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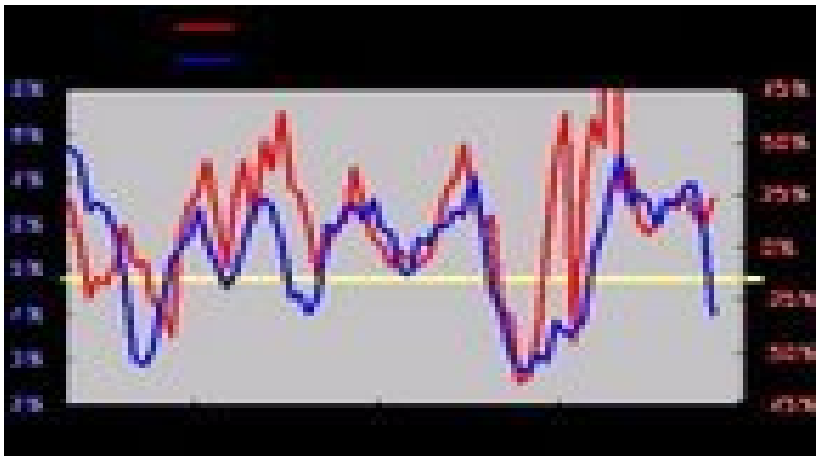
Department of Economics

MSc in Politics & Economic Science

Thesis

"Government expenditure & growth rate"



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Abstract

The recent literature on endogenous growth models has emphasized the role of government expenditure as an important determinant of long-run national growth rates and growth rate differentials. Beginning with Barro (1990), a number of authors have introduced government expenditure as an argument in the production function, to reflect its impact on the productive capacity of the economy.

Using annual data of public, private investment (as a share of GDP), as well as the growth maximizing tax rate for 58 countries (41 non oecd and 17 oecd), we proceed an empirical investigation of the theoretical implication of the model about the long run relationship between economic growth and government expenditure for an 11-years period. This leads to a number of important propositions relating the growth rate to the size of government and to characterization of optimal expenditure policy.

Keywords: public capital, economic growth, convergence

1. Introduction

A fundamental model of economic growth developed by Robert Solow (1956) suggests that while some economies may be wealthier than others, in the long run they should all grow at the same rate. More recent work has suggested that not only do economies actually have substantially different growth rates over lengthy time periods (Quah 1996; Gwartney and Lawson 1997), there are also good theoretical reasons for believing that countries can maintain the different rates (Lucas 1988; Romer 1990).

In the mid-1980s, a group of growth theorists led by Paul Romer (1986) became increasingly dissatisfied with exogenously driven explanations of long-run productivity growth. This dissatisfaction motivated the construction of a class of growth models in which the key determinants of growth were endogenous to the model. The determination of long-run growth within the model, rather by some exogenous growing variables like unexplained technological progress, is the reason for the name endogenous growth.

Public capital and especially infrastructure, is central to the activities of households and firms. According to the World Bank (1994), public capital represents the 'wheels' of economic activity. Input-output tables show that telecommunications, electricity, and water are used in the production process of nearly every sector, while transport is an input for every commodity. However, the World Bank (1994, p.19) also concludes that "*infrastructure investment is not sufficient on its own to generate sustained increases in economic growth"*.

Recent studies suggest that public capital may, under specific circumstances, raise income per capita. The possibility of a long-run impact of infrastructure on income depends on whether the data are generated by a neoclassical exogenous growth model or an endogenous growth model.

In the exogenous growth model, in which technical progress drives long-run growth, shocks to the infrastructure stock can only have transitory effects. In an endogenous growth model, shocks to infrastructure can raise the steady-state income per capita.

Apart from the growth model selected, the existing capital stock matters for the marginal productivity of public capital. This is clear from a network perspective: a network may yield a one-time increase in productivity rather than a continuing path to prosperity (Fernald, 1999). Furthermore, according to the law of diminishing returns, an

increment to the public capital stock would have small output effect if the capital stock in the previous period was large and vice versa. There is evidence that countries with a small public capital stock have the highest marginal productivity of public capital (Demetriades and Mamuneas, 2000).

Over the past decade a substantial volume of empirical and theoretical literatures study the effects of fiscal policy on economic growth, motivated by the theoretical and empirical work of Barro (1990) and Aschauer (1989), respectively. One revelation is that government expenditure in the areas of infrastructure and human capital development plays an important role in promoting long run growth. We are told that the relationship between the tax rate used to finance the public capital and long run growth is non-linear, which forms an inversed U-shape, while the growth maximizing tax becomes equal to the share of public investment on the total production.

Barro (1991) provided evidence on the relation between government spending and economic growth in a sample of 98 countries over the period 1960 to 1985[1]. Government consumption, G^c, was measured by government consumption purchases as reported in the standard national accounts, less the amounts spent on national defense and education. The assumption was that G^c proxied for public services that enter into household utility functions. The data indicated a significant negative relation between G^c/Y and the growth rate of per capita real GDP.

Public investment, G^i, was taken as a proxy for the government activities that enter into production functions. The empirical results indicated little relation between G^i/Y and economic growth. One interpretation of this finding is that public investment is not very important for economic growth. An alternative explanation is that governments are optimizing and are therefore going to the point where the marginal effect of public investment rate is close to zero.

Canning and Pedroni (1999) develop a model in which public investment spending lowers investment in other types of capital because they all need to be financed out of savings[2]. In the endogenous growth model with constant returns to aggregate capital of

[1] Barro, J., R., Xavier S.,I.,M., *"Public Finance in Models of Economic Growth",* Review of Economic Studies (1992), vol.59, p.651, The Review of Economic Studies Limited, 1992

[2] Ward R., Jacob H., *"Public Capital and Economic Growth: A Critical Survey",* Perspektiven der Wirtschaftspolitik, vol 8 (Special Issue), p.29, 2007

Canning and Pedroni, positive shocks to infrastructure stocks raise long-run income per capita when the economy is below efficient infrastructure level[3].

The effect of public investment on growth is likely to depend on how the increased spending is financed. Increases in taxes are widely considered to reduce the rate of economic growth. An increase in the public capital stimulates economic growth only if the productivity impact of public capital exceeds the adverse impact of higher taxes. If cutting other government spending finances an increase in capital spending, there is still no guarantee that growth will be enhanced. Hulten (1996) argues, for instance, that new infrastructure construction may have a perverse effect if it draws scarce government resources away from maintenance and operation of the existing capital stock.

In this approach, there is a certain level of public capital that maximizes economic growth, and if there is too much infrastructure, it diverts investment away form other productive uses to the point where income growth falls. In this setting, the effect of an increase in public investment on economic growth depends on the relative marginal productivity of private versus public capital. In other words, we need to know not only whether public capital is productive but also whether it is productive enough to boost economic growth. An interesting finding of this study is that the assumption of parameter homogeneity can clearly be rejected. Thus, there is much heterogeneity among countries with regard to the optimal level of capital.

Although not all studies find a growth-enhancing effect of public capital, there is more consensus in the recent literature than in the older that public capital stimulates growth, but there is also evidence for reverse causality. The impact found is usually substantially less than found by Aschauer(1989). Aschauer was the first to hypothesize that the decrease in productive government services in the US may be crucial in explaining the general decline in productivity growth in that country. Based on his results, a 1 per cent increase in the public capital stock might raise total factor productivity by 0.4 per cent. The implications of these results for policymakers seem to be clear: public investment should go up to give a boost to the economy.

[3] Ward R., Jacob H., *"Public Capital and Economic Growth: A Critical Survey",* Perspektiven der Wirtschaftspolitik, vol 8 (Special Issue), p.9, 2007

Aschauer (1989, 1990) proved that there is strong relation between productivity and public capital in United States. The impact estimated from the elasticity of the product to the public capital. Researches have shown that the elasticity is statistically important. Aschauer's evidence was three-fold. In his first paper on this topic (1989a) he presented time-series evidence linking productivity growth between 1949 and 1985 and different types of public capital. He found that a measure of "core infrastructure" which included highways, mass transit, airports, electrical and gas facilities, water, and sewers had a highly significant effect on both labour and multifactor productivity. The decline in US infrastructure investment after 1970 had led, according to Aschauer' s calculations, to a decline in TFP growth of 0.8 percent a year – a very large effect.

Aschauer's second and third papers (1989b, 1989c) complemented this evidence with cross-sectional evidence from US states and with panel data from 7 OECD economies. The results of these studies were consistent with the time-series US evidence: infrastructure spending was found to have a significant positive effect on productivity.

On other issue now, recent empirical findings (see Durlauf and Johnson, 1995; Liu and Stengos, 1990; Pack and Page, 1994; Quah, 1996) on convergence. demonstrate that the relationship between per capita growth and initial income is clearly non linear. Liu and Stengos found that the presence of nonlinearities were mainly due to groupings of countries according to their level of initial income.

The curvature of the graphs implies that, on average, middle income countries experience the highest growth rates. As will be argued shortly, this nonlinear relationship can be modeled as a fourth degree polynomial in initial income.

Furthermore as has been pointed out by Durlauf and Quah (1999), the dominant focus in these studies is on certain aspects of estimated conditional means, such as the sign or significance of the coefficient of initial incomes, how it might change if other conditioning variables are included, or with their functional forms for the production function or regressions.

In regard with the implications of growth rate and other variables we have seen that the only finding that Levine and Renelt (1992) support that stands always is the positive relation between growth rate and the percentage of investments to GDP. This shows the predominant role of investments in the growth rate of a country. Also they support that

outcomes change importantly every time the explanatory variables change in the equation. So the outcomes in the literature must not be absolute.

On empirical research using panel data, as government outlays in the United States have grown from 28.4 percent of GDP in 1960 to 34.6 percent in 1996 investment as a share of GDP, labour productivity, and real GDP growth have fallen. Data for 23 OECD countries also revealed that higher government expenditures were correlated with both less investment and lower rates of growth during the 1960-96 period. An analysis of data for a larger set of 60 nations illustrates the same thing.

Also, one can cite (among others) the papers by Devarajan *et al*. (1996) – henceforth DSZ – and Gupta et al. (2005) on the composition of government expenditure and growth for a sample of developing countries. DSZ found a negative (positive) and significant relationship between the capital (current) component of public expenditure and per capita real GDP growth for 43 countries over the period 1970-1990, while Gupta et al. (2005) found quite the reverse for 39 countries between 1990 and 2000. Also Evans and Karras (1994) show a negative effect.

In addition, some empirical literature which find a positive effect of public capital on economic growth is Alfranca and Galindo 2003; Aschauer 1989; Cashin 1995; Galindo and Escot 1998; Munnell 1990; Otto and Voss 1992.

Which conclusion is true? Maybe it depends on the initial level of taxes and how they are spent by the government (on productive or non-productive sectors). Due to heterogeneity we can see different effects of government expenditure. Our results confirm the negative effect of government expenditure. Otherwise (by the other opinion), if government augments the public expenditure continuously, we will never stop having increasing growth.

1.1 Stock of public capital

In calculating the stock of capital on the basis of investment flow data, researchers typically use the sum of past-investments, adjusted for depreciation. In applying the so-called perpetual inventory method, the researcher has to make certain assumptions about assets' lifespan and depreciation. Furthermore, one needs an initial level for the capital stock. Usually, the initial stock is calculated by assuming that the real investments were constant at the level of the first observed investment level and that the capital stock was at its steady state, at the start of the observed time series. To calculate the public capital stock one needs long term time series on public investment. Long term national account time series data on government investment spending are available for most OECD countries.

However, for many developing countries the availability of long term data is more of a problem, so that that the public capital stock cannot constructed for these countries. Therefore various studies use government investment or some physical measure of infrastructure (like number of kilometers of paved roads, kilowatts of electricity generating capacity and the number of telephones) instead of the government capital stock.

Also, prices for infrastructure capital vary widely across countries. Furthermore, the level of expenditure may say little about the efficiency in implementing the investment project.

