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Abstract This paper analyzes the role of the composition of public consumption in a non-scale R&D based growth model by drawing a distinction between two broad categories of current government spending: final good purchases and public employee compensations. The composition of government expenditure plays a crucial role because changes in the goods and the employment components have different effects on an economy's long run performance. Unlike an increase in government spending in final goods, an increase in public employment reallocates labor away from the private sector with a negative effect on per capita output, research effort and innovation. In addition, for given level of public expenditure a change in its composition affects the steady-state allocation of resources and influences the economy's transitional dynamics by varying the speed of convergence towards the steady state.

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1 Introduction

In recent years a vast literature has explored the effects of fiscal policy on economic growth with a number of studies investigating the role of public spending composition in the determination of an economy's long run performance. A widely used approach distinguishes between public investment and public consumption (Barro, 1990; Turnovsky, 1996, 2000; Chen, 2006), while other papers use a *functional* classification of government expenditure (Devarajan et al, 1996) by examining the effects of specific categories such as education (Glomm and Ravikumar, 1997; Blankenau and Simpson, 2004) or health (Bloom et al, 2001). Existing models characterize public spending either as being *productive* or *unproductive* - with productive public services externally enhancing private sector production. By focusing on these supply side effects, this literature neglected any effect of fiscal policy operating through the demand side.

In this paper we introduce a different notion of public expenditure composition by drawing a distinction between purchases of goods and services and wage payments to public employees. To our knowledge, the role of this *economic* classification of public consumption has not been explored in an endogenous growth framework yet. In the literature it is generally assumed that public consumption consists only of government expenditure on goods and services. Empirical data, however, show that compensations to public employees represent a large share of public consumption in national accounts. Moreover, it cannot be neglected that the transmission mechanisms associated to changes in government purchases of goods and services and in public employment are not the same: unlike public spending on final goods, government employment changes do not alter directly the prevailing demand conditions on the goods market[1]. These considerations suggest that a growth model which explicitly distinguishes between these two components of current government expenditure can offer a better understanding of the long run effects of public consumption.

In this paper we employ a semi-endogenous version of a R&D based growth model, first proposed by Romer(1990) and Grossman and Helpman(1991), which does not exhibit the *scale effect* that has been questioned on empirical ground (Jones 1995, 1999). We show that the composition of public consumption expenditure plays a crucial role because changes in the goods and employment components have different effects on the long run equilibrium of the economy. Unlike an increase in government spending in

[1]The different effects on the economy arising from shocks to government good purchases and shocks to government employment has been recognized in some real business cycle models (Finn,1998; Ardagna, 2001).

final goods, a rise in public employment reallocates labor away from the private sector with a negative effect on per capita output, research effort and innovation. Moreover, for given level of public expenditure a change in the composition between wages and salaries for government employees and public spending on final goods affects the steady state allocation of resources and influences the economy's transitional dynamics by varying the speed of convergence toward the steady state.

The paper is organized as follows. Section 2 sets up the model. Section 3 discusses the long run effects of public consumption and the transitional dynamics. Section 4 concludes.

2 The Model

We consider a simple R&D based growth model of the increasing variety type with three sectors. The final output Y is produced using a set of intermediate goods x_i

$$Y = \left[\int_0^A x_i^{\varepsilon} di \right]^{\frac{1}{\varepsilon}}, \qquad 0 < \varepsilon < 1. \tag{1}$$

The stock of intermediates A can be expanded employing labor (L_A) in the research sector in accordance with the following production function

$$\dot{A} = L_A A^{\phi}, \qquad \phi < 1. \tag{2}$$

As in Jones (1999), the parameter ϕ discriminates between two classes of growth models. The restriction $\phi < 1$ represents the easiest way to eliminate the scale effect, while with $\phi = 1$ the model exhibits a traditional endogenous growth setup.

In the sector of intermediates each variety i is produced by a monopolistically competitive firm using labor L_i

$$x_i = L_i, \tag{3}$$

The final good sector is competitive. Given (1) profit maximization implies the following price rule for the final output under symmetry

$$P = A^{\frac{\varepsilon - 1}{\varepsilon}} p, \tag{4}$$

where the price of a single intermediate p is determined as a constant markup over marginal labor costs $p = \frac{1}{\varepsilon} w$.

