EURASIAN JOURNAL OF SOCIAL SCIENCES

<http://www.eurasianpublications.com/>

GOVERNMENT SIZE VERSUS GOVERNMENT EFFICIENCY IN A MODEL OF ECONOMIC GROWTH

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Abstract

We develop a Solow type growth model where firms produce a single homogenous good using labor, private capital and a public good. The "amount" of public good depends on current government spending and government quality. Quality is the result of the accumulation of public capital. Governments charge distortionary taxes and provide the public good, investing also in "quality" by accumulating public capital. We analyze how the composition of government spending between current expenditures and quality affects the equilibrium levels. We aim to understand the difference in terms of steady state levels between leviathan, quality driven and benevolent governments.

Keywords: Solow Model, Government Efficiency, Public Capital, Economic Growth

1. Introduction

For several different reasons, the causes and consequences of the size of government have long preoccupied economists and policy-makers alike. At least since Wagner (1893) there is a widespread perception of a positive relationship between per capita income and the share of government spending in Gross Domestic Product (GDP). Knoop (1999), for instance, studies the link between size of government and growth exploring different types of cuts in public spending. Tanzi and Schuknetch (2000) report a rise in general government spending in OECD countries from 13 to 46 percent of GDP between 1913 and 1996. In the last two decades, the share of total government spending in GDP has increased by 10 percent in OECD countries, according to the World Bank (2001), the continuation of a long trend in government growth in the twentieth century. On the consequences of government spending, there is not a consensus, namely on its impact on economic growth.¹ Given the high share of public spending in output observed in developed economies and the recurring calls for government intervention in addressing critical issues, the demand for further government action can best be met by an increase in government efficiency, higher output of governmental action without further increases in expenditures. There is also some literature concerned with the relation between government quality and economic growth. In Easterly (2006) the author concludes that there is statistical evidence that suggests that all measures of government quality used in the paper are good predictors of economic growth. In La Porta *et al.* (1999) the authors use several measures of government efficiency one of which is the degree of democracy. In Minier (1998) the author

¹ See Barro (1990) for a model of the relationship between government spending and economic growth. Lindauer and Velenchik (1992), in a survey of the effects of aggregate public spending on economic growth, conclude that there is little support for the claim that it is a significant determinant of growth rates.

concludes that countries in the process of democratization tend to grow faster than others². The relation between institutional behavior and economic growth is widely analyzed by the authors of Glaeser *et al.* (2004). While there is an extensive literature on both government size and government efficiency³, the two issues are seldom treated together, and very rarely in an aggregate and theoretical fashion that illustrates the relationship with economic growth.⁴ This likely shift towards an emphasis in the efficiency of government provision is addressed in this paper, which studies the normative issues facing the trade-off in the governmental choice between how much to spend and how much to improve the efficiency of public spending. Our model endogenizes both public spending and its efficiency, both considered as productive inputs to private production, and investigates the consequences for per capita consumption and income of three government types: a leviathan type of government that maximizes expenditure in steady state; an efficiency -seeker government that tends to maximize the efficiency of spending; and, last but not least, a benevolent government that maximizes private consumption in steady state. We investigate this issue in the theoretical framework of a growth model that can be closely linked with the existing literature on models of economic growth.

There are at least three good reasons to conduct such an exercise. First, the decision on the size and the efficiency of government spending, though complex and of a dynamic nature, is certainly a joint decision. Analyzing one without the other is likely to be greatly misleading.⁵ While there is a substantial body of theoretical and empirical work on the relationship between government spending and economic growth⁶, there is little on the role of government efficiency, a harder concept to grasp, and practically nothing on the joint choice of size and efficiency of government spending.⁷ In Ghosh and Gregoruos (2008), and Devarajan *et al.* (1996), the authors go in this direction but focus on the existence of two public goods with different productivities. Both public goods are equal in nature. We consider a prior distinction between the two types of public spending. One demands an accumulation effort and the other doesn't. We introduce two types of capital (public and private) and focus part of our analysis on the relation between the two. Moreover we analyze different attitudes from the government considering the possibility of a self-driven government. We support our analysis on the empirical evidence that we have very different governmental behaviors. Second, the burgeoning literature on corruption -or, more generally, "bureaucracy" -its determinants and consequences, has put forward interesting models and results but is still poorly connected to a general framework to analyze the larger issue of government efficiency as it relates to the size of government, growth and economic development.⁸ Third, whereas the micro determinants of the efficiency of government programs have been widely examined, many conclusions are not generalizable and much more needs to be understood at the aggregate, macroeconomic level. After a review of the literature one is left with important questions unanswered, among them: why are some countries stuck in a "bad" equilibrium with low income levels, inefficient and large governments, while others display large but efficient governments that are associated to high personal income

² In Ileana (2015) the author addresses the importance of the public sector in social responsibility which is increasingly seen as a key feature of sustainable economic growth.

³ Papers such as Aschauer (1989) and Barro (1990) model the role of productive spending.