The stock of public capital (G_t) may enter the production function in two ways. First, it may enter the production function directly, as a third output. Second, it may influence multifactor productivity (A):

$Q_t = A(G_t)f(K_t,L_t,G_t)$,

Where Q_t is real aggregate output of the private sector, L_t the labour force (aggregate hours worked by) and K_t is the aggregate non-residential stock private fixed capital.

Public investment is financed through general tax revenues or government debt, per units costs of public capital are not market determined. Moreover there is no guarantee that the total cost of infrastructure to the firm related to the amount it uses. Aaron (1990) argues that this absence of a market test, coupled with possible government pricing inefficiencies, makes it impossible to assume that public capital as a factor input would

be remunerated in line with its marginal product. An alternative would be to incorporate public capital into the production function as part of the technological constraint that determines total factor productivity. Rather than acting as a discretionary factor input, public investment increases total productivity by lowering production costs. By increasing the technological index, additional public capital shifts the production function upward, and thus enhances the marginal products of the factor inputs.

However, as pointed by Sturm et al. (1998), in a Cobb-Douglas function (estimated in log levels) it does not make any difference whether public capital is treated as a third production factor or as influencing output through the factor representing technology.

A better way to model the growth effect of public capital is by focusing explicitly on the services provided by the assets. For instance, Fernald (1999) assumes that for each industry i, production depends, apart from L_i and K_i, on transport services (T_i) produced within that particular sector. These services, in turn, depend upon the flow of services provided by the aggregated stock of government capital (roads) G and the stock of vehicles in the sector V_i. Also, the amount of services provided is also determined by the efficiency with which they are provided from the stock of public capital. Indeed, there is substantial room for improving the efficiency in many countries. Output also depends on the Hicks-neutral level of technology U_i and this yields: $Q_i = U_i F^i(K_i, L_i, T_i(V_i, G))$.

1.2 Cross-Section studies

Since the mid-1980s, the study of economic growth and its policy implications vigorously re-entered the research agenda. Various studies tried to explain, theoretically and empirically, why differences in income over time and across countries did not disappear as the neoclassical models of growth predicted.

The idea that emerged from this literature is that economic growth is endogenous. That is, economic growth is influenced by decisions of economic agents, and is not merely the outcome of an exogenous process. Endogenous growth theory assigns a central role to capital formation, where capital is not just confined to physical capital, but includes human capital, infrastructure and knowledge capital.

Unfortunately, most empirical economic growth studies do not distinguish between public and private investment, instead relying on an aggregate measure of total

investment which is inappropriate because the services from public investment projects are likely to differ from those of private investment projects for a number of reasons.

There are three important general problems in the cross-country growth regressions: one is model uncertainty, other is outliers and parameter heterogeneity (Temple, 2000, and Sturm and de Haan, 2005) and last multicollinearity.

The main issue here is that several models may all seem reasonable given data, but yield different conclusions about parameters of interest. Unfortunately, economic growth does not provide enough guidance to properly specify the empirical model. For instance, Sala-i-Martin (1997) identifies around 60 variables supposedly correlated with economic growth. The so-called extreme bound analysis (EBA) of Leamer (1983) and Levine and Renelt (1992) is therefore often used to examine how 'robust' the economic growth effect of as certain variable is.

The second problem is the role of outliers and parameter heterogeneity. Although economists engaged in estimating cross-country growth models often test the residuals of their regressions for heteroskedasticity and structural change, they hardly ever test for unusual observations. In particular, less developed countries tend to have a lot of measurement error in national accounts and other data. This may have affected the conclusions of cross-country growth models.

The last is that the link between most other fiscal variables and growth is statistically fragile. The statistical significance of these variables in a cross-section regression context depends heavily on what other control variables are included in the regression. The fragility is partly a result of multicollinearity. Fiscal variables tend to be highly correlated with the level of income in the beginning of the period and are highly correlated among themselves.

1.3 The relationship between Public and Private Capital

Public infrastructure investment and capital can affect private investment through various channels, which may be classified into two broad sets of effects: complementarity and crowding-out effects, and output and relative price effects.

According to the complementarity effect, public capital (as opposed to public investment) may stimulate private capital formation because it raises the marginal

productivity of private physical capital. Alternatively, a complementarity effect between public capital and private investment may operate through adjustment costs.

The availability and quality of public capital affects some of the costs that firms may incur when investing. For instance, a better road network may reduce expenses associated with the construction of a new factory or transportation costs. By lowering production costs and raising the expected rate of return, public capital may have strong impact on private capital formation.

However, public investment may also displace or crowd out private investment. Such crowding-out effects may occur if public investments are financed through an increase in distortionary taxes, which may reduce the expected net rate of return to private capital, or through borrowing on domestic financial markets, which may lead to higher domestic interest rates or a greater incidence of rationing of credit to the private sector.[4]

Public investment and capital may also affect private capital formation indirectly, through changes in output and relative prices. Public capital may increase the marginal productivity of capital and labour, and the implied scale effect of this on output may lead, to higher private investment. Also may affect through its effect on the price of domestic consumption goods relative to the price of imported goods, and that is the real exchange rate.

An increase in public investment will raise aggregate demand and domestic prices and if the nominal exchange rate does not depreciate fully to offset the increase on domestic prices, the domestic-currency price of imported consumption goods will fall in relative terms, stimulating demand for these goods and dampening domestic activity.

The net effect on output may be positive or negative, depending on the intertemporal elasticity of substitution between domestic and imported goods. The increase in government investment may also raise the price of domestic capital goods, so that the domestic-currency price of imported capital goods will fall in relative terms. This relative price effect may be particularly important in developing countries where a large fraction of capital goods used by the private sector are imported.

[4] Ward R., Jacob H., *"Public Capital and Economic Growth: A Critical Survey",* Perspektiven der Wirtschaftspolitik, vol 8 (Special Issue), p.26, 2007

The impact of public investment on private may not be linear, but depend on the level of public investment. Some studies report support this. For instance Apergis (2000), using cointegration techniques finds that the relationship between public and private investment in Greece is positive during the period 1948-80 but negative during the period 1981-86 during which the share of public investment in total investment increased sharply.

1.4 Government size and economic growth

The real per capita growth rate is related with two kinds of variables. First, initial levels of state variables, such as the stock of physical capital and the stock of human capital in the forms of educational attainment and health, and second, control or environmental variables, such as the ratio of government consumption to GDP, the ratio of domestic investment to GDP, the black-market premium on foreign exchange (intended as a proxy for market distortions), movements in the terms of trade, the fertility rate, measures of political instability and the rule of law, the amounts of political freedom and civil liberties, tariff rates and so on.

A study of the impact of government size on economic performance and growth is important. Theoretically, one point of view suggests that a larger government size is likely to be detrimental to efficiency and economic growth because government operations are often conducted inefficiently or the regulatory proves imposes excessive burdens and costs on the economic system or many of government's fiscal and monetary policies tend to distort economic incentives and lower productivity of the system[5].

A National Tax Journal article explained: "The appropriate size and role of government depend on how costly it is to transfer funds from taxpayers to the government. That cost includes more than the administrative cost of the government and the time spent by taxpayers to keep records and complete forms. It also includes the loss of real income that occurs because taxes distort economic incentives. Recent econometric work implies that the deadweight burden caused by tax increases may exceed one dollar for every dollar of additional tax revenue that is raised. Such estimates imply that the true

[5] Ram, R., *"Government Size and Economic Growth: A New Framework and Some Evidence form Cross-Section and Time-Series Data",* American Economic Review, vol..76 (1), p.191, 1986

economic cost of each extra dollar of government spending is more than two dollars. That is, individuals lose the equivalent of more than two dollars of additional consumption for every extra dollar of government spending."

At the other extreme, one can identify some points of view that assign to the government a critical role in the process of economic development, and could argue that a larger government size is likely to be a more powerful engine of economic development. There are several arguments on which the latter point of view is based. These include, beside others, role of the government in harmonizing conflicts between private and social interests, prevention of exploitation of the country by foreigners and securing an increase in productive investment and providing a socially optimal direction for growth and development.

It is difficult not to take into account that government size has sometimes a positive effect on economic performance and growth. Even more interesting seems to be nearly equally pervasive indication of a positive externality effect of government size on the rest of the economy. It is possible to infer from the cross-section evidence that relative factor productivity was higher in government sector than in the rest of the economy during the 1960's. The positive externality effect of government may have increased over the 1970's, relative factor productivity in the government sector could have declined during that period, and the positive effect of government size on growth could well be stronger in lower-income contexts.

Typically, compared with more developed economies, domestic prices of government services are considerably lower, and of investment goods higher, in less developed countries (LDCs). Also the positive effect of government on growth is stronger in poorer LDCs.

1.5 Why Do Government Expenditures Affect Economic Growth?

Economic growth, the increase in the quality and quantity of goods and services, is the result of hundreds of thousands of entrepreneurs hiring more workers, introducing technological innovations, and improving worker productivity. Entrepreneurs expand businesses and hire more workers when they think that they can make profits. Likewise, they introduce technological advances or invest in new machines when they perceive that

they will receive a return on the expenses paid for machines and research and development.

Government provision of both a legal and physical infrastructure for the operation of a market economy and a limited set of public goods can provide a framework conducive for economic growth. However, as governments move beyond these core functions, they will adversely affect economic growth because of the disincentive effects of higher taxes, diminishing returns as governments undertake activities for which they are ill-suited, and an interference with the wealth creation process, because governments are not as good as markets at adjusting to changing circumstances and finding innovative new ways of increasing the value of resources. So Government spending increases interest rates which decrease private investment. Government spending creates uncertainty that reduces the return of long-term investments.

First, the higher taxes and/or additional borrowing required to finance government expenditures exert a negative effect on the economy. As government takes more and more of the earnings of workers, their incentive to invest, to take risks, and to undertake productivity-enhancing activities, decreases. Like taxes, borrowing will crowd out private investment and it will also lead to higher future taxes. Thus, even if the productivity of government expenditures did not decline, the disincentive effects of taxation and borrowing, as resources are shifted from the private sector to the public sector, would exert a negative impact on economic growth.

Second, as government grows relative to the market sector, diminishing returns will be confronted. Suppose that a government initially concentrates on those functions for which it is best suited (for example, activities such as protection of property rights, provision of an unbiased legal system, development of a stable monetary framework, and provision of national defence). By performing these core functions well, the government provides the framework for the efficient operation of markets and thereby enhances economic growth. As it expands into other areas, such as the provision of infrastructure and education, the government might still improve performance and promote growth, even though the private sector has demonstrated its ability to effectively provide these things. If the expansion in government continues, however, expenditures are increasingly channelled into less and less productive activities. Eventually, as the government

becomes larger and undertakes more activities for which it is ill suited, negative returns set in and economic growth is retarded. This is likely to result when governments become involved in the provision of private goods, goods for which the consumption benefits accrue to the individual consumers. Goods like food, housing, medical service, and child care fall into this category. There is no reason to expect that governments will either allocate or provide such goods more efficiently than the market sector.

Finally, the political process is much less dynamic than the market process. While competition rewards alertness, it also imposes swift and sure punishment on those who make bad decisions and thereby reduce the value of resources. Adjustment to change is much slower in the public sector. By way of comparison with markets, the required time for the weeding out of errors (for example, bad investments) and adjustments to changing circumstances, new information, and improved technologies is lengthier for governments. This is a major shortcoming as it relates to economic growth. To a large degree, growth is a discovery process. As entrepreneurs discover new and improved technologies, better methods of production, and opportunities that were previously overlooked, they are able to combine resources into goods and services that are more highly valued (Kirzner 1973, 1997, Schumpeter 1912).

2. Theoretical Framework

2.1 Ramsey Model

One shortcoming of the model Solow-Swan is that the saving rate is exogenous and constant. In Ramsey model the path of consumption and, hence, the saving rate is determined by optimizing households and firms that interact on competitive markets. The saving rate is not constant in general, but is instead a function of the per capita capital stock, k.