Calling $L_x = xA$ total employment in the intermediate good sector, the flow of profits for any intermediate producer is

$$\pi = \frac{1-\varepsilon}{\varepsilon} w \frac{L_x}{A}. \tag{5}$$

As the innovation sector is competitive, free entry forces profits to zero. The cost of a single blueprint must be equal to the discounted perpetual flow of profit v, generated by the new intermediate variety

$$\frac{w}{A^{\phi}} = v. \tag{6}$$

Households

The economy is populated by identical individuals; L is the size of population growing over time at the constant rate μ. Each individual is endowed with one unit of time and derives utility from consumption c and leisure $(1 - l_S)$

$$\max U = \int_0^\infty \exp[-\rho t] \left[\alpha \ln c(t) + (1-\alpha)\ln(1 - l_S(t))\right] dt \tag{7}$$

subject to the constraint

$$\dot{A} = \frac{1}{v}\left(\pi A + w l_S L - PcL - \tau L\right), \tag{8}$$

where τ denotes lump sum taxation. Utility maximization yields the following dynamic and static optimal conditions

$$\frac{\dot{z}}{z} = \frac{\pi}{v} + \frac{\dot{v}}{v} - (\mu + \rho), \tag{9}$$

$$w\left(1 - l_S\right) = \frac{1-\alpha}{\alpha} Pc, \tag{10}$$

with $z = Pc$ denotig per capita consumption expenditure.

The Government

Government consumption consists of final good purchases and employee compensations. To finance consumption the government withdraws a fixed amount τ of income from every individual. Therefore $T = \tau L$ represents overall lump sum taxation. A fraction η of T is allocated to consumption of final output, and the remaining $(1 - \eta)$ to wage compensations:

$$C_G = \frac{\eta T}{P_D} \quad , \quad L_G = \frac{(1-\eta)T}{w}, \tag{11}$$

where L_G is the quantity of labor employed in the public sector and C_G the public consumption of final output.

Equilibrium Conditions and Steady State

To solve the model we start from per capita equilibrium conditions in the market for final output ($c + c_G = y$) and in the labor market ($l_S = l_x + l_A + l_G$). Recalling that $x = L_x/A$, from (1) and (2) we get

$$c + c_G = y = A^{\frac{1-\varepsilon}{\varepsilon}} l_x, \tag{12}$$

$$\dot{a} = a^{\phi}(l_S - l_x - l_G) - \frac{\mu}{1-\phi} a. \tag{13}$$

Lower case letters indicate per capita quantities, while $a = A/L^{\frac{1}{1-\phi}}$ defines the stationary level of the stock of intermediates, since by time differentiating (2) the long run growth rate of innovation is $\frac{\dot{A}}{A} = \frac{\mu}{1-\phi}$. The wage rate is taken as the numeraire. Given (5), (6) and (13) we rewrite the optimal dynamic path of per capita consumption expenditure z in (9) as

$$\frac{\dot{z}}{z} = l_x a^{\phi-1} \frac{1-\varepsilon}{\varepsilon} - \phi a^{\phi-1}(l_S - l_x - l_G) - (\mu + \rho). \tag{14}$$

Using (10), (11), (12), (13) and (14) we obtain the two differential equations in the (z, a) space describing the equilibrium dynamics of the economy

$$\dot{z} = \left\{ a^{\phi-1} \left[\frac{(1-\varepsilon)\alpha + \phi(1-\alpha+\alpha\varepsilon)}{\alpha} z + \psi\tau - \phi \right] - (\mu + \rho) \right\} z \tag{15}$$

$$\dot{a} = a^{\phi} \left[1 - \frac{(1-\alpha+\alpha\varepsilon)}{\alpha} z - (1-\eta+\eta\varepsilon)\tau \right] - \frac{\mu}{1-\phi} a, \tag{16}$$

where $\psi = [(1-\varepsilon)\eta + \phi(1-\eta+\eta\varepsilon)]$. By setting $\dot{z} = 0$ and $\dot{a} = 0$ in (15) and (16), the steady state values of a and z are obtained

$$a^* = \left[\frac{(1-\varepsilon)(1-\phi)(\alpha + \tau(\eta - \alpha))}{\mu + (1-\alpha+\alpha\varepsilon)\rho(1-\phi)} \right]^{\frac{1}{1-\phi}}, \tag{17}$$

$$z^* = \frac{[\mu + \rho(1-\phi)](\alpha + \tau(\eta-\alpha))}{\mu + (1-\alpha+\alpha\varepsilon)\rho(1-\phi)} - \eta\tau, \tag{18}$$

and the stock of intermediates in steady state is simply given by $A^* = a^* L^{\frac{1}{1-\phi}}$, that grows at rate $\mu/(1-\phi)$.

