7 THE ROLE OF PUBLIC SPENDING IN THE GROWTH THEORY EVOLUTION

Alexandru MINEA*

Abstract

We propose in this paper a survey over the evolution of growth theory with respect to public spending. Building on evidence from neoclassical growth models, we emphasize growth effects of public spending in the endogenous growth literature, and particularly in the Barro (1990) model with productive public spending. A final section proposes a discussion on what fundamentally changed the introduction of productive public spending in the growth theory, as well as on some future research paths.

Keywords: economic growth, public spending, government policies

JEL Classification: E62, H54, H11

Public spending represents one of the most important policy instruments for governments. Consequently, they are expected to engender large effects on economic growth. We aim in this paper to present a survey on the relationship between public spending and economic growth, and more precisely to outline the role played by public spending in the economic growth theory evolution.

The neoclassical growth model of Solow (1956), or its version in optimal growth formalized by Cass (1965) and Koopmans (1965) following previous evidence in Ramsey (1928), leaves little place for public policy to economic growth interaction. Long-term economic growth is zero (or exogenous), thus government decisions are ineffective in the long-run. Moreover, they at best leave unchanged the short-run growth rate or equilibrium levels of different macroeconomic variables, without any possibility for positive effects.

* *LEO, Faculté de Droit, d'Economie et de Gestion, Rue de Blois – B.P. 6739, 45067 Orléans Cedex 2, France; CRP Tudor and STATEC, Luxemburg. The opinions expressed in this study are those of the author and do not necessarily reflect the positions of the CRP Tudor or the STATEC.* E-mail: *alexandru.minea@univ-orleans.fr.*
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After almost thirty years of stagnation, these topics came alive following the work of Romer (1986), who constructed a model that allows for an endogenous positive long-run economic growth rate. This result generated an optimistic wave, as many studies reopened the question of public policy influence on economic growth. However, results were highly disappointing and not very different from those in exogenous growth models, since government actions were detrimental or neutral to long-run economic growth.

The Barro (1990) model constitutes without any doubt a breaking point in this evolution. By allowing for productive public spending, *i.e.* public spending that increases private capital marginal productivity, as for example infrastructure or property rights, the author identifies the existence of a positive correlation between government spending and long-run economic growth.

This result represents in fact a necessary condition in order to conduct a consistent analysis of government policies. Indeed, most of public policies that are realistic (flat-rate taxes, the use of public deficits, seigniorage financing) imply a certain form of distortion. Consequently, if these measures are not supposed to be compensated by some positive effects, there exists no uncertainty (and little interest) in the analysis, since their overall effect would be negative. The presence of growth-enhancing productive public spending allowed to stress that, for example, flat-rate taxes, persistent deficits or seigniorage financing might be desirable in terms of long-run economic growth (see, *i.e.* Minea and Villieu, 2007, 2008). Furthermore, this opens the path to numerous research projects on public policy, as we emphasize at the end of this survey.

The paper is organized as follows. Section one analyzes the correlation between public spending and economic growth in the neoclassical models, while section two presents the impressive theoretical and empirical evolution in the theory of economic growth in the mid-80's and early 90's, followed by a short presentation of the Barro (1990) model and of some of its most important extensions. Section three outlines some of the main changes provoked by the presence of productive public spending, while section four concludes.

1. An introductory case: optimal growth and public spending

In 1956 Robert Solow published "A Contribution to the Theory of Economic Growth", article for which he received the Nobel Prize in Economics in 1987[1]. Compared to his predecessors Harrod (1939) and Domar (1946), Solow establishes the conditions that allow for a full-employment stable long-run equilibrium. Few years later, Cass (1965) and Koopmans (1965), based on earlier contribution from Ramsey (1928), developed the Solow (1956) model to allow endogenous saving/consumption decision, thus expanding the optimal saving rule derived first by Phelps (1961) exclusively for the long-run[2].

[1] However, Swan (1956) separately published a model similar to Solow (1956) in both hypothesis and conclusions, which is why the model is often cited as the "Solow-Swan" model.