⁴ On the determinants of government efficiency, Isham *et al.* (1997) find a strong empirical positive relation between civil liberties and the performance of government of projects, Knack (2002) examines the relationship between different facets of social capital and governmental efficiency across U.S. states; Adsera *et al.* (2002) explore the positive relation between political participation and government efficiency.

⁵ An exception is Devarajan *et al.* (1997).

⁶ See, for instance, Aschauer (1989), Barro (1981) and Barro and Sala-i-Martin (1992).

⁷ See Calderon and Chong (2004) for an empirical and sectorial study. The authors examine how income distribution empirically affects both the volume and the quality of infrastructure. In Ghosh and Gregoruos (2008) the authors go in this direction but focus on the existence of two public goods with different productivities and their impacts on optimal fiscal policy.

⁸ Mauro (1998), for instance, finds evidence that economic growth and private investment are negatively affected by the extent of corruption. Kaufmann (2005) questions how fundamental are "good governance and controlling corruption for country development?". Recently, Guedes de Oliveira (2012) has shown that the two concepts -corruption and government efficiency-, though empirically correlated, are quite distinct, even in their empirical implications.

and wealthier economies? In the relationship between government behavior and economic performance, size is not all and may actually mean very little.

The distinction between government size and efficiency can be restated as a decision between current expenditures and capital expenditures. In Table 1 below we present data on three variables, measured over long time periods, and for 21 OECD countries. The variables are: per capita gross domestic product, government expenditures as a percentage of GDP -net of social security and welfare spending-, and the net capital stock of public capital as a percentage of GDP. Even for this restricted group made up overwhelmingly of highly developed economies, one can detect contrasting choices. We have ordered countries by decreasing income per capita (see the first column) and then shaded the seven countries with highest share of total government spending to GDP and highest share of public capital to GDP. As can be verified, of the seven richest countries, only one is also among the top seven in terms of public spending -Ireland, and two among the top seven in terms of public capital -Switzerland and the United States. Of the next seven countries in terms of income, five are among the top in terms of public capital, and only one is among the top spenders. Finally, among the seven poorest of the OECD, five are top spenders and only one is a top investor. This simple breakdown shows that there is a choice between size and efficiency, and that choice is exerted by countries: only one of the twenty-one countries is both a top spender and a top investor, none is top in the three categories, and only three are in two categories.⁹ In addition, of the twenty-one, only three countries are out of the top third in all three categories. If we examine countries that are among the top in only one category we can obtain three broad categories of countries:

- High Spenders: Belgium, United Kingdom, Italy, Portugal and Greece
- High Stock of Public Capital: Iceland, Japan, Austria and France
- Wealthier nations: Canada, Denmark and Australia

Ireland and the United States seem to balance high government size and high stock of public capital with a high level of personal income. Thus, at first pass, countries seem to fit nicely into one of the three types of governments we want to examine: the leviathan, the efficiency-seeker, and the benevolent government.

In addition to the existence of choice, choices seem to have important consequences: if anything it is much more likely for governments that invest in public capital to be among the top in terms of income.

Figure 1 presents the same data in a different format, with the aim of highlighting our statement. We represent each country by a circle proportional to output per capita, and position them in the plane relative to the average government spending and average public capital in the sample of countries. The way countries fall into the four quadrants suggests the existence of efficiency-seeker countries -in the top left quadrant, where public capital is relatively high and spending low-, and high spenders -in the bottom right. The high income countries tend to be close to the median in terms of spending and public capital, -such are the cases of Norway and Denmark-, or well below the average in terms of both variables -as is the case of Australia, Canada, and Switzerland.

⁹ In an interesting exercise with some analogies to ours, Gawande *et al.* (2009) use trade theory to determine the relative weight ascribed by governments to private interests versus aggregate welfare and find, for a large cross-section, that indeed there is wide variation in government choices. Sanz and Velazquez (2004) analyze the composition of public expenditures in OECD countries and find evidence of convergence to a distribution, with important differences between countries that may have consequences in the long-run equilibria if expenditures are productive.

Table 1. GDP pc, public expenditures and public capital

	GDP pc	Total expend.	Pub. capital
United States	33,615.74	15.11	53.34
Ireland	28,783.94	31.94	50.96
Norway	27,786.45	24.40	50.86
Canada	27,688.35	14.19	41.26
Denmark	27,094.42	22.16	52.77
Australia	26,701.20	18.18	43.82
Switzerland	26,284.06	11.18	53.92
Germany	26,210.36	15.32	49.77
Iceland	25,139.82	24.14	53.89
Japan	24,840.87	13.88	107.09
Finland	24,439.04	20.85	51.74
Netherlands	24,246.45	33.14	62.83
Sweden	24,190.18	22.14	43.22
Austria	23,984.57	20.06	63.86
Belgium	23,948.96	28.33	42.11
United Kingdom	22,952.96	26.42	45.50
France	22,829.14	23.90	55.43
Italy	22,254.68	27.59	49.65
Spain	18,779.27	16.15	47.88
Portugal	15,990.37	29.33	38.57
Greece	15,711.08	25.22	51.84

Figure 1. GDP pc, public expenditures and public capital

Notes: Real GDP per capita in constant prices - reference year is 1996, Laspeyres Index -computed as the average of the last ten years available.

