PRODUCTIVE GOVERNMENT SPENDING, WELFARE AND EXCHANGE RATE DYNAMICS

Juha TERVALA, PhD[1]
Department of Economics
University of Helsinki, Finland

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Abstract

This study analyses the consequences of productive government spending on the international transmission of fiscal policy. A standard result in the new open economy macroeconomics literature is that a fiscal shock depreciates the exchange rate. I demonstrate that the response of the exchange rate depends on the productivity of government spending. If productivity is sufficiently high, a fiscal shock appreciates the exchange rate. It is also shown that the introduction of productive government spending increases both domestic and foreign welfare, when compared with the case where government spending is wasted. This is because productive government spending has a positive effect on private consumption in both countries in a two country NOEM model.

Keywords: New open economy macroeconomics, fiscal policy, international policy transmission

1 Introduction

The new open economy macroeconomics (NOEM) literature pioneered by Obstfeld and Rogoff (1995; 1996) has paid a lot of attention to the analysis of the international effects of fiscal policy shocks.[2] A general feature of these models is that government spen-

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[2] An excellent survey of the NOEM literature by Lane (2001) focuses completely on monetary policy issues. Lane and Ganelli (2003) survey more recent developments in the literature as well as fiscal policy topics. Coutinho

ding is assumed to be a complete waste of resources, i.e. it does not affect private utility or productivity. The possibilities for modelling government spending in (sticky-price) NOEM models are, however, as numerous as with flexible-price models. In flexible-price models, government investment spending has different effects on government consumption spending, and the effects of government consumption spending are sensitive to whether government consumption is a substitute for or a complement to private consumption (Obstfeld and Rogoff 1996). The same effect seems to result in NOEM models, as researched by Ganelli (2003). He develops a version of the Obstfeld-Rogoff model, assuming that government consumption is a substitute for private consumption. He finds that introducing utility-enhancing government spending reduces the fiscal multiplier but increases domestic welfare compared to the `pure waste' benchmark.

Although virtually every government is involved in the provision of productive public services and it is often discussed whether governments should provide more inputs into private production, the consequences of productive government spending have so far been neglected in the NOEM literature. Thus, the literature has ignored the effects of fiscal policy on aggregate supply, ignoring an important channel through which fiscal policy affects the economy. This paper attempts to fill a gap in the literature by analysing the consequences of productive government spending on the international transmission of fiscal policy. I consider the role of government spending as an input to private production. An example of such productivity-enhancing government spending is education. For example, Evans and Karras (1994) find that public educational services have a strong positive effect on productivity. The idea of productive government spending is commonly used in the economic growth literature.[3] The concept is also used in the business cycle literature e.g. in Baxter and King (1993), Turnovsky and Fisher (1995) and Linnemann and Schabert (2006), who use closed economy models.

The introduction of productive government spending seems important in the light of the results of Linnemann and Schabert (2006). They show that a rise in government spending will not induce a fall in wealth and private consumption if government spending generates a sufficiently strong production externality. In addition, real wages do not need to fall because productive government spending increases the marginal product of labour. Recent empirical evidence shows that the effects of fiscal expansions on employment, real wages and private consumption are positive (Blanchard and Perotti, 2002; Canzoneri et al. 2003 and Gali et al. 2007). This evidence is not easily reconciled with infinite-lived, intertemporally optimising households. Typically, a rise in government spending implies a reduction in wealth due to higher taxes. This reduces private consumption and leads to an increase in labour supply, lowering the real wage. The situation may be different when the standard model is modified by introducing productive government spending.

In this paper I also study the consequences of productive government spending on welfare. This exercise is of interest for two reasons. First, in NOEM models, due to im-

(2005) focuses solely on fiscal policy topics. Important NOEM papers that address fiscal policy issues include, but are not limited to, Beetsma and Jensen (2005), Betts and Devereux (2000, 2001), Buch, Döpke and Pierdzioch (2005), Caselli (2001), Corsetti and Pesenti (2001, 2005), Evers (2006), Ganelli (2003, 2005), Obstfeld and Rogoff (1995, 1996), Pierdzioch (2004) and Sutherland (1996).

[3] See Turnovsky (2000).

perfect competition, aggregate output falls below the social optimum opening the door for a potentially beneficial fiscal policy intervention. Second, although one advantage of the NOEM framework is that it also yields normative insights, relatively few authors have addressed the welfare effects of fiscal policy in any detail. A standard result in the NOEM literature, also found by Obstfeld and Rogoff (1995; 1996), is that a rise in government spending is a beggar-thyself policy as it decreases private consumption and increases labour supply. The introduction of productive government spending could, in principle, reverse this result if it had a sufficiently strong effect on private consumption.