[2] The Phelps (1961) article on the "Golden Rule of Accumulation" is presented as a legend and describes a "Solowian" economy. Beyond the quality of the results, its beauty and elegance

The Solow model revisited: the Cass-Koopmans-Ramsey optimal growth model

The optimal growth Cass-Koopmans-Ramsey model differs from the Solow model on two aspects. First, it introduces a representative consumer-producer agent, which maximizes the discounted sum of instantaneous utility based on consumption (c_t), with $(0 < \rho << 1)$ the continuous-time discount rate:

$$\underset{\{c_t\}}{Max}\left\{U = \int_0^{\infty} \exp(-\rho t)u(c_t)dt\right\} \tag{1}$$

Second, as we can observe, consumption is no longer a residue ($c = (1-s)y$, with s the constant saving rate) as in the Solow model, but a choice variable at any moment of time t. Of course, as in the Solow model, the representative agent must respect a budget constraint:

$$\dot{k}_t \equiv dk_t / dt = y_t - c_t \tag{2}$$

Thus, the representative agent augments his (per capita) capital stock ($\dot{k}_t > 0$) in each period by the amount revenues y_t minus consumption (we suppose, without any loss of generality thorough the paper, that private capital does not depreciate and population is constant).

To resume, the representative agent maximizes his inter-temporal utility (1) under the budget constraint (2), classical initial condition for capital (k_0 given) and transversality condition, using the *current Hamiltonian*[1]. Under a typical isoelastic instantaneous utility function

$$u(c) = \frac{c^{1-1/S} - 1}{1 - 1/S}, \quad u_c = c^{-1/S} > 0, \quad u_{cc} = -\frac{1}{S}c^{-1/S-1} < 0, \quad \frac{-u_c}{cu_{cc}} \equiv S, \text{ with } S > 0$$

the constant consumption elasticity of substitution[2], the maximization problem yields the well-known Keynes-Ramsey rule (a), which, together with the IS equilibrium (b), constitute the reduced form of the model (time index will be henceforth omitted whenever unambiguous):

$$\begin{aligned} &(a) \quad \gamma_c \equiv \dot{c}/c = S(dy/dk - \rho) \\ &(b) \quad \dot{k} = y - c \end{aligned} \tag{3}$$

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were without any doubt among the reasons for which Edmund Phelps received the Nobel Prize in Economics in 2006.

[1] For more details on this method, see Barro and Sala-i-Martin (1995) Mathematical Methods Appendix and more precisely Section 1.3. Dynamic continuous time optimization.

[2] For more details on the utility function, see the introductory chapter of Aghion and Howitt (1997) or Romer (2001), as well as Blanchard and Fischer (1989).

Extension to public spending

The literature on the topic differentiates three types of public spending: productive, consumption-enhancing and wasteful[1]. We focus in this section on wasteful public spending.

Wasteful public spending represents a deadweight loss for the economy, as it has no effect on either private consumption (thus its utility) or private capital accumulation. Thus, introducing (per capita) wasteful public spending g does not change the production function $y \equiv f(k) = Ak^{\alpha}$ (with $A > 0$ the (constant) total factor productivity and elasticity $0 < \alpha < 1$, as in Cass-Koopmans-Ramsey or Solow[2]), but only the IS equilibrium:

$$\begin{aligned} &(a) \qquad \gamma_c \equiv \dot{c}/c = S\left(\alpha A k^{\alpha} - \rho\right) \\ &(b) \qquad \dot{k} = Ak^{\alpha} - c - g \end{aligned} \tag{4}$$

As (4a) does not change, private capital returns are decreasing and, consequently, output long-run growth γ (which in the long-run equalizes other variables' growth rates, *i.e.* balanced growth, $\gamma \equiv \gamma_y = \gamma_c = \gamma_k$) is zero, as in the neoclassical models.

Thus, considering wasteful public spending does not alter long-term results (zero growth and the same private capital steady-state value), except for a one-to-one crowding out on steady-state consumption c^*[3]. Finally, a zero-public spending path consumption dominates any positive-public spending path consumption at any moment of time $t \in [0, \infty)$, thus inter-temporal welfare is always higher with than without wasteful public spending.

What financing for public spending?

In the previous sub-section, we studied wasteful spending effects on growth without addressing any financing question. Let us suppose two means of financing, lump-sum taxes and flat-rate taxes on output.

With lump-sum taxes τ_t^L, the representative agent budget constraint changes to $\dot{k}_t = y_t - c_t - \tau_t^L$. However, lump-sum taxes do not depend on either consumption or capital (they are exogenous for the agents), thus they do not change first-order conditions in the Keynes-Ramsey rule, $\gamma_c \equiv \dot{c}/c = S\left(\alpha A k^{\alpha} - \rho\right)$. Under unchanged

[1] This theoretical classification must not obstruct the reader from knowing that in practice there exist intense controversies on how to classify public spending (see the General Introduction in Minea, 2007).

[2] This function is known as the "neoclassical" production function, see Inada (1963).

[3] To put it differently, higher public spending $\Delta g > 0$ diminishes long-term consumption c^* by Δg.

IS equilibrium $\dot{k} = Ak^{\alpha} - c - g$, we conclude that financing wasteful spending by lump-sum taxes does not modify previous results.

