

A META-ANALYTIC STUDY OF THE ROLE OF GOVERNMENT IN LONG-RUN ECONOMIC GROWTH*

Jacques Poot

*School of Economics and Finance
Victoria University of Wellington
P.O. Box 600, Wellington
New Zealand*

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Abstract. This paper focuses on the mechanisms through which government policies can potentially influence the economy's transition towards a steady-state growth path and the steady-state rate of growth itself. Theoretical possibilities are illustrated by means of very simple and commonly used exogenous and endogenous growth models. The paper then provides a synthesis of the 1983-98 published literature on the empirical evidence regarding the interaction between government policies and growth. Five policy areas are considered: general government consumption, tax rates, education and health expenditures, defense and public infrastructure. The most conclusive results in the literature relate to the positive impact of education expenditures on growth. Public infrastructure also appears important. Regression analysis remains the most commonly adopted research methodology. A better link with current theories will be obtained when parameter calibration methods for micro-foundations based models replace parameter estimation of regression models with ad hoc specifications. Nonetheless, there will remain severe limitations on what can be learned for policy from highly aggregative models of endogenous growth. Better data are needed at the regional macro and meso levels to complement the currently available pooled cross-section time-series country data. The potential endogeneity of government fiscal variables can be resolved through the selection of appropriate instrumental variables, such as those that arise in cases of "natural experiments".

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"What is the main thing governments must do to spur economic growth? Ah, well, that remains a mystery."
(*The Economist*, March 6th, 1999, p. 84)

1. Introduction

The extent to which the government can influence the long-run growth path of the economy has intrigued economists for a long time. The rewards from identifying policies which can *permanently* raise a country's, or region's, growth rate are potentially huge, due to the exponential nature of the growth process. However, the conventional neoclassical growth model formulated by Solow (1954) and Swan (1954) provides no guidance as to how governments can influence the long-run growth rate. Yet, despite the emergence of a wide range of *endogenous* growth models, the Solow-Swan model continues to play a prominent role in thinking about growth. This model is consistent with the stylised facts of long-run growth as listed by Kaldor (1963). Nonetheless, the Solow-Swan model describes how economies approach a long-run path of steady-state growth in income per capita, but not what actually determines this steady-state growth rate itself.

Since this exogenous growth rate is traditionally called the rate of *technological* change, it is obvious that technological progress was considered the main driving force of per capita income growth. Clearly, other factors - sometimes difficult to measure - were also believed to foster economic growth, such as education, cultural factors, institutional support systems and efficient business organisation (see also e.g. Leibenstein 1976). However, as Krugman (1995), Aghion and Howitt (1998) and others have argued, strategic behaviour, product and process innovations are phenomena that are incompatible with the paradigm of perfect competition that characterised growth theorising in the 1950s. Consequently, few attempts were made at the time to endogenise the rate of technological change. From the policy perspective there was in fact no need to study technological change as long as it was primarily a private sector activity and diffusion of new advances spread readily across the world. In this case, and assuming similar preferences and open economies, countries would converge to the same level and rate of change in income per head in the long run (e.g. Nijkamp and Poot, 1998). From this perspective, policy would have the rather narrow role of "speeding up" this convergence process by ensuring that market forces would not be restricted. Hence, the removal of trade barriers, the protection of property rights, etc. would simply aid the catching-up process, but would have no consequence for the long-run growth rate.

New developments in modelling dynamic general equilibrium in the economy led to a wave of new models of growth, commencing with those described in the seminal articles by Romer (1986) and Lucas (1988). Problems that would have emerged from the imperfect competition associated with innovative activities were resolved, for example in a model of expanding product variety by Romer (1987) through the adoption of Dixit and Stiglitz's (1977) theory of monopolistic competition in markets with product diversity.

Another feature of the new growth literature is that economic agents are forward looking and expected to respond relatively smoothly to jumps, shocks and long wave phenomena. Structural changes in this case lead to an evolutionary rather

than a “revolutionary” transition path. This perspective is reinforced by the current literature on evolutionary and complexity economics (see also Nijkamp and Reggiani 1998).

The new growth literature mattered from the policy perspective because it gave prominence to the external benefits associated with the accumulation of knowledge through education or innovation. The growth path coinciding with the socially *optimal* resource allocation of workers and firms to such activities, and the *market equilibrium* growth path are not the same in the presence of externalities. Moreover, the endogenous growth models generate long-run growth rates as functions of several parameters, some of which can be influenced through policies by means of, for example, "subsidies to schooling" or "industrial policies focussing on picking winners" (Lucas 1988, p. 31). The theoretical literature is summarised extensively in a range of surveys (e.g. Jones and Manuelli 1997; Klenow and Rodriguez-Clare 1997; and Nijkamp and Poot 1998) and in the books by Barro and Sala-i-Martin (1995) and Aghion and Howitt (1998).

Facilitated by the emergence of large data sets on macroeconomic characteristics of most countries of the world (e.g. Kravis et al. 1978; Summers and Heston 1991; International Monetary Fund, various years, World Bank, various years), a parallel development has been a new wave of empirical studies of the determinants of growth. In contrast with the growth accounting methods used by Denison (1967) and others during the 1960s, the new growth studies employed almost exclusively regression models to identify the determinants of growth. While much of the empirical research on growth during the last decade used *cross-country* data, in recent years there has been a rapidly expanding literature on *regional* growth and convergence, with the articles by Barro and Sala-i-Martin (1992) and Sala-i-Martin (1996) providing a major impetus.¹

Many of the empirical studies of the "engines of growth" include government-related variables such as tax rates, government size, indicators of law and order, etc. The purpose of the present paper is to assess whether there are any robust findings from this, by now vast, literature that would be of benefit for gaining new perspectives on policies for *regional* development. With this aim, the paper does not address the impact of the removal of trade barriers, the implications of monetary policy, social security programs, law and order measures and the institutional structure.² Instead the focus is solely on *fiscal* policies, i.e. public consumption and investment and the revenues required to finance such activities. Moreover, most of theories and the empirical analyses of endogenous growth literature take a purely *macroeconomic* perspective (even when the theoretical model has solid micro foundations) and this is therefore also the approach adopted in this paper.

¹ A quick search of the EconLit database showed that, even when limiting the search to 1997 and 1998 only, there were more than 25 articles published in refereed economic journals specifically on the topic of regional convergence. The studies covered sub-national regions in a wide range of countries across the world.

² A particularly interesting question is whether the trend towards greater liberalisation in many countries has raised economic growth through a greater total factor productivity (TFP) growth. An interesting case study in this context is the New Zealand experience, given that its economic reform program has been the most extensive in the OECD. Recent studies show that the reforms indeed appear to have slightly raised long-run TFP growth, but that there are major differences across sectors (see Lawrence and Diewert 1999 and Kleinveld 1999).

Despite this narrower focus than might be desirable for operational models of specific issues in development, the consideration of endogenous growth theories from a regional perspective permits an emphasis on *openness* in the space economy. For example, factor movements may lead to a faster tendency towards spatial convergence. Furthermore, the consideration of governance systems in a multiregional setting can be useful to see how public and institutional forces affecting growth are spatially interdependent, see e.g. the fiscal federalism debate and the issue of territorial competition (see Poot 1999).

The next section provides some theoretical perspectives on the relationship between public sector activities and long-run growth in exogenous and endogenous growth models. The section also comments briefly on the difficulties in testing empirically the hypotheses that emerge from the theoretical models. Section three comments on the trends that have been observed in recent decades regarding the role of government in the economy and the actual growth experience. The section reviews the major empirical findings regarding the interaction between these phenomena on the basis of a literature search among post-1982 published articles. The summary of information on each paper can be found in the Annex. Key conclusions from organising this literature in a way that has attempted to identify robust results are provided. The final section provides some concluding remarks.

2. How government could influence the growth rate

In most market-oriented economies, there has been during the last two decades a trend towards greater reliance on market forces and less government involvement in the economy. This trend towards greater economic liberalism resulted from the widespread belief that the extent of government intervention in the economy had become detrimental to the objectives of allocative efficiency and long-run growth (e.g., Osterfeld 1992). Yet, national, regional and local governments continue even in the more liberal environment to influence the economy in at least seven different ways. Firstly, governments remain responsible for pure public goods such as defense, general administration and public infrastructure. Secondly, even in the presence of independent central banks, government's budgetary decisions influence monetary conditions. Thirdly, taxes and duties affect market prices. Fourthly, governments may own and control enterprises and other organisations that provide quasi-public or private goods that are deemed to have external benefits to society (e.g. education and health services) or that are natural monopolies (such as sewage treatment and the electricity distribution network). Fifthly, regulations, controls and economic instruments (such as auctions) enable the protection of property rights (through the enforcement of law and order) or enhance allocative efficiency in the presence of externalities (such as due to environmental damage). Sixthly, income redistribution through taxes and social security premiums aims to create a more equitable society and to provide a safety net for those adversely affected by market outcomes. Finally, (local) government acts as an intermediary or facilitator in markets with asymmetric and imperfect information, e.g. to reduce unemployment or enhance investment opportunities.