A two-country NOEM model is a natural candidate for analysing the questions I address in this paper because two-country NOEM models highlight "international transmission channels and allow interest rates and asset prices to be endogenously determined in international capital markets" (Lane 2001: 256). The model presented in this paper is based on Betts and Devereux (2000). I apply two modifications to their model. The first is the assumption of productive government spending. The second is the introduction of a staggered price setting. The assumption of staggered pricing allows for richer and somewhat more realistic dynamic responses to fiscal shocks than the simple hypothesis of simultaneous one-step-ahead pricing.

I show that a rise in government spending can decrease or increase domestic private consumption depending on the productivity of government spending, as in the closed economy model of Linnemann and Schabert (2006), but a rise in government spending increases private consumption only if the productivity of government spending is very high. A rise in government spending tends to decrease domestic private consumption due to the rise in taxes. When government spending is productive, free inputs that the government provides to producers cause a positive effect on output and consequently consumption. When government spending generates a sufficiently strong effect on production, the positive effect outweighs the fall in consumption caused by higher taxes. Hence, domestic consumption increases, consistently with empirical evidence (Blanchard and Perotti 2002, Canzoneri et al. 2003 and Gali et al. 2007). However, pessimism about the ability of productive government spending to account for the empirical evidence is in order because a fiscal shock increases private consumption only if the productivity of government spending is very high.

I also demonstrate that the assumption of productive government spending has significant implications for exchange rate dynamics and welfare. If the productivity of government spending is low or zero, the money market equilibrium requires a depreciation of the nominal exchange rate, which is a standard finding in the NOEM literature. On the other hand, if the productivity of government spending is sufficiently high, the increase in relative domestic consumption requires an exchange rate appreciation through money market equilibrium. The productivity of government spending, however, has to be very high in order to generate an exchange rate appreciation. In addition, I show that productive government spending increases both domestic and foreign welfare, when compared with the `pure waste' (Obstfeld-Rogoff) benchmark. This is because productive government spending has a positive effect on private consumption in both countries.

The rest of the paper is organised as follows. In Section two I lay out the model and derive the equilibrium conditions. In Section three I use numerical calculations to analyse the international transmission of fiscal policy. As hinted above, I emphasize the consequences of productive government spending. Finally, Section four concludes the paper.

2 The Model

In this section, I develop a fairly standard NOEM model. The model is based on Betts and Devereux (2000). I extend their model by the introduction of a staggered price setting framework and productive government spending.

Most of the contributions that address the international transmission of fiscal shocks, including the Obstfeld-Rogoff model, assume that export prices are set in the producer's currency. Motivated by the weak empirical support for the law of one price in internationally traded goods, by the evidence of limited exchange rate pass-through to import prices and the sources of real exchange rate fluctuations, Betts and Devereux (2000, 2001), among others, have assumed that export prices can be set in the consumers' currency. The model presented in this paper is based on the local-currency pricing (LCP) paradigm in which the prices of imported goods are temporarily rigid in the importing country's currency. A drawback of this assumption is that empirical findings suggest that exchange rate pass-though to import prices is, however, seldom zero as it is in the case of LCP (See e.g. Sekine 2006).

2.1 Households

The world consists of two countries, home and foreign, and is populated by a continuum of households. Each household produces a single differentiated good, indexed by z. The world size is normalised to 1. Consider that *n* households reside in the home country. All households have identical preferences. The utility function of a typical domestic household is given by (a foreign household's utility function is identical to that of a domestic household)

$$U_t(z) = \sum_{s=t}^{\infty} \beta^{s-t} \left[\log C_s + \frac{\chi}{1-\varepsilon} \left(\frac{M_s}{P_s} \right)^{1-\varepsilon} - \frac{l_s(z)^2}{2} \right]. \tag{1}$$

In this equation C_t denotes a consumption basket (defined below), M_t denotes nominal balances, P_t indicates the consumer price index (defined below), ε is the inverse of the consumption elasticity of money demand and l denotes labour supply. In equation (1) variable C is a real consumption index $C_t = \left[\int_0^1 c_t(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}}$, where *c(z)* is consumption of good z and θ (>1) is the elasticity of substitution between differentiated goods.

Prices p represent domestic currency prices, prices p^* represent foreign currency prices.[4] The home country CPI is

$$P_t = \left[\int_0^n p_t(z)^{1-\theta} dz + \int_n^1 p_t(z^*)^{1-\theta} dz\right]^{\frac{1}{1-\theta}}. \quad (2)$$

The foreign country CPI is

$$P_t^* = \left[\int_0^n p_t^*(z)^{1-\theta} dz + \int_n^1 p_t^*(z^*)^{1-\theta} dz\right]^{\frac{1}{1-\theta}}. \quad (3)$$

where $p^*(z)$ is the foreign currency price of domestic good z and $p^*(z^*)$ is the foreign currency price of the foreign-produced good.