With flat-rate $\tau \in [0,1]$ taxes on output, the agent's constraint is $\dot{k}_t = (1-\tau)y_t - c_t$, thus first order conditions change to $\gamma_c \equiv \dot{c}/c = S(\alpha(1-\tau)Ak^{\alpha} - \rho)$, with unchanged IS equilibrium. In this case, long-run growth is still zero, but steady-state capital stock is lower with than without wasteful spending, decreasing even more steady-state consumption, the consumption path and inter-temporal utility. This result is the consequence of the fact that flat-rate taxes are distortionary, since they lower the private capital marginal productivity, with a negative effect on capital accumulation.

Overall, these two simple examples show that (*i*) financing wasteful spending through lump-sum and/or flat-rate taxes has no growth effect, and (*ii*) lump-sum taxes are preferred to flat-rate taxes in terms of steady-state and inter-temporal utility[1]. These two results highly conditioned the development of economic growth analysis for three decades, *i.e.* between the Solow (1956) model and the Romer (1986) endogenous growth model. Consequently, two research paths have crystallized.

First, as described above, even if fiscal policy (through wasteful spending and/or taxes) cannot affect long-term growth, it may however affect the transition path. Consequently, many studies investigated the duration of the transition period. Several authors among whom Sato (1963), conclude that fiscal policy effects may last up to half of century. This result is confirmed by Barro (1991), Barro and Sala-i-Martin (1992) or Mankiw, Romer and Weil (1992), who fix the convergence rate at 2-3% per year. However, other contributions argue that adjustment dynamics are considerably quicker, as in Islam (1995), between 4.7% and 9.7%, Evans (1997), around 6%, or Temple (1998), up to 6.7% per year.

The second research path analyzes, at least initially, the fiscal policies' effects on steady-state *levels* of different variables. For example, Agell, Lindh and Ohlsson (1997) recall that a country with an inefficient fiscal system may grow in the long-term as rapidly as its neighbors, but with a constantly lower production level. They base their results on simulations from Jorgenson and Yun (1986, 1990), who credit important welfare gains to switches from direct to indirect taxation in the US. However, as this last example suggests, this second research path progressively evolved towards a new theory, namely the *optimal taxation theory*.

The optimal taxation theory diverges from the economic growth theory. For example, one of the most important applications in optimal taxation concerns the comparison between the performances of lump-sum taxes as compared to flat-rate taxes, in terms of a certain goal, *i.e.* inter-temporal welfare or long-term variables' levels (in the spirit of our analysis above). However, optimal taxation is inspired from optimal growth in the sense that it allows *non-constant* (in time) taxation rates (as optimal growth allows

[1] This result comes close to the conclusions of Sato (1967), Krzyaniak (1967) and Feldstein (1974) in a neoclassical model with exogenous saving rate.

for non-constant *ex-ante* saving rates), in what is often called a *Ramsey-program*[1]. For example, in a literature survey, Sandmo (1976) concludes that taxation should be "uniform" (as in lump-sum), in order to avoid distortions in the consumption/saving decisions. Further evidence in Chamley (1985, 1986) and Judd (1985) sustain that, for the same reasons, optimal taxes on capital (and accumulating factors in general) should be zero, while taxes on labor should be positive in order to finance a (given) amount of public spending (the "Chamley-Judd" result)[2].

However, as emphasized by this last paragraph, the optimal taxation theory gives (very) little importance to the fiscal policies effects on economic growth. First, in exogenous growth models there is no growth, thus fiscal policy cannot affect long-term growth. Second, even in the endogenous growth theory in most cases public spending are given (fixed) and optimal taxation focuses on how to finance this amount with as little distortions as possible. Consequently, economic growth receives at best a second-order importance, *i.e.* what optimal tax structure would *diminish least* long-term growth and not what optimal structure could *enhance* long-term growth. The latter question constitutes the starting point of our next section.

2. The theory of endogenous growth: introducing productive public spending

The 80's represent with no doubt an exceptional period in Economics, because of the number, but especially the quality of new concepts introduced over this period. In particular, the theory of economic growth has benefited of some outstanding discovers.

Without any doubt, one explanation of the fact that the Solow model (or its version in optimal growth) has lasted for thirty years as the main tool in economic growth resides in its capacity to explain the convergence process within the OECD during the 60's and 70's. The relative failure of neoclassical inspiration economic policies in the 80's reevaluated the importance of government. Thus, the objective becomes to somehow build a model that would generate self-sustained long-term economic growth, in order to revitalize the importance of economic policy decisions in the long-run.