We deal, in particular, with infinitely lived households that choose consumption and saving to maximize their dynastic utility, subject to an intertemporal budget constraint.

The simple model of Ramsey describes a closed economy with households and enterprises. Household's optimal behavior determines the supply of production factors

and the total demand of production, though the enterprise's behavior, determines the total supply of products with the intention of maximization of profits[6].

A percentage of income t_t retains in the state with the aim to dispose late on with the form of public expenditure g_t. Lets suppose that public expenditure is equal to rates (taxes) ($g_t = t_1$), that is that the government does not have budget deficit or surplus.

Decentralized economy:

The income constraint for households is:

$$\dot{b} = w_t + (r_n - n)b_t - c_t - \tau_t \qquad (1.1)$$

Let it be that the present value of current and future assets of household is asymptotically non negative. So the households can not borrow so such at the end of their life to have debts or equally that the households' debt do not increase asymptotically with a faster rate than interest. In mathematic orders that is:

$$\lim_{t\to\infty}(b_t e^{-\int_0^t (R_S - n)ds}) \geq 0 \quad (1.2)$$

The aim of each household is to maximize utility. If we suppose that economy consists of only one household with L_t members then the utility function is:

$$U=\int_0^\infty u(c_t)L_t e^{-\rho t}dt = \int_0^\infty u(c_t)e^{nt}e^{-\rho t}dt \quad (1.3)$$

where ρ is the rate of time preference (ρ>0). The greater it is the smaller value in terms of utility has the future consumption in relation with current consumption. Also if we normalize the number of adults at time 0 to unity, then the family size at time t is $L(t)= e^{nt}$.

Using the condition (1.2), the income constraint is shaped diachronically:

$$\int_0^\infty c_t e^{-\int_0^t (R_S - n)ds} dt = b(0) + \int_0^\infty w_t e^{-\int_0^t (R_S - n)ds} dt - \int_0^\infty \tau_t e^{-\int_0^t (R_S - n)ds} dt \quad (1.4)$$

In accordance to (1.4), the present value of total consumption of households is equal with the initial wealth and the present value of total labour's incomes less the present

[6] Καλαϊτζιδάκης Π., Καλυβίτης Σ., *Οικονομική Μεγέθυνση, Θεωρία και Πολιτική,*σελ.197, εκ. Κριτική, Αθήνα 2002

value of total taxation. On the score of balancing budget, also equals with the present value of total public expenditure.

In the equilibrium, as long as, per capita household's assets are equal to the ratio capital-labour ($b_t = k_t$), the equation of accumulation of capital modified as such:

$$\dot{k} = f(k) - (n + \delta)k - c - \tau \qquad (1.5)$$

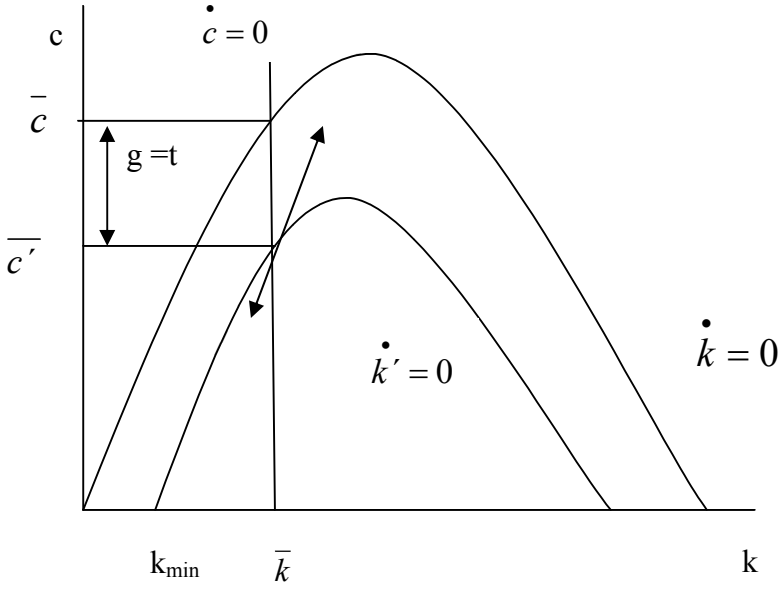

Figure 1: Equilibrium graph of
Neoclassic growth model

The line $\dot{k}=0$ moves parallel downwards at $\dot{k}'=0$, and the movement is equal to the amount of public expenditure g=τ. The economy is driven in a new equilibrium point with lower consumption $\bar{c}' < \bar{c}$ with $\bar{c}' - \bar{c} = g = \tau$, though the increase of public expenditure equals to the increase of income rate. The existence of government guides in full crowding-out of private sector with equivalent reduction of private consumption, leaving the capital and equilibrium income unaffected.

2.1.1 The AK Model

The key property of endogenous-growth models is the absence of diminishing returns to capital. The global absence of diminishing returns to capital may be unrealistic, but the

idea becomes more plausible if we construe capital, K, broadly to encompass human capital, knowledge, public infrastructure and so on.

Also the Inada conditions are violated, f´(k) =A as k goes to zero or infinity. The simplest version of a production function without diminishing returns is the AK function: Y=AK, where A is a positive constant that reflects the level of the technology. Output per capita is y=Ak, and the average and marginal products of capital are constant at the level A>0

In the AK model anything that changes the level of the baseline technology, A, affects the long run per capita growth rate. Government activities can be viewed as effects on the coefficient A and hence on the growth rate. Some activities are the provision of infrastructure services, the protection of property rights, and the taxation of economic activity

2.2 Public Expenditure in the production function (Barro Model)

The governmental activities turn out to have effects on long run growth rates because we are considering models that generate endogenous growth. If we include the effects of government in the Solow-Swan model or the Ramsey model, they will change the steady-state level of per capita output and would also affect per capita growth rates during the transition to the steady state. Also we will see that the long-run growth rate depends on the level of the technology and the willingness to save. Endogenous growth may arise if the returns to capital do not fall on the long run below some positive, baseline value.

We will see how fiscal policy affects the economic growth. Supposing the government produce pure public goods, non rival-non excludable goods (hence, each firm makes use of all G, and one firm's use of public good does not diminish the quantity available to others). The government expenditure affects the private firms' production function. The representative firm i, produce the product Y_i, as such:

$Y_i = F(K_i, L_i, G)$

K_i is the private capital and L_i the labour of the firm i, and G is public expenditure for all public goods. Suppose that there is no labour change and the production function has Cobb-Douglas form: $Y_i = A K_i^{\alpha} L_i^{1-\alpha} G^{1-\alpha}$ (2.0)

where 0<a<1, α is the portion of private capital and (1-a) the portion of labour, A is a certain technological parameter, A>0,. We can see that the private capital and labour have together constant scale effects. Private capital has decreasing scale effects α<1, but in combination with public expenditure G has constant scale effects.

For fixed G, the economy faces diminishing returns to the accumulation of aggregate capital, K, as in Ramsey model. If however, G rises along with K then equation (2.0) implies that diminishing returns will not arise, that is, the production function specifies constant returns in K_i and G for fixed L_i. If the government keeps public expenditure G in a fixed ratio with private capital then economy will have endogenous economic growth[7]. The form of production function implies that the public services are complementary with the private inputs in the sense that an increase in G raises the marginal products of L_i and K_i.

The government finances the economic activities charging a constant tax at rate τ on the aggregate of gross output (at the enterprise's profits). Suppose that we have a balanced budget:

$$G= \tau Y \qquad (2.1)$$

We assume that τ and, hence, the expenditure ratio, G/Y, are constant over time. In the competitive economy, firms maximize their profits, choosing the proportion of private capital (or the ratio capital to labour), considering the public expenditure fixed.

The firm's after-tax profit is

$$\Pi_i= L_i [(1-\tau)Ak_i^{\alpha} G^{1-\alpha} -w-rk_i] \qquad (2.2)$$

k_i is the private capital per employee (K_i/L_i), w is the wage rate and r is the interest rate. In the equilibrium $k_i = k$, then the first order condition regarding the capital is:

$$\partial\Pi_i / \partial k_i = 0 \rightarrow (1-\tau)\alpha Ak^{-(1-\alpha)}G^{1-\alpha} = r \qquad (2.3)$$

Combining the conditions 2.0 and 2.1 we have:

$$G=(\tau AL)^{1/\alpha}k \qquad (2.4)$$

Subsituting to 2.3 we have:

$$(1-\tau)\alpha A^{1/\alpha}(\tau L)^{(1-\alpha)/\alpha} = r \qquad (2.5)$$

[7] Barro, J., R., Xavier S., I., M., *Economic Growth*, p.154, McGraw-Hill, Inc, United States of America 1995

The left part of the equation is the after-tax marginal product of private capital, which in the equilibrium has to be equal to the return of capital. As long as the term τ and L are constant in the equilibrium, we can see that r (interest rate) is also constant (invariant with k and increasing with L)(2.5).

Implications of public expenditure to the consumption

The utility function of consumer (constant substitution elasticity diachronically) is

$u(c)=c^{1-\theta}/1-\theta$

The representative household maximizes the utility function:

$$\max \int_0^{\infty} u(c)e^{-\rho t}\,dt$$

under the restriction that accumulation of wealth equals to wage plus the return of wealth less consumption:

$\dot{k}$ =rk + w – c (the individual wealth equals the capital per employee)

The Hamilton equation for the problem is:

J= u(c) + λ(rk + w – c)

where $\lambda' = \lambda e^{-\rho\tau}$ is the present value of shadow price of wealth. The first order conditions are:

$\partial J/\partial c=0 \quad \rightarrow c^{-\theta} = \lambda$ (3.0)

$\partial J/\partial k=-\dot{\lambda}' \rightarrow \dot{\lambda} -\lambda\rho=-\lambda r$ (3.1)

The conditions 3.0 and 3.1 give a constant change rate per capita consumption:

$\dot{c}/c=1/\theta(r-\rho)$ (3.2)

In equilibrium the change rate per capita income $\dot{y}/y$ and the ratio capital-labour $\dot{k}/k$ are constant and equal with the change rate of consumption. If $r>\rho \rightarrow (1-\tau)\alpha A^{1/\alpha}(\tau L)^{(1-\alpha)/\alpha}>\rho$ these transitions are positive.

Can the government determine the public expenditure G (or rate coefficient τ) such as to achieve the greater rate of economic growth? Through the conditions 3.2 and 2.5 the rate of economic growth is a function of τ:

$g_y= \dot{y}/y = 1/\theta[(1-\tau)\alpha A^{1/\alpha}(\tau L)^{(1-\alpha)/\alpha} – \rho]$ (3.3)

The government interference affects the change rate in two ways. First of all through the term (1-τ), which express the negative effect of taxation on the after-tax marginal product of capital reducing the firm's profits. Secondly through the term $\tau^{(1-\alpha)/\alpha}$, which reflects the positive effect, G, through the production function on the marginal product of capital.

At low values of τ, the positive effect of G/Y on capital's marginal product dominates and g_y rises with τ.Reversely, as τ rises, the adverse impact of distorting taxation becomes more important, and g_y eventually reaches a peak. For still higher values of τ, the taxation effect dominates and g_y declines with τ. In both cases, the rate of economic growth is lower than the maximum feasible.

We can see in a graph:

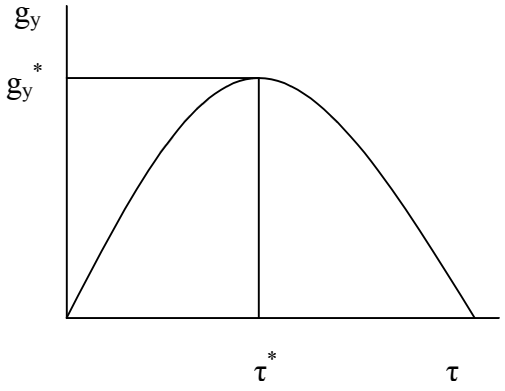

Figure 2: Economic growth and rate
(Inverse U-shaped)

best tax rate τ^* maximize the growth rate and is (by setting the derivative with respect to τ to 0): $\partial g_y/\partial\tau = 0 \rightarrow \tau^* = 1-\alpha$ (3.4)

The maximum long-lasting growth rate g_y in the model of public expenditure achieved when $\tau^* = 1-\alpha$, that is when the percentage of public expenditure in the income equals with the elasticity of public expenditure in the income.

