Productive Government Spending and the International Transmission of Fiscal Policy

Juha Tervala
University of Helsinki and HECER

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Abstract

This paper uses a dynamic general equilibrium model to analyze the consequences of productive government spending on the international transmission of fiscal policy. The numerical solution of the model is used to show that the introduction of productive government spending has significant implications for the international transmission of fiscal policy. It is demonstrated that productive government spending has a positive effect on private consumption in both countries. It is also shown that the sign of the nominal and real exchange rate response to a fiscal shock depends on the productivity of government spending. If the productivity is high (low), a fiscal shock appreciates (depreciates) the nominal and real exchange rate.

JEL Classification: F41, F42, F62

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Juha Tervalal

Department of Economics
University of Helsinki
P.O. Box 17 (Arkadiankatu 7)
FI-00014 University of Helsinki
FINLAND

e-mail: juha.tervala@helsinki.fi

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1 Introduction

The question of how the international transmission of fiscal policy shocks depends on the composition of government spending has received very little attention in the new open economy macroeconomics (NOEM)\footnote{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 and also fiscal policy issues. Coutinho (2005) focuses completely on fiscal policy issues.} literature. In NOEM models, government spending is virtually always pure waste and does not affect private utility or productivity. However, any role for fiscal policy requires that government spending is somehow useful. One way to motivate government spending is to introduce government consumption that yields utility, as in Ganelli (2003). Another way to motivate government spending is to assume public services that affect production. In this paper, we consider the role of public services as a productive input for private producers, as e.g. in Barro (1990). The idea of productive government spending is commonly used in the economic growth literature.\footnote{See Turnovsky (2000).} The idea is also used in the business cycle literature in Turnovsky and Fisher (1995) and Linnemann and Schabert (2006), using closed economy models. On the other hand, in the NOEM literature the consequences of productive government spending have been ignored. This paper attempts to fill a gap in the literature by analyzing the consequences of productive government spending on the international transmission of fiscal policy.

The introduction of productive government spending seems to be important in the light of the results of Linnemann and Schabert (2006). Recent empirical papers show that the effects of fiscal expansions on real wages and private consumption are positive (Blanchard and Perotti 2002, Canzoneri et al. 2003 and Gali et al. 2004). This evidence is not easily reconciled with infinite-lived, intertemporally optimizing households. Typically, a rise in government spending implies a reduction in wealth. This reduces private consumption and leads to an increase in labor supply, lowering the real wage. Linnemann and Schabert (2006) show that if government spending generates sufficiently strong production externality, a rise in government spending does not imply a fall in wealth and private consumption. In addition, the real wage does not need to fall because productive government spending increases the marginal product of labor.

Literature on the international transmission of fiscal policy has been almost exclusively theoretical. In an important empirical paper, Arin and Koray (2006) investigate how U.S. fiscal policy affects the U.S. economy and how these shocks are transmitted to the Canadian economy. Using a semi-structural VAR model, the authors find that U.S. output increases and Canadian output decreases in response to a positive shock to U.S. govern-
ment spending. One aim of this paper is to address the question of why a fiscal expansion causes an increase in domestic output and a fall in foreign output, as the results of Arin and Koray (2006) suggest.

A two-country NOEM model is a natural candidate for analyzing the questions we address in this paper because two-country NOEM models highlight "international transmission channels and allows interest rates and asset prices to be endogenously determined in international capital markets" (Lane 2001, 256). The model presented in paper is based on Betts and Devereux (2000). We make two modifications to their model. The first is the use of staggered price setting. The second is the assumption of productive government spending.

Most of the contributions that address the international transmission of fiscal shocks, including the seminal Redux model of Obstfeld and Rogoff (1995), assume that export prices are set in the producer’s currency. On the other hand, motivated by the weak empirical support for the law of one price in internationally traded goods, the evidence of limited exchange rate pass-through to import prices and the sources of real exchange rate fluctuations, among others Betts and Devereux (1996, 2000, 2001) 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.

We show that the introduction of productive government spending has significant implications for the international effects of fiscal shocks. As in the closed economy model of Linnemann and Schabert (2006), domestic private consumption can decrease or increase depending on the productivity of government spending. A rise in government spending tends to decrease domestic private consumption due to the rise in taxes. On the other hand, when government spending is productive, free inputs that the government provides to producers cause a positive effect on output and consequently consumption. If the productivity of government spending is low (or zero), the former effect dominates. Thus a rise in government spending induces a fall in consumption. The effect of productive government spending on output and consumption is however positive, compared with the pure waste case. When government spending generates a sufficiently strong effect on production, the positive effect (that free inputs induce) on consumption offsets the fall in consumption caused by higher taxes. Hence, domestic consumption increases, consistent with empirical evidence (Blanchard and Perotti 2002, Canzoneri et al. 2003 and Gali et al. 2004). The impact on foreign output is roughly consistent with the empirical finding of Arin and Koray (2006): the impact on foreign output is negative; only immediately after the shock the impact is positive. In addition, soon after the shock, productive government spending reinforces the negative effect on foreign output. However, the effect of productive government spending on foreign
consumption is always positive because of a higher current account surplus which allows for a higher level of consumption.