Nevertheless, it has to be recognised that the role of government as a “pure” regulator of the economy has considerably diminished in recent years. We observe more diffuse roles of government departments and agencies at the interface of the private sector and the public sector. The effectiveness of the interaction between these two sectors may in itself form a critical success factor for (regional) economic policy.

The above listing of seven areas of influence of government in the economy is useful to emphasise that even in models in which long-run productivity growth is considered exogenous, government is still likely to influence the actually observed level of income and the growth rate during the *transitional* phase towards the steady state. This can be easily illustrated by means of the Solow-Swan model, of which we will, for the sake of clarity, reiterate the essentials here. Central to this model is the existence of a macroeconomic production function

$$Y(t) = F (K(t), L(t) e^{xt}) \quad (1)$$

where $Y(t)$ is final real output, $K(t)$ is the stock of capital at time t , $L(t)$ is labour employed (growing at the exogenous rate n) and e^{xt} represents the effect of exogenous labour-augmenting technical progress. Since production is assumed to have constant returns to scale, equation (1) can be rewritten as

$$\hat{y} = f(\hat{k}) \quad (2)$$

where the symbol $\hat{\cdot}$ denotes a quantity per effective unit of labour $L(t)e^{xt}$. We shall assume that $f(\cdot)$ has the usual “well-behaved” properties, formalised in the Inada (1963) conditions. If the rate of depreciation of capital is a fraction δ of the stock, net investment is given by

$$\dot{K} = Y - C - \delta K \quad (3)$$

where $\dot{\cdot}$ denotes a derivative with respect to time and C is the level of consumption. Under these assumptions, we can derive the following equation of motion for the amount of capital per effective unit of labour \hat{k} :

$$\dot{\hat{k}} = f(\hat{k}) - \hat{c} - (n+x+\delta) \hat{k} \quad (4)$$

If it is assumed that households save a constant fraction of income s , equation (4) simplifies to the so-called *fundamental growth equation*:

$$\dot{\hat{k}} = s f(\hat{k}) - (n+x+\delta) \hat{k} \quad (5)$$

It is straightforward to show that given the assumptions made, any initial resources $K(0)$ and $L(0)$, and the dynamics described by (5), the economy will converge to a steady-state path asymptotically. In the steady state, the quantities \hat{y} , \hat{k} and \hat{c} do not change and the steady-state value of \hat{k} , \hat{k}^* , is found by solving

$$s f(\hat{k}^*) = (n+x+\delta) \hat{k}^* \quad (6)$$

Alternatively, savings behaviour can be made endogenous. In the so-called Ramsey model (see e.g. Barro and Sala-i-Martin 1995), it is assumed that households maximise the net present value of the discounted total household utility derived from per capita consumption in the future. In this case, it can be shown by dynamic optimisation methods that under certain conditions, and with a commonly assumed utility function, a steady state exists. The steady state \hat{k}^* can be found as the solution to

$$f(\hat{k}^*) = \delta + \rho + \theta x \quad (7)$$

where ρ is the discount rate and $-\theta$ is the assumed constant elasticity of marginal utility $u'(c)$ with respect to c .

In either case, it is possible for governments to affect the actual growth rate observed during the *transition* to the steady state and the per capita income level in the steady state, if its actions have a bearing on the production function $Y=F(K,L)$, on the rate of depreciation δ or on the rate of population growth n . Moreover, government policies may also affect savings behaviour, either through s in the Solow-Swan model or through the “preferences” parameters ρ and θ in the case of the Ramsey model.

These points are further clarified by explicitly considering a specific production function, such as the Cobb-Douglas production function. In this case, equation (1) becomes

$$\hat{y} = A\hat{k}^\alpha \quad (8)$$

This makes explicit the two additional parameters A and α , which could potentially be influenced by government policies. The growth rate of per capita income can be expressed as follows:

$$\frac{\dot{y}}{y} = \alpha \frac{\dot{\hat{k}}}{\hat{k}} + x \quad (9)$$

Substituting (5) and (8) into (9), and recalling that $s = I/Y$, we find

$$\frac{\dot{y}}{y} = \alpha \left[\frac{I}{Y} A\hat{k}^{\alpha-1} - (n + x + d) \right] + x \quad (10)$$

Given (8), it is clear that the transitional growth rate of per capita income rises with a greater profit share α , *ceteris paribus*. It also rises with increases in the efficiency parameter A . Moreover, a lower \hat{k} , i.e. a lower level of current income, implies a higher rate of return to capital $f'(\hat{k}) = \alpha A\hat{k}^{\alpha-1}$ and hence a higher growth rate (the so-called “catching-up” effect). For a given rate of return, the growth rate will also be higher, the higher the investment ratio I/Y . Furthermore, the growth rate will be inversely related to the population growth rate n and to the rate of depreciation. Finally, the transitional growth rate of income per head will be higher when the rate of technological change (also referred to as the rate of total factor productivity (TFP) growth), x , is higher. The long-run growth rate will converge to x as long as α is less

than one. Thus, government action is likely to affect the transition to the steady state, but not the steady state itself, unless there is a direct impact of government policies on the productivity growth rate x .

Despite the simplicity of the neoclassical model expressed by equation (10), it has identified two determinants of the growth process that have indeed turned out to be robust predictors of observed per capita income growth in cross-country regressions. They are the investment ratio (affecting income growth positively) and population growth (affecting income growth negatively), see e.g. Levine and Renelt (1992) and Dowrick and Nguyen (1989). However, much of the empirical literature ignores the endogeneity of the investment ratio, specifically its relationship with entrepreneurial expectations (likely to be related to past growth experiences) and the rate of return to capital.

The reduced form of the simplest class of endogenous growth models is identical to a special case of (10), namely the case in which $\alpha=1$. Given the model described above, $\alpha=1$ implies that $Y = A K$. The $Y = A K$ model emerges when the rate of TFP growth x is endogenised in certain ways. As noted by Aghion and Howitt (1998), Frankel (1962) appears to be the first to have formulated such a model. Frankel assumed that the level of TFP is positively related to the capital-labour ratio with a constant elasticity. However, endogenous growth models with the $Y = A K$ reduced form became well known with the influential contribution by Romer (1986). Romer assumed that capital accumulation generated publicly available improvements in technology that would offset the diminishing returns to private capital. The result is a growth path with constant, or even increasing, returns. In these types of models, the long-run growth rate is positively related to the propensity to save and to the scale of the economy (number of firms or the size of the labour force).

There are also a wide range of models in which the production function is still of the form (1), but in which there are spillover benefits from education, endogenous R&D, learning by doing, etc. A simple example that is a direct extension of the Solow-Swan model is the model of endogenous R&D described by Nijkamp and Poot (1997). In their model, the production function (1) is replaced by the slightly more general form

$$Y(t) = F (K(t), L(t) T(t)) \quad (1a)$$

and technical knowhow $T(t)$ is produced in the R&D sector with a constant returns to scale production function

$$\dot{T} = H\left(\frac{R}{L}, T\right) \quad (11)$$

with the resources devoted to R&D being a fraction r of income, i.e. $R = r Y$. It is then straightforward to derive that the fundamental growth equation (5) changes to

$$\hat{k} = sf(\hat{k}) - [n + h(rf(\hat{k})) + d]\hat{k} \quad (12)$$

in which the function $h(\cdot)$ is the per unit of knowhow equivalent of $H(\cdot, \cdot)$. This model has the property that when the production function is Cobb-Douglas, an increase in r will lead to a *permanently* higher per capita growth rate even when $\alpha < 1$. Given the

public good nature and non-appropriability of new knowledge, governments tend to play a major role in the R&D process and can influence in this simple endogenous growth model the long-run growth path via the parameter r .

Many models that have been formulated in recent years provide precise micro-level descriptions of how firms and households generate technological change. These include models that analyse the impact on growth of learning-by-doing, knowledge spillovers, an expanding variety of products, innovation diffusion and factor mobility - see Barro and Sala-i-Martin (1995) for an overview. Another class of models formalises the Schumpeterian ideas of product quality improvements through "new combinations" and "creative destruction". This strand of the literature is described extensively in Aghion and Howitt (1998). In the latter models innovations emerge stochastically at a rate that depends on the research budget. Innovations have positive spillovers in terms of greater knowhow and incomes, but also a "business stealing" effect through the destruction of rents captured by owners of patents on previous innovations.

In both classes of endogenous growth models, the equilibrium growth rate may not be equal to the Pareto-optimal growth rate. In the case of external benefits to human or physical capital accumulation, the equilibrium growth rate will be *below* the socially-optimal growth rate, but in the Schumpeterian models growth may be *excessive* under laissez-faire.

It is obvious that much empirical research at meso and micro-levels is needed to test the empirical plausibility of the micro-foundation of endogenous growth models. Such evidence has started to emerge in recent years. For example, Caballero and Jaffe (1993) provide support for the Schumpeterian model.

Whether or not long-run growth is ultimately constrained by diminishing returns to reproducible factors is an important issue for policy. The case of constant returns may be considered a reasonable description of the growth process when capital is interpreted broadly, i.e. when it is assumed to include human capital. Given the model described above, $\alpha=1$ implies that $Y = A K$ and equation (10) reduces to

$$\frac{\dot{y}}{y} = \frac{I}{Y} A - n - d \quad (13)$$

It is clear from (13) that a *permanent* change in investment (and savings) behaviour, population growth, the rate of depreciation and the efficiency parameter A now have a *permanent* effect on the long-run growth rate.