The budget constraint of a typical domestic household is

$$M_t + \delta_t D_t = D_{t-1} + M_{t-1} + w_t l_t - P_t C_t + \pi_t - P_t \tau_t, \quad (4)$$

where M_t is the money holding at the beginning of the period and δ_t is the nominal price of a bond ($\delta_t=(1+i_t)^{-1}$, where i is the nominal domestic interest rate). In addition, D_t denotes holdings of domestic currency-denominated nominal bonds, w is the nominal wage rate, π represents the nominal profits of domestic firms and τ denotes per capita taxes.

There is an integrated world capital market and the only asset households trade is a nominal bond, denominated in domestic currency. The aggregate asset-market-clearing condition is thus given by $nD_t + (1-n) D_t^* = 0$. Consequently the budget constraint of a representative foreign household is

$$M_t^* + \delta_t \frac{D_t^*}{E_t} = \frac{D_{t-1}^*}{E_t} + M_{t-1}^* + w_t^* l_t^* - P_t^* C_t^* + \pi_t^* - P_t^* \tau_t^*, \quad (5)$$

where E is the exchange rate (the domestic currency price of foreign currency). Assuming open capital markets, uncovered interest rate parity must hold $1 + i = \left(1 + i_t^*\right)\frac{E_{t+1}}{E_t}$.

2.2 First-Order Conditions for the Typical Household's Problem

A typical domestic household maximises the utility function subject to the budget constraint. The first-order condition for optimal consumption is

$$\delta_t P_{t+1} C_{t+1} = \beta P_t C_t. \quad (6)$$

[4] In general, foreign country variables are indicated by asterisks but in the context of goods prices an asterisk means a price set by foreign firm z^*. Thus, $p_t(z)$ is the domestic currency price of the domestic good and $p_t(z^*)$ is the domestic currency price of foreign good z^*.

This Euler equation states that the household smoothes consumption over time. The first-order condition governing the household's optimal labour supply can be written as

$$l_t = \frac{w_t}{C_t P_t}. \tag{7}$$

Equation (7) ensures that the marginal disutility of labour equals the marginal utility of consumption. Finally, the first-order condition for the household's money demand can be written as

$$\frac{M_t}{P_t} = \left[\chi C_t \left(\frac{1}{1-\delta_t} \right) \right]^{\frac{1}{\varepsilon}}. \tag{8}$$

This equation states that the optimal amount of money balances is a positive function of consumption and a negative function of the interest rate.

A foreign household's optimal labour supply is analogous to that of a domestic household. In addition, a foreign household's optimal consumption and money demand can be written as:

$$\delta_t P^*_{t+1} C^*_{t+1} E_{t+1} = \beta P^*_t C^*_t E_t, \tag{9}$$

$$\frac{M^*_t}{P^*_t} = \left[\chi C_t \left(\frac{1}{1-\delta_t E_{t+1}/E_t} \right) \right]^{\frac{1}{\varepsilon}}. \tag{10}$$

2.3 The Government

I assume that governments in both countries balance their budgets each period and finance their spending by means of non-distorting taxes and seigniorage. The government budget constraint, expressed in per capita terms, is given by

$$G_t = \tau_t + \frac{M_t - M_{t-1}}{P_t}. \tag{11}$$

Government consumption takes the same form as the private consumption index. Government spending is assumed to follow a first-order autoregressive process, $\hat{G}_t = \rho \hat{G}_{t-1} + \eta_t$.

In the preceding equation, ρ governs the persistence of a fiscal shock, η is an unpredictable shift in government spending and the hat notation is used to represent the percentage deviations from the initial steady state. The foreign country's budget constraint, government composite consumption and government spending are analogously defined.

2.4 Firms

2.4.1 Technology and Profits

I assume the role of public services as an input to private production. To simplify the analysis, these public services are publicly-provided private goods, for example, they can be schools, hospitals, public sector R&D etc. The government purchases a flow of output from the private sector and makes public services available to firms. As emphasised by Barro (1990), the idea of including public services as a separate argument of the production function is that private inputs are not a close substitute for public inputs. For example, some public services like the maintenance of law and order cannot be (easily) replaced with private services. While the economic growth literature focuses on the productivity of (the stock of) public capital, business cycle analysis points the spotlight at the flow of government spending. Thus, I assume that the flow of government spending, rather than the stock of public capital, is an input to private production, as e.g. in Linnemann and Schabert (2006).

Each firm, with the total number normalized to unity, produces a differentiated good. I assume that the flow of public services that enter the production function corresponds to (per capita) government spending. The production function of domestic firm z is

$$y_t(z) = l_t(z)G_t^{\alpha}, \tag{12}$$

where $y_t(z)$ is the total output of firm z and parameter α $(\alpha \leq 0)$ captures the degree of the positive effect that government spending has on the firm's production.

Total output is divided between output sold in the home market, denoted by $x_t(z)$, and output sold in the foreign market, denoted by $v_t(z)$. Firm z minimises cost $w_t l_t(z)$ subject to the above technology. The nominal marginal cost is given by $MC_t(z) = \frac{w_t}{G_t^{\alpha}}$.