The endogenous growth theory…

The new theory, called the *endogenous growth theory*, integrates two fundamental hypotheses, namely that private capital productivity should not be decreasing and the externality concept. In a few years, several seminal models made their way. The first one, Romer (1986), assimilates to capital the stock of knowledge created by a

[1] Solving a Ramsey-program resembles to a Stackelberg duopoly, since the representative agent maximizes first, then the social planner maximizes under the choices made by the representative agent.

[2] For further evidence on optimal taxation, see Diamond and Mirrlees (1971), Chamley (1981), Judd (1987) and the first model in King and Rebelo (1993). The same problem is treated in finite horizon by Summers (1981) and Auerbach and Kotlikoff (1987), in stochastic environment by Eaton (1981) and in RBC (Real Business Cycle) by Baxter and King (1993) and Chari, Christiano and Kehoe (1993).

learning-by-doing process, in the spirit of Haavelmo (1956) and Arrow (1962). This article was promoted by the architect of the neoclassical economy, Lucas, in 1988, who proposed his own endogenous growth model with human capital as the engine of perpetual growth, in the spirit of Uzawa (1965)[1].

As the economic growth theory knew an important boom period, this spilled over the empirical research, which found in the study of the relationship between economic policy variables and growth a new challenge. Since public spending presents a key role in our analysis, we hereafter describe the manner the empirical studies investigated the potential link between public spending and growth.

…and the flare-up of empirical studies

In a survey, Gramlich (1994) considers that the genesis of this research project lies in the contributions of Aschauer (1989 a,b,c). His main conclusion is that *productive public spending*[2] is a fundamental variable in order to explain economic growth rates heterogeneity among countries. Furthermore, these studies reinforce the importance of the existent contributions and generate an eruption of empirical papers analyzing the correlation between productive public spending and economic growth, "*at least 40 studies since 1989*" (Gramlich, 1994, page 1177). Table 1 proposes a synthesized classification of these empirical studies, depending on the correlation between public spending and economic growth.

Table 1

The empirical correlation between public spending and economic growth

Positive	No or difficult to isolate	Negative
Ratner (1983), Kormendi and Meguire (1985), Ram (1986), Aschauer (1989 a,b,c), Munell (1992), Easterly and Rebelo (1993), Gramlich (1994), Morrison and Schwartz (1996)	Levine and Renelt (1992), Holtz-Eakin (1994), Sturm and De Haan (1995), Slemrod (1995), Agell, Lindh and Ohlsson (1997)	Landau (1986), Grier and Tullock (1989), Evans and Karras (1994)

[1] An alternative view to the presence of externalities is to revisit Adam Smith's and Joseph Schumpeter's propositions. First, following Adam Smith, a strand of research considers that development is connected to the market size and variety is growth enhancing (see, Romer, 1990, or Grossman and Helpman, 1991). A second research path places Schumpeter's innovation concept in the heart of economic growth, as in the "creative destruction" model of Aghion and Howitt (1992). A certain number of surveys, among which Solow (1988), Sala-i-Martin (1990a, 1990b), Stern (1991), Helpman (1992), Abramovitz (1993), Romer (1993) or Hammond and Rodriguez-Claire (1993) may allow the reader to measure the importance assigned to the endogenous growth theory in these early years of its existence.

[2] Public spending that enhances private capital productivity, as public infrastructure, property rights, order, security, national defense, public transports, water and electricity networks, police and fire department. For more details, see Barro (1991) or Kneller, Bleaney and Gemmell (1999).

The purpose of Table 1 is to reveal the important (but hardly exhaustive!) amount of empirical contributions in the field of public spending to growth relation, in order to emphasize the challenge launched to theoreticians. The goal becomes to find analytical evidence of the existence of an effect of government policies on economic growth and, if such an effect would exist, to establish its nature (growth-enhancing or growth-diminishing).

To deal with this question, we reassess our analysis in section 1 above. Assuming, as in Rebelo (1991), an "Ak" function, namely $y = Ak$, yields the following economic growth rate:

$$\gamma = S(A - \rho) \tag{5}$$

As compared to Solow or Cass-Koopmans-Ramsey models, economic growth is constant in the long-run, since private capital marginal productivity is not decreasing (constant) in the long-run. On the other hand, in this kind of one-sector model there are no transitional dynamics and the economy is at steady state starting the initial time $t = 0$.

If we introduce wasteful public spending, recall that IS equilibrium is $\dot{k} = Ak - c - g$. However, remark that changing g has no effect on the growth rate, which is constant and independent of public policy. Instead, changing g only changes (in the opposite way) the consumption (to private capital ratio), still on a one-to-one basis, since $c/k = A - \gamma - g/k$, A and γ are constant, while private capital is always at its initial level k_0. Overall, in this case, changing public spending has no effect on long-run economic growth.