2.2.1 Implications

We conclude that the optimal tax rate must be such as to equal the marginal cost to marginal benefit of public expenditure. If public expenditure increases per 1 unit, then the marginal cost of expenditure is 1 unit. The marginal benefit of an increase on the

expenditures is the augmentation of products that induced by the augmentation of the expenditures which is (marginal product of public services):

$\partial Y/\partial G= (1-\alpha)Y/G=(1-\alpha)/\tau$

When $\tau=1-\alpha$ the marginal benefit of public expenditure equals to one unit and together equals to marginal cost then the proportion of public expenditure is at the finest level. ($\partial Y/\partial G=1$)

On one hand when τ^* is lower, economy does not have large enough public sector to support private sector's activities, and economic growth rate is able to augment if the government augments the respective tax rate and the public expenditure. On the other hand, when $\tau>\tau^*$, economy has too much large public sector in relation to private, so that the economy will benefit if reduce the respective tax rates and public expenditure.

We can conclude that the government role has special implications in the endogenous economic growth. That's because competitive equilibrium not fully take advantage of economy's productive abilities when we have externalities. It is required governmental intervention that will determine the size of the public sector in the optimal proportion and then will leave the economy to work at the regime of competitive equilibrium.

The key distortion in the decentralized model is that individual investors take account of the private marginal product of capital $(1-\tau)\ \partial Y_i/\partial K_i$, which falls short of the social marginal product, $\partial Y_i/\ \partial K_{i,}$ because of the tax rate, τ. This wedge between social and private returns leads to a short fall of the growth rate.

It is possible to generate the growth rate of social planner in a decentralized set up. First, the government sets $G/Y= (1-\alpha)$ to get the right quantity of public goods. Second, the government finances its expenditure with a lump-sum tax (a tax with a marginal rate of zero with respect to production).

The predicaments concern the large breadth of public expenditure which we have to include in the production function and the unevenness of elements. The optimal point may be different in each country, and that's why public expenditure is productive in some economies and in other not.

In three models that Barro has investigated-learning by doing with spillovers, taxation of income from capital and varieties of capital goods in an environment of imperfect competition- the key element is the shortfall of the private rate of return of

investment from the social rate of return. It follows that a Pareto optimum can be attained in each model if the government raises the private rate of return on investment to the social rate of return without introducing other distortions. This outcome can be achieved in the capital-varieties model either by subsidizing the purchase of capital goods (at a rate α) or by subsidizing the income on capital (at a rate $\alpha/(1-\alpha)$)

If the social rate of return on investment exceeds the private return, then tax policies that encourage investment can raise the growth rate and thereby increase the utility of the representative household. An excess of the social return over the private return can reflect learning-by-doing with spillover effects, the financing of the government consumption purchases with an income tax, and monopoly pricing of new types of capital goods.

On the other hand, tax incentives to investment are not called for if the private rate of return on investment equals the social rate of return (accumulation of capital does not entail diminishing returns or technological progress that appears as an expanding variety of consumer products).

3 Infrastructure (Public Capital)

In fundamental sectors such as research, education, telecommunications, transfers, energy it is necessary the government intervenes through subsidies or directly through governmental investment, in order to counterbalance the divergence between public and private benefit.

These sectors consists the infrastructure of economy. Distinguished in public and private infrastructure. It depends on the ownership regime. Usually governmental activity is related to public investments. The planning is made through the annual national budget. It is essential enough to dispose a great amount on investments because in that way save resources from the present and ensure augmentative future economic activity.

The most important implication comes from the stock of public capital that there is on the disposal of economy. So we examine the impact of the aggregate public infrastructure. The main impact on economy is estimated not from the respective amount that expended the certain period but it must be estimated by the whole period that the construction works. Thus the positive effects emerge the whole period that work. It is

important to mention that no economy had great over the long run development without having adequate infrastructure[8].

How we define public capital? First, only spending by various government sectors is included. That implies that spending by the private sector (including public utility firms concerned with electricity generation, gas distribution, and water supply) is excluded. Secondly, public investment includes spending on various items (public buildings and swimming pools, for instance), which may not add anything to the productive capacity of an economy.

3.1 Endogenous economic growth according to public and private capital

Suppose an economy that there are a large number of uniform firms and produces a product Y. The economy consists of a fixed number of employees that consume the product Y.

The representative firm i produces the product Y_i and the production function has the following Cobb-Douglas form:

$$Y_i = AK_i^{\alpha}(hL_i)^{1-\alpha} \qquad (1.0)$$

K_i and L_i are private capital and labour respectively. A is a technological parameter, while (a) and (1-a) are proportions of private capital and labour respectively. The parameter h is the human capital per employee which is a function of total private and public capital per employee such as:

$$h = K^{\beta}\Lambda^{1-\beta}/L \qquad (1.1)$$

Thus, the product of the economy is a function of private capital and total per capita stock of capital which is available in the economy. The return of private capital is decreasing ($\alpha<1$).

The cost of investment depends on its size and on the stock of the already available firm's capital.

$$\text{Investment cost} = I_i[1 + \Phi/2(Ii/ K_i)] \qquad (1.2)$$

I_i is the investment of the firm i and depends positively on the ratio of Ii/ K_i, and as larger is the ratio so larger is the cost of the investment. (Adjustment cost)

[8] Καλαϊτζιδάκης Π., Καλυβίτης Σ., *Οικονομική Μεγέθυνση, Θεωρία και Πολιτική,*σελ.215, εκ. Κριτική, Αθήνα 2002

The accumulation procedure of the firm's private capital and public capital is (*constraints*):

$$\dot{K}_t = I_i - \delta_\kappa K_i \qquad (1.2.1)$$

$$\dot{\Lambda} = G - \delta_g \Lambda \qquad (1.2.2)$$

δ_κ , δ_g are the rates of depreciation of public and private capital respectively, G are the public expenditure. The G financing is being through the tax rate τ:

$$G = \tau Y \qquad (1.2.3)$$

The problem of the firm is to maximize diachronically the present value of current and future pure product that is the production after the taxation less the labour and investment cost for fixed h:

$$\max \pi_i = \int_0^\infty e^{-rt}\left\{(1-\hat{o})\tilde{O}_i - w_i L_i - I_i[1+\ddot{O}/2(\acute{E}_i/K_i)]\right\}dt \qquad (1.3)$$

under the restrictions 1.2.1, 1.2.2

The solution of the problem following Hamilton is:

$$J = e^{-rt}\left\{(1-\hat{o})Y_i - w_i L_i - I_i[1+\ddot{O}/2(\acute{E}_i/K_i)]\right\} + q(I_i - \ddot{a}_k \hat{E}_i)\Big\} \qquad (1.4)$$

q is the shadow cost of private capital

$q' = qe^{-rt}$ is the present value of the shadow value of private capital

The first order conditions to labour and the private capital are:

$$\partial J/\partial L_i = 0 \quad \rightarrow w_i = (1-\tau)A(1-\alpha)(K_i/L_i)^{\alpha} h^{1-\alpha} \qquad (1.5)$$

$$\partial J/\partial I_i = 0 \quad \rightarrow I_i/K_i = (q-1)/\varphi \qquad (1.6)$$

$$\partial J/\partial K_i = -\dot{q}' \rightarrow \dot{q} = (r+\delta_k)q - (1-\tau)A\alpha(K_i/L_i)^{\alpha-1} h^{1-\alpha} - \Phi/2(I_i/K_i)^2 \qquad (1.7)$$

Using the equation 1.1 we have:

$$w = (1-\tau)A(1-\alpha)(K/\Lambda)^{\alpha+\beta(1-\alpha)}\Lambda/L \qquad (1.8)$$

$$(I/K) = (q-1)/\varphi \qquad (1.9)$$

$$\dot{q} = (r+\delta_k)q - (1-\tau)A\alpha(K/\Lambda)^{-(1-\alpha)(1-\beta)} - (q-1)^2/2\varphi \qquad (1.10)$$

condition (1.8) equals real wage to marginal product of labour. While eq. (1.9) express the private investment as an increasing function of shadow value of private capital and a decreasing function of parameter φ that determines the adjustment cost.

Equation (1.10) reflects the transition of capital's shadow price as a positive function of interest rate and the depreciation of private capital multiplied by the shadow value less the return of private capital and the marginal reduction of adjustment cost, while the private capital augments.

In the competitive economy we regard the variable h as fixed and that is the reason why the solution of the firms not equal to the solution of the social planner who takes into consideration the equation (1.1). Thus, the marginal product of capital will be lower but the capital will be greater in relation to competitive equilibrium (since the term α at 1.10 is replaced from $\alpha + (1-\alpha)\beta$).

The last equation that we have to take into consideration is the tranversability equation:

$$\lim_{t\to\infty} (qe^{-rt} K) = 0 \qquad (1.11)$$

as the capital have to be zero in the infinity or have to have zero present value

3.2 Long run equilibrium and dynamic function of the model

The total production function combining 1.0 and 1.1 is:

$$Y=AK^{\alpha+\beta(1-\alpha)}\Lambda^{(1-\beta)(1-\alpha)} \qquad (2.0)$$

we can derive from equations 2.0, 1.2.1,1.2.2,1.2.3,1.9 that:

$$\dot{K}/K= (q-1)/\varphi - \delta_k \qquad (2.1)$$

$$\dot{\Lambda}/\Lambda= A\tau(K/\Lambda)^{\alpha+\beta(1-\alpha)} - \delta_g \qquad (2.2)$$

Suppose that we define: $z = \Lambda/K$, thus $\dot{z}/z = \dot{\Lambda}/\Lambda - \dot{K}/K$

Then the conditions 2.1 and 2.2 convert into:

$$\dot{z}/z = A\tau z^{-\alpha-\beta(1-\alpha)} - (\delta_g-\delta_k) - (q-1)/\varphi \qquad (2.3)$$

$$\dot{q} = (r + \delta_k)q - (1-\tau)A\alpha z^{(1-\alpha)(1-\beta)} - (q-1)^2/2\varphi \qquad (2.4)$$

In the long run equilibrium public and private capital have the same growth rate, that is $\dot{Y}/Y = g_y = \dot{\Lambda}/\Lambda = \dot{K}/K$ and thus there is endogenous economic growth.

Since condition 2.1, the long run equilibrium value of shadow value of capital is given from $\bar{q} = 1+\varphi(\overline{g_y} + \delta_\kappa)$ (2.5)

The parameter q depends positively on economic growth rate. Higher development entails both increased product and profits in the future. Also the parameter δ_κ related to growth rate because greater rate of depreciation requires greater q value on the score of greater adjustment cost.

The tranversability condition is:

$$\lim_{t\to\infty}(qe^{-(r-g_y)}z)=0$$

This means that in the long run equilibrium the growth rate of product (therefore the rate of accumulation of public and private capital) can not exceeds the real interest rate.

The conditions 2.3, 2.4 express the dynamic evolution of the system. The set of spots $\dot{z}=0$ has negative declination, because $dz/dq_{(\dot{z}=0)} < 0$ for all spots that holds $q>1+\varphi(\delta_k-\delta_g)$. (that holds for equilibrium values that come up from condition 2.5). That's mean that for each value of the ratio public to private capital, the shadow value of capital must decreases continually as the ratio increases (because an increase of private can achieved only if the shadow value of this is low enough). On the other side the set of spots of $\dot{q}=0$ has positive inclination because $dz/dq_{(\dot{q}=0)} >0$. With decreasing scale effects for each flow (private, public), an augmentation of private, entails lower return and shadow value of private capital.