The profits of a domestic firm are given by

$$\pi_t(z) = p_t(z)x_t(z) + E_t p_t^*(z)v_t(z) - w_t l_t(z). \tag{13}$$

The first term on the right hand side is revenues from home country sales while the second term captures revenues from foreign country sales. The total output of a foreign firm is divided between output sold in the home market, denoted by $v_t^*(z^*)$, and output sold in the foreign market, denoted by $x_t^*(z^*)$. The profits of a foreign firm are given by

$$\pi_t^*(z^*) = p_t^*(z^*)x_t^*(z^*) + \frac{p_t(z^*)v_t^*(z^*)}{E_t} - w_t^* l_t^*(z). \tag{14}$$

Given composite consumption indexes and integrating demand for good z across all households, one can see that the demand functions for a typical domestic firm's output are given by

$$x_t(z) = \left(\frac{p_t(z)}{P_t}\right)^{-\theta} \left(nC_t + nG_t\right).$$

$$v_t(z) = \left(\frac{p_t^*(z)}{P_t^*}\right)^{-\theta} \left[(1-n)C_t^* + (1-n)G_t^*\right].$$

These equations represent goods market clearing conditions for a typical domestic firm in the home and the foreign market, respectively. Analogously, the demand functions for a typical foreign firm in the home and the foreign market, respectively, are given by

$$v_t^*(z^*) = \left(\frac{p_t(z^*)}{P_t}\right)^{-\theta} \left(nC_t + nG_t\right),$$

$$x_t^*(z^*) = \left(\frac{p_t^*(z^*)}{P_t^*}\right)^{-\theta} \left[(1-n)C_t^* + (1-n)G_t^*\right]$$

2.4.2 International Price Setting

I assume that firms set prices in a staggered fashion, as in Calvo (1983). But before turning to staggered adjustment, I first examine the optimal price setting under complete price flexibility. Since monopoly firms can price-discriminate across national borders, they are free to set different prices in the countries in question to maximise profits. However, a profit maximising domestic firm ends up choosing prices that are a constant markup over marginal costs

$$p_t(z) = E_t p_t^*(z) = \frac{\theta}{\theta - 1} MC_t \tag{15}$$

in accordance with the law of one price. The price setting problem facing a typical foreign firm is identical to that of a domestic firm. The foreign firm chooses prices that are a constant markup over foreign marginal costs.

In the short run, prices are sticky. Following Calvo (1983) I assume that each firm resets its price in any given period with a probability 1-γ, independently of time elapsed since the last price adjustment. When setting its profit-maximising price, each firm has to take into account the $0<\gamma<1$ probability that in every subsequent period it will not be able to revise its price setting decision. When setting a new price in period t, each firm seeks to maximise the present value of profits weighting future profits by the probability that the price will still be effective in that period. Thus, a typical domestic firm seeks to maximise $\max_{p_t(z), p_t^*(z)} V_t(z) = \sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} \pi_s(z)$, where is the $\zeta_{t,s} = \Pi_{j=s}^{t} (1+i_j)^{-1}$ domestic nominal discount factor between period t and period s. The pricing rules for domestic goods are given by

$$p_t(z) = \left(\frac{\theta}{\theta-1}\right)\frac{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s+G_s)\left(\frac{1}{P_s}\right)^{-\theta}MC_s(z)}{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s+G_s)\left(\frac{1}{P_s}\right)^{-\theta}}, \tag{16}$$

$$p_t^*(z) = \left(\frac{\theta}{\theta-1}\right)\frac{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s^*+G_s^*)\left(\frac{1}{P_s}\right)^{-\theta}MC_s(z)}{\sum_{s=t}^{\infty}\gamma^{s-t}\zeta_{t,s}(C_s^*+G_s^*)\left(\frac{1}{P_s}\right)^{-\theta}E_t}. \tag{17}$$

The pricing rules of foreign firms are the same as equations (16) and (17), except that the exchange rate should be replaced with $\boldsymbol{1/E_t}$ and foreign prices - of course - depend on foreign marginal costs.

2.5 Symmetric Equilibrium

All firms (in the country) are symmetric, which implies that they set the same output and when resetting prices in any given period they choose the same price. The law of large numbers states that in each period a number of 1-γ of firms reset their prices while a fraction γ keep their prices unchanged.