Source: Penn World Table 6.1. Total Government Expenditures -excluding social security and welfare-, computed as the average of the last ten years available. IMF: Government Financial Statistics. Government net capital stock, - beginning-of-year stock - computed as the percentage of GDP and the average of the last ten years available (Kamps, 2004).

Given these different government types, how can we formalize the options open to cabinets? What is the shape of the trade-off between size and efficiency of government? How do choices in those loci affect the long-run performance of the economy. Our paper attempts to provide just such a theoretical framework, and a contribution to the shortcomings in the literature.

For instance, in Irmen and Kuhnel (2008) the authors present a comprehensive survey on the link between economic growth and government expenditures and conclude that future work should focus on endogenous growth models. In our growth model firms produce a single homogenous good using labor, private capital and the public good as inputs. The amount of public good available depends both on current government spending -which can be viewed as basically spending on personnel and other current items -and government efficiency, which is the result of the accumulation of public capital in the past. Governments charge distortionary taxes and can use revenues either to pay for current expenses or invest in efficiency by accumulating public capital. We analyze how the composition of government spending between current and capital expenditures affects the steady-state equilibrium level of income and the growth rate in steady state. We show how the steady-state equilibrium is stable. We do not take

government decisions as given,¹⁰ and analyze the impact of government choices on the different model variables.

Specifically, we compare outcomes for governments that maximize spending in steady-state, government efficiency, or private consumption.

We model size and efficiency as a multiplicative term, where government size is associated with current spending and efficiency is the result of the accumulated of public capital over time and depreciates in a similar way as private capital. We can think of a government bureau which has the choice between hiring more employees and current expenditures, and thus increase government size, or buy more computers for a given number of employees, thus raising the efficiency of each employee but being subject to depreciation.

Think of the choice between putting more policemen in the streets or better surveillance and crime prevention with the aide of better equipment, and so on for similar choices. Our model thus departs from models where government decides between a productive public good and a government- provided private good that enhances private consumption, as in Alesina and Rodrik (1994) and Chen (2006). We also depart from Devarajan *et al.* (1996), who model a productive economy with two publicly provided productive goods that are separable in production. In the latter case, the authors model how the impact on economic growth depends on the government spending mix and the underlying productivity parameters and conduct an empirical exercise that shows that public investment, which tends to be considered productive, actually does not come out as such in the cross-section data.¹¹ A substantive difference is that we consider the accumulation of public capital explicitly, which is closer in line with the existing literature on productive public spending. Devarajan *et al.* (1996) consider a flat tax rate rather than distortionary taxation, as is the case in our model, which models explicitly the disincentives of raising public revenues through taxation. Also notice that, in this paper, we analyze performance as it relates to income and consumption per capita. There are other relevant measures of performance that may be examined.¹²

The paper is structured as follows. After the introduction, Section 2 presents the benchmark model and the steady-state. Furthermore, we present empirical evidence that our specification is sound. In Section 3 we compute model responses for the three government types. In Section 4 we conclude.

Appendix A presents the model dynamics, including the phase diagram in terms of private and public capital.

2. The Model

2.1. Government

In our model government has two alternative uses for its revenues: finance a productive public good H_t through public spending or investment that increases public capital, K_{gt} , which affects the efficiency of public spending.¹³

The efficiency of public spending, q_t , depends on the amount of public capital available and a technical parameter so that efficiency has the characteristics of capital good, with delayed but persistent effects on output. As Guedes de Oliveira (2012) demonstrates for a cross-section of OECD countries, there is a robust positive relationship between measures of public capital and several indicators of government efficiency and quality. In contrast to current spending in the public good, government efficiency takes time to build through capital accumulation, which is subject to depreciation. One can think of the government as choosing between public

¹⁰ As in, for instance, Ghosh and Gregorouos (2008).

¹¹ Ghosh and Gregoriou (2009) use a GMM estimation procedure and obtain a similar result.

¹² Rajkumar and Swaroop (2008) examine the role of governance in improving the efficacy of government spending in improving human development outcomes.

¹³ Here and elsewhere in this paper we use the terms public spending, public services, and public consumption, all meant to capture productive current spending by the government. Both public goods that affect utility directly, as well as transfer payments, which are not considered in this paper.

spending, H_t , and increases in public investment, K_{gt} , which impacts efficiency q_t .¹⁴ The following equations describe respectively public spending, public investment and quality.

$$H_t = (1 - \theta)\tau Y_t \quad (1)$$

$$\dot{K}_{gt} + \delta K_{gt} = \theta \tau Y_t \quad (2)$$

$$q_t = (K_{gt})^\psi \quad (3)$$

Government taxes the economy's income Y_t at the proportional tax rate τ . A fraction $(1 - \theta)$ of tax revenues, τY_t finances government spending and a fraction θ of tax revenues finances investment in public capital. Both τ and $1 - \theta$ are government policy decisions. θ is analogous to a public saving rate as it sacrifices benefits today in the form of productive spending, for the benefit of the accumulation of public capital and future government efficiency.

