-0.203		
		(0.005)		
PR_GOVI(GOV≤33)				0.093
				(0.587)
PR_GOVI(GOV>33)				-0.196
				(0.128)
LINI_GDP	-5.799	-5.719	-9.599	-10.16
	(0.003)	(0.003)	(0.000)	(0.000)
INF	-0.005	-0.006	-0.0004	-0.0002
	(0.316)	(0.268)	(0.693)	(0.759)
INV	0.238	0.189	0.253	0.297
	(0.000)	(0.003)	(0.001)	(0.000)
OPEN	0.0450	0.0403	0.018	0.020
	(0.046)	(0.045)	(0.419)	(0.365)
Constant	49.32	49.81	65.32	66.68
	(0.008)	(0.006)	(0.000)	(0.000)
Observations	120	120	274	274
Number of countries	25	25	78	78
R-squared	0.586	0.614	0.432	0.476
Wald test $\beta_1=\beta_2$ (p-value)		0.001		0.005

Note. Robust p-values in parentheses. Time dummies included but not reported.

Table A4

Sensitivity Analysis – Alternative Composition of Covariates

Estimation Technique: Two-way FE
Dependent variable: Real GDP p.c. growth

Variable	*INF* omitted	*INV* omitted	*OPEN* omitted	*SCH* included	Low Government Effectiveness	High Government Effectiveness
	(1)	(2)	(3)	(4)	(5)	(6)
GOV				-0.058		
				(0.014)		
GOVI(GOV≤λ)	-0.019	-0.004	-0.006		0.004	0.023
	(0.564)	(0.914)	(0.872)		(0.932)	(0.595)
GOVI(GOV>λ)	-0.050	-0.037	-0.042		-0.079	-0.026
	(0.049)	(0.201)	(0.129)		(0.058)	(0.443)
LINI_GDP	-7.491	-6.804	-6.950	-5.907	-9.277	-7.238
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INF		-0.001	-0.001	-0.001	-0.001	-0.020
		(0.001)	(0.004)	(0.014)	(0.078)	(0.000)
INV	0.214		0.209	0.131	0.323	0.176
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
OPEN	0.029	0.039		0.026	0.048	0.022
	(0.002)	(0.000)		(0.003)	(0.088)	(0.016)
SCH				0.493		
				(0.024)		
Constant	53.252	51.920	51.256	42.953	54.833	59.465
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	592	565	563	438	258	299
No. of countries	143	136	136	96	75	61
R-squared	0.379	0.335	0.380	0.349	0.492	0.513
Wald test $\beta_1=\beta_2$ (p-value)	0.036	0.039	0.018		0.002	0.007

Note. Robust p-values in parentheses. Time dummies included but not reported.. λ = 33 in all specifications except column (6) when λ =30.

Table A5

Sensitivity Analysis - Developing Country Regressions by Region, FE

Variable	Africa $\hat{\lambda} = 35$			America $\hat{\lambda} = 34$			Asia $\hat{\lambda} = 41$			ECA $\hat{\lambda} = 33$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
GOV	-0.062	0.347		-0.166	0.109		0.053	0.416		0.113	1.049	
	(0.379)	(0.200)		(0.030)	(0.482)		(0.482)	(0.166)		(0.283)	(0.057)	
GOV^2		-0.006			-0.006			-0.006			-0.013	
		(0.149)			(0.168)			(0.143)			(0.060)	
$GOVI(GOV \leq \lambda)$			0.065			-0.124			0.196			0.197
			(0.450)			(0.040)			(0.090)			(0..090)
$GOVI(GOV > \lambda)$			-0.026			-0.180			0.090			0.124
			(0.701)			(0.017)			(0.275)			(0.239)
LINI_GDP	-6.543	-7.692	-7.267	-7.848	-7.836	-7.733	-6.039	-6.373	-6.326	-15.714	-17.386	-15.998
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INF	-0.000	-0.000	-0.000	-0.002	-0.001	-0.001	-0.065	-0.055	-0.050	-0.003	-0.003	-0.002
	(0.015)	(0.039)	(0.035)	(0.029)	(0.067)	(0.072)	(0.026)	(0.074)	(0.080)	(0.088)	(0.070)	(0.181)
INV	0.174	0.221	0.213	0.185	0.173	0.181	0.097	0.117	0.116	0.274	0.307	0.285
	(0.034)	(0.017)	(0.010)	(0.011)	(0.022)	(0.014)	(0.246)	(0.210)	(0.239)	(0.011)	(0.003)	(0.006)
OPEN	0.045	0.036	0.049	0.020	0.018	0.016	-0.002	-0.002	-0.005	-0.013	-0.052	-0.025
	(0.359)	(0.449)	(0.297)	(0.483)	(0.523)	(0.579)	(0.903)	(0.904)	(0.787)	(0.670)	(0.117)	(0.517)
Constant	39.620	41.120	40.617	61.480	58.960	60.210	40.126	37.189	38.314	107.678	109.322	109.191
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	118	118	118	110	110	110	97	97	97	59	59	59
No. of countries	35	35	35	26	26	26	22	22	22	20	20	20
R-squared	0.437	0.464	0.497	0.589	0.596	0.607	0.456	0.468	0.509	0.924	0.930	0.930
Wald test $\beta_1=\beta_2$ (p-value)			0.011			0.025			0.024			0.040