It is possible to "explain" the long-run growth path with suitable, but reasonably plausible, parameter values in either equation (10) or in (13). For example, assume that $x = 0.02$, $I/Y = 0.24$, $A = 0.25$, $n = 0.01$, $d = 0.03$ and $r = 0.05$. Substituting these parameters in (13) gives a per capita income growth of 0.02 (2 percent), i.e. equal to x .

Consider now a small increase in the investment ratio from 0.24 to 0.25. If the economy evolves according to (10), per capita income will temporarily grow a little faster than 2 percent, but converge again on the 2 percent rate. In the case of (13) the growth rate increases *permanently* to 2.25 percent. With a discount rate of five percent, the net present value of this quarter percent increase in the GDP growth rate is huge. It can be easily shown to be about three times total current income.

Given the potentially large impact of government policies in endogenous growth models, statistical verification of the impact of exogenous shocks in government policy-related variables on growth is an important empirical issue. Kocherlakota and Yi (1997) define the growth process to be endogenous when, in a regression of growth rates on current and lagged policy variables, the sum of the slope coefficients for each policy variable is nonzero. Using time series spanning up to 100 years for the United States and 160 years for the United Kingdom, they find that when both a tax variable and a public capital variable are included in the regression, there is evidence of endogenous growth. Kocherlakota and Yi (1997) find that their results are consistent with a production function that exhibits constant returns to scale in reproducible inputs, i.e the $Y = AK$ model.

Glomm and Ravikumar (1997) provide by means of the discussion of an illustrative model with several extensions a broad survey of micro-foundations based endogenous growth models which explicitly take government expenditures into account. Specifically they consider the impact of public provision of infrastructure such as roads, airports or public sector R&D. They also consider the impact of public education expenditure.

Technically, the illustrative model used by Glomm and Ravikumar (1997) is an overlapping generations model, which goes back to e.g. Diamond (1965). In contrast, many other authors use infinitely-lived optimising agent models, of which the Ramsey model is a simple case. The former are somewhat easier to solve, the latter are easier to link to empirical research. Yet qualitatively similar results can be derived with both types.

To fund public infrastructure or public education, Glomm and Ravikumar introduce a tax on wage and interest income. The government budget is assumed balanced in each period. The main conclusion of their model is that there is a concave relationship between the tax rate and the long-run growth rate and that the growth-maximising tax rate is exactly equal to the output elasticity of public infrastructure or human capital.

An important issue in this context is that government policy itself is likely to be endogenous. This is not a problem if one can assume that government is a benevolent agent who aims to maximise the utility of the representative household. However, if households do not have identical preferences, majority-based voting rules can lead to a sequence of tax rates that is not optimal.

The endogeneity of government may also be due to the "taste" for public spending. The demand for public services is likely to be income elastic. This is referred to in the literature as Wagner's Law (see Wagner 1883, 1890). This law, combined with the inelastic price elasticity for public services is responsible for the growth in the share of government spending as a proportion of income (also referred to as the "size" of government) that has been commonly observed among developed economies during the post-war period.

Rodrik (1998) found recently that, all else being equal, government size is bigger in more open economies. He attributes this to governments in open economies acting as an insurer against the exposure of domestic firms to external risk. Economies with the strongest terms of trade risk tend to have the largest relative government size.

The impact of government spending in endogenous growth models can be easily illustrated by means of the $y = A k$ model. Consider an economy with a consumption, investment and public sector. Hence, in per capita terms

$$y = c + i + g \quad (14)$$

Government spending evolves according to Wagner's Law, that is,

$$g = \tau(y) y \quad (15)$$

whereby $\tau(y)$ is bound between zero and one and evolves towards a long-run steady state value of τ^* . A possible function is depicted in Figure 1.

Private consumption is related to disposable income according to a long-run consumption function. Under the assumption of a balanced public budget, disposable income is $y - \tau y$ and the consumption function is

$$c = \gamma (y - \tau(y) y) \quad (16)$$

Similar to Glomm and Ravikumar (1997), it can be assumed that the productivity of private capital has a concave relationship with the tax rate $\tau(y)$. A possible relationship is depicted in Figure 2. A problem with this conceptualisation is that government expenditures are often designed to enhance public *welfare* rather than *measured* national income. For example, the relationship shown in Figure 2 may well be different if, for example, the impact of government expenditures on environmental protection is included in the measure of national output.

Ignoring depreciation, $i = k$. It is then straightforward to derive the following equation for the endogenous growth rate

$$\frac{\dot{y}}{y} = A(\tau(y))(1 - \mathbf{g})(1 - \mathbf{t}(y)) \quad (17)$$

Differences between the regions and countries in terms of the steady-state growth in per capita income can then be related to differences in the steady-state tax rate τ^* .

It is easy to see that the effect of an increase in the tax rate τ^* can be positive or negative:

$$\frac{d\left(\frac{\dot{y}}{y}\right)}{dt} = \frac{dA}{dt} (1 - \mathbf{g})(1 - \mathbf{t}) - A(1 - \mathbf{g}) \quad (18)$$

A higher tax rate lowers the growth rate due to the consumption effect, but the productivity gains effect resulting from the corresponding public expenditures may be stronger for relatively small tax rates.

Equation (17) has some implications for empirical research: in cross-section growth regressions, the coefficient of the tax rate is likely to vary between different "clubs" of countries. In time-series research, we expect the coefficient of the tax rate to be time-varying, turning eventually negative. Finally, we expect country and time fixed effects in pooled cross-section time series analyses to be significant.

Against a background of frequently inconclusive empirical results, the question therefore emerges whether regularities and generalisations can be made by means of comparative cross-country research findings. Modern meta-analysis may in this case be

helpful to pinpoint commonalities in explanatory frameworks, not only theoretically or methodologically, but also empirically and in terms of policy analysis.

In the next section, a first attempt is made at such a meta-analysis by categorising, and assessing the relative strengths, of empirical findings on the relationship between government and growth.

3. The interaction between government policies and growth in practice

One of the key features of macroeconomic development in the post-war period has been the growth of government at national, regional and local levels. Table 1, reproduced from Gwartney et al. (1998), shows that among OECD countries total national government outlays as a percentage of GDP have nearly doubled over the 1960-96 period. The growth of government was particularly rapid during the 1960-80 period. Subsequently, the growth of government declined and in some countries there has been a reversal of the long-run trend, particularly since 1990. Coinciding with the growth of government since 1960, there has been growth in real per capita income in OECD countries due to long-run economic growth. Hence, it appears that the s-shaped curve depicted in Figure 1 provides a reasonable stylised representation of the actual experience of OECD countries. It is possible that in some countries government size has “overshot” to beyond τ^* , leading to the downward adjustment that we are now observing in small open economies such as New Zealand, Norway and Ireland.

At the aggregate level, government size and the annual growth rate of real GDP are inversely related. This can be seen from Figure 3, also reproduced from Gwartney et al. (1998). The way in which the data are represented in Figure 3 suggests a monotonically declining relationship between the government share of expenditures on GDP and the annual growth rate. This is undoubtedly partly due to the choice of countries, the level of aggregation and the choice of time period. Scatter diagrams of the relationship between economic growth and government size reported in Slemrod (1995) for the period 1970-90 show a far less convincing downward slope. Yet, if the economic growth process is consistent with the $Y = AK$ model and the relationship between size of government and growth continues to hold after controlling for other factors that affect the growth rate (such as the initial income level), a relationship between A and τ (and therefore also between the growth rate and τ) such as depicted in Figure 2 may emerge (with a relatively small value of τ being optimal).

However, simple correlations provide no evidence of causation. The observed relationship in Figure 3 may be entirely due to the fact that low income countries have a low preference for public consumption (i.e. Wagner’s law), while such countries grow faster due to the high rate of return to capital at a low level of per capita income. Besides causality at the macro level, the *composition* of public expenditure is also likely to be of great importance.

Consequently, the relationship between government and growth can not be studied properly without a formal theoretical framework, suitable cross-section and/or time series data and appropriate econometric methods. Empirical research in this area has been a relatively recent phenomenon. Landau (1986) remarked that "There are virtually no empirical studies of the general impact of government on economic growth. An extensive literature search turned up only three papers" (p.35)³ However,

³ This search naturally covered the pre-1985 period. Of the three papers mentioned by Landau, one was an IMF working paper and excluded from the database due to the self-imposed restriction of only including refereed articles. The other two papers are included.

since the mid 1980s there have been many empirical analyses of the relationship between government and growth, either as a by-product of e.g. tests of conditional convergence, or to address the issue explicitly. From this vast literature of several hundred published and unpublished papers, a selection of 93 published articles from the period 1983-98 was made. These papers are listed and summarised in the Annex.