We also demonstrate that the assumption of productivity government spending has notable implications for the response of the exchange rate to a fiscal shock. As in the Obstfeld-Rogoff model (1995, 1996), relative consumption changes affect the exchange rate by changing relative money demand. As mentioned, if the productivity of government spending is low or zero, a rise in government spending causes a fall in domestic consumption. Thus the relative consumption change decreases the relative demand for domestic money and consequently the exchange rate depreciates. However, the assumption of productive government spending moderates the depreciation of the nominal and real exchange rate, compared with the pure waste case. On the other hand, if the productivity of government spending is sufficiently high, domestic consumption increases more than foreign consumption. Therefore, the nominal and real exchange rate appreciate because the relative consumption change increases the relative demand for domestic money. In addition, if the productivity of government spending is sufficiently high (low), a fiscal shock temporarily raises (lowers) the world interest rate.

The rest of the paper is organized as follows. In Section 2 we lay out the model and derive the equilibrium conditions. In Section 3 we use illustrative numerical calculations to analyze the international transmission of fiscal policy. As hinted above, we emphasize the consequences of productive government spending. Finally, in Section 4 we provide some conclusions.

2 The Model

In this section, we develop a fairly standard NOEM model. The model is based on Betts and Devereux (2000). We extend their model by allowing for a staggered price setting framework and productive government spending.

2.1 Households

The world is made of two countries, Home and Foreign, and is populated by a continuum of households. Each household produces a single differentiated good, indexed by $z$. We normalize the world size to 1 and consider that first $n$ households reside in the Home country. All households have identical preferences. The utility function of a typical Home household is given by

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

(1)

In this equation $C_t$ is a consumption basket (to be defined below), $M_t$ is nominal balances, $P_t$ is the consumer price index (to be defined below), $\varepsilon$
is the inverse of the consumption elasticity of money demand and $\ell$ denotes the labour supply. In equation (1) variable $C$ is a real consumption index

$$C = \left[ \int_0^1 c(z)^{\frac{\theta}{\theta-1}} \, dz \right]^{\frac{\theta}{\theta-1}},$$

where $c(z)$ is consumption of good $z$ and $\theta (> 1)$ is the elasticity of substitution between differentiated goods.

The Home country CPI is

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

where $p(z)$ denotes the Home currency price of a Home-produced good $z$ and $p(z^{*})$ is the Home currency price of a Foreign good $z$.

A Foreign households’s utility function is completely identical to that of a Home household. 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 a Home good $z$ and $p^{*}(z^{*})$ is the Foreign currency price of the Foreign-produced good.

The Home country’s import and export price indexes, respectively, are defined as

$$b_t (z^{*}) = \left[ \int_n^1 p_t(z^{*})^{1-\theta} \, dz \right]^{\frac{1}{1-\theta}},$$

$$b_t^{*} (z) = \left[ \int_0^n p_t^{*}(z)^{1-\theta} \, dz \right]^{\frac{1}{1-\theta}} .$$

For future reference, the Home terms of trade, the relative price of Home imports in terms of Home exports, can be expresses as

$$TOT_t = \frac{b_t (z^{*})}{E_t b_t^{*} (z)} , \quad (4)$$

where $E$ is the nominal exchange rate (the Home currency price of Foreign currency).

The budget constraint of a typical Home household is

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

4
where $M_t$ is the money holding at the beginning of the period and $\delta_t$ is the nominal price of a bond ($\delta = (1 + R)^{-1}$, where $R$ is the nominal Home interest rate). In addition, $D_t$ denotes holdings of Home currency denominated nominal bonds, $w$ is the nominal wage rate, $\pi$ represents the nominal profits of Home firms (Home households own Home firms and Foreign households own Foreign firms) and $\tau$ denotes per capita taxes.