In this symmetric equilibrium, the consolidated budget constraint of the home economy is derived by using equation (4), the government budget constraint (11) and the profits of a domestic firm (13). It can be written as

$$\delta_t D_t = D_{t-1} + p_t(z)x_t(z) + E_t p_t^*(z)v_t(z)_t - P_t C_t - P_t G_t.$$

Analogously, the consolidated budget constraint of the foreign economy is derived by using corresponding foreign equations and the asset-market-clearing condition

$$-\frac{n}{1-n}\delta_t\frac{D_t}{E_t} = -\frac{n}{1-n}\frac{D_{t-1}}{E_t} + p_t^*(z^*)x_t^*(z^*) + \frac{p_t(z^*)v_t^*(z^*)}{E_t} - P_t^*C_t^* - P_t^*G_t^*.$$

Following previous work, I consider the special case of zero net foreign assets and zero government spending levels. In addition, in this steady state all exogenous variables are constant. Constant consumption implies that the steady-state world interest rate is tied down by consumption Euler equations (6) and (9): $\beta = \bar{\delta} = (1+\bar{i})^{-1}$, where steady-state values are marked by overbars. In addition, assume that the production function in the initial steady state is given by $y_t(z)=l_t(z)$. This, together with equations (7) and (15), implies that $\bar{y}_0 = \bar{l}_0 = \left(\frac{\theta-1}{\theta}\right)^{\frac{1}{2}}$, where 0 subscripts on barred variables indicate the initial steady state.

The linearisation is implemented by expressing the model in terms of percentage deviations from the initial steady state. Those variables whose initial steady-state value is zero are normalised by consumption. Equilibrium is defined as sequences of variables that (ai) clear the labour, goods and money markets in each region in each period, (b) satisfy

the optimality conditions for consumption evolution, (c) satisfy the optimal pricing rules and (d) satisfy the intertemporal budget constraints.

2.6 The Choice of Parameters

The choice of parameter values follows Sutherland (1996), whose values are widely used in the NOEM literature. The main assumptions underlying the choice of parameter values are as follows. The elasticity of substitution between differentiated goods θ is set to 6, a value consistent with a 20 percent mark-up in the steady state. The subjective discount factor β is set to 1/1.05. Parameter γ, the probability of not adjusting prices in any given period, is set equal to 0.5. This implies an average delay between price adjustments of two periods. I set $\varepsilon = 9$ which implies a rather low consumption elasticity of money demand ($1/\varepsilon$). The two countries are of equal size, and thus n is set to 0.5. Parameter ρ is set to one due to the fact that government spending shocks are permanent.

In addition, a parameter value for α is needed, to highlight the consequences of productive government spending. I use the estimate of the output elasticity of public capital as a proxy for the positive effect that government spending exerts on the firms' production. Aschauer (1989) found a widely cited estimate of the output elasticity of public capital of 0.39. Glomm and Ravikumar (1997, Section 4.1) survey the literature on empirical estimates of the output elasticity of public capital. They quote estimates in the range of zero to 0.39. For example, Ai and Cassou's (1995) estimates of output elasticity of public capital are in the range of 0.15 to 0.26. I consider three values of α in this experiment, $\alpha=0$, $\alpha=0.2$ (as in Linnemann and Schabert 2006) and $\alpha=0.5$. The estimate of $\alpha=0.2$ is quite realistic in that Glomm and Ravikumar (1997) mention seven studies in which the output elasticity of public capital is 0.2 or higher.[5]

3 The International Transmission of Fiscal Shocks

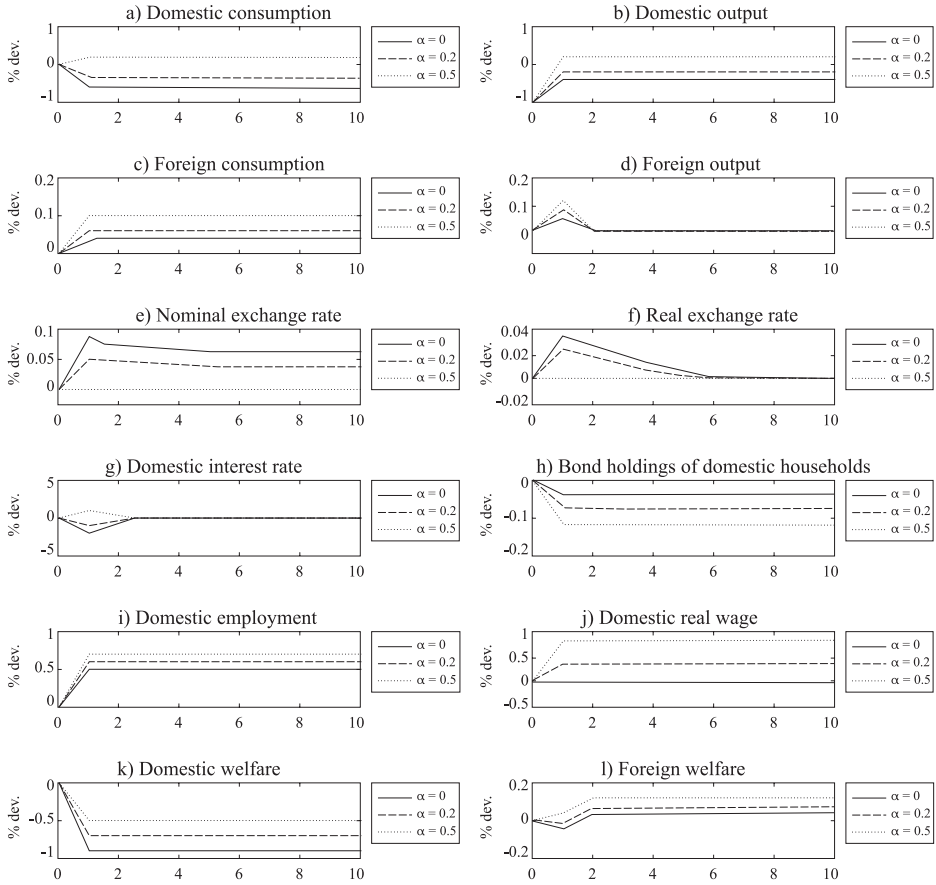
Figure 1 illustrates the impulse responses to a 1 percent tax-financed rise in domestic government spending. In the figures, the horizontal axes show time and the vertical axes show the variables' percentage deviations from the initial steady state.[6] However, the change in the interest rate is measured as a percentage point deviation from initial equilibrium. The solid line depicts the case where government spending is `pure waste' ($\alpha = 0$), with government spending not affecting productivity. This corresponds to the standard case that is often analysed in the NOEM literature. The dashed lines display the case $\alpha = 0.2$, while the dotted lines refer to the case in which the productivity of government spending is very high, $\alpha = 0.5$. The CPI-based real exchange rate is defined as $RER = \frac{E_t P_t^*}{P_t}$.