All the selected articles have been published in refereed international journals in the English literature. Being cited in later research was also a criterion for inclusion. With a few exceptions, most empirical studies reported in books of edited papers, papers published in working paper series and papers in languages other than English have been excluded. However, by focusing specifically on relatively high-quality commonly cited papers, it was felt that useful generalisations could be made from this body of knowledge. The synthesis attempted here undoubtedly suffers from publication bias (e.g. Begg 1994) in that significant findings are likely to be more prominent in the papers summarised here than in the excluded papers. However, the ultimate objective of the exercise is to assess the difference in robustness of the findings across different areas of government behaviour and it is not clear that publication bias would systematically differ across these different areas.

The articles were classified in three different ways: the spatial level (national or regional), the method of analysis and the area of government activity (or nature of hypothesis to be tested). With respect to the method of analysis, there are four categories: cross-section regression analysis (CS), time-series regression analysis (TS), pooled cross-section time-series regression analysis (CSTS) and other methods. With respect to the impact of government on growth, five types of effects were considered: general government consumption in relation to overall GDP (also referred to as government size), tax effects, educational and health effects, defense effects and infrastructure effects. For each study, the time period considered and the number of countries or regions included in the analysis are also reported in the Annex.

Before a discussion of specific results, it is useful to point out some general features in this body of research. Firstly, the vast majority of studies have used standard regression techniques. Ordinary Least Squares (OLS) has been the most commonly adopted technique. The suitability of this method (i.e. the extent to which the standard linear regression model is appropriate for the given data) was rarely tested by means of diagnostic statistics. Moreover, many studies paid scant attention to the problem of potential simultaneity bias, or to the possibility of heteroscedasticity in cross-section data.

There has been an increasing use of pooled cross-section time-series data, as the availability of such data has improved. This is a welcome trend, as the CSTS studies show that region and period fixed effects are important. In TS studies, we see in recent years a growing use of vector autoregressions, Granger causality tests and the cointegration framework.

The dearth of studies that adopt a dynamic simulation modeling approach is rather surprising. Our sample of 93 studies includes only two studies that have adopted a calibration/simulation approach, namely Van Sinderen (1993) and Berthélemy et al. (1995). There appear to be few studies that have adopted a computable general equilibrium (CGE) model approach. A recent exception is Kim (1998), who modelled the effects of transportation investment on the Korean economy. The likely reason for an absence of *multi-sectoral* CGE models in the study of government and growth is that such models have been primarily used to consider the comparative-static impact of fiscal changes on the allocation of resources in the economy. To assess the impact of

fiscal changes on growth by means of multi-sectoral computable CGE models would require dynamic models with forward-looking agents. Such models are at present in their infancy due to computational complexities.

Klenow and Rodriguez-Clare (1997) suggest nonetheless that a tighter link between theory and evidence regarding economic growth can be achieved by following the methodology common in the business cycle literature, that is, the calibration of parameter values by simulations that aim to replicate properties of the macroeconomic data. Such an approach is definitely also feasible with respect to models of long-run growth, as long as data for a sufficiently long time span are available. In this respect, it is an additional weakness of many past regression studies that these purport to provide information on long-run growth, but use only observations over a relative 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, e.g. because of a complementarity with certain types of private capital that may, for various reasons, only be undertaken at a slow rate. In this case it may be very hard to detect the effect of an additional amount of public investment compared with the (unobservable) counterfactual.

In an influential paper, Levine and Renelt (1992) use Extreme Bounds Analysis (EBA) to show that many of the results from CS regression analyses of the determinants of long-run growth are not robust. However, their conclusion does not appear to have discouraged others from continuing to carry out CS regression analyses, although TS and CSTS analyses have become far more prominent in recent years. Levine and Renelt find that in multivariate growth regressions using combinations of a wide range of macroeconomic indicators, the only robust correlation is between growth and the share of investment in GDP.

If most economies are in a transitional phase rather than on the long-run steady-state path, such a correlation between the investment ratio and the growth rate is clearly demonstrated by equation (10) above. However, we would also expect that economic conditions and policies that affect population growth, the depreciation of the capital stock and TFP growth to play a role. Yet Levine and Renelt found that none of a wide range of fiscal policy indicators were robustly correlated with growth.

Sala-i-Martin (1997) criticised Levine and Renelt for using a too severe test of robustness. Assessing instead the robustness of a variable by the probability that the coefficient is on one side of zero in the cumulative distribution function of the regressions which include this variable, Sala-i-Martin finds that 22 out of 59 possible determinants of growth are "significant". Interestingly, no measure of government spending (including investment) is among these 22 variables.

Virtually all studies of government and growth are *primary* analyses, in the sense of the terminology introduced by Glass (1976). Each study has rather unique features in terms of the specification of the model, the sample of countries or regions considered, the time period of observation and the range and definitions of the variables used. Few authors have carried out replications or extensions of earlier research (i.e., *secondary* analysis). Cases of secondary analysis among the articles in the Annex are Rao (1989), Eisner (1991) and Mohammed (1993).

However, *tertiary analysis* in the form of a survey is more common. There have been several surveys/syntheses of the empirical research. The ones included in the Annex are Lindgren (1984), Grobar and Porter (1989), Munnell (1992), Sala-i-Martin (1994), Dunne (1996) and Glomm and Ravikumar (1997). Among the articles included

in our sample, there is only one example of *meta-regression* analysis, namely Button (1998).

A final general finding from the publications included in the Annex is that most of the studies on the relationship between government and growth have focused on government at the national level and have consequently used country data. Only about one fifth of the studies reported in the Appendix use regional data.

Table 2 reports the studies that have focused on the impact of government consumption on economic growth. This is the most commonly studied issue in this context, 38 studies were included in the table. The usual measure of government consumption or “size” is the ratio of public expenditures over GDP. A weakness of the studies 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. Few studies also provide a disaggregated analysis, that is, a comparative analysis of the impact on growth of various types of government consumption, such as general administration, health, education, R&D etc. Since some of these are a form of investment while others are “true” consumption, the impact is likely to differ between categories. For example, Devarajan et al. (1996) find that an increase in the share of current public expenditure has a positive impact on growth, while the relationship between the capital component of public expenditure and growth appears to be negative. In this paper, the impact of government size (including or excluding capital expenditure) is considered separately from the impact of public infrastructure. A further breakdown would be desirable. For example, the impact of public R&D expenditure is an issue that warrants a separate investigation.

The use of total government consumption as an explanatory variable may be responsible for the relatively large number of studies that suggest an insignificant effect. However, the majority of studies that did detect a significant effect, found this effect to be negative. Hence, a broad conclusion from Table 2 is that “big government” appears to be detrimental to growth. Table 7 provides a comparative probability statement (based on frequencies in the table cells) of this hypothesis in relation to the others considered below and shows that the evidence for this conclusion is rather weak compared with other areas of government influence.

A remarkable weakness of various regression studies of the effects of government consumption and taxes is that many such studies do not take the implications for the government budget constraint into account. An increase in government spending or taxes has implications for public debt that are likely to affect the behaviour of firms and households so that the revenue and cost side of budgetary decisions should be considered simultaneously. In a time-series context, Kocherlakota and Yi (1997) show that a failure to do so leads to inconclusive results.

Studies of tax effects are somewhat less common than studies of expenditure effects on growth. Table 3 shows that among the 9 studies listed in the table there were no studies that found higher tax rates to be associated with higher economic growth. Instead, there appears to be empirical support for the hypothesis that higher taxes lower growth and this is particularly true for studies that focus on *marginal* rather than *average* tax rates, such as Garrison and Lee (1995).

Table 4 classifies 13 studies on the impact of education and/or health expenditure on long-run growth. The impact of health expenditure on growth and productivity of the work force appears to be a rather neglected area. Only one study,

Singh and Weber (1997), discussed evidence of the impact of health expenditure on growth. These authors found that public health care expenditure had a negative impact on the long-run growth rate.

Most of the 13 studies included in Table 4 provide support for the hypothesis that education has a positive impact on growth. Despite this, it is very hard to derive a *quantitative* generalisation of the impact of education due to the fact that the studies use a wide range of statistical proxies to measure the level of education of the work force or actual educational expenditure by government. For example, Barro (1997) found that an extra year of upper-level average schooling of the male work force is estimated to raise the growth rate by 1.2 percentage points per year. In contrast, Hansson and Henrekson (1994) measure the impact of an increase in the share of educational expenditure on GDP growth.⁴ Others, such as Evans and Karras (1994) compute the elasticity of private output with respect to spending on educational services. They find that the elasticity of gross private nonagricultural output with respect to current educational services is about 0.04 with a standard error of 0.02. Baffes and Shah (1998) compare the output elasticity of human resource-development capital with that of private capital. Their data suggest that the average output elasticity of human resource-development capital is 0.62, more than twice as much as that of the private capital stocks. Yet, despite these measurement and methodological differences, Table 7 shows that the evidence on the positive link between growth and education appears the most conclusive relative to the other areas of government influence.

Another relatively well-researched topic is the impact of defense expenditure on growth. Lindgren (1984) surveyed 41 empirical studies between 1968 and 1984. Dunne (1996) reports on 54 studies between 1973 and 1996 of economic effects of military expenditure in LDCs. Another example of research synthesis in this area is Grobar and Porter (1989). The process of (nuclear) disarmament, the break-up of the Soviet-Union and the emerging new global order have provided a new impetus for research on the relationship between defense spending and growth. The central question is whether the end of the arms race generated a so-called *peace dividend* in the form of higher economic growth, particularly in developing countries (e.g. Gleditch et al. 1996). However, the balance of the evidence of the 22 studies reported in Table 5 is rather inconclusive. While there were more studies suggesting that defense spending is detrimental to growth rather than the opposite, Table 7 shows that the probability that a randomly selected study (from the sample considered here) suggested a negative impact of greater defense spending was about 0.5.