δK_{gt} is the depreciation of existing public capital, so that $\dot{K}_{gt}$ is net public investment. The function q_t transforms public capital into government efficiency in the provision of the productive public services. The parameter ψ represents the elasticity of quality q_t with respect to K_{gt} . Introducing this production function for quality allows for diminishing returns on public capital, corresponding to the assumption that $\psi \leq 1$. Y_t is the aggregate output of the economy, described by a production function which we present in the next section.

Before going further let's examine a little bit closer our variables. The weight of government is given by τ , the tax rate on income. A fraction θ has a lagged effect on productivity through the accumulation of public capital. Thus equation (1) is the amount of public spending, with the same factor composition as private output Y_t . As for government efficiency, q_t , in order for it to be sustained or increased it requires an investment effort from the government. This layout will allow the study of economies where governments pursue different objective functions: a leviathan government maximizes H_t , and an efficiency-seeker type of government wants to maximize q_t , while a benevolent government pursue private consumption maximization. All cabinets manipulate the instruments τ and θ to pursue their distinct objectives.

2.2. Private Production

There is only one production good, which is also the consumption good. We define the aggregate production function as:

$$Y_t = (K_{pt}^\alpha L_t^{1-\alpha})^\beta (H_t q_t)^{1-\beta} \quad (4)$$

Where K_{pt} stands for private capital and L_t represents labor. The first part of the production function is a Cobb-Douglas production function with capital and labor as complements, each with diminishing returns on Y_t . Both public spending and efficiency matter for production, with the same weight, so that efficiency "qualifies" the amount of spending. There is some literature that supports a private production function with public inputs. We can

¹⁴ Models of productive public investment in the literature tend to disregard public capital accumulation by taking depreciation equal to 1.

say that our production function is a Barro-type (Barro, 1990) production function that has been consistently used in the literature (see for example, Feehan and Matsumoto (2002) or Knoop (1999))¹⁵. The law of motion for private capital is given by:

$$\dot{K}_{pt} = s(1-\tau)Y_t - \delta_p K_{pt} \quad (5)$$

where s is the exogenous, private saving rate out of net income and δ_p stands the depreciation rate of private capital. We assume that s is constant and henceforth we assume, with no loss of generality, that the labor force, L_t , is constant and normalize it to 1:

$$Y_t = (K_{pt}^\alpha)^\beta (H_t q_t)^{1-\beta} \quad (6)$$

Using equation (1) and replacing it in the expression above we get:

$$Y_t = K_{pt}^\alpha ((1-\theta)\tau q_t)^{\frac{1-\beta}{\beta}} \quad (7)$$

Finally, replacing quality from expression 3 we obtain:

$$Y_t = K_{pt}^\alpha ((1-\theta)\tau K_{gt}^\psi)^{\frac{1-\beta}{\beta}} \quad (8)$$

The economy's output depends positively on private and public capital, the government policy parameters θ and τ , as well as technological parameters.

2.3. Growth Rates and the Steady State

We have already defined the law of motion for private capital in (5)

$$\dot{K}_{pt} = s(1-\tau)Y_t - \delta_p K_{pt} \quad (9)$$

We conclude that:

$$\frac{\dot{K}_p}{K_{pt}} = s(1-\tau)K_{pt}^{\alpha-1} ((1-\theta)\tau K_{gt}^\psi)^{\frac{1-\beta}{\beta}} - \delta_p \quad (10)$$

so that the growth rate of private capital depends on its level, on the saving rate net of taxes and on the level of public capital.

We have defined the accumulation of public capital in (2):

$$\dot{K}_{gt} = \theta \tau Y_t - \delta K_{gt} \quad (11)$$

Which, through appropriate transformation, gives us:

¹⁵ In Mitnik and Newman (2003) the authors find evidence that support the nonlinearity of public consumption in the Barro-type production function. They cannot find evidence of such relation in the case of public evidence but they do not reject such hypothesis.

$$\frac{\dot{K}_g}{K_{gt}} = \theta \tau K_{pt}^\alpha \left((1-\theta) \tau \right)^{\frac{1-\beta}{\beta}} K_{gt}^{\frac{\psi(1-\beta)}{\beta}-1} - \delta_g \quad (12)$$

Similar to what we had on (10) we have that the growth rate of public capital depends on its own level and on the level of private capital.

In the steady state we have $\dot{K}_g = \dot{K}_p = 0$. We assume that $\delta_p = \delta_g = \delta$ i.e., the nature of public and private capital is similar as far as depreciation, and we rewrite the dynamic equations for the two types of capital:

$$\begin{cases} s(1-\tau) K_{pt}^{\alpha-1} \left((1-\theta) \tau K_{gt}^\psi \right)^{\frac{1-\beta}{\beta}} = \delta \\ \theta \tau K_{pt}^\alpha \left((1-\theta) \tau \right)^{\frac{1-\beta}{\beta}} K_{gt}^{\frac{\psi(1-\beta)}{\beta}-1} = \delta \end{cases} \quad (13)$$

Which leads to the following steady state ratio of private to public capital:

$$\frac{K_{pt}}{K_{gt}} = \frac{s(1-\tau)}{\theta \tau} \quad (14)$$

In Appendix A we present the phase diagram and investigate the stability of the steady-state, and find that, independently of the starting levels of K_{pt} and K_{gt} we will end up in the steady-state equilibrium.