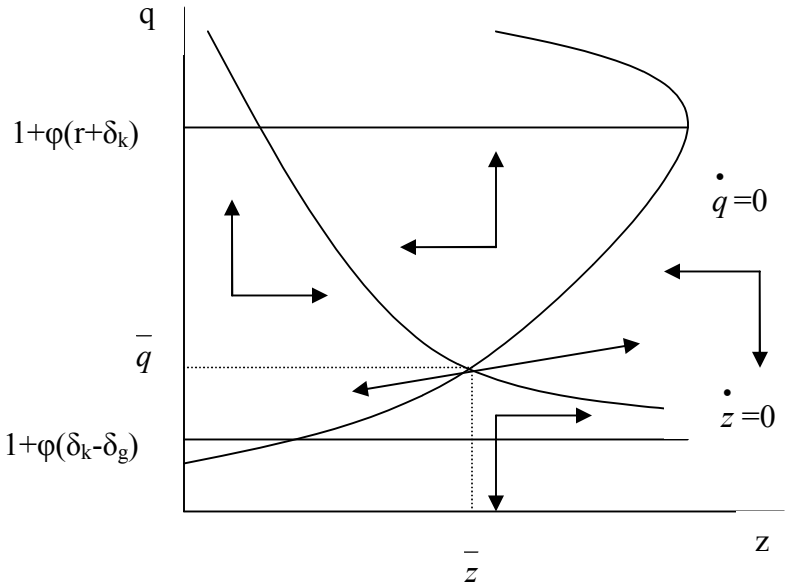

Figure 3: Dynamic impacts between shadow value of capital and ratio public-private capital

Since $\frac{\partial \dot{q}}{\partial q} \rangle 0$ and $\frac{\partial \dot{z}}{\partial z} \langle 0$, there is an equilibrium set of points. q as a jump variable can take any value is required.

3.3 Tax rate τ

Enterprises spend an amount for financing the government which decreases their profits but provides public infrastructure which benefit them. Greater the tax rate it is, greater the public infrastructure, and the benefit that the firms obtain through the production function. On the other side minor is the profit that they obtain after the taxation, and have fewer incentives to produce, with implications to production and the growth rate.

If we augment the parameter τ we can see the following implications.

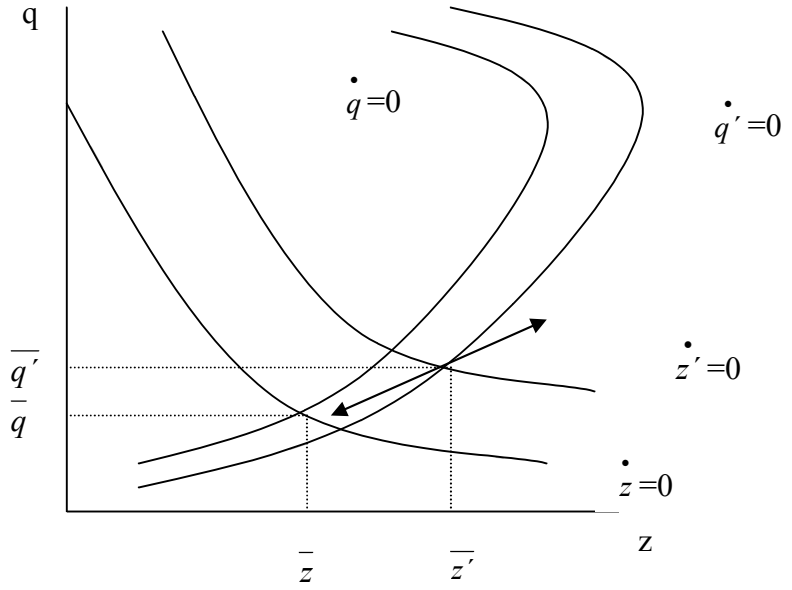

Figure 4: implications of the augmentation of the public infrastructure when τ<(1-α)(1-β)

We observe that on both cases the set of spots $\dot{z}=0$ moves upwards and right, as long as for fixed ratio public to private capital, the shadow value of private capital is greater if we augment the parameter τ.

Also on both cases the set of spots $\dot{q}=0$ moves downwards and right, as long as on fixed the shadow value of private capital the ratio public and private capital is greater if we augment the parameter τ.

The only difference is the way that the shadow value of private capital reacts, which defines the accumulation of private capital and the growth rate.

In the first case, the tax rate is low and holds that $\tau<(1-\alpha)(1-\beta)$, the augmentation of public infrastructure leads to augmentation of shadow value of public capital, which produces now much more product.

Gradually, after the increase of public investments, the accumulation of public capital accelerates and the ratio public to private capital increases. Parallel the adjustment cost of investments increases and the ratio investments to capital stock has increased. The shadow value augments but with decreasing rate and the economy catch up the new point of equilibrium with higher economic growth rate.

The effects are converse when $\tau>(1-\alpha)(1-\beta)$. In this case augmentations of tax rate decrease the shadow value of private capital, because exceed the expected benefit on the score of production's increase. The ratio public to private capital increases and the private capital decreases since the shadow value decreases as well. This declination is moderate on the score of the decrease of adjustment cost, which makes more profitable the private investments.

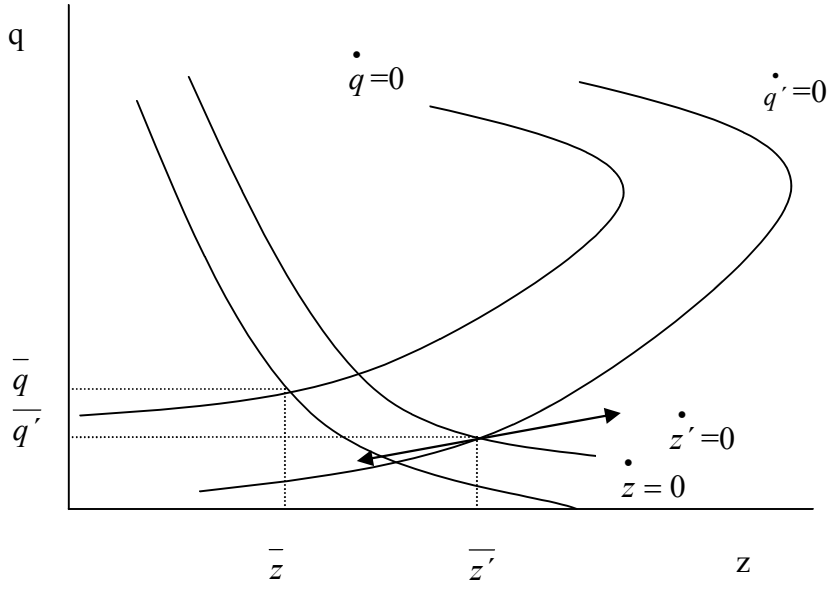

Figure 5: implications of the augmentation of the public infrastructure when $\tau>(1-\alpha)(1-\beta)$

Thus, as we can see in the graph 5 after the first drop in the new equilibrium point, the shadow value comes up and the economy approaches a new equilibrium point with lower growth rate(and accumulation of private and public capital) and higher ratio public to capital.

On both situations, on the long run, the accumulation rate public and private capital at the end balances but has changed the ratio public to private capital. Suppose that this ratio gives the size of public sector in economy we can say that the size of public sector z increases after an increase of public infrastructure τ and reversely.

The maximum economic growth rate is achieved when $\tau=(1-\alpha)(1-\beta)$, and that is when the percentage of public investment on the income equals to the elasticity of public capital in the production function[9].

As we have seen in the previous section, the proportional change per unit in infrastructure corresponds to a proportional change in production per $(1-\alpha)(1-\beta)$ which is the benefit. Parallel the cost is given from tax rate τ^* which in the maximum point is $(1-\alpha)(1-\beta)$.

[9] Καλαϊτζιδάκης Π., Καλυβίτης Σ., *Οικονομική Μεγέθυνση, Θεωρία και Πολιτική,*σελ.227, εκ. Κριτική, Αθήνα 2002

The effect of the impact of τ varies in proportion to the current available infrastructure of economy. If the economy shortfalls at the available infrastructure and holds that $\tau<(1-\alpha)(1-\beta)$, then the benefits overrule and while τ reaches maximum τ^* then the growth rate augments. Indeed, if we have surplus of the available economy and $\tau>(1-\alpha)(1-\beta)$, then as the τ increases we will have deterioration of the growth rate.

We have to take into consideration that the creation of infrastructure does not imply indispensably the upgrade of growth rate. Furthermore it is required to ensure the long run economic growth of an economy.

4. Bureaucratic corruption

Public services and goods provide necessary inputs into private activities. Modern states finance these inputs through taxes collected from the community. When this process is influenced by bureaucratic corruption, the efficiency of public expenditure decreases. Illegal agreements allow personal profit, and governments fight corruption through costly monitoring of public purchases. The first comprehensive econometric research to assess the impact of corruption on economic growth is by Mauro (1995). On the basis of cross-country data, Paulo Mauro finds a significant negative relation between a corruption index, built using information assembled from the correspondents of Business International in 70 countries in the early of 1980s, and the rate of growth.

"*A country that improves its standing on the corruption index, say, 6 to 8 (O being the most corrupt,10 the least), will experience a 4 percentage point increase in its investment rate and a 0.5 percentage point increase in its annual GDP growth rate*"(Mauro, 1998a).

Corruption can act as a tax and can lower incentive to invest. Also can increase the ability of agents to get resources from central and local governments. Therefore, public resources reward the more 'able' people, not the best entrepreneurs. Over and above can distort the composition if government expenditure as corrupt politicians may be expected to invest in large non-productive projects from which it is easier than in productive activities to exact large bribes[10].

Bribes are the extra-price charged by bureaucrats to private customers, and arise like rents. The economic consequences of this phenomenon concern distortion in resources allocation mainly in terms of less private investment, and a reduced rate of human capital formation (have a negative influence on investments in human capital).

Also, corruption has strong negative effects on economic growth by lowering the amount and quality of public infrastructure and services supplied to the private sector. Corruption arises when bureaucrats manage public resources to produce public goods and services. Asymmetric information between government and its agents is the basic assumption that we make in a model of economic growth. The State cannot fully

[10] A., Del Monte, E., Papagni, *"Public Expenditure, corruption, and economic growth: the case of Italy",* European Journal of Political Economy, vol.17, p.2, 2001

ascertain what (its quality or efficiency) bureaucrats buy and the actual price they charge. Illegal behavior results from providing the government with low quality goods at the same price as private markets, acquiring the same goods at a higher price, or both cases. Bureaucrats and private agents agree to profit from a lack of information of citizens, even if their behavior is harmful for the welfare of community.

This case of corruption appears relevant in undeveloped countries (Bardhan, 1997) where the organization of the State is especially inefficient, democratic control of the civil community over government actions is absent, and bureaucrats have wide discretionary power (Azariadis and Lahiri, 1997).

One problem that arises in the interpretation of regressions based on cross-country data is the following: countries differ greatly, not only in levels of corruption, but also in the extent of administrative controls on different aspects of economic life, the importance of government-subsidies and transfers, the incidence of government-operated enterprise, etc.

Data

They have used data on time series of 20 Italian regions to determine whether corruption is one of the possible causes of the limited success of the policies addressed to the development of Southern Italy. The results show that the efficiency of public expenditure is lower in regions where corruption is higher, and that corruption has negative effect on economic growth of Italian regions.

Punishment

Ex-post monitoring over government purchases makes revenues from corruption uncertain. Discovery and punishment occurs with probability P. Monitoring has a cost that causes a certain amount of resources to be wasted to fight corruption. Agents decide the extent of their involvement in this illegal activity maximizing expected revenues.

Agents are assumed to be risk neutral and to choose θ, the quantity of public resources they steal, maximizing the illegal expected net income. Entrepreneurs are engaged in two different activities: goods production and corruption. We assume the two are fully separate. In fact, each agent has little significance with respect to the aggregate, and he chooses k assuming no effect of his decisions on the level of income and public

expenditure. This also means that variations in capital stock do not change the revenue from corruption.