The change in utility in period t is given by $dU_t = \hat{C}_t - \bar{l}_0^2 \hat{l}_t$.

[5] I simulate the model using the algorithm developed by Klein (2000) and McCallum (2001).

[6] Since variables, with an initial steady-state value of zero are normalised by consumption, home bond holdings show deviations as a percentage of the initial consumption level.

Figure 1 3.1 The Effects of Fiscal Shocks on Output, Employment and Consumption



3.1 The Effects of Fiscal Shocks on Output, Employment and Consumption

As can be seen from Figure 1, a rise in domestic government spending causes domestic and foreign output to move in the same direction immediately after the shock. In case $\alpha = 0$, domestic consumption falls and foreign consumption rises, so that the cross country co-movement of consumption levels is negative. A rise in domestic government spending increases the demand for both domestic and foreign goods, but domestic households foot the tax-bill to finance it. Since the demand for foreign goods rises and prices are sticky, foreign output increases. As prices adjust and the effect of higher consumption begins to come into force, foreign output falls. Higher taxes lead to an immediate fall in domestic wealth and consumption, but because households respond by substituting work for leisure at the same time, the net effect on world aggregate demand is positive. A permanent rise in government spending implies a permanent reduction in private consumption and thus the increase in labour supply is permanent.

Panel (b) shows that the more productive government spending is, the more domestic output increases. This is consistent with the closed economy model of Linnemann and Schabert (2006). In addition, panel (a) demonstrates that if government spending is very productive ($\alpha = 0.5$) a rise in government spending increases domestic consumption. When public services enter into the production function, government spending has a direct positive effect on aggregate supply. The higher the productivity of government spending, the stronger the effect on the production possibilities. When the productivity of government spending is not very high, the rise in output is not enough to offset the rise in taxes. Thus, the introduction of productive government spending only mitigates the fall in private consumption. However, if government spending generates a sufficiently strong effect on private production, a rise in government spending does not need to lead to a reduction in wealth. Thus, in the case where $\alpha = 0.5$, the response of consumption to a rise in government spending is positive because output increases substantially. Consequently a rise in government spending produces a positive cross country co-movement of consumption.

Panel (j) illustrates that when government spending is `pure waste', an increase in labour supply lowers the real wage. But when government spending is sufficiently productive, the real wage does not fall. As explained in Linnemann and Schabert (2006), the marginal product of labour may increase, despite higher employment, due to the productivity effect of government spending. The positive response of the real wage and employment to a rise in government spending is supported by empirical evidence (Blanchard and Perotti 2002, Canzoneri et al. 2003 and Gali et al. 2007). Panel (j) suggests that a moderate productivity of government spending is sufficient to account for the evidence.

3.2 Exchange Rate Dynamics

Panel (e) illustrates that the nominal exchange rate depreciates if government spending is `pure waste'. In the case of LCP, exchange rate overshooting can occur in response to economic shocks if $\varepsilon > 1$, as shown by Betts and Devereux (2000).[7] The nominal exchange rate is determined by the relative demand for money and thus by the consumption differential between countries. The nominal exchange rate depreciates because the relative consumption change lowers the relative demand for domestic money. In the short run, due to full LCP, price levels are unaffected by the exchange rate change. Thus, the money market equilibrium requires a fall in relative domestic consumption and/or a fall in the relative domestic interest rate. A fall in the relative domestic interest rate is possible if the exchange rate is expected to appreciate. The exchange rate overshoots its long-run equilibrium, inducing an interest rate differential that equals the rate of appreciation. However, a rise in government spending temporarily lowers the interest rate in both countries because world private consumption falls.