Some basic conclusions can be drawn from the relation described in (14). First, if the rate of private saving rate increases, this ratio will also increase so that we will end up with relatively more private capital in the steady state. This is intuitive given the positive relation between private capital accumulation and the saving rate.¹⁶ Secondly, if the percentage of public resources that are directed towards the accumulation of public capital, θ , which is analogous to a public saving rate, increases, then the ratio of private to public capital naturally decreases. Thirdly, if the tax rate increases the ratio of private to public capital also decreases, as private capital accumulation is discouraged and more resources are taken from the private sector.¹⁷

¹⁶ From: $s(1-\tau) K_{pt}^{\alpha-1} \left((1-\theta) \tau K_{gt}^\psi \right)^{\frac{1-\beta}{\beta}} = \delta$ (15) and replacing K_{gt} using the relation given by (14), and solving for

K_{pt} we are left with: $K_p^{ss} = \left\{ \frac{\tau^{(1-\beta)(1+\psi)} (1-\theta)^{\psi(1-\beta)} [s(1-\tau)]^{\beta-\psi(1-\beta)} \theta^{(1-\beta)}}{\delta^\beta} \right\}^{1/\beta}$ (16). Some conclusions can be drawn concerning the relation between the model parameters, the policy variables and private capital. The depreciation rate should have a negative impact on the steady state level of private capital so that $\frac{\partial K_p^{ss}}{\partial \delta} \leq 0$. This implies that:

$\frac{\beta}{\beta(1-\alpha)-\psi(1-\beta)} \geq 0$ (17). This ratio will be zero only in the case where $\beta = 0$. This would mean that the private inputs have no relevance to production whatsoever, which is rightly excluded here. This leads to the requirement that:

$\beta(1-\alpha)-\psi(1-\beta) > 0$ (18) or $\alpha + \psi \frac{1-\beta}{\beta} < 1$ (19). In other words, we need diminishing returns on private and

public capital together, this will be important later on. From 19 we can state $\frac{\psi(1-\beta)}{\beta} < 1$ (20) or $\beta > \psi(1-\beta)$ (21). That is, on the margin private capital is "more productive" than public capital.

¹⁷ As the tax rate increases the income available to the private sector decreases which results in a slower rate of private capital accumulation (for a given saving rate). Secondly, if the tax rate increases then a higher share of the economy's resources are taken by the public sector and, for a given θ , more resources are invested as public capital.

2.4. Evidence

The relation between private and public capital in steady-state is an important result that we would like to test for. In Table 2 we present regression results using data from Kamps (2004) and from World Development Indicators 2004. In regression 1 we estimated (14) using a panel of 22 OECD countries.¹⁸ The specification in regression 2 is similar to 1 but uses only Euro countries. Specification 3 uses OLS estimates based on a pooled data set of 536 observations and confirms that the private saving rate has a positive effect on the private to public capital

ratio, the public saving rate has a negative impact on the same ratio, and the tax ratio ($\frac{1-\tau}{\tau}$) has a positive effect, as suggested by (14). Regression 4 uses five year averages¹⁹ and regression 5 does the same but includes a dummy for each country. Results hold and the quantitative estimates are practically unchanged. Regression 6 is, again pooled and it uses the complete sample but with a dummy variable that takes the value of 1 if a country belongs to Europe. As we can easily see all regressions confirm our initial results.

With panel data analysis, the uncontrolled heterogeneity across countries must be accounted for. The effect of country-specific characteristics, like latitude, potentially correlated with our dependent variable, can be explored by estimating both the fixed and the random effects versions of the model. When choosing between fixed effects and random effects estimation, an important issue is whether the country effects are correlated with the explanatory variables. In the absence of such correlation, random effects estimation is consistent and efficient. Otherwise, fixed effects estimation should be adopted. Equation 14 was estimated using fixed effects and random effects. In regression 1 and 2 the random effects model was chosen using Hausman test statistics that confirmed that country-specific characteristics are independent of regressors.

Table 2. Regression results

$\ln\left(\frac{K_{pt}}{K_{gt}}\right)$	1	2	3	4	5	6
$\ln S$	0.0831 (2.27)	0.1530 (3.43)	0.2385 (5.79)	0.2155 (2.22)	0.2143 (2.23)	0.0063 (0.82)
$\ln\left(\frac{1-\tau}{\tau}\right)$	0.0676 (3.15)	0.0778 (2.38)	0.2309 (9.47)	0.248 (4.00)	0.2552 (4.21)	0.1621 (7.31)
$\ln \theta$	0.0052 (0.31)	-0.2341 (-0.91)	-0.1055 (-3.51)	-0.1243 (-1.78)	-0.1304 (-1.85)	-0.0842 (-3.44)
DC					-0.0039 (-0.98)	
DE						0.277 (6.38)
Fsta.			7119.62	1292.91	948.45	36.95
Prob>F			0.000	0.000	0.000	0.000
WaldChi	20.20	33.80				
Prob>Chi2	0.0002	0.000				
No.Obs			536	107	107	536
No.groups	22	11				

Notes: For regression 2,3,4,5 and 7 heteroskedasticity-corrected t-statistics are in parentheses .