The final area of public expenditure considered in this paper is public infrastructure. Table 6 classifies 34 papers on this topic. There are broadly two types of studies on this topic. The first type, which is the more common, compares the productivity of public capital such as roads, dams, airports etc. with the productivity of private capital. The often-cited articles by Aschauer (1989a, 1989b, 1989c) provided a major boost to research in this area. Button (1998) discusses a meta-analysis of studies that aim to estimate the output elasticity of public capital. The second approach is to consider the impact of the flow of current government expenditures on infrastructure. With either approach, the evidence is relatively strongly supportive of a positive impact of infrastructure on growth. Table 7 shows that in total about three quarters of the studies on the relationship between infrastructure and growth suggest a positive

⁴ They find that an increase in the share of educational expenditure in GDP by one percentage point would increase the rate of total factor productivity growth by 0.28 percent per annum.

impact. After the impact of education and health, this is the relatively most conclusive body of research. However, it is also here hard to make firm quantitative generalisations. Button (1998) reports a range of output elasticities of between 0.03 and 0.39. These elasticities appear to be related to the level of geographic aggregation. The output elasticity of public capital becomes less, the smaller the geographical area that acts as the unit of observation. As noted by Munnell (1992), the most obvious reason for this that due to leakages, small regions cannot capture all of the payoff to infrastructure investment. Moreover, any dynamic spillover effects may also be primarily reaped by the rest of the economy.

4. Conclusions

This paper reviewed some of the mechanisms through which government policies can potentially influence the economy's transition towards a steady-state growth path and the steady-state rate of growth itself. Theoretical possibilities were illustrated by a comparison of some simple and commonly used exogenous and endogenous growth models. The empirical evidence for the link between government and growth was assessed by a synthesis of a sample of 93 published post-1983 articles in refereed journals. Five policy areas were considered: general government consumption, tax rates, education and health expenditures, defense and public infrastructure. It was found that the most conclusive results in the literature relate to the positive impact of education expenditures on growth. Public infrastructure also appears important.

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. For example, several models have been developed that describe explicitly the impact of R&D expenditure and the diffusion and adoption of innovations in a multi-regional context (see e.g. Nijkamp et al. 1991, Nijkamp and Poot 1993), but these and many other models of endogenous growth, such as those described in Aghion and Howitt (1998), still require rigorous empirical scrutiny. Research at the industry level may also be a promising avenue. For example, Arora et al. (1998) report on empirical studies of the critical success factors in innovation and growth of the chemicals industry. Such studies suggest that issues such as the encouragement of free enterprise, and the protection of law and order may play a role. These factors were considered in some of the empirical growth analyses reported in the Annex, e.g. Barro (1997), but have not been explicitly tabulated here.

In any case, it is possible that more can be learnt from parameter calibration methods for micro-foundations based models than from parameter estimation of regression models with ad hoc specifications. However, there remain severe limitations on what can be learned for policy from highly aggregative models of endogenous growth. Better data are needed at the regional macro and meso levels to complement the commonly used pooled cross-section time-series country data of macro economic conditions and growth.

Another area that needs further attention is the potential endogeneity of government expenditure itself. It was noted earlier that the size of government is related to the stage of development and the openness of the economy. In addition, the size and nature of government will depend on political, institutional and cultural aspects of society. If growth regressions continue to have policy variables on the right hand side, special efforts should be made to find suitable instrumental variables to avoid biased policy variable coefficients. Potential candidates could be certain

demographic, geographic or political features of countries and regions (see also Slemrod 1995).

Finally, there are at least two, less conventional, avenues for research that potentially could provide new insights into the links between government and growth. The first of these is a more in-depth meta-analytic assessment of the type of data contained in a literature data base such as the one given in the Annex. While there may be difficulties in carrying out conventional meta-regression with this type of data (given the wide variety of policy measures such as illustrated earlier in the case of human capital), other meta-analytic techniques, e.g. rough set analysis, may provide a promising new avenue (see for example Nijkamp and Pepping 1998 for an example of this technique).

Alternatively, it has been found in micro-economic research that so-called *natural experiments* may be a useful means of deriving new results. One field where such an approach is quite common is labour economics, e.g. in the study of the impact of education on earnings by means of the analysis of a sample of twins (e.g. Ashenfelter and Krueger 1994). Much of this research is at the micro-level, but occasionally macro-level natural experiments emerge also. For example, one can try to assess the impact of immigration on the local economy after a sudden and large influx of refugees (e.g. Card 1990). Consequently, it may be fruitful to search for case studies of relatively large policy shocks at the local or regional levels and to assess the impact on growth of such shocks by comparison with a “control group” of regions which were not exposed to the shock, but which are otherwise similar. For example, with respect to public consumption or investment, one could consider the local or national impact of government expenditure induced by natural disasters.

In summary, the commonly observed *observational equivalence* of competing theoretical models of the macro-economy, make it unlikely - as many authors have noted - that much can be learned from additional cross-country growth regressions. However, alternative approaches such as those outlined above may shed more light on ways in which a public claim on resources and other forms of intervention in the market economy remain essential for sustainable growth in the standard of living.

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Landau (1985) G & I *16 developed countries, 1952-76, CSTS* Increased government expenditure is correlated with the slowdown in growth in per capita product. Both consumption and investment expenditures by government exhibit the negative correlation with growth, but transfers do not.

Saunders (1985) G *23 OECD countries, 1960-81, CS* The results provide little evidence that government size and expansion have been detrimental to economic performance, particularly for 1975-81, although an inverse relation existed in the sixties between government size and economic growth.

Biswas and Ram (1986) D *58 LDCs, 1960-77, CS* Outcomes differ between studies because of different specifications, sampling variation and time periods. There is no consistent statistically significant connection between military spending and economic growth.

Landau (1986) G *96 countries, 1960-80, CSTS* There is a negative relationship between the share of government consumption expenditure (excluding military and educational expenditure) in GDP and the growth of per capita GDP. Government capital development expenditure appears to do nothing to accelerate economic growth. Private investment has a noticeable positive impact on economic growth, especially when compared with public investment. Foreign official (government) aid shows no net positive impact on growth. Private foreign transfers generally have a positive impact on economic growth.

Ram (1986) G *115 countries, 1960-80, CSTS* The overall impact of government size on growth is positive in almost all cases. The (marginal) externality effect of government size is generally positive (in the 1970s stronger than in the 1960s).

Canto and Webb (1987) T *48 contiguous US states, 1957-77, TS (replicated for each state)* The results suggest that state and local taxes have a significant and negative effect on the growth in state income.

Da Silva Costa, Ellson and Martin (1987) I *48 contiguous US states, 1972, CS* Labour and public capital are complementary inputs, and public capital exhibits diminishing returns. The ratio of public to private capital is negatively related to the output elasticity of public capital. Scale elasticities are greater for rich than for poor states.

Bairam (1988) G *New Zealand, 1960-80, TS* An increase in government expenditure accelerates business investment (and eventually economic growth).

Grossman (1988) G *Australia, 1949-84, TS* The impact of government-related variables on economic growth depends on the specification of the model. The relative size of the government bureaucracy, and special interest legislation appear to have no significant impact on economic growth.

Aschauer (1989a) I *G7 countries, 1966-85, CSTS* There exists a strong, positive correlation between various productivity measures and public non-military capital expenditure. Public capital is a vital ingredient in the recipe for economic growth and rising standards of living.

Aschauer (1989b) I *United States, 1949-85, TS* The non-military public capital stock is dramatically more important in determining productivity than the military capital stock and the flows of non-military or military spending. A “core” infrastructure of streets, highways, airports, mass transit, sewers, water systems, etc. has most explanatory power for productivity. A 1% increase in the ratio of public to private capital stocks raises total factor productivity by 0.39%.

Aschauer (1989c) I *United States, 1953-86, TS* An increase in public investment may be expected to reduce private investment nearly one to one. However, public infrastructure complements private capital in the production and distribution of private goods and services, leading to higher profitability. The net effect of a rise in public investment expenditure is to raise private investment.

Grier and Tullock (1989) G *113 countries, 1950-81, CSTS* The growth of government consumption is significantly negatively correlated with economic growth in three of four subsamples, including the OECD. There is no positive association between inflation and growth, but there is a significant negative relationship between inflation variability and growth.

Grobar and Porter (1989) D *Literature survey of 29 studies, 1972-88* Models that allow military spending to affect growth through multiple channels find that, while the effect through some channels is positive, the net effect is negative. The most important negative effect is that higher military spending reduces national savings rates, thereby reducing rates of capital accumulation.

Gyimah-Brempong (1989) D *39 Sub-Saharan African countries, 1973-83, CSTS* Defense expenditure has indirectly a significantly negative effect on economic growth through its effects on investment rate and the supply of skilled labor to the civilian economy.