Furthermore, if we consider that these spending are lump-sum tax financed, economic growth is still unaffected. On the other hand, if government uses a flat-rate tax on output, the growth rate lowers to $\gamma = S((1-\tau)A - \rho)$. As in our previous section, using flat-rate taxes to finance wasteful spending distorts private capital accumulation and lowers economic growth.

These results synthesize the main findings from endogenous growth models or optimal taxation models with long-run growth[1]. *Proposition 1* below summarizes these findings:

Proposition 1:

- *(a) wasteful public spending have no effect on long-run growth or the steady-state private capital ratio in models that lack perpetual growth;*
- *(b) if we consider the financing of wasteful spending, lump-sum taxes leave growth (or the capital stock) unaffected, while flat-rate taxes on output diminish it;*

[1] See, for example, Jones and Manuelli (1990), Trostel (1993), Pecorino (1993), Devereux and Love (1995), Stokey and Rebelo (1995), or Milesi-Feretti and Roubini (1998).

(c) *in a more general view, inspired from optimal taxation, flat-rate taxes on any accumulating factor (output, private capital, human capital etc) diminish long-run growth, while flat-rate taxes on non-accumulating factors (labor, consumption in models with inelastic labor supply) do not affect long-term growth*[1].

While these results are highly disappointing, since long-run growth can at most not be reduced by public policies, one could ask if theory can provide a model in line with Aschauer's (1989 a,b,c) results. The answer to this question is positive: Barro (1990) proposed an endogenous growth model with productive public spending where fiscal policy can raise economic growth.

The Barro (1990) model with productive public spending

In 1990, Robert Barro published "Government Spending in a Simple Model of Endogenous Growth", article that was to reassess economists' view over the relationship between fiscal policy and economic growth. This model was also based on a consumer-producer representative agent set-up, with production function:

$$y = f(k, g) = Ak^{\alpha} g^{1-\alpha} \tag{6}$$

This production function is inspired from Arrow and Kurz (1970), with g (per capita) productive public spending that enhance the private capital marginal productivity[2]. The latter is non-decreasing (constant), thus allowing for perpetual growth. This assumption does not change the IS equilibrium $\dot{k} = Ak^{\alpha} g^{1-\alpha} - c - g$, but the long-run growth rate (from the Keynes-Ramsey relation) becomes:

$$\gamma = S\left(\alpha A(g/k)^{1-\alpha} - \rho\right) \tag{7}$$

To simplify our analysis, we directly consider the two financing ways presented above. With lump-sum taxes, the government budget constraint is $g = \tau^L$, while the representative agent constraint becomes $\dot{k} = Ak^{\alpha} g^{1-\alpha} - c - \tau^L$. In this case, the growth rate is the one in (7). However, one may remark that in order to obtain a constant growth rate the ratio g/k should be constant. Denoting, as usual, the steady-state growth rate by γ, this follows that both g and k should grow at this same growth rate in the long-run. From the government budget constraint $g = \tau^L$ we

[1] In a Ramsey-program, Jones, Manuelli and Rossi (1993, 1997) extend the Chamley-Judd result to an endogenous growth frame with human capital, while d'Autume (2007) proposes a discussion of these results.

[2] The analysis of the effect of productive public spending on economic growth goes back at least to Young (1928) and Rosenstein-Rodan (1943), and their famous "big-push" theory. This idea, revisited in a more recent paper by Murphy, Shleifer and Vishny (1989), implies that government offers to households public goods that may enhance their productivity and hence (positively) influence their long-term wealth.

can write $g/k = \tau^L/k$, thus the ratio τ^L/k is constant in steady-state. Let us suppose that this ratio equals $\tau^L/k \equiv p$. Consequently, the growth rate is:

$$\gamma = S\left(\alpha A p^{1-\alpha} - \rho\right) \tag{8}$$

Relation (8) emphasizes that a higher p ratio raises steady-state growth. For example, a raise in the tax τ^L raises the p ratio and long-run growth. Consequently, in this set-up, government can *raise* long-run growth by raising taxes.