Given (2), (3), (10), (17) and (18) the steady state per capita level of employment, output, and the labor shares in the intermediates and in the innovation sectors are easily derived

$$
\begin{aligned}
l_S^* &= \frac{\alpha[\mu+\varepsilon(1-\phi)\rho]+(1-\alpha)[\mu+(1-\phi)\rho(1-(1-\varepsilon)\eta)]\tau}{\mu+(1-\alpha+\alpha\varepsilon)\rho(1-\phi)}, && (19)\\
l_A^* &= \frac{(1-\varepsilon)\mu(\alpha+\tau(\eta-\alpha))}{\mu+(1-\alpha+\alpha\varepsilon)\rho(1-\phi)}, && (20)\\
l_x^* &= \frac{\varepsilon[\mu+\rho(1-\phi)](\alpha+\tau(\eta-\alpha))}{\mu+(1-\alpha+\alpha\varepsilon)\rho(1-\phi)}, && (21)\\
y^* &= A^{*\frac{1-\varepsilon}{\varepsilon}} l_x^*. && (22)
\end{aligned}
$$

In steady state l_S^*, l_A^* and l_x^* are constant, while the growth rate of y along the balanced growth path is driven by the long run growth rate of innovation

$$\frac{\dot{y}}{y}=\frac{1-\varepsilon}{\varepsilon}\frac{\dot{A}}{A}=\frac{1-\varepsilon}{\varepsilon}\frac{\mu}{1-\phi}. \tag{23}$$

Transitional dynamics

To study the behavior of the economy along the transitional path, we linearize the dynamic system (15) and (16) about the steady state

$$\begin{pmatrix} \dot{a} \\ \dot{z} \end{pmatrix} = \begin{pmatrix} -\mu & -\frac{[\alpha(\varepsilon-1)+1]a^{*\phi}}{\alpha} \\ -\frac{(1-\phi)(\mu+\rho)z^*}{a^*} & a^{*(\phi-1)}\frac{[(1-\varepsilon)\alpha+\phi(1-\alpha+\alpha\varepsilon)}{\alpha}z^* \end{pmatrix} \begin{pmatrix} a-a^* \\ z-z^* \end{pmatrix}. \tag{24}$$

The two eigenvalues associated to the Jacobian matrix in (24) are of opposite sign. Therefore, the transitional dynamics is characterized by a unique stable saddle path. We denote λ the stable (negative) root:

$$
\begin{aligned}
\lambda &= -\frac{1}{2\alpha a^*}\left[-z^*[\alpha(1-\varepsilon)(1-\phi)+\phi)]a^{*\phi}+\alpha\mu a^*+\sqrt{\Delta}\right] && (25)\\
\Delta &= \left[-z^*a^{*\phi}[\alpha(1-\varepsilon)(1-\phi)+\phi]+\alpha\mu a^*\right]^2+4\alpha z^*a^{*\phi+1}[(1-\alpha+\alpha\varepsilon)(1-\phi)\rho+\mu]
\end{aligned}
$$

Starting from $a(0)=a_0$, the stable solution to (24) is

$$
\begin{aligned}
a(t) &= a^*+(a_0-a^*)\,e^{\lambda t}\\
z(t) &= z^*+(a_0-a^*)\,h_{21}e^{\lambda t}
\end{aligned}
$$

where $h_{21}=\frac{2z^*\alpha(\mu+\rho)(1-\phi)}{z^*a^{*\phi}[\alpha(1-\varepsilon)(1-\phi)+\phi]+\alpha\mu a^*+\sqrt{\Delta}}$ represents the slope of the transitional path in the $(z,\,a)$ space, which can be shown to be strictly positive[2].

[2] The term h_{21} corrisponds to the element of the normalized eigenvector associated with the stable root λ.

3 Effects of Changes in Public Consumption

In this non-scale innovation based growth model fiscal variables do not influence the long run balanced growth rates, but they affect the steady state *levels* of per capita output and employment, the long run allocation of labor across sectors and the economy's transitional dynamics.

In the present setting fiscal policy can be implemented through two different tools. On the one side a balanced budget policy can be pursued by changing the total level of current expenditures. On the other side, an effective fiscal policy can be implemented by varying the composition of public consumption between wages and goods at an unchanged level of expenditure.

Current government spending consists of direct purchases of the final good and wages to public employees. Both components of public consumption affect the economy through the crowding out of private consumption and the wealth effect on labor supply. However, these two fiscal instruments impact differently on aggregate demand and exert opposite effects on final output through a reallocation of labor across sectors.