[7] In the Obstfeld-Rogoff model, the nominal exchange rate jumps immediately to its long-run level. In Sutherland's calibrated model (Sutherland, 1996), which introduces a staggered price setting into the Obstfeld-Rogoff model, the nominal exchange rate produces a once-and-for-all step change in response to monetary and fiscal shocks.

In the case where $\alpha = 0.2$, the nominal exchange rate depreciates less than in the `pure waste' case. The rationale for this is that the relative consumption change is smaller than in the `pure waste' case and consequently the nominal exchange rate depreciates less.

Figure 1 shows that a rise in government spending can appreciate the nominal and real exchange rate if the productivity of government spending is very high. The nominal exchange rate appreciates if the relative consumption change increases the relative demand for domestic money. In the case where $\alpha = 0.5$, domestic consumption increases more than foreign consumption. Thus, the relative consumption change increases the relative demand for domestic money and consequently the nominal exchange rate appreciates. With full LCP, the money market equilibrium implies an immediate rise in relative domestic consumption and a rise in the domestic interest rate. A rise in global private consumption in any case increases the interest rate in both countries.

When prices are sticky and denominated in the currency of the buyer, the movement in the nominal exchange rate translates into a real appreciation/depreciation. When $\alpha = 0.2$, due to a smaller nominal exchange rate depreciation, the real exchange rate depreciates by less than in the `pure waste' case. If, however, the productivity of government spending is very high, the real exchange rate appreciates. As prices are free to adjust, the real exchange rate moves back towards its original level. The assumption of identical consumption baskets together with the law of one price (under flexible prices) implies a constant real exchange rate in the long run.

Due to LCP, there is no exchange rate pass-through to import prices and thus changes in the nominal exchange rate do not affect the relative price of domestic and foreign goods. Consequently, the assumption of full LCP eliminates the expenditure switching effect associated with unexpected changes in the nominal exchange rate. In the case of LCP, exchange rate movements have important implications for the revenues of firms, rather than altering relative prices. For example, the depreciation raises the revenues of domestic firms measured in domestic currency terms, and reduces the revenues of foreign firms measured in foreign currency terms, at given production levels. Therefore, the depreciation causes a redistribution of income towards the home economy and this effect raises domestic consumption relative to foreign consumption. However, this effect is more than offset by higher taxes and thus it only diminishes the fall in domestic consumption.

3.3 The Current Account, the Terms of Trade and Foreign Consumption

Panel (h) shows wealth accumulation by foreign households immediately after the shock and demonstrates that productive government spending reinforces the impact of a fiscal shock on the current account. A rise in government spending increases foreign output in the short run. To smooth consumption, foreign households save part of this added income by running a current account surplus. This allows them to smooth the increase in consumption over the future. Panel (d) displays that if government spending is productive, a rise in government spending induces a stronger tilt in the output path. Thus, foreign households accumulate more wealth compared to the `pure waste' benchmark. A permanent improvement in the bond holdings of foreign households implies a permanent trade balance deficit which is financed by interest income. The trade balance deficit allows for higher foreign consumption.

Panel (c) shows that the impact of a rise in domestic government spending on foreign consumption is positive. The reason for this is that both higher foreign wealth and the improvement in the foreign terms of trade[8] allow foreign households to increase their consumption. A rise in the supply of domestic goods implies a deterioration of the home country's terms of trade (not shown). If government spending is productive, the terms of trade deteriorate more than in the `pure waste' case as domestic firms sell their added production at lower prices. Because productive government spending reinforces the effect of a fiscal shock on the current account and the terms of trade, its impact on foreign consumption is positive, when compared with the `pure waste' case. Moreover, a closer look at Panel (d) shows that higher foreign consumption leads to a decrease in the labour supply in the long run. This effect is very small if not negligible.

3.4 Welfare Analysis of Fiscal Shocks

As indicated earlier, I focus on the real component of the utility function, neglecting the welfare effects of real balances. As shown by Obstfeld and Rogoff (1995, 1996), a rise in domestic government spending benefits foreign households but impoverishes domestic households, if government spending is `pure waste'.

Panels (k) and (l) depict the welfare effects of fiscal policy. In the case of `pure waste', domestic households work harder and consume less, not only because of higher taxes but also because of foreign debt and a deterioration in their terms of trade. Thus, a rise in government spending is a beggar-thyself policy. In the long run, foreign households work less but, consume more due to external assets and an improvement in their terms of trade. Initially, a rise in government spending increases foreign labour supply. The negative welfare effect of this is larger than the positive welfare effect of higher consumption. Had I measured the change in utility as the discounted present value of utility change, as in Obstfeld and Rogoff (1995, 1996), a rise in government spending would be unambiguously beneficial to foreign households.