¹⁸ We used the maximum number of years available between 1972 and 2000.

¹⁹ 1975-79, 1980-84, 1985-89, 1990-94, 1995-99, and 1999-2004.

3. Government Decisions

In the previous section we have presented the steady-state levels for the main variables in the model. We now turn to the government decision on the size of government and the efficiency of government spending, τ and θ , the policy variables that affect steady-state equilibrium levels. We start with a benevolent government which desires to maximize the steady-state level of consumption, and then consider a leviathan government which maximizes current spending, and last efficiency - seeker government which maximizes the level of quality in steady-state.

3.1. Benevolent Government Maximizing Consumption

In this section we present the policy choices of a government interested in maximizing the steady state level of consumption.²⁰ We can imagine a representative consumer that drives utility from consumption. For the government, maximizing consumption implies maximizing utility and, in a way, welfare. Making use of (8), (14) and finally of (16). After some algebra, the steady state level of per capita output can be shown to be:

$$Y^{ss} = \left\{ \frac{\tau^{(1-\beta)(1+\psi)} \theta^{\psi(1-\beta)} [s(1-\tau)]^{\alpha\beta} (1-\theta)^{(1-\beta)}}{\delta^{\alpha\beta+\psi(1-\beta)}} \right\}^{\frac{1}{\beta(1-\alpha)-\psi(1-\beta)}} \quad (22)$$

And, using the expression for consumption, we obtain:

$$C^{ss} = (1-\tau)(1-s)Y^{ss} \quad (23)$$

where C^{ss} stands for steady state level of consumption. We can replace Y^{ss} in the above equation, making use of (22) to obtain:

$$C^{ss} = (1-s) \left\{ \frac{\tau^{(1-\beta)(1+\psi)} \theta^{\psi(1-\beta)} s^{\alpha\beta} (1-\tau)^{\beta-\psi(1-\beta)} (1-\theta)^{(1-\beta)}}{\delta^{\alpha\beta+\psi(1-\beta)}} \right\}^{\frac{1}{\beta(1-\alpha)-\psi(1-\beta)}} \quad (24)$$

Taking the partial derivative of steady-state consumption, with respect to θ , we obtain:

$$\frac{\partial C^{ss}}{\partial \theta} = 0 \Leftrightarrow \theta = \frac{\psi}{1+\psi} \quad (25)$$

Equation (25) above is like a modified golden-rule, which gives us the government saving rate, θ , that maximizes steady-state consumption.

The tax rate that maximizes the steady state level of consumption is:

$$\frac{\partial C^{ss}}{\partial \tau} = 0 \Leftrightarrow \tau = (1-\beta)(1+\psi) \quad (26)$$

We are now able to draw some conclusions. The percentage of public resources devoted to public capital accumulation, θ , that maximizes the steady state level of consumption is an increasing function of ψ the elasticity of quality with respect to public capital. This makes

²⁰ In Appendix A we consider the objective of maximizing output.

perfect sense: the more sensitive quality is to increases in the amount of public capital, the larger should be the amount of resources allocated to investment in public capital.

As to level of the tax rate, we can confirm that $\tau = 0$ if $\beta = 1$. In other words, if only private capital matters for production, there is no point in taking resources from the private to the public sector. On the other extreme, if $\beta = 0$ then $\tau = 1$, meaning that if the production function was to depend only on the public sector then the government would want to collect as much resources as possible. As β increases from 0 to 1, τ will go from 1 to 0. The higher the weight of private inputs in the production function, the fewer the resources transferred from the private sector if the aim is maximizing the steady-state level of private consumption. The optimal tax rate is a positive function of ψ since, as the elasticity of quality with respect to public capital increases, the steady-state consumption level is maximized at higher tax rates.

Notice that if $0 < \beta < 1$ and if $0 \leq \psi \leq \frac{\beta}{1-\beta}$, then $0 < \tau < 1$.²¹ In this case, the tax rate that maximizes the equilibrium level of consumption depends negatively on the weight of private capital in the production function, β , and positively on the marginal productivity of public capital, ψ . As the weight of private capital in production increases, a benevolent policy maker will be relatively more interested in decreasing the tax rate in order to increase income, and consequently C^{ss} . If, on the other hand, public capital is relatively more productive, accumulating it will have more of a positive effect on available income (and consequently on consumption). A benevolent government, interested in the welfare of private citizens, will thus increase τ .