The outcome of corruption is uncertain because of the repressive action of the State. When successful (with probability 1-P), entrepreneurs' profits are: θty. Ex-post monitoring of the transactions in the public sector occurs with frequency P, and a cost per unit value of public expenditure S(P) that increases with P

$S_p=\partial S/\partial P>0, S_{pp}>0$.

In cases of unsuccessful attempts at corruption, guilty agents take θty but are charged with a monetary penalty Mty, they can be thought of as a direct consequence of punishment (as a fine), or indirect as income losses deriving from both imprisonment and the monetary value of losses in social status. M(θ) is a positive increasing function of θ, that approximate crime seriousness, with $M>\theta$, $M(0)=0$, $M_\theta>0$, $M_{\theta\theta}\geq 0$.

The expected profit of corruption is

$E(\pi_c)=(1-P)\theta ty + P\theta ty - PM(\theta)ty = \theta ty - PM(\theta)ty$ (1)

A representative agent maximizes eq.1 with respect to θ. The first order condition is

$\partial E(\pi_c)/\partial\theta = 1 - PM_\theta = 0$ (2)

From eq.2 the optimal value of effort θ is an inverse function of the probability P

$M_\theta = 1/P$ and $\theta = M_\theta^{-1}(1/P)$, with $\theta(1)=0$. Of course, according to eq.1 it is always possible to set such a high fine that it discourages any illegal activity, or to check any transaction (P=1). But, in order to describe real economies they rule out these opportunities.

Legal systems today even in undeveloped countries, do not allow the setting of very high penalties for crimes against the administration. We assume that there are costs in collecting penalties from guilty agents. They collaborate with the State, and pay the penalty if they feel that the amount is fair relative to the seriousness of the crime, hence, collection costs are low.

These costs increase if agents consider that the fine is disproportionate with respect to the crime and fight against such an unfair penalty. The government can choose for each value of θ the penalty M(θ) that maximizes the revenue from fines net of costs.

Even though poor regions have grown substantially, today their distance from the rich is still wide notwithstanding the huge program of public intervention that was carried

out during the last 40 years. We conjecture that corruption is one of the main reasons of lower efficiency of expenditure on infrastructures is such regions.

After dealing with the phenomenon of corruption that arises from purchases made by government officials they maintain that this kind of corruption has a direct negative effect on the long run opportunities of economic growth because governments can offer less inputs to private economic activities[11].

With a positive amount of corrupt transactions, some economic resources are wasted and fewer infrastructures or public services are disposable for private production. The econometric results show two distinct negative effects of corruption on economic growth. One effect seems to be that on private investment, the other is on the efficiency of expenditures on public investment. Policies to deter corruption and to increase the efficiency of local public institutions could give very positive impulse to economic growth.

[11] A., Del Monte, E., Papagni, *"Public Expenditure, corruption, and economic growth: the case of Italy",* European Journal of Political Economy, vol.17, p.14, 2001

5. Empirical Framework

5.1 Production Function

In the literature one can roughly distinguish four approaches to measure the impact of public capital on economic growth. The most common approach is what is often labelled the production function approach..

In the so-called behavioural approach, a cost or profit function in which the public capital stock is included is estimated. It allows the use of more flexible functional forms and takes somewhat better account of the different characteristics of public versus private capital.

By imposing as few economic restrictions as possible, Vector Auto Regressions (VAR) models try to solve some of the causality and endogeneity problems related to the first two approaches.

A final alternative way to model the growth effects of public capital spending is to include government investment spending in cross-section growth regressions.

Each approach has its merits and own set of problems. However, the overall conclusions derived from these different approaches are surprisingly similar. Or, at least, the differences in estimated output effects can rarely be attributed to the use of different approaches.

Issues ranking high on the list of potential problems include reverse causation from productivity to public capital and a spurious correlation due to non-stationarity of the data.

Data

We use annual data on government expenditure for 58 countries (41 non oecd and 17 oecd)[12] for period 1985-1995 with constant year 1995.

We compute the ratio Private Investments to GDP and Government expenditure to GDP over a period of 11 years. Output per capita equals GDP divided by population:

y_t= GDP/Population. Finally compute the growth rate: $g_t = (y_t - y_{t-1})/y_{t-1}$

The method we use for our analysis is cross-section regression. In particular it has the following shape:

[12] See p.55

$$\hat{y} = \alpha + \beta y + \gamma(PRI/GDP) + \delta(G/GDP) + \varepsilon_i$$

• Dependent variable: average annual growth rate
• Explanatory variables:
  1. Initial GDP
  2. Government consumption as a share of GDP
  3. Private Investment as a share of GDP

5.2 Interpretation of results

We divide our research in three categories. We first estimate the whole sample (58 countries) and then we divide the sample into two subgroups: OECD countries (17) and Non OECD countries (41) separately. The results are different and the subgroups tend to be closer to the theory.

After many cross section regressions we show six equations that express better the variation of independent variables in relation to the dependent variable growth rate. We present the same six equations for all categories and we compare them.

In the first equation (table 1) we test the linearity of the variables. Specifically, the initial GDP (lagged income) is related negatively with the growth rate and it is statistically non significant. We can see the there is no convergence between the countries, and this is because we include too many countries with different characteristics.

When we try to find the form of the initial income to growth rate, we regress the initial income in different orders ($y, y^2, y^3, y^4 y^5$) but again we can not conclude to significant interpretations, as income is statistically non significant. That is because the same reason as above.

In relation with private investment (as a percentage of Income), we can see that is always positive and significant. This is consistent with the theory of Levine and Renelt (1992), who support how robust this variable is to economic growth.

With reference to public expenditure (as a percentage of income) we can see that in the first equation the relation is negative and significant and that holds with the theory of previous researches theoretical or empirical of Barro (1991), Bleaney, Gemmell, Kneller (2001), Devarajan (1996), Evans and Karras (1994), Holcombe Lacombe (2004).

Testing the form of the public expenditure we run regressions with independent variable the G/GDP, $(G/GDP)^2$ $(G/GDP)^3$, $(G/GDP)^4$. We can see that R^2 augments when we take into account the $(G/GDP)^2$, and the same the T-statistic. In the contrary when we take into account $(G/GDP)^3$ the R^2 decreases and so does the T-statistic. In this point our conclusions harmonize with the theoretical model of Barro (1991) and with Aschauer (1989), Bleaney, Gemmell, Kneller (2001), Devarajan (1996), Evans and Karras (1994), Holcombe Lacombe (2004). The shape of public expenditure takes the form of an inverse U. At low values of public expenditure, the positive effect of G/Y on capital's marginal product dominates and growth rate rises with public expenditure. Reversely, as public expenditure rises, the adverse impact of distorting taxation becomes more important, and growth rate eventually reaches a peak. For still higher values of public expenditure, the taxation effect dominates and growth rate declines with public expenditure.

Table 1 : All Countries

Variable	1	2	3	4	5	6
C	-0.003567 (-0.571774)	-0.022997 (-2.173175)	-0.025476 (-1.407050)	-0.003503 (-0.549372)	-0.023830 (-2.218109)	-0.027562 (-1.487752)
Lagged GDP	-5.08E-08 (-0.281168)	-1.20E-07 (-0.655485)	-1.08E-07 (-0.553505)	-8.35E-08 (-0.065962)	-9.10E-07 (-0.694804)	-9.26E-07 (-0.705708)
Lagged GDP^2				2.69E-12 (0.036165)	4.60E-11 (0.601248)	4.90E-11 (0.631980)
Lagged GDP^3				-4.87E-17 (-0.042451)	-6.68E-16 (-0.569919)	-7.24E-16 (-0.605990)
Share of Private Investment	(7.449126) 0.230138	0.231916 (7.531196)	0.231127 (7.414636)	0.230261 (7.092776)	0.237813 (7.317916)	0.236716 (7.211473)
Share of Total Public Spending	-0.076788 (-2.283180)	0.223450 (1.636868)	0.288175 (0.708078)	-0.077120 (-2.213051)	0.245020 (1.729891)	0.343444 (0.813191)
Share of Total Public $Spending^2$		-0.969142 (-2.268796)	-1.441951 (-0.509008)		-1.036125 (-2.345910)	-1.754795 (0.247396)
Share of Total Public			1.003829 (0.168835)			1.519818 (0.247396)

Spending[3]						
R-squared	0.106327	0.114256	0.114300	0.106331	0.114833	0.114927
Adjusted R-squared	0.101673	0.108095	0.106585	0.098547	0.105564	0.104096
Number of observations	580 after adjustments					

The equations which express better the growth rate are number two and five. Have the larger R^2 and imply that government expenditure take the form of second order while for the initial income we do not infer significant interpretations. Private investment is robust and positive for all equations.

With regard to two subgroups the implications are a little bit better. Firstly, we estimate the subgroup of OECD countries.

The initial income is more significant in his linear form and especially in equation two. The relation with growth rate is negative (ceteris paribus) and we can see the appearance of convergence. The impact of convergence is not as robust as previous researches have shown because of the far-out observations of Korea, Greece and Turkey that period. (graph2, p.54). If we investigate the composition of government expenditure into military and public spending we will see that the results will be more robust[13].

The share of private investment remains significant and positive in all equations in accordance with Levine and Renelt (1992) that support how robust for the growth rate the private investments are.

In reference with public expenditure the linear form is not adequate and when we regress to second order the results are better. In second order the T-statistic and R^2 are better signing the significance of a non linear form of government expenditure. On the contrary when take third or fourth order the coefficients remain non significant. The results are in accordance with Barro (1991) and with Aschauer (1989), Bleaney, Gemmell, Kneller (2001), Devarajan (1996), Evans and Karras (1994), Holcombe Lacombe (2004).

Generally the equation which expresses better the growth rate is number 2 (table 2), where we observe that the form of the income tends to be linear, the public expenditure to

[13] see Moulara M., Military and Growth Rate, dissertation, University of Crete, Rethymno 2007

income takes a second order shape. Private investments remain positive and significant. (R^2 remains high).

Table 2 : OECD Countries

Variable	1	2	3	4	5	6
C	0.020958 (1.239481)	-0.040986 (-1.060598)	0.075028 (0.647553)	0.016855 (0.895133)	-0.050118 (-1.174872)	0.063453 (0.532724)
Lagged GDP	-8.62E-09 (-0.034137)	-2.03E-07 (-0.741328)	-8.62E-08 (-0.292208)	9.99E-07 (0.536182)	-9.48E-07 (-0.438988)	-7.74E-07 (-0.356980)
Lagged GDP^2				-5.57E-11 (-0.601796)	2.22E-11 (0.216921)	2.14E-11 (0.209061)
Lagged GDP^3				8.02E-16 (0.607013)	-1.78E-16 (-0.124307)	-1.86E-16 (-0.130086)
Share of Private Investment	0.110688 (1.715026)	0.163762 (2.315742)	0.132887 (1.738592)	0.107846 (1.561808)	0.184062 (2.263513)	0.151703 (1.738463)
Share of Total Public Spending	-0.098098 (-1.455460)	0.618731 (1.515518)	-1.622189 (-0.754831)	-0.090601 (-1.054186)	0.734796 (1.530469)	-1.450201 (-0.661348)
Share of Total Public $Spending^2$		-2.086612 (-1.779905)	11.90916 (0.900169)		-2.347080 (-1.747044)	11.24580 (0.840613)
Share of Total Public $Spending^3$			-27.87521 (-1.062063)			-27.02325 (-1.021216)
R-squared	0.062179	0.079847	0.086132	0.064287	0.081486	0.087362
Adjusted R-squared	0.045231	0.057540	0.058270	0.035759	0.047676	0.047927
Number of observations	170 after adjustments					

In the last group Non-OECD countries the results are even better.

Testing the same equations, we can see that the relation between growth rate and initial income is clearly non linear. This nonlinear relationship can be modeled as a third degree polynomial in initial income. Absolute value of T-statistic>2 signs that the coefficients are significant. The relation takes the shape of U.