Koester and Kormendi (1989) T *63 countries, 1970-79, CS* Negative effects of tax rates on growth disappear upon controlling for (1) potential endogeneity of average tax rates to per capita income and (2) the catching-up effect of low income levels on growth. Controlling for average tax rates, increases in marginal tax rates have negative effects on the level of economic activity but not on the growth rate.

Rao (1989) G *115 countries, 1960-80, CRSA & TS* The results of Ram (1986) are of limited significance because causation at best is bidirectional in a few countries, and there is little direct evidence to support the type of causation implied in the Ram model.

Scully (1989) G *115 countries, 1960-80, CRSA* Nations with relatively large government shares in 1960 grew more slowly over 1960-80 than nations with relatively small state sectors. The rise in the size of the government had a substantial depressing effect on economic growth. The size of the government share was negatively correlated with economic efficiency and inter-period change in economic efficiency.

Bairam (1990) G *20 African countries, 1960-85, TS (replicated for each country)* The effects of government expenditure on economic growth differ from country to country and they cannot be generalized.

Grossman (1990) G *48 countries, 1970-83, CS* The effect of government growth on economic growth is positive, but at the margin approximately offset by distortionary effects attendant with increases in the relative size of the government.

Mullen and Williams (1990) I *29 US Standard Metropolitan Statistical Areas, 1963-66, CS* The coefficient of infrastructure (in the form of highways) is not significantly related to changes in total factor productivity in the manufacturing sector of urban areas.

Munnell (1990a) I *United States, 1949-87, TS* Much of the decline in multi-factor productivity growth during the 1970s in the U.S. is a result of a decline in the growth of public capital.

Munnell (1990b) I *48 contiguous US states, 1970-86, CS* The public capital elasticity is about 0.1. If public capital is taken to be only highways and streets, the elasticity is 0.06 and when public capital is taken to be water and sewer systems, the elasticity is 0.12. With respect to regions, estimates range from 0.07 for the Northeast U.S. to 0.36 for the South.

Barro (1991) EH&G&I *98 countries, 1960-85, CS* Growth is inversely related to the share of government consumption in GDP, but insignificantly related to the share of public investment. Growth rates are positively related to measures of political stability and inversely related to a proxy for market distortions. The growth rate of real per capita GDP is positively related to 1960 school enrolment rates and negatively related to the initial level (1960) of real per capita GDP. Countries with higher human capital have lower fertility rates and higher ratios of physical investment to GDP.

Chowdhury (1991) D *55 developing countries, 1961-87, TS (Granger causality tests)* The relationship between defense spending and economic growth cannot be generalised across countries.

Eisner (1991) I *48 contiguous US states, 1970-86, CS (re-analysis of Munnell 1990b)* The cross-section results do indicate a significant and substantial association between public capital and state output. However, the causality is not clear.

Hulten and Schwab (1991) I *9 large US regions, 1970-86, CSTS & Growth accounting* There is no significant relationship between growth in regional public capital and growth in regional multi-factor productivity.

Moomaw and Williams (1991) EH & I *48 contiguous US states, 1954-76, CS* Government spending on transportation infrastructure and education are important in explaining both differences in total factor productivity across states and growth rates in total factor productivity.

Yu, Wallace and Nardinelli (1991) T *50 US states, 1929-85, CS (for various sub-periods)* Catching up provides the most powerful explanation for differing state growth rates. State taxes have a negative impact, but are only weakly significant.

Levine and Renelt (1992) EH&G *83-101 countries (World Bank/IMF data), 1960-89; 86-103 countries (Summers-Heston data) 1960-85, CS* A positive and robust correlation between growth and the share of investment in GDP, also between the investment share and the ratio of international trade to GDP. None of a broad array of fiscal indicators and a large assortment of other economic and political indicators are robustly correlated with growth or the investment share.

Lynde and Richmond (1992) I *Unites States, 1958-89, TS* Public capital is a significant input in a translog cost function and has a positive marginal product. Public and private capital are complements in production, rather than substitutes.

Munnell (1992) I *Literature survey of 38 published and unpublished papers, 1973-92* Public infrastructure investment has a significant and positive effect on output and growth.

Bajo-Rubio and Sosvilla-Rivero (1993) I *Spain, 1964-88, TS (cointegration analysis)* The stock of public capital plays an important role in affecting private sector productivity.

Binswanger, Khandker and Rosenzweig (1993) I *85 districts in India, 1960-81, CS* The agricultural output elasticity with respect to road investment is about 0.2. Some of the effects of improved roads on output are lagged and indirect. Improved roads induce commercial bank expansion, which in turn accelerates investment and therefore generates growth.

Durden and Elledge (1993) G *US states, 1982-93, CS* Higher levels of government employment levels generally have a positive and significant effect on gross state product, with state and local employment levels having apparently greater influence. The positive influence of absolute government size may be offset by a negative relationship between GSP growth and the relative size of government.

Easterly and Rebelo (1993) I&T *100 countries, 1970-88, CS* There is a strong association between the development level and fiscal structure. Poor countries rely heavily on international trade taxes, while income taxes are only important in developed countries. The scale of the economy, measured by its population, influences fiscal policy. Investment in transport and communication is consistently correlated with growth. The effects of taxation are difficult to isolate empirically.

Lynde and Richmond (1993) I *US nonfinancial corporate sector, 1958-89, TS* Services of public capital are an important part of the production process. About 40 percent of the productivity decline is explained by a fall in the public capital-labour ratio.

Mohammed (1993) D *39 Subsaharan countries, 1973-83, CSTS (re-analysis of Gyimah-Brempong 1989)* The results are weak and the defense burden/growth rate multiplier is not statistically significant.

Park (1993) D *Korea, 1963-87, TS* The relationship between defense spending and economic growth is not significant. The growth effect of defense spending may be positive when there is significant slack in the economy, or it may be negative when there is no slack in the economy.

Sattar (1993) G *13 developing Asian countries, 3 Asian NICs, 8 industrial market economies (incl. Japan), CS* There is evidence of a significant linkage between government and growth in developing Asia, but not in the NICs or in 8 of the leading market economies of the world.

Sheehy (1993) G *102 countries, 1960-1980, CSTS* The effect of government expenditure on growth ranges from significantly positive to significantly negative, depending on the relative size of the government sector and on the initial level of per capita GDP.

Van Sinderen (1993) T *The Netherlands, 1985, simulation with a macroeconomic model* Balanced budget restrictions in taxes on wages and profits exert favourable effects on employment and growth. The relative impact depends on the specific government outlays and taxes which are cut back.

Assane and Pourgerami (1994) G *10 CFA-zone African countries and 23 non-zone Sub-Saharan African countries, 1970s and 1980s, CS* Government spending has negative effects on output growth. Monetary expansion and capital formation have positive impacts on output growth.

Evans and Karras (1994) D&EH&G *48 contiguous US states, 1970-86, CSTS* Current government educational services are productive but there is no evidence that the other government activities are productive. Government capital has often statistically significant negative productivity.

Hansen (1994a) G *11 OECD countries, 1966-88, CSTS* The effect of government growth (weighted by the share of government spending in GDP) is insignificant.

Hansen (1994b) G *New Zealand, 1968-91, TS* The effect of the government sector on the rate of growth of the economy is insignificant.

Hansson and Henrekson (1994) EH, G, I *14 industries in 14 OECD countries, 1970-87, CS* Government transfers, consumption and total outlays have consistently negative effects, while educational expenditure has a positive effect, and government investment has no effect on private productivity growth.

Holtz-Eakin (1994) I *48 contiguous US states, 1969-86, CSTS* Production functions that use standard techniques to control for unobserved state-specific characteristics reveal no role for public sector capital in affecting private sector productivity.

Hsieh and Lai (1994) G *G7 countries, 1885-1987, TS (time series span varying between countries)* No consistent evidence is found that government spending can increase per capita output growth, neither is there consistent support for the negative argument.

Kusi (1994) D *77 countries, 1971-89, TS (Granger causality tests)* The relationship between economic growth and defense spending cannot be generalized across countries. The results depend on the sample period of study and the level of socioeconomic development of the country concerned.

Lee and Lin (1994) G *114 countries, 1960-85, CS* When demographic variables (such as young and old age dependency variables, the population size and population density) are included in regression models, the effect of government expenditure share on economic growth becomes insignificant rather than significantly negative. There is a strong positive relationship between population density and economic growth. Demographic variables affect not only the rate of economic growth but also determine the size of government.

Lin (1994) G *20 ADCs and 42 LDCs, 1960-1985, CS* Government size (measured by the rate of change in the share of government consumption spending in GDP) has a positive impact on economic growth in the short-run, but not in the intermediate-run (25 years).

Sala-i-Martin (1994) EH&G *Literature survey of 12 studies based on cross-sectional analysis* There is ample evidence of conditional convergence at a slow rate. Growth is significantly correlated with the investment rate and with the level of education of the work force. Government policies affect growth. The data are not fine enough to tell whether policies of financial repression, trade distortions or price distortions are causing this correlation.

Andrews and Swanson (1995) I *48 contiguous US states, 1970-86, CSTS* Public capital can have an indirect impact on output by increasing the marginal product of private capital. The impact of investment in public capital on the private sector is positive but small (due to state specific effects).