Before interpreting this result, let us consider the case of a flat-rate tax on output. This changes households' budget constraint $\dot{k} = (1-\tau)Ak^{\alpha}g^{1-\alpha} - c$, government constraint $g = \tau y$ and long-run economic growth $\gamma = S\left(\alpha(1-\tau)A(g/k)^{1-\alpha} - \rho\right)$. As above, we can find the ratio g/k from the government budget constraint: $g = \tau y = \tau\, Ak^{\alpha}g^{1-\alpha} \Leftrightarrow g/k = (\tau A)^{1/\alpha}$, and long-run growth rate:

$$\gamma = S\left(\alpha A^{1/\alpha}(1-\tau)\tau^{(1-\alpha)/\alpha} - \rho\right) \tag{9}$$

In this case, the effect of the government *via* the tax rate can be computed with the first derivative, namely $d\gamma/d\tau = S\alpha A^{1/\alpha}\tau^{(1-2\alpha)/\alpha}(1-\alpha-\tau)$. In accordance with *Figure 1* below, this effect is positive if $\tau < 1-\alpha$ and negative for $\tau > 1-\alpha$.

Figure 1

Taxes and steady-state economic growth

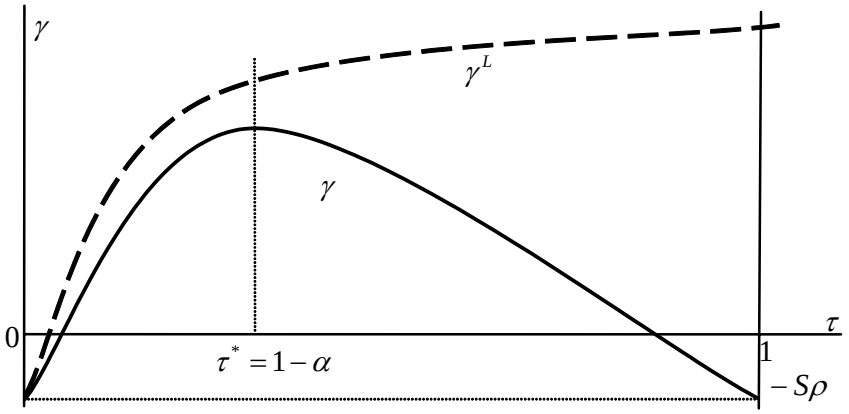

Figure 1 shows that the growth rate describes an inverted-U shape or a Laffer curve[1], with respect to the flat-rate tax. For comparison, we have also represented the growth

[1] Arthur Laffer (University of Chicago at that time), during a dinner in 1974 with (among others) Donald Rumsfeld and Dick Cheney, drew a curve illustrating the trade-off between flat-rate taxes and fiscal revenues. Even if this curve is known as the "Laffer curve", it is not an

rate γ^L associated with a lump-sum tax, assuming that the p ratio (defined as $p \equiv \tau^L / k$) equals the tax rate τ [1]. According to previous evidence, rising τ, which corresponds to raising the lump-sum tax τ^L, unambiguously enhances the steady state growth rate γ^L.

To explain these effects, we use the same explanations as above, but we include the reference to *productive* public spending. Lump-sum taxes are distortion-free and the resources they generate unambiguously increase growth-enhancing productive spending and, consequently, economic growth. Similarly, with flat-rate taxes, new resources are used for productive spending and economic growth increases. Nevertheless, at the same time, higher taxes induce higher distortion in the private capital accumulation, which is growth-reducing. When the tax rate τ is low, the former effect dominates the latter, with reversed results when the tax rate is high enough.

Overall, remark that there is a (distortionary) flat-rate tax, namely $\tau^* = 1 - \alpha$, that maximizes long-run economic growth (and also welfare, see Barro, 1990, page S111). This result can be explained as following. Under competitive equilibrium, the share of public spending in GDP (g / y) equals $1 - \alpha$ (see the production function). However, since $g / y = \tau$, we obtain $g / y = 1 - \alpha = \tau$. To put it differently, to maximize growth, government must equalize the benefit he would have had (on one side) and the marginal productivity of public spending (on the other side), if public spending were a production factor remunerated at its marginal productivity.

Proposition 2 centralizes some of the most important results of the Barro (1990) model:

Proposition 2:

- *(a) lump-sum financed productive public spending are always long-run growth enhancing;*
- *(b) if the government uses flat-rate taxes on output to finance productive public spending, this yields an inverted U-shape between the tax rate and long-run growth;*
- *(c) to maximize economic growth (and welfare), the government should equal the flat-rate tax to the output to public spending elasticity in the production function.*

invention of Laffer, as explained by him. Indeed, proofs of its existence appear in the 14th century, and this vision considering that "too much taxes kill the tax" is embraced by several economists, among whom John Maynard Keynes or Jean-Baptiste Say, the latter concluding that "an exaggerated tax rate destroys the base on which it draws".

[1] This means that the tax τ^L is lump-sum ex-ante and flat ex-post, as explained in Barro (1990).