We can see (grahp3, p.54) that there is convergence only on groups. Appeared two seperate subgrups that tend to the initial income. This is in accordance with Durlauf and Johnson (1995), Liu and Stengos (1990), Pack and Page (1994), Quah (1996) that support non linearity and convergence only on subgroups.

The private investments are positive and significant as we have seen before.

The public expenditure is modeled once again as a second degree polynomial (inverse U) in accordance with the theory. When government expenditure is below the efficient level, and government augments the public expenditure, it increase parallel with growth rate. Conversely if public expenditure is already above the efficient level, the growth rate deteriorates with an increment of the public expenditure.

The equation which expresses better the variation of growth rate on the Non OECD countries is number five (table 3). The initial income is significant and modeled as a third degree polynomial. Once again private investment is significant and positive. Public expenditure estimated better as a second degree polynomial. As we can see a linear form or third degree polynomial does not express well the dependent variable.

We can see analytically the results from the table below:

Table 3: Non-OECD Countries

Variable	1	2	3	4	5	6
C	-0.005059 (-0.706112)	-0.022706 (-1.900736)	-0.038636 (0.480944)	0.003916 (-1.113726)	-0.013906 (-1.591866)	-0.034345 (-1.591866)
Lagged GDP	-7.21E-07 (-0.525172)	-1.22E-06 (-0.875861)	-1.33E-06 (-0.950751)	-1.98E-05 (-2.337640)	-2.05E-05 (-2.426349)	-2.18E-05 (-2.551966)
Lagged GDP^2				6.46E-09 (2.285487)	6.52E-09 (2.313482)	6.90E-09 (2.432421)
Lagged GDP^3				-5.53E-13 (-2.182316)	-5.58E-13 (-2.206506)	-5.91E-13 (-2.324897)
Share of Private Investment	0.255970 (6.642727)	0.260963 (6.775429)	0.258734 (6.701458)	0.272249 (6.898144)	0.277549 (7.036354)	0.275432 (6.978241)
Share of Total Public Spending	-0.084342 (-2.085158)	0.199442 (1.253009)	0.622429 (1.235977)	-0.082152 (-2.020859)	0.206021 (1.298562)	0.762068 (1.510942)
Share of Total Public $Spending^2$		-0.925810 (-1.843035)	-4.032845 (-1.137560)		-0.939843 (-1.878697)	-5.023284 (-1.414437)
Share of Total Public $Spending^3$			6.541544 (0.885351)			8.595743 (1.161370)
R-squared	0.114523	0.121888	0.123588	0.125971	0.133560	0.136457
Adjusted R-squared	0.107980	0.113215	0.112741	0.115154	0.120660	0.121420
Number of observations	410 after adjustments					

This paper shows that the analysis of the factors that influence economic growth is complex, as it depends on the different characteristics of the countries. Moreover, it is a difficult task for the policy makers to determine which are the best policies and the most appropriate institutions to improve economic growth.

Also, although the quality is quite good, the comparison is sometimes difficult, on the score of the different statistical methods that every country has used, and the measurement mistakes in the older years

Like many issues, conclusions reached depend on the definition of the variable, the methodology used and the time of period over which the model is estimated.

A positive coefficient means that, holding fixed the other variables an increase in that variable has a positive marginal effect on the dependent variable.

Theory provides evidence of conditional convergence in OECD countries because usually the coefficient of initial income is negative and significant. We can see that we conclude to different results because the initial income is negative but no significant. This is because some countries with unusual observations like Korea, Greece and Turkey the period 1985-1995 have influenced the results.

We can see that the relationship between per capita growth and initial income is clearly non linear on All and Non-OECD countries. This is consistent with recent empirical findings (see Durlauf and Johnson, 1995; Liu and Stengos, 1990; Pack and Page, 1994; Quah, 1996) on convergence. As argued shortly before, this nonlinear relationship can be modeled as a third degree polynomial in initial income.

The growth rate is related positively with the investments. This robust effect shows how investments influence growth rate on the long run.

The growth rate is related negatively with the government expenditure as a percentage of initial income. The main conclusions of the estimations are that public capital has negative effects on economic growth and it considers the importance of an appropriate institutional structure that is formed within an appropriate legal framework and social capital to improve economic growth. This result is coherent with Evans and Karras (1994).

In other words, as governments divert resources away from private entrepreneurs, jobs, investment, and productivity decline which ultimately slows down the economy. A broad conclusion is that “big government” appears to be detrimental to growth.

5.3 Studies – shortcomings

The most commonly studied issue in this context is the impact of government consumption on economic growth. The usual measure of government consumption or "size" is the ratio of public expenditure to GDP. A weakness of the study is that it is not always clear that the measured government expenditure represents government's consumption of resources,that is net of public financial transfers (social security payments and subsidies). Net and gross measures of expenditure may be expected to have quite different impacts on growth.

There is heterogeneity: the effect of public capital on growth, differs across countries, regions and sectors. A better way is to examine subgroups with homogenous characteristics or each country seperately.

A different issue but significant is that attempts at explaining existing differences in capital stock are only in their infancy. According to Estache (2006, p.5), "*There is strong anecdotal evidence now that politics matter. Experiences in Asia, Eastern Europe or Latin America show that politicians will never give up the control of a sector that buys votes in democratic societies. Moreover in societies in which corruption is rampant, they will not give up control of a sector involving large amounts of money and in which contract award processes often provide opportunities for unchecked transactions."* This probably also holds for industrial countries.

Furthmore, only a few of the enormous bulk of studies on the output effects of infrastructure base their estimates on solid theoretical models. But to understand non-linearity and heterogeneity, we must understand the channels through which infrastructure affects economic growth.

An additional weakness of many past regression studies (and this study) is that these purport to provide information on long-run growth, but use only observations over a relatively short time span of 5 to 30 years. For example, it is possible that public infrastructure does raise the (local) long-run growth rate, *ceteris paribus*, but that the effect only emerges very gradually over time.

However, a major weakness of many studies in this area is the highly aggregative nature of the research. Future research should endeavour to distinguish between different

types of government expenditure and provide a better link between theory and the empirical research.

In addition, Sala-I-Martin has found 60 variables that affect economic growth which have impact to limited degrees of freedom. With an EBA (Extreme Bound Analysis) can somebody find how robust a variable is.

Closing, simultaneity, multicollinearity, are important practical problems for anyone trying to draw inferences from international data. Unfortunately economic variables are highly depended inter se and with the initial income.

5.4 Direction

Government expenditure

This paper shows that excessively large government reduces economic growth. Congress should develop a long-range strategy to reduce the size of government so we will be able to achieve a more rapid rate of economic growth in the future. So some countries have to reduce ratio of overall government expenditure to GDP.

To ensure well-functioning markets, government must expend resources to enforce contracts, provide national security, and protect against criminals. Increased government expenditures, above this minimal level, have a diminishing effect on the growth of the economy. At some level of spending, the impact of government expenditure on the production of goods and services is negative. Excessive government spending makes everybody poorer. However, it is important where the government spends taxes. Public investment on roads, ports, and bridges compliments private investment to improve economic productivity, though economic growth suffers when government diverts funds that could be more profitably used to hire workers or buy new machines. Spending cuts are particularly important when government is extremely large, as in Denmark and much of Western Europe, Japan.

The policy lesson is that a smaller government share in GDP, a reallocation of funds away from the wage bill to public investment, and an improvement in government quality/efficiency can become engines of long-term growth

In the debate over the negative effects of high tax rates and the near obsession with the budget deficit, the negative effects of government expenditure have been ignored. Resources, taken from citizens and consumed by the state, are not available for private investment or consumption regardless of how government expenditures are financed. In the short-term, if the government grabs more resources from citizens, citizens can pay the additional burden from savings or foreigners can invest in the United States without changes in private consumption or investment. However, in the long-run, increased government expenditure reduces private investment and consumption. The economy cannot grow without increased private investment and consumption.

Many assert that government expenditure has a clear positive effect in the short and imminent period while it is not the same once we consider a longer time span. These results are further borne out when we investigate country and sector specific characteristics.

After a couple of decades of declining growth rates, many economists now "know" that high-income developed economies can no longer achieve and sustain real growth rates of 3.5 percent and up. There are various explanations why. For a while, sluggish growth rates were blamed on rising energy prices. But real energy prices have been declining during the last 15 years, and there is little sign of a turnaround in growth. Some now argue that wealthy high-income nations are unable to grow rapidly because their citizens are unwilling to save very much. Still others argue that constraints imposed by technology, or the global movement of capital, or some factor explains why today's growth rates are so much lower than a few decades ago.

Economies of Ireland, United Kingdom (in the 1980s), and more recently, New Zealand reverse course and achieve higher growth rates when government expenditure were reduced as a share of GDP. Also, the size of government is important, and all of the world's fast-growing economies have governments of modest size. Large and expansionary government has retarded economic growth, particularly in high-income countries.

Empirical observation shows that increases in government expenditure mean that more workers are employed in the public sector relative to the private sector than would otherwise be. The bureaucratic rules and rigidities of the public sector hamper the ability

of the labour market to function. A properly-functioning labour market will allow a flow of workers from declining ventures to successful ventures. Private markets permit a smoother transition among various job market opportunities which reduces unemployment. Lower unemployment increases the economic growth rate.

Unfortunately, many policy-makers appear to be largely oblivious to the negative impact of government expenditures on economic growth. As the budget deficit shrinks during the current expansion, increasingly the focus of policy-makers is shifting toward the introduction of new programs. This is a serious error. Higher spending levels will retard the growth of income. This led to policies of rising public spending, often coupled with increased public intervention. The more stringent financial environment following the 1973 and 1979 oil shocks triggered a movement to curtail public expenditure growth in many of these countries.

This is based on the view that centralized decision making, lack of profit motive, and absence of competition, which typifies government operations, make government production always less efficient than private sector production. Hence, any increase in government expenditure would result in slower economic growth in the economy as a whole. Further, because of the transfer of resources from the private sector to the government, there may be a slowdown in the accumulation of human and physical capital and the pace of innovation in the private sector.

Now is the time to develop a long-range strategy to reduce the size of government and restrict its activities to areas where it has a clear comparative advantage. If we follow this course, the experience of nations around the world clearly illustrates that will be rewarded with higher rates of economic growth.

6. Concluding Comments

In the traditional Solow [neoclassical] model increased taxation as well as increased saving and investment only have transitory effects on the rate of growth, while the economy moves toward the new higher steady-state equilibrium. In this type of model growth depends solely on exogenous technological change, leaving no role for changing economic policies and institutions in explaining changing long-run growth rates. The

neoclassical model assumes perfect competition, constant returns to scale, and the absence of externalities. In contrast, the rapidly expanding literature on endogenous growth highlights the fact that if productivity is to increase year after year, the economy must continuously provide the workforce with more "tools." By tools the theorists mean a very broad concept of reproducible capital including physical capital, human capital, and knowledge capital (technology).

Endogenous growth theory directs our attention to the only way by which government can affect long-run growth, namely via its impact on investment in machines, skills and technology. To the extent that capital and labour taxation deter such investments they reduce growth. Similarly, public expenditure that deter such investments by creating additional marginal tax wedges over and beyond those induced by the taxes required financing these programs, or that reduce incentives to save and accumulate capital in other ways, reduce growth in these models.

Not all studies find a growth-enhancing effect of public capital and there is more of a consensus in the recent literature than in the older literature as summarized by Sturm et al(1998). Furthermore, according to most studies the impact is much lower than found by Aschauer (1989), which is generally considered to be the starting point of this line of research.

Empirical studies of growth and government spending indicates that there is a negative correlation between growth and government consumption/GDP ratio. However, if government spending is for productive purposes the correlation becomes positive.

Using these regressions to decide how to foster growth we must consider that he results are not absolute. Simultaneity, multicollinearity, limited degrees of freedom are important practical problems for anyone trying to draw inferences from international data.