Berthélemy, Herrera and Sen (1995) D *India and Pakistan, 1972, Calibrated simulation model* A major economic consequence of excessive military expenditure could be growth retardation due to insufficient resources being available for human capital development. A reduction in Pakistan's military expenditure relative to GDP would increase the steady-state level of aggregate welfare. Steady state growth could potentially rise significantly if India could reduce its defense burden.

Chletsos and Kollias (1995) D *Greece, 1974-90, TS* Military spending in Greece appears to stimulate consumption, which is least partially offset by a crowding out of investment. The overall effect is inconclusive.

Garrison and Lee (1995) G&T *67 countries, 1960-87, CS* There is no evidence that countries which pursue macroeconomic policies that result in high inflation, large budget deficits, and high levels of government consumption spending suffer low rates of growth in per capita output. There is weak evidence for a negative effect of high marginal tax rates on growth.

Holtz-Eakin and Schwartz (1995) I *48 contiguous US states, 1971-86, CSTS* Raising the rate of infrastructure investment would have had a negligible impact on annual productivity growth between 1971 and 1986.

Karikari (1995) G *Ghana, 1963-84, TS* The impact of government on economic growth was unambiguously negative. The positive externality effects of public goods were overwhelmed by the inefficiency in their supply.

Macnair, Murdoch, Pi and Sandler (1995) D&G *10 NATO allies, 1951-88, CSTS* An increase in nondefense public spending has a greater impact on growth than a decrease in defense spending. The overall net stimulant to the economy of NATO from the peace dividend is anticipated to be modest (less than 0.5 % growth from a 10% cut in defense).

Andrés, Doménech and Molinas (1996) G *24 OECD countries, 1960-90, CSTS* The public sector size and the public surplus are found to be weakly correlated with growth. Public consumption is insignificant. The inflation rate and growth of money supply are significant when exports and the first difference of inflation is included.

Devarajan, Swaroop and Zou (1996) G&I *43 developing countries, 1970-90, CSTS* An increase in the share of current public expenditure has positive and statistically significant growth effects. The relationship between the capital component of public expenditure and per-capita growth is negative. Expenditures, which are normally considered productive, could become unproductive if there is an excessive amount of them.

Dunne (1996) D *Literature survey of 54 studies, 1973-96* Military spending has at best no effect on growth. It is likely to have a negative impact, certainly there is no evidence of a positive effect. This suggests that disarmament can indeed provide an opportunity for improved economic performance.

Harmatuck (1996) I *United States, 1949-85, TS* Aggregate output elasticity of net non-military public investment is about 0.03, as opposed to 0.39 in Aschauer (1989b).

Kocherlakota and Yi (1996) D&I&T *United States, 1917-88, TS* The innovations to policy variables in endogenous growth economies can lead to permanent changes in GNP levels. Of the seven U.S. policy variables examined, only non-military equipment capital and non-military structural capital (and several components thereof) have a statistically and economically significant effect upon long-run GNP levels. The non-military equipment capital result is not robust.

Morrison and Schwartz (1996) I *Manufacturing in 48 contiguous US states, 1970-87, CSTS* Infrastructure investment provides a significant return to manufacturing firms and augments productivity growth. The net benefits of infrastructure investment may or may not be positive, depending upon the social costs of infrastructure investment and the relative growth rates of output and infrastructure.

Roux (1996) D *South Africa, 1960-90, TS* The military burden had a negative effect on economic growth between 1960-1990.

Wylie (1996) I *Canada, 1946-91, TS* Infrastructure, especially public infrastructure, has had a significant and positive role to play in national economic growth and productivity.

Ansari and Singh (1997) EH *India, 1951-87, TS (Granger causality tests)* Even though public spending on education may not cause national income directly, it can still influence national income indirectly through capital formation. An unanticipated shock to public spending on education had a considerable positive effect on national income in India.

Barro (1997) EH&G *100 countries, 1960-90, CSTS* The growth rate of real per capita GDP is enhanced by better maintenance of the rule of law, smaller government consumption, and lower inflation.

Brumm (1997) D *88 countries, 1974-89, CS* The military expenditures share of GDP has a statistically significant positive impact on the growth rate of per capita GDP. The growth rate of real GDP per capita is positively correlated with the average investment share of GDP and the secondary school enrolment rate, and negatively correlated with the population growth rate and the initial level of real GDP per capita. The negative economic climate created by a government in disarray is found to lower the growth rate of real GDP per capita.

Glomm and Ravikumar (1997) EH&I *Literature survey of 31 papers, 1983-94* There are two types of influences of productive government expenditures on long-run growth: through the production function for final output (infrastructure) and through investment technologies (expenditures on education). Public health may also have a large impact on long-run growth.

Guseh (1997) G *59 middle-income developing countries, 1960-85, CSTS* Growth in government size has negative effects on economic growth in developing countries, but the negative effects are three times as great in nondemocratic socialist systems as in democratic market systems.

Kocherlakota and Yi (1997) T&I *US 1891-1991; UK 1831-1991, TS* Exogenous growth is usually rejected when both a tax variable and a public capital variable are included in the regression. At the aggregate level, the production function appears to exhibit constant returns to scale in reproducible inputs. Government policy can have permanent effects on growth rates.

Kollias and Makrydakis (1997) D *Turkey, 1954-93, TS (Granger causality tests)* Results reveal the absence of any causal ordering between military expenditure and growth in the case of Turkey.

Lau and Sin (1997) I *United States, 1925-89, TS* The evidence is unfavourable to the endogenous growth model with public infrastructure. The estimated elasticity of output with respect to public capital is 0.11.

Odedokun (1997) I *48 developing countries, 1970-90, CSTS* Infrastructural public investment facilitates private investment (especially in the long run), promotes economic growth and efficiency. Non-infrastructure investment does the reverse. Long-term effects of public investment tend to be much more positive than short-term ones.

Singh and Weber (1997) EH *Switzerland, 1950-94, TS* Expenditures on education and health care have respectively positive and negative permanent effects on long-run growth. Higher spending on transport infrastructure and defense appear to exert a temporary influence.

Baffes and Shah (1998) D&EH *21 countries, 1965-84, CSTS* Developing countries can improve their growth performance by adopting economic strategies that foster education and training, as well as private capital formation, while limiting military spending.

Button (1998) I *Literature survey and meta-analysis of 28 studies, 1973-94* The body of evidence available regarding the impact of infrastructure on productivity is far from conclusive. However, surveys which have concentrated on North American research may have been underestimating output elasticities in many parts of the world.

Cronovich (1998) G *30 countries, 1970-90, CS* Government spending has several opposing effects on growth. After netting out relative wage effects, government spending is significantly positively correlated with growth across countries. Relative wage effects appear to be empirically important in countries where (a) government spending comprises a sufficiently large share of aggregate spending and (b) government spending is particularly human capital-intensive.

Sanchez-Robles (1998) I *sample 1: 57 countries across the world, 1970-85 and 1980-92; sample 2: 19 Latin American countries 1970-85, CS* Public capital has a positive impact on the growth rate of output during the transition to the steady state. Public investment in some countries may suffer from a lack of efficiency.

Zhang and Zou (1998) G *28 provinces in China, 1978-92, CSTS* A higher degree of fiscal decentralization of government spending is associated with lower provincial economic growth over the past 15 years. This is consistently significant. The association between central government development spending and economic growth is positive and significant. Provincial government development spending is negatively associated with growth.

**Table 1 Total Government Outlays as a Percentage of GDP:
OECD Countries, 1960-1996**

Country	1960	1970	1980	1990	1996	Increase 1960-96
Australia	21.2	25.5	34.0	37.7	37.5	16.3
Austria	35.7	39.2	48.9	49.3	52.7	17.0
Belgium	34.5	36.5	50.7	54.6	54.5	20.0
Canada	28.6	35.7	40.5	47.8	46.4	17.8
Denmark	24.8	40.2	56.2	58.6	60.8	36.0
Finland	26.6	31.3	36.6	46.8	59.4	32.8
France	34.6	38.9	46.1	49.9	54.7	20.1
Germany	32.4	38.6	48.3	45.7	56.0	23.6
Greece	17.4	22.4	30.5	49.6	49.4	32.0
Iceland	28.2	29.6	32.2	39.9	37.3	9.1
Ireland	28.0	39.6	50.8	40.9	37.7	9.7
Italy	30.1	34.2	41.9	53.8	52.7	22.6
Japan	17.5	19.3	32.6	31.9	36.9	19.4
Luxembourg	30.5	33.1	54.8	45.5	49.3	18.8
Netherlands	33.7	46.0	57.5	57.5	58.1	24.4
New Zealand	27.7	34.4	47.0	50.0	42.3	14.6
Norway	29.9	41.0	48.3	51.3	46.4	16.5
Portugal	17.0	21.6	25.9	41.9	46.0	29.0
Spain	13.7	22.2	32.9	43.0	45.4	31.7
Sweden	31.0	43.7	61.6	60.8	66.1	35.1
Switzerland	17.2	21.3	29.3	30.9	36.9	19.7
United Kingdom	32.2	39.2	44.9	42.3	43.7	11.5
United States	28.4	32.5	33.7	34.8	34.6	6.2
Average	27.0	33.3	42.8	46.3	48.0	21.0