Developments of the Barro (1990) model

To resume, Barro (1990) proposes an endogenous growth model with productive government spending modeled as an externality, inspired from Romer (1986). Solow (1994) discusses the pertinence of externality-based endogenous growth models and in particular the fundaments of overall constant returns to scale, as in the Barro (1990) production function. In the original paper, Barro (1990) himself analyzes the *first-best* or *social-planner* maximization problem, inter-temporal welfare, but also the impact of consumption spending in comparison with productive spending. On this latter point, he concludes that flat-rate taxes financed public consumption always lowers long-term growth[1].

Beyond these extensions, the Barro (1990) model has known an impressive number of developments, which we classify, for simplicity, in "internal" and "external" developments.

Among the developments that are close to the original form of the model ("internal"), Barro and Sala-i-Martin (1992) analyze the type of productive public good, among two properties, its rivalry and its excludability. Building on these ideas, Turnovsky (1996) and Fisher and Turnovsky (1998) study the congestion phenomenon. Moreover, Futagami, Morita and Shibata (1992) consider that public spending can be accumulated (stock). Finally, Barro (1990) and Turnovsky (1995) show that taxes on consumption are growth enhancing in the Barro (1990) model with inelastic labor supply (because they provide resources without any distortion whatsoever), while Glomm and Ravikumar (1997) study the effects of productive spending financed by taxes on capital and/or labor.

On the other hand, several developments are rather different as compared to the initial form of the Barro (1990) model (we call them "external"). One such development considers overlapping generations (in the spirit of Samuelson, 1958, Barro, 1974, and Blanchard, 1985), as in Jones and Manuelli (1992), Boldrin (1992), Mourmouras and Lee (1999) or Rivas (2003). Second, a certain number of papers assume that labor supply is elastic, *inter alias* Tanzi and Zee (1993), Milesi-Feretti and Roubini (1994) and Turnovsky (2000). Third, some models are constructed in a stochastic environment, such as Zhu (1992), Aizenman and Marion (1993), Turnovsky (1993), Benavie, Grinols and Turnovsky (1996), Turnovsky (1999a) or Chamley (2001). Fourth, several authors consider an open economy, for example Abe (1991), Razin and Yuen (1992), Rodrik (1996), Alesina and Wacziarg (1997) or Turnovsky (1999b).

[1] *Indeed, this explains why we focus so little on consumption (utility enhancing) public spending, as their effects on economic growth are similar to the effects of wasteful spending. However, they may enhance intertemporal utility, as shown by Barro (1990), but this is beyond the goal of our paper. While it is generally accepted that consumption spending are growth-reducing (if flat-rate tax financed), there exists an interesting exception. Chen (2006) supposes that public consumption acts as a substitute of private consumption. Thus, higher public consumption lowers private consumption, which frees resources for private investment, which is growth-enhancing. Overall, the author argues that raising public consumption may raise economic growth. Even if this strand of literature looks promising, it is clear that the substitution hypothesis between public and private consumption needs justification that is more robust.*

Finally, interest is given to the presence of scale effects, in line with Segerstrom (1998), Young (1998), Jones (1999) or Eicher and Turnovsky (1999).

3. Discussion: what have productive public spending conceptually changed?

Building on the evidence above, the goal of this section is to propose a discussion over the importance of productive public spending in the growth theory. We wish to highlight three characteristics of the Barro (1990) model that present, in our view, a particular importance and which we regroup in *Proposition 3* below:

Proposition 3:

(a) the Barro (1990) model with productive public spending allows for long-run endogenous growth;
(b) consequently, it also allows for studying long-run growth effects of the government policies;
(c) in the presence of public spending, government policies may induce positive effects on long-run economic growth.

(a) Public spending and long-term growth

In a strictly economic growth vision, the Barro (1990) model allows to obtain long-term growth. Indeed, as compared to the Solow model or its version in optimal growth by Cass-Koopmans-Ramsey, in the Barro (1990) model the per capita production function yields (as we have seen) constant returns to scale. Consequently, there exists a positive long-run growth rate that is model-generated or endogenous, whereas in exogenous growth models this rate comes at best from outside the model.

As important as this contribution might seem, the Barro (1990) model represents, from this point of view, another seminal papers among others. Precisely, it joins Romer (1986) or Lucas (1988) work on externality-driven long-run economic growth or Romer (1990) and Aghion and Howitt (1992) contributions on innovation-driven economic growth. To put it differently, one can obtain long-run growth even without productive public spending.

(b) The impact of government policy on long-term growth

Due to the presence of long-run growth, the Barro (1990) model implicitly opens the way to the analysis of government policies impact on long-run economic growth. However, in any model with long-term economic growth (see footnote 13 above for a selection of endogenous growth models), one can study the effect of different public policies on economic growth.