Table A6

Sensitivity Analysis - Income Class Subsamples, FE

Variable	Low Income $\hat{\lambda} = 30$			Lower Middle Income $\hat{\lambda} = 33$			Upper Middle Income $\hat{\lambda} = 49$			High Income $\hat{\lambda} = 30$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
GOV	-0.035	0.242		-0.198	-0.173		-0.050	-0.315		-0.114	-0.423	
	(0.647)	(0.288)		(0.000)	(0.256)		(0.491)	(0.102)		(0.030)	(0.030)	
GOV^2		-0.006			-0.000			0.004			0.004	
		(0.220)			(0.843)			(0.111)			(0.058)	
$GOVI(GOV \leq \lambda)$			0.073			-0.109			-0.096			-0.016
			(0.333)			(0.041)			(0.183)			(0.774)
$GOVI(GOV > \lambda)$			-0.042			-0.164			-0.026			-0.077
			(0.537)			(0.000)			(0.732)			(0.092)
LINI_GDP	-4.703	-5.260	-5.223	-8.662	-8.687	-8.729	-11.727	-12.125	-11.980	-6.766	-7.019	-6.882
	(0.005)	(0.005)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INF	-0.001	-0.000	-0.000	-0.003	-0.003	-0.003	-0.018	-0.017	-0.017	0.014	-0.010	0.007
	(0.040)	(0.048)	(0.032)	(0.064)	(0.066)	(0.057)	(0.002)	(0.005)	(0.001)	(0.117)	(0.375)	(0.406)
INV	0.293	0.302	0.335	0.274	0.276	0.294	0.401	0.389	0.380	0.045	0.047	0.042
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.625)	(0.605)	(0.623)
OPEN	0.074	0.077	0.101	0.070	0.070	0.070	0.027	0.032	0.036	0.019	0.016	0.023
	(0.068)	(0.064)	(0.015)	(0.011)	(0.012)	(0.011)	(0.167)	(0.090)	(0.053)	(0.413)	(0.488)	(0.271)
Constant	18.253	18.603	17.973	57.570	57.355	55.903	87.023	93.561	89.785	66.297	74.593	65.432
	(0.019)	(0.020)	(0.019)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Observations	93	93	93	158	158	158	129	129	129	177	177	177
No. of countries	31	31	31	41	41	41	31	31	31	33	33	33
R-squared	0.456	0.464	0.541	0.562	0.562	0.577	0.691	0.696	0.705	0.402	0.418	0.432
Wald test $\beta_1=\beta_2$			0.000			0.059			0.035			0.015

Table A7

Sensitivity Analysis - Alternative Sample Periods

Estimation technique: Two-way FE

Dependent variable: Real GDP p.c. growth

Variable	1981-2005			1986-2005			1991-2005		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GOV	-0.063	-0.119		-0.046	-0.117		0.006	-0.169	
	(0.089)	(0.175)		(0.320)	(0.383)		(0.932)	(0.473)	
GOV^2		0.001			0.001			0.003	
		(0.398)			(0.557)			(0.411)	
GOVI(GOV≤33)			0.018			0.049			0.099
			(0.658)			(0.324)			(0.209)
GOVI(GOV>33)			-0.042			-0.022			0.037
			(0.208)			(0.606)			(0.585)
LINI_GDP	-9.542	-9.450	-9.671	-11.650	-11.573	-11.885	-16.945	-16.804	-16.938
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
INF	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(0.089)	(0.092)	(0.076)	(0.104)	(0.103)	(0.078)	(0.239)	(0.206)	(0.238)
INV	0.259	0.257	0.270	0.317	0.316	0.320	0.403	0.399	0.399
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
OPEN	0.018	0.019	0.018	0.019	0.021	0.017	0.031	0.036	0.027
	(0.241)	(0.233)	(0.220)	(0.161)	(0.131)	(0.160)	(0.028)	(0.018)	(0.056)
Constant	69.319	69.540	68.572	85.224	85.489	85.377	122.228	123.243	120.805
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	447	447	447	381	381	381	302	302	302
No. of countries	135	135	135	134	134	134	126	126	126
R-squared	0.438	0.438	0.456	0.532	0.533	0.556	0.624	0.625	0.636
Wald test β_1=β_2 (p-value)			0.011			0.003			0.060

Robust p-values in parentheses. Time dummies not reported.

Table A8

Threshold Identification and Inference Subsamples

Sub-sample	Threshold estimate $\hat{\lambda}$	LR_0
	Regional groups	
Africa	35	8.459
Americas	34	3.250
Asia	41	6.896
Europe	33	1.646
	Income classes	
Low income	30	9.262
Lower -middle income	33	3.629
Upper -middle income	49	4.049
High income	30	6.848
	Productive expenditure	
Full sample	33	12.419
Developed countries	32	5.921
Developing countries	33	15.298

Note. Regional decomposition is for developing countries only.

APPENDIX B

Table B1

Variations in the Elasticity of Production of Human Capital

Parameter	Benchmark v = 0.90	v = 0.85	v = 0.80
$\varepsilon = 0.30$	2.50	2.90	3.19
$\varepsilon = 0.15$	2.02	2.26	2.43
$\varepsilon = 0.10$	1.81	1.98	2.09

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During her time at Georgia State she was employed as a Graduate Research Assistant and later as a Research Associate in the Fiscal Research Center. She is also a member of Phi Beta Delta, the honor society for international scholars exhibiting academic excellence. Her primary research interests include public finance and economic development, with special emphasis on applied econometrics.

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