Financing Productive Government Expenditures: The Importance of Initial Fiscal Conditions

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Abstract

This paper 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.

1 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,[1] 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.[2] 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 healthcare, also has significant growth effects in the long-run.[3] 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

[1] 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.

[2] 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.

[3] 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.

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 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.

2 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.[4] 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 between government spending on the basis of output elasticities.[5] 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.[6] 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.[7] Agénor

[4] 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).

[5] 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.

[6] 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).

[7] 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 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 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).[8]

[8] The previous chapter in this dissertation also finds support for a weak nonmonotonic relationship between

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 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

government spending and economic growth in a panel of 136 developed and developing countries.

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.

3 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.

3.1 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

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

where the time argument has been suppressed.[9] $\rho \in (0,1)$ denotes the pure rate of time pref-

[9] 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.

erence and σ is the inverse of the inter-temporal elasticity of substitution in consumption.[10] 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 $r_B = r - \delta_K/\,(1 - \tau_K)$.[11] Thus, the budget identity of the household can be re-written as

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

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

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

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

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

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

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

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

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

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

[11] 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 $r_B = r - \delta_K/\,(1 - \tau_K)$.

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.

3.2 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.

3.2.1 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[12]

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

where A is a productivity parameter and K_G represents the stock of public capital. $u, v \in$

[12] 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.

$(0,1)$ 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. $\alpha, \beta \in (0,1)$ denote output elasticities so that production displays constant returns to scale in all factors together.[13]

3.2.2 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

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

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

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

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

3.3 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

[13] 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).

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[14] 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 returns in the future, but must finance public consumption expenditures and interest payments from current tax revenue so that $C_p + rB = b_1 T$, $0 < b_1 < 1$. 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).[15] 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

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

[14] 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).

[15] 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.

3.4 Equilibrium Conditions and the Balanced Growth Path

3.4.1 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.

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

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

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

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

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

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

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

3.4.2 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, $\frac{\dot{C}}{C} = \frac{\dot{K}}{K} = \frac{\dot{H}}{H} = \frac{\dot{K}_G}{K_G} = \frac{\dot{B}}{B} = \gamma$, $\gamma > 0$ 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

$$\frac{\dot{c}}{c} = \frac{\dot{C}}{C} - \frac{\dot{K}}{K} = 0,$$

$$\frac{\dot{h}}{h} = \frac{\dot{H}}{H} - \frac{\dot{K}}{K} = 0,$$

$$\frac{\dot{b}}{b} = \frac{\dot{B}}{B} - \frac{\dot{K}}{K} = 0,$$

$$\frac{\dot{g}}{g} = \frac{\dot{K}_G}{K_G} - \frac{\dot{K}}{K} = 0, \qquad (23)$$

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

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

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

4 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.[16] 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 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.

[16] 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).

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.[17] 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.

5 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 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

[17] 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.

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). [18]

5.1 The Region Average

5.1.1 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

[18] 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.

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.

5.1.2 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).[19] Conversely, reducing the income tax rate reduces available funds for public investment and reduces the growth rate.

[19] 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).

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, 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.[20] 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 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.

[20] 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).

5.1.3 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.

5.2 Fiscal Strategy under Different Initial Fiscal Conditions

5.2.1 "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.

5.2.2 "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.

5.2.3 "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.[21] 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 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

[21] 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.

long-run growth.

6 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.

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TABLES

Table 1

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 2

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 3

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 4

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_1						
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 5

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 6

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 7
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 $b_1^* = 0.9189$.

APPENDIX

Table A1

Variations in the Elasticity of Production of Human Capital

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