Source: Gwartney et al. (1998)

Table 2: The Impact of Government Consumption on Long-Run Growth

	<i>Cross-Section Regression Analysis</i>	<i>Time-Series Regression Analysis</i>	<i>Pooled Cross-Section / Time-Series Regression Analysis</i>	<i>Other Methods</i>
<i>Significantly Positive Effect</i>	Grossman (1990) Cronovich (1998)	Bairam (1988) Sattar (1993)	Ram (1986) Macnair, Murdoch, Pi and Sandler (1995) Devarajan, Swaroop & Zou (1996)	
<i>Significantly Negative Effect</i>	Landau (1983) Saunders (1985) Scully (1989) Barro (1991) Durden & Elledge (1993) Assane & Pourgerami (1994) Hansson & Henrekson (1994)	Karikari (1995)	Landau (1985) Landau (1986) Grier & Tullock (1989) Barro (1997) Guseh (1997)	
<i>Inconclusive/ No Effect/ Complex Effects</i>	Gemmell (1983) Kormendi & Meguire (1985) Rao (1989) Levine & Renelt (1992) Lee & Lin (1994) Lin (1994) Garrison & Lee (1995)	Grossmann (1988) Bairam (1990) Hansen (1994b) Hsieh & Lai (1994) Rao (1989)	Sheehey (1993) Evans & Karras (1994) Hansen (1994a) Andrés, Doménech & Molinas (1996) Zhang & Zhou (1998)	Sala-i-Martin (1994)

Table 3: The Impact of Taxes on Long-Run Growth

	<i>Cross-Section Regression Analysis</i>	<i>Time-Series Regression Analysis</i>	<i>Pooled Cross-Section / Time-Series Regression Analysis</i>	<i>Other Methods</i>
<i>Significantly Positive Effect</i>				
<i>Significantly Negative Effect</i>	Yu, Wallace & Nardinelli (1991) Garrison and Lee (1995)	Canto & Webb (1987) Kocherlakota & Yi (1997)	Helms (1985)	Van Sinderen (1993)
<i>Inconclusive/ No Effect/ Complex Effects</i>	Koester & Kormendi (1989) Easterly & Rebelo (1993)	Kocherlakota & Yi (1996)		

Table 4: The Impact of Education and/or Health Expenditure on Long-Run Growth

	<i>Cross-Section Regression Analysis</i>	<i>Time-Series Regression Analysis</i>	<i>Pooled Cross-Section / Time-Series Regression Analysis</i>	<i>Other Methods</i>
<i>Significantly Positive Effect</i>	Landau (1983) Barro (1991) Moomaw & Williams (1991) Hansson & Henrekson (1994)	Ansari & Singh (1997) Singh & Weber (1997)	Evans & Karras (1994) Barro (1997) Baffes and Shah (1998)	Sala-i-Martin (1994) Glomm and Ravikumar (1997)
<i>Significantly Negative Effect</i>		Singh & Weber (1997)		
<i>Inconclusive/ No Effect/ Complex Effects</i>	Levine & Renelt (1992)			

Table 5: The Impact of Defense Spending on Long-Run Growth

	<i>Cross-Section Regression Analysis</i>	<i>Time-Series Regression Analysis</i>	<i>Pooled Cross-Section / Time-Series Regression Analysis</i>	<i>Other Methods</i>
<i>Significantly Positive Effect</i>	Brumm (1997)		Gyimah-Brempong (1989) Macnair, Murdoch, Pi and Sandler (1995)	
<i>Significantly Negative Effect</i>	Deger & Smith (1983) Lim (1983)	Roux (1996) Kollias & Makrydakis (1997)	Faini, Annez & Taylor (1984) Cappelen, Gleditsch & Bjerkholt (1984) Evans & Karras (1994) Baffes and Shah (1998)	Lindgren (1984) Grobner and Porter (1989) Berthélemy, Herrera & Sen (1995)
<i>Inconclusive/ No Effect/ Complex Effects</i>	Biswas & Ram (1986)	Chowdhury (1991) Park (1993) Kusi (1994) Chletsos & Kollias (1995) Kocherlakota & Yi (1996)	Mohammed (1993)	Dunne (1996)

Table 6: The Impact of Public Infrastructure and/or Public Investment on Long-Run Growth

	<i>Cross-Section Regression Analysis</i>	<i>Time-Series Regression Analysis</i>	<i>Pooled Cross-Section / Time-Series Regression Analysis</i>	<i>Other Methods</i>
<i>Significantly Positive Effect</i>	Da Silva Costa, Ellson & Martin (1987) Munnell (1990b) Moomaw & Williams (1991) Binswanger, Khandker and Rosenzweig (1993) Easterly & Rebelo (1993) Kocherlakota & Yi (1996) Sanchez-Robles (1998)	Ratner (1983) Aschauer (1989b) Aschauer (1989c) Munnell (1990a) Harmatuck (1996) Lynde & Richmond (1992) Lynde and Richmond (1993) Bajo-Rubio & Sosvilla-Rivero (1993) Wylie (1996) Kocherlakota & Yi (1997) Lau & Sin (1997)	Aschauer (1989a) Andrews & Swanson (1995) Morrison and Schwartz (1996) Odedokun (1997)	Eisner (1991) Munnell (1992) Glomm and Ravikumar (1997)
<i>Significantly Negative Effect</i>			Landau (1985) Devarajan, Swaroop & Zou (1996)	
<i>Inconclusive/ No Effect/ Complex Effects</i>	Mullen & Williams (1990) Barro (1991) Hansson & Henrekson (1994)		Holtz-Eakin (1994) Holtz-Eakin & Schwartz (1995)	Hulten & Schwab (1991) Button (1998)

Table 7 A Probability Measure of Empirical Support for Conventional Hypotheses Regarding the Impact of Fiscal Policies on Long-Run Economic Growth

Type of fiscal policy	Hypothesis	CS	TS	CSTS	Other	Total
EH	+	0.80	0.66	1.00	1.00	0.79
I	+	0.70	1.00	0.50	0.60	0.74
T	-	0.50	0.67	1.00	1.00	0.67
D	-	0.50	0.29	0.57	0.75	0.50
C	-	0.44	0.13	0.38	0.00	0.34

Figure 1 Wagner's Law.

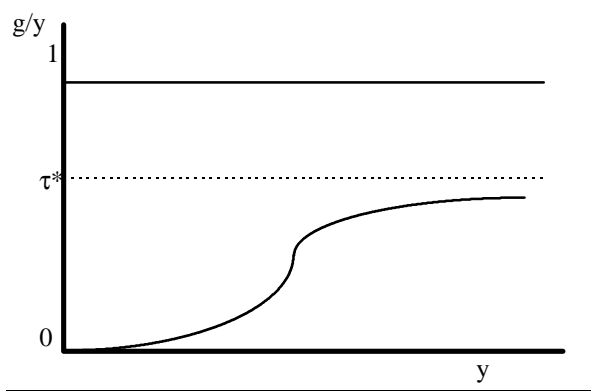
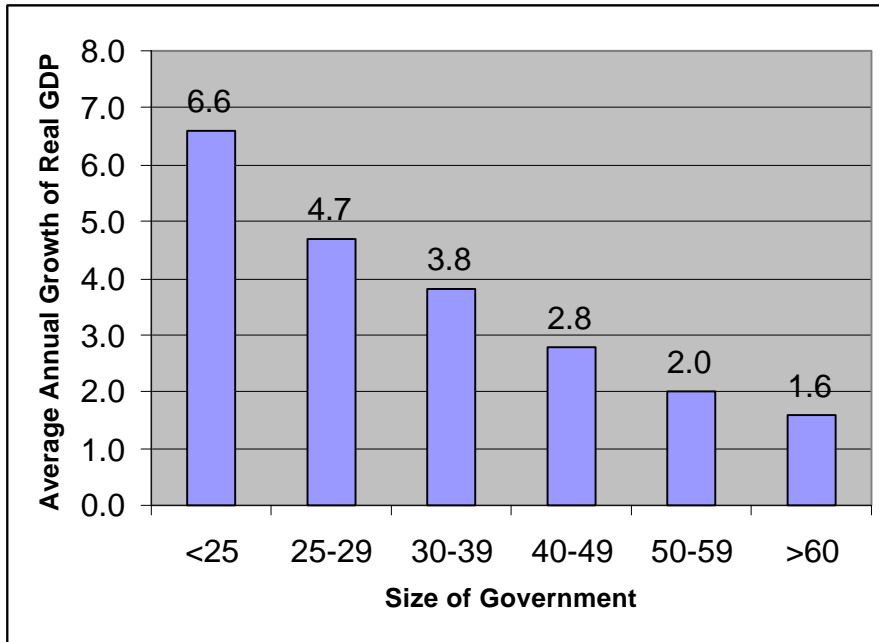


Figure 2 The Likely Relationship between the Average Tax Rate and the Productivity of Private Capital



Figure 3 **Size of Government and the Annual Growth of Real GDP in OECD Countries, 1960-1996**



Source: Gwartney et al. (1998)