Panel (k) illustrates that the introduction of productive government spending increases domestic welfare, when compared with the `pure waste' case. It, however, also shows that a rise in government spending is still a beggar-thyself policy. As mentioned, the introduction of productive government spending implies a rise in domestic labour supply and private consumption, compared to the `pure waste' benchmark. The positive welfare effect of higher consumption is larger than the negative welfare effect of higher labour supply. Thus, productive government spending increases welfare, when compared with the `pure waste' benchmark. Overall domestic households' welfare decreases - even in the case of a beneficial effect of increased consumption. The negative welfare effect caused by work effort outweighs this effect.

As can be seen from Panel (l), the introduction of productive government spending has a positive effect on foreign welfare. As explained earlier, in the case where government spending is productive there are benefits for foreign households: they enjoy (more) leisure and consume more.

[8] The foreign terms of trade are (defined as) the relative price of the foreign country's exports in terms of the foreign country's imports.

As emphasised by Lane (2001), many results of NOEM models are sensitive to the choice of parameter values. A natural next step would be to analyse how sensitive the main predictions of the model are to changes in parameter values. The main results of this paper, however, are not sensitive to the choice of parameter values, except for the productivity of public services. The effects of varying of other parameter values would cause minor changes.

3.5 The Consequences of Productive Government Spending: A Discussion

As emphasised by Obstfeld and Rogoff (1995:652), some of the precise positive implications of their model depend on the exact manner in which government spending enters it. This analysis suggests that the macroeconomic effects of fiscal policy are not sensitive to the introduction of productive government spending - unless the productivity of government spending is very high. The introduction of productive government spending does not cause qualitative changes; the consequences on the macroeconomic variables are purely quantitative.[9] A typical finding in the NOEM literature is that a rise in government spending causes a fall in domestic private consumption, a depreciation of the exchange rate and a fall in the world interest rate. It is shown that the introduction of productive government spending can reverse these effects, but only if the productivity of government spending is very high and higher than empirical estimates of the output elasticity of public capital.

Recent empirical evidence shows that the effect of a rise in government spending on private consumption is positive (Blanchard and Perotti 2002, Canzoneri et al. 2003 and Gali et al. 2007). Theoretical economists, both in the RBC and Keynesian tradition, have struggled to develop models capable of reproducing an increase in private consumption following a rise in government spending.[10] Linnemann and Schabert (2006) show that if government spending generates a sufficiently strong production externality, an increase in government spending will cause an increase in private consumption. The findings of this paper suggest that one should be somewhat pessimistic about the ability of productive government spending to account for the empirical evidence. In this standard NOEM model, the value for the productivity of government spending had to be very high in order to generate a positive consumption response.

The results imply that the government should take into account the productivity of public services when implementing fiscal policy. Strictly speaking, if the government maximises the welfare of households, then there is no useful role for any government spending. Loosely speaking, however, public expenditure on education, health care and the maintenance of law and order are, from the welfare point of view, better than non-productive public expenditure, for instance, on public administration. The composition of public expenditure (productive/non-productive) is also important from the business cycle perspecti-

[9] The real wage is an exception.

[10] The papers by Ravn, Schmitt-Grohe and Uribe (2006) and Gali, Lopez-Salido and Javier Valles (2007) offer important advances. Ravn, Schmitt-Grohe and Uribe (2006) demonstrate that countercyclical mark-ups caused by habit formation (over individual varieties of goods) may explain the increase in private consumption. Gali, Lopez-Salido and Javier Valles (2007) show that the presence of rule-of-thumb consumers, who do not save or borrow, can explain why a rise in government spending increases private consumption.

ve. As emphasised elsewhere, e.g. Gali et al. (2007), the response of private consumption to a rise in government spending is a key determinant of the size of the fiscal multiplier, since private consumption is the largest component of aggregate demand. In this model, if the governments would like to, for business cycle reasons, increase employment and/or output, then it is better to use public expenditure on productive purposes rather than on non-productive purposes.

4 Conclusions

This paper shows that the introduction of productive government spending has important implications for fiscal policy transmission, exchange rate dynamics and welfare. In a framework in which government spending is productive, a rise in government spending increases aggregate supply. As a result, the introduction of productive government spending has a positive effect on domestic output and consumption, when compared with the `pure waste' benchmark where government spending is a complete waste of resources. Productive government spending also has a positive effect on foreign consumption. Because productive government spending has a favourable effect on private consumption in both countries, it has a positive effect on welfare, when compared with the `pure waste' benchmark. Finally, it has been shown that if the productivity of government spending is low or zero, a fiscal shock will cause a depreciation of the exchange rate. When productivity of government spending is very high, the expansion of production possibilities more than offsets the fall in wealth induced by higher taxes. In this case, money market equilibrium requires an appreciation of the nominal exchange rate. Thus, productive government spending can alter the standard finding in the NOEM literature that a fiscal shock depreciates the exchange rate. However, in the context of this model, the exchange rate depreciation requires implausibly high productivity of public services.

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