In addition, we must consider that there is heterogeneity: the effect of public investment differs across countries, regions, and sectors. We are able to show that allowing for heterogeneity across countries is also very important for policy purposes, average results for groups of countries tend to disguise large differences between countries.

The network character of public capital, notably infrastructure, causes non-linearity. The effect of new capital will crucially depend on the extent to which investment spending aims at alleviating bottlenecks in the existing network. Some studies also suggest that the effect of public investment spending may also depend on institutional and policy factors.

This empirical paper uses annual data for 58 countries for 11 years period to study the link between fiscal policy and economic growth. The relation between initial income and economic growth changes in proportion to the data. When we use data from OECD countries the relation tends to be negative and linear (with tendecy to convergence). While when we use data from all or Non-OECD countries the relation is clearly non linear, takes a third order polynomial form and appears convergence only on subgroups.

Conversely, the relation between private investements and economic growth is always positve and significant, and shows how robust this variable is.

With reference to governement expenditure our regression analysis implies that, although a smaller public sector can be good for growth, it is necessary to look beyond size, the composition and quality/efficiency of the public sector are equally important. The policy lesson is that a smaller government share in GDP, a reallocation of funds away from the wage bill to public investment, and an improvement in government quality/efficiency can become engines of long-term growth. Regardless of the methodology or model, it appears that government spending is associated with weaker economic performance.

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Appendix I: Graphs

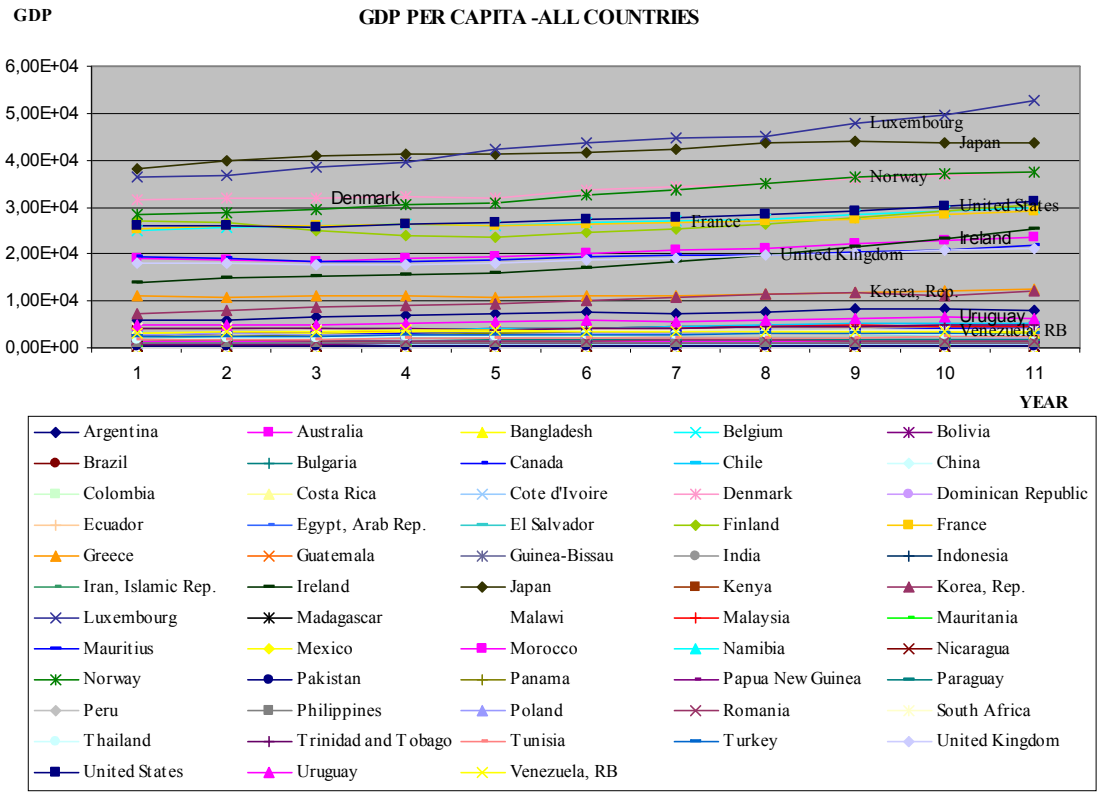

Figure 1: All Countries – GDP per capita (1985-1995)

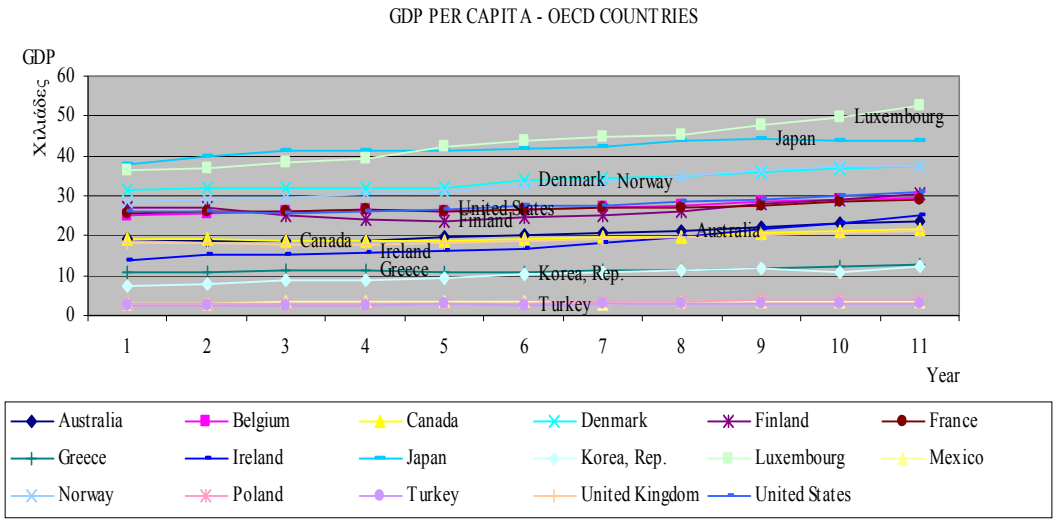

Figure 2: OECD Countries – GDP per capita (1985-1995)

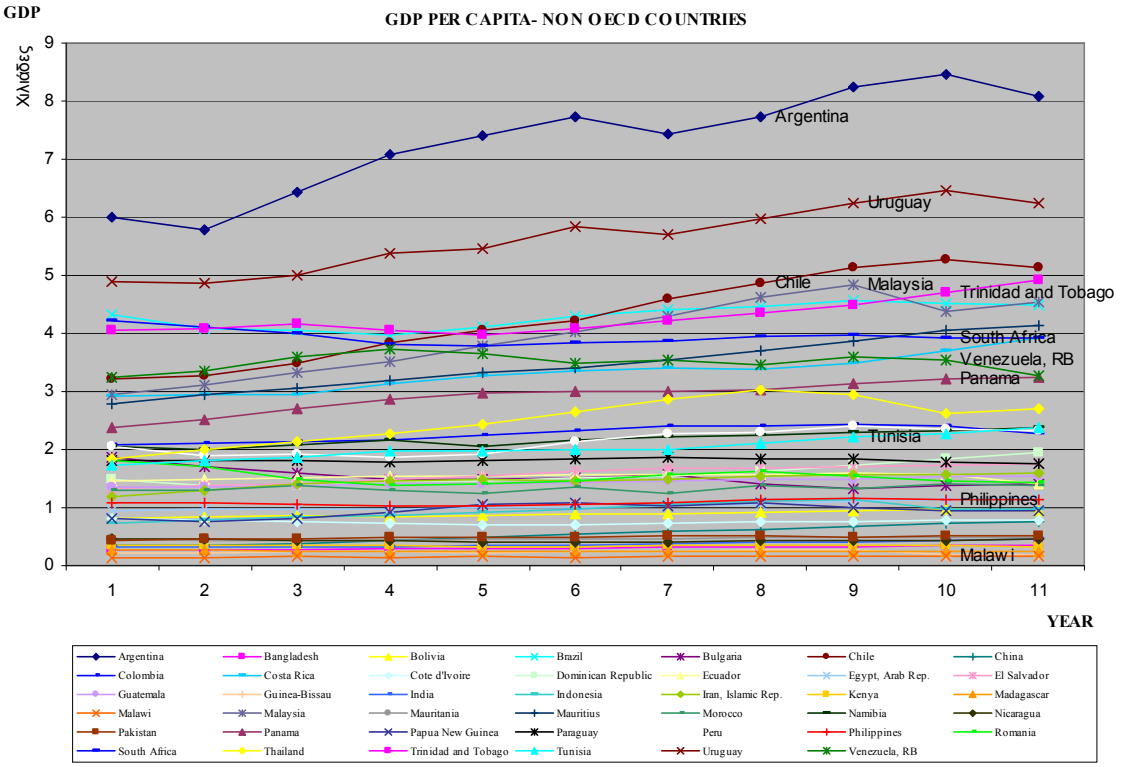

Figure 3: Non-OECD Countries – GDP per capita (1985-1995)

List (Countries):

	Non OECD	OECD
1	Argentina	Australia
2	Bangladesh	Belgium
3	Bolivia	Canada
4	Brazil	Denmark
5	Bulgaria	Finland
6	Chile	France
7	China	Greece
8	Colombia	Ireland
9	Costa Rica	Japan
10	Cote d'Ivoire	Korea, Rep.
11	Dominican Republic	Luxembourg
12	Ecuador	Mexico
13	Egypt, Arab Rep.	Norway
14	El Salvador	Poland
15	Guatemala	Turkey
16	Guinea-Bissau	United Kingdom
17	India	United States
18	Indonesia	
19	Iran, Islamic Rep.	
20	Kenya	
21	Madagascar	
22	Malawi	
23	Malaysia	
24	Mauritania	
25	Mauritius	
26	Morocco	
27	Namibia	
28	Nicaragua	
29	Pakistan	
30	Panama	
31	Papua New Guinea	
32	Paraguay	
33	Peru	
34	Philippines	
35	Romania	
36	South Africa	
37	Thailand	
38	Trinidad and Tobago	
39	Tunisia	
40	Uruguay	
41	Venezuela, RB	

Appendix II: Historical data

Growth in Rich Countries Since 1950

Observations:

In past surveys we have seen that a usual developed country growth rate of 2% implies a doubling of y in 35 years. Therefore, each generation can enjoy double the living standard of their parents. The Asian Tigers (Singapore, Taiwan, South Korea etc..) had g=8% (up early 1990s) where standard of living doubles in 10 years. China in the 1990s had g=13% where standard of living doubles in 7 years. But there are countries in which growth is negligible (doubling of y in 500 years in parts of Africa)

The standard of living has increased significantly since 1950. Growth rates of output per capita have decreased since the mid-1970s. In particular, 1950-1973 4.4% (y doubles every 16 years) 1973-1998 1.9% (y doubles every 37 years). There has been convergence, that is, the levels of output per capita across the five countries have become closer over time. Countries with lower levels of output per capita in 1950 have typically grown faster.

Here are the three basic facts about growth in rich countries since 1950:

The large increase in the standard of living

The decrease in growth since the mid-1970s

Convergence of output per capita

Looking Across Two Millennia

There is agreement among economic historians about the main economic evolutions over the last 2,000 years: From the end of the Roman Empire to roughly year 1500, there was essentially no growth of output per capita in Europe. From about 1500 to 1700, growth of output per capita turned positive, about 0.1% per year. Even during the Industrial Revolution, growth rates were not high by current standards. On the scale of human history, the growth of output per capita is a recent phenomenon. From the 1st Millennium until the 15th Century, China had the highest output per capita.

World economic leaders in output per capita change frequently (leapfrogging):

Italy – during Renaissance

Netherlands – 17th Century

Great Britain – 18th Century

United States – since 1870

Notation

OECD and Asian countries are converging. African countries are not converging (growth disasters). International growth experiences are very heterogeneous (miracles and disasters).