(c) Productive public spending and economic growth

In the Barro (1990) model, government makes *productive* public spending that positively affects private capital marginal productivity. This is, in our view, the most important contribution of this model. Below we detail some of the main results that draw on this assumption.

First, because public spending enhances private capital accumulation, it also enhances long-term economic growth. Thus, generally speaking, it is the first time when a fiscal policy decision *augments* long-run growth. Indeed, in endogenous growth models without productive spending, all government spending were at best neutral, if not harmful to economic growth (the equivalent is true on steady-state aggregates, *i.e.* output or capital, in exogenous growth models), as we tried to highlight in the previous two sections.

Second, let us consider the financing of productive public spending, by starting with taxes financing. Financing productive spending with lump-sum taxes (or, equivalently, with consumption taxes, provided that labor supply is inelastic) is always growth-enhancing. However, what is more important is that the use of flat-rate taxes may be desirable in terms of long-run economic growth. This result has deep implications. On the one hand, it implies that raising distortionary taxes may be advantageous for *long-run* growth. On the other hand, this is the first model where *long-run distortionary taxes* (on accumulating factors) are strictly positive, thus in line with empirical evidence. In particular, this finding refutes results in optimal taxation theory (Chamley-Judd and Jones-Manuelli-Rossi), that advise for zero long-term taxes on all accumulating factors, even if in a rather different set-up with endogenous public spending (while public spending are generally given in optimal taxation). Of course, all these results are possible because productive spending allows for some positive effects of government actions in the long-run.

Moreover, this reasoning applies to other public spending financing methods. One example concerns public spending financing through deficit and/or debt. The presence of fiscal deficits in the long-run generates a perpetual flow of interest burden, with crowding-out effect on public resources in the government budget constraint. If this negative effect is not compensated by some positive back-up, it is obvious that deficit financing is growth-reducing. This analysis becomes consistent in the presence of productive public spending and it can be shown, for example, that financing public spending with persistent deficits may be long-run growth-enhancing, provided that government diminishes some unproductive expenditure (see Minea and Villieu, 2008).

A second example concerns the monetary financing of public spending by using seigniorage revenues. Higher monetary growth rates imply however higher inflation rates that distort households activity and accumulation. However, in the presence of productive public spending this negative influence is accompanied by a positive one. Altogether, these effects may explain the presence on non-linearities between monetary policy and economic growth, in line with empirical evidence in Adam and Bevan (2005), as in the endogenous growth model with money-constrained private and public investment of Minea and Villieu (2007).

Finally, from a general point of view, the fact that government action may *a priori* enhance long-term growth opens numerous paths to a consistent analysis. Indeed, it may allow for analyzing the impact of any government decision (linked to the production of public spending) that generates a distortion, because the negative effect that it induces can be confronted with the positive effect of productive spending.

4. Conclusions

In this paper, we propose a survey between public spending and economic growth. For a long period of time, this kind of analysis has been penalized by the absence of long-run economic growth, as in the neoclassical models of Solow (1956) and Cass (1965) – Koompans (1956) – Ramsey (1928). Consequently, most studies focused on the effects of public spending on the steady-state values of different macroeconomic variables, as well as on the transition period from equilibrium to another. Results were however highly disappointing, since all government actions could at best be neutral, if not harmful.

The theoretical model of Romer (1986) seemed to bring some enlightenment, because it emphasized the existence of an endogenous economic growth rate in the long-term. Therefore, numerous contributions tried to outline the effect public policy may have on long-run growth. However, once again results were deceiving, which was even more frustrating as the empirical literature was providing strong evidence on the existence of a positive correlation between public spending and economic growth, as in Aschauer (1989 a,b,c).

Things radically changed since the Barro (1990) model with productive public spending. In his model, raising public spending is long-run increasing, and it is even optimal to set a strictly positive value for the distortionary (on the revenue) tax rate, in terms of long-run economic growth (and welfare). Based on some examples, we aim to suggest that this set-up allows for a coherent and consistent analysis of some key problems, as for example the long-run growth effects of deficits.

In this perspective, it becomes clear that several interesting research path are waiting to be explored. For example, Agénor and Neanidis (2006) or Monteiro and Turnovsky (2007) combine productive public spending with human capital accumulation and study long-run growth effects. Optimal taxation would be another field were modeling endogenous productive spending could produce some interesting results. Finally, the existence of some *a priori* positive effects in the long-run, by incorporating productive spending, may allow robust analysis of different government policies that imply distortions. This is particularly important, as most *realistic* government decisions (*i.e.* flat-rate taxes) imply distortions.

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