3.1 Steady state effects

First we consider the effects of a change in government expenditure for a given composition of public consumption. From (22) the long run effect on output is given by

$$\frac{\partial y}{\partial \tau}\frac{1}{y} = \frac{(1-\epsilon\phi)(\eta-\alpha)}{\epsilon(1-\phi)\tau(\eta-\alpha)+\epsilon(1-\phi)\alpha} \gtreqless 0 \quad \text{if} \quad \eta \gtreqless \alpha. \tag{26}$$

Notice that the composition of government consumption matters for the effectiveness of fiscal policy only to the extent that the share of government spending allocated to consumption of goods differs from the propensity to consume of the private sector. On impact, an additional unit of government spending rises by η total consumption, while the lower disposable income reduces private demand by α. If $\eta = \alpha$ demand conditions in the final good market do not change and the output multiplier is zero. Therefore, the traditional neutrality result of lump-sum financing of public expenditure emerges in this context as a special case. In general, with $\eta \neq \alpha$ fiscal policy does influence the long run level of economic activity. In particular, when $\eta > \alpha$ the initial effect of an expansionary fiscal policy is a net increase of demand in the final good market that starts an adjustment process that leads to a higher level of steady state per capita output. The excess demand for the final good causes higher demand of intermediate inputs that stimulates employment and profits in the monopolistic sector. At the same time the promises of higher profits boost activity and employment in the research sector expanding the stock of intermediates. In the labor market, the positive wealth effect on labor supply exceeds the increase in public employment. As a result, the higher labor supply meets the increased demand in the intermediates and innovation sector with an overall expansion of per capita output.

On the contrary, when $\eta < \alpha$ the initial drop in the demand for final output gives rise to an adjustment process that eventually depresses output and innovation. In this case the increased labor supply following the expansionary fiscal policy, does not suffice to provide the additional workers demanded by the public sector. The expansion of public employment crowds out employment in the private sector and the fewer resources available to production of intermediates and research eventually reduce per capita output.

In addition, our model allows to investigate the consequences of a change in the composition of public consumption for a given level of total expenditure. The effect of a change in η on the steady state level of per capita output is given by

$$\frac{\partial y}{\partial \eta}\frac{1}{y} = \frac{\tau(1-\epsilon\phi)}{\epsilon(1-\phi)[(\eta-\alpha)\tau+\alpha]} > 0.$$

A rise in η implies that a greater fraction of public consumption is devoted to the purchase of final output. The higher demand for the final good increases the share of labor employed both in the intermediates and in the $R\&D$ industry. The latter, in turn determines an upward shift of the growth path of productivity, as A^* permanently increases. The expansionary effect of an increase in η reflects the reallocation of labor between private and public employment. Even though labor supply decreases as a consequence of the higher disposable income, the larger share of labor devoted to market activity eventually increases productivity and output.

3.2 Transitional dynamics and speed of convergence

In this model fiscal policy influences the transitional dynamics towards the steady state as well. Figure 1 shows the effects of a permanent change in the composition of public spending η. The $\dot{z} = 0$ and $\dot{a} = 0$ curves are obtained from equations (15) and (16), while the dotted line represents the unique stable saddle path trajectory following an increase in η. Starting from the steady state equilibrium at point E, the impact effect of an increase in the share of public purchases of final goods is the crowding out of per capita consumption expenditure, which falls from E to point B. Households react to the reduction in their disposable income by supplying more labor. However,