3.2. Self-Interested Government: The Efficiency-Seeker

We now consider a government that desires to maximize its efficiency, an efficiency-seeker type of government. Making use of relations (3) and (14) we can write the following:

$$q^{ss} = \left[\frac{\theta \tau}{s(1-\tau)} K_p^{ss} \right]^\psi \quad (27)$$

and replacing K_p^{ss} by (16) we get:

$$q^{ss} = \left\{ \frac{\tau^{\psi(1-\beta\alpha)} (1-\theta)^{(1-\beta)\psi} \theta^{\psi\beta(1-\alpha)} [s(1-\tau)]^{\beta\alpha\psi}}{\delta^{\beta\psi}} \right\}^{\frac{1}{\beta(1-\alpha)-\psi(1-\beta)}} \quad (28)$$

We can obtain the maxima for the level of government quality by taking the derivative with respect to θ and τ :

$$\frac{\partial q^{ss}}{\partial \theta} = 0 \Leftrightarrow \theta = \frac{\beta(1-\alpha)}{1-\beta\alpha} \quad (29)$$

$$\frac{\partial q^{ss}}{\partial \tau} = 0 \Leftrightarrow \tau = 1 - \beta\alpha \quad (30)$$

²¹ If $\beta = 0$ or $\psi > \frac{\beta}{1-\beta}$ we would have $\tau > 1$ and a negative level of consumption, which we rule out.

The only parameter of the model that influence the choice of the public saving rate and the tax rate in order to maximize efficiency are the weights private and public inputs in the production function.

A higher β means less weight of the public inputs and implies that the public saving rate has to increase in order to achieve higher efficiency.

On the other hand, a higher α implies more weight of private capital in production meaning that governments will be more efficient if it deviates less resources from the public sector.

Replacing (29) and (30) into (28) we obtain:

$$q^{ss} = \left\{ \frac{\tau^{\psi(1-\beta\alpha)} \left[1 - \frac{\beta(1-\alpha)}{1-\beta\alpha} \right]^{(1-\beta)\psi} \left[\frac{\beta(1-\alpha)}{1-\beta\alpha} \right]^{\psi\beta(1-\alpha)} (s\beta\alpha)^{\beta\alpha\psi}}{\delta^{\beta\psi}} \right\}^{\frac{1}{\beta(1-\alpha)-\psi(1-\beta)}} \quad (31)$$

3.3. Self-Interested Government: The Leviathan

In this section we are interested in the policy choices of a leviathan government which aims at maximizing the size of the public sector. Using the relation between income and the amount of public good provided, we have:

$$H^{ss} = (1-\theta)\tau Y^{ss} \Leftrightarrow \quad (32)$$

$$H^{ss} = \left\{ \frac{\tau^{\beta(1-\alpha)+1-\beta} \theta^{\psi(1-\beta)} [s(1-\tau)]^{\alpha\beta} (1-\theta)^{\beta(1-\alpha)+(1-\beta)(1-\psi)}}{\delta^{\alpha\beta+\psi(1-\beta)}} \right\}^{\frac{1}{\beta(1-\alpha)-\psi(1-\beta)}} \quad (33)$$

Taking the partial derivative of public consumption with respect to θ :

$$\frac{\partial H^{ss}}{\partial \theta} = 0 \Leftrightarrow \theta = \frac{(1-\beta)\psi}{1-\beta\alpha} \quad (34)$$

The θ that maximizes the quantity of public good in the steady state depends positively on the marginal productivity of public capital in generating government efficiency, ψ . On the other hand this maximum is a positive function of the weight of the public sector on private production, $(1-\beta)$.

Looking at the tax rate we now have:

$$\frac{\partial H^{ss}}{\partial \tau} = 0 \Leftrightarrow \tau = 1 - \beta\alpha \quad (35)$$

We can observe that, if $\beta = 0$ we will have $\tau = 1$. In other words, if private inputs do not contribute to production then the government will be interested in taking all the resources from the private sector in order to maximize the amount of public goods. If $\beta = 1$, $\tau = 1 - \alpha$, that is, even if public inputs are of no interest to production, the policy maker will still be interested in collecting taxes at a positive rate since its objective is to maximize public consumption.

Comparing the two types of self-interested governments we can verify that the efficiency-seeker government will choose a larger θ if $\frac{\beta(1-\alpha)}{1-\beta\alpha} > \frac{(1-\beta)\psi}{1-\beta\alpha}$ that is $\beta(1-\alpha+\psi) > \psi$.

6. Conclusions

We model the trade-off between the size of government and its efficiency in a growth model where the effect of a productive public service on output is augmented by an efficiency factor. Efficiency depends on past accumulation of public capital. Per capita output depends on private capital, the amount of public spending, and private capital, the latter because it is the determinant of efficiency. We assume diminishing returns on both types of capital. The government decides both the amount of public spending and its efficiency level. We find a steady-state in terms of private and public capital for which we provide empirical evidence. The economy converges to this stable steady state independently of the starting values of both types of capital.