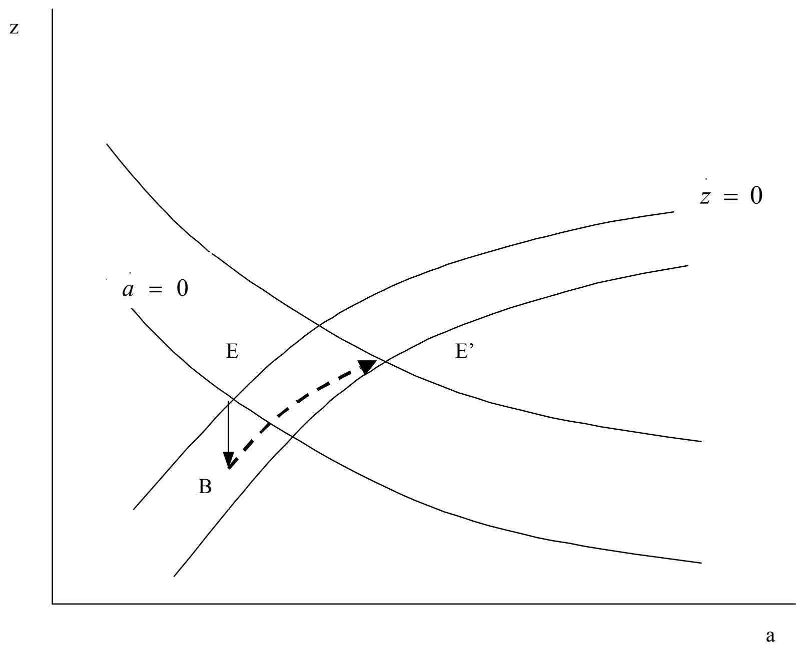

Figure 1: A rise in η

this initial crowding out causes a reallocation of labor across sectors, that starts a crowding in transitional path towards permanently higher levels of a and z. The higher value of η increases the demand for the final good. Given a, this rises the demand for intermediates, increasing l_x and profits. At the same time, the prospect of higher profits stimulates $R\&D$ activity and the share of labor allocated to research increases. These initial effects start the transition along the saddle path BE'. Approaching the new steady state, the expanding stock of varieties increases profits and thus the transition growth rate of private expenditure is positive, with a positive growth rate of l_A and a negative growth rate of l_S. Moreover, in our model a change in composition varies the speed of convergence towards the steady state. It can be shown that the absolute value of λ in (25) is a decreasing function of η. Thus, a rise in public employment speeds up the transitional dynamics, while a greater share of expenditure in the final good slows down the convergence to the steady state.

Along the same lines, it can be shown that a change in the level of public consumption τ starts a transitional path displaying opposite features depending on $\eta \gtreqless \alpha$. Specifically, if $\eta > \alpha$ ($\eta < \alpha$) an additional unit of government spending shifts to the right (left) the $\dot{z} = 0$ and $\dot{a} = 0$ curves. However, since total demand increases (decreases) on impact, the saddle path lies above (below) the $\dot{z}$ curve. This implies that the economy moves towards the new steady state along a path with positive (negative) growth rates of per capita output, investment and private expenditure. Thus, splitting aggregate government spending into its main economic components brings the theoretical prediction that transitional effects of fiscal policy may display opposite patterns. If the share of public consumption on goods and services exceeds the propensity to consume of the private sector, then higher levels of public expenditure are associated with positive growth rates of per capita output, but the reverse occurs when public employment represents a substantial share of total expenditure. In addition, if $\eta > \alpha$ ($\eta < \alpha$) a rise in public consumption decreases (increases) the speed of convergence towards the steady state.

4 Final Remarks

In this paper we employ a R&D based growth model of the increasing variety type to explore the effectiveness of fiscal policy when government consumption is allocated to the purchase of goods and to public employee compensations. The demand management of public expenditure displays positive or negative long run effects on economic activity depending on the composition of public consumption because of the different impact on final good demand of the two components of public spending. While an increase in public employment crowds out private spending and private employment, a rise in the purchases of final good increases profits in the market for intermediates that in turn stimulate innovation and output.

The simple R&D based growth model used in this paper can be developed both in a scale and in a non scale version depending on the value of the parameter ϕ measuring the intensity of the externality in the innovation activity. Our analysis can be easily extended within a traditional endogenous growth (scale) setup where the composition of public consumption affects the long run balanced rate of growth of innovation and output. In this case, a change in the composition of government consumption more oriented towards purchases of final good fosters innovation and effectively stimulates long run growth.

The results of the paper have relevant implications, that deserve further investigation also on an empirical ground. On the one hand, our paper offers a new theoretical perspective to the empirical debate concerning the relationship between economic activity and public consumption expenditure. Indeed, the body of evidence pointing at the relationship between growth and government consumption does not display any clear pattern (e.g. Ram, 1986;

Barro, 1991; Easterly and Rebelo, 1993). In this paper we have shown that government expenditure on goods and public employment exert opposite effects on long run economic activity. Therefore, taking into account the composition of public spending in empirical analysis might be helpful for a better understanding of evidence.

On the other hand, as a policy implication our model highlights the possibility to implement an active fiscal policy simply by varying the composition of public consumption between wages to public workers and purchases of goods and services. In the present situation with many governments oriented to strict control of public expenditure as a credible action to avoid the pathology of high budget deficits, the prospect of a policy action leaving total level of taxation and expenditure unchanged represents *per se* an appealing opportunity.

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