Income per capita has an inverted U - curve relationship with the tax rate, consistent with Barro (1990). The levels of the tax rate and of the public saving rate that maximize each of the variables of interest in the model depend on the parameters of the model. The level of the tax rate that maximizes the steady-state level of consumption is a negative function of β and a positive function of ψ , where α is the elasticity of production with respect to private capital, β the share of private inputs in production, and ψ a measure of the impact of public capital in government efficiency. In terms of policy decisions it is fundamental that decision makers now the parameters and elasticities of the several variables they have to decide upon. Only then they can truly choose the tax rate and the saving rate that allows them to maximize their objectives.

Consumption also has an inverted U-curve relationship with, public saving rate, so that there is also an optimal mix of government spending on current and capital expenses. When analyzing a self-interested government (whether it is an efficiency-seeker or a leviathan) we also find values for τ and θ that maximize public consumption or public efficiency. In table 3 we synthesize the different choices of τ and θ .

Table 3. Choices of τ and θ for different types of government

	θ	τ
Benevolent Government	$\frac{\psi}{1+\psi}$	$(1-\beta)(1+\psi)$
Efficiency-Seeker	$\frac{\beta(1-\alpha)}{1-\beta\alpha}$	$1-\beta\alpha$
Leviathan	$\frac{(1-\beta)\psi}{1-\beta\alpha}$	$1-\beta\alpha$

In terms of policy implications we can conclude that a government that is primarily concerned in maximizing consumers welfare should take it's one efficiency when choosing public saving rate. The choice of the tax rate should be guided by public sector efficiency and the weight of private inputs in production.

A government focused on its own efficiency should consider the weight of private inputs and of private capital in production before deciding on the public saving rate or the tax rate.

Last a government concerned with dimension, has to take into account the weight of the private sector in the economy, but also its own efficiency when choosing the public saving rate.

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Appendix A. The Equilibrium Path

Having analyzed the steady state levels for the several variables in the model, and the government decisions to maximize the different variables, we are now interested in analyzing the stability of the equilibrium. To do that we will discuss the phase diagram of the two state variables in the model: private capital and public capital (presented in Figure 1). Recall equations (10) (12) and assuming that capital depreciates at the same rate, irrespective of its private or public nature, we can write:

$$\dot{K}_{pt} = s(1-\tau)K_p^\alpha \left(\theta \tau K_g^\psi \right)^{\frac{1-\beta}{\beta}} - \delta_p K_{pt} \quad (36)$$

$$\dot{K}_{gt} = (1-\theta)\tau K_p^\alpha \left(\theta \tau \right)^{\frac{1-\beta}{\beta}} K_g^{\frac{\psi(1-\beta)}{\beta}} - \delta K_{gt} \quad (37)$$

Setting both expressions to zero and assuming that expression (19) holds, we can draw Figure A1.

Figure A1. Phase diagram

The concave line represents $\dot{K}_g = 0$ and the other line represents $\dot{K}_p = 0$. The interception point gives us the steady state ratio described in (14).

If we increase K_p from the $\dot{K}_p = 0$ line -moving to a point below the curve -this will lead to $\dot{K}_g > 0$ so that, below $\dot{K}_g = 0$, K_g tends to increase. On the other hand if we increase K_g from the $\dot{K}_p = 0$, going to a point above this curve, we are left with $\dot{K}_p > 0$ so that, above $\dot{K}_p = 0$, K_p will tend to increase. There are four distinct regions in Figure A1:

- Above both lines - Region A
- Between both lines and below $\dot{K}_g = 0$ - Region B
- Below both lines - Region C

- Between both lines but above $\dot{K}_g = 0$ - Region D

Let us now see what can happen if we are located in each of these four regions. If we are in Region A, we have K_p growing and K_g diminishing. One of three things might happen: we could reach immediately the equilibrium, we can first reach the line $\dot{K}_g = 0$ or we can first reach the line $\dot{K}_p = 0$.

In the first scenario the problem would be automatically solved. In the second one we would be in a situation where K_g does not grow and K_p is still growing we would then go to a point inside Region B. In the third scenario K_p does not grow but K_g is decreasing, we would fall inside Region D.

If we start at a point in Region B we can also reach one of the two lines. If we reach the line $\dot{K}_g = 0$ we would be in a situation where K_g does not grow but K_p grows. We would be driven towards the interior of region B again but this time closer to the equilibrium. On the other hand we can fall into the line $\dot{K}_p = 0$ first. In this case because K_p is not growing but K_g is, we would fall back into Region B but once again closer to the equilibrium. This situation would repeat itself until we reach the interception point.

If we start at a point located at Region D and reach the line $\dot{K}_g = 0$ we will fall back inside Region D because K_g will not grow and K_p will decrease.

If we reach $\dot{K}_p = 0$ then, because K_g is decreasing and K_p is not growing, we will go back to Region D. In both cases we are again inside Region D but we are one step closer to the equilibrium and sooner or later we will reach it.

The last hypothesis is to be start from a point in Region C. Once again we can reach each of the lines. If we reach $\dot{K}_g = 0$ and because K_p is now decreasing we will get inside Region D leading us to the equilibrium. If we reach $\dot{K}_p = 0$ we know that K_p is not growing but K_g is. This will lead us to a point inside Region B. Once inside Region B we will eventually reach the equilibrium point.