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

$$M^*_t + \delta^*_t \frac{D^*_t}{E_t} = \frac{D^*_{t-1}}{E_t} + M^*_{t-1} + w_t \ell_t^* - P^*_t C^*_t + \pi_t^* - P^*_t \tau_t^*.$$  \hspace{1cm} (6)

### 2.2 First-Order Conditions for the Typical Household’s Problem

A typical Home household maximizes the utility function subject to the budget constraint, specified in equation (5). The first-order condition for optimal consumption is

$$\delta_t P_{t+1} C_{t+1} = \beta P_t C_t.$$  \hspace{1cm} (7)

This Euler equation states that the household smooths consumption. The first-order condition governing the household’s optimal labour supply can be written as

$$\ell_t = \frac{w_t}{C_t P_t}.$$  \hspace{1cm} (8)

Equation (8) 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

$$\frac{M_t}{P_t} = \left[ \chi C_t \left( \frac{1}{1 - \delta_t} \right) \right]^\frac{1}{2}.$$  \hspace{1cm} (9)

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 Home household. In addition, a Foreign household’s optimal consumption and money demand can be written as

$$\delta^*_t P^*_{t+1} C^*_{t+1} E_{t+1} = \beta P^*_t C^*_t E_t,$$  \hspace{1cm} (10)

$$\frac{M^*_t}{P^*_t} = \left[ \chi C^*_t \left( \frac{1}{1 - \delta^*_t E_{t+1} / E_t} \right) \right]^\frac{1}{2}.$$  \hspace{1cm} (11)
2.3 The Government

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

\[ G_t = \tau_t + \frac{M_t - M_{t-1}}{P_t}, \quad (12) \]

Government spending is assumed to follow a first-order autoregressive process

\[ \hat{G}_t = \rho \hat{G}_{t-1} + \text{shock}. \]

In the preceding equation, \( \rho \) governs the persistence of a fiscal shock 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

We assume the role of public services as an input to private production, as in Barro (1990). In this case, we assume that public services are publicly-provided private goods, which are rival and excludable. Thus, public services are not subject to congestion effects and the model abstracts from externalities associated with the use of public services. As pointed out by Barro (1990), the general idea of including public services a separate argument of the production function is that private inputs are not a close substitute for public inputs. We assume that the flow of public services that enter the production function corresponds to (per capita) government spending.

Each firm, with the total number normalized to unity, produces a differentiated good. The production function of Home firm \( z \) is (the situation of Foreign firms is completely analogous)

\[ y_t(z) = \ell_t(z) G_t^\alpha, \]

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

Total output is divided between output sold at the Home market, denoted by \( x_t(z) \), and output sold at the Foreign market, denoted by \( v_t(z) \). Firm \( z \) minimizes cost \( w_t \ell_t(z) \) subject to the above technology. The nominal marginal cost is given by

\[ MC_t(z) = \frac{w_t}{G^\alpha}. \quad (13) \]
The profits of a Home firm are given by

\[ \pi_t (z) = p_t (z) x_t (z) + E_t p_t^* (z) v_t (z) - w_t \ell_t (z). \]  

The first term on the right hand side is revenues from Home sales and the second term is revenues from Foreign sales. The total output of a Foreign firm is divided between output sold at the Home market, denoted by \( v_t^* (z^*) \), and output sold at the Foreign market, denoted by \( x_t^* (z^*) \). The profits of a Foreign firm are given by

\[ \pi_t^* (z^*) = p_t^* (z^*) x_t^* (z^*) + \frac{p_t (z^*) v_t^* (z^*)}{E_t} - w_t^* \ell_t^* (z^*). \]  

Given composite consumption indexes and integrating demand for good \( z \) across all households, we see that the demand functions for a typical Home firm’s output are given by

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

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

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

Making use of goods market clearing conditions, the profit functions of a typical Home and Foreign firm can be written as

\[ \pi_t (z) = \left[ \frac{p_t (z)}{P_t} \right]^{-\theta} [(1 - n) C_t^* + (1 - n) G_t^*] (E_t p_t^* (z) v_t (z) - MC_t (z)) + \left[ \frac{p_t (z)}{P_t} \right]^{-\theta} (nC_t + nG_t) (p_t (z) - MC_t (z)), \]
\[ \pi_t^* (z^*) = \left[ \frac{p_t^* (z^*)}{P_t^*} \right]^{-\theta} [(1 - n) C_t^* + (1 - n) G_t^*] (p_t^* (z^*) - MC_t^* (z^*)) + \left[ \frac{p_t (z^*)}{P_t} \right]^{-\theta} (nC_t + nG_t) \left( \frac{p_t (z^*)}{E_t} - MC_t^* (z^*) \right). \]
2.4.2 Staggered Price Setting

We assume that firms set prices in a staggered fashion, as in Calvo (1983). But before turning to staggered adjustment, we first examine the optimal price setting under complete price flexibility. Since monopoly firms can price-discriminate across countries, that are free to set different prices across countries to maximize profits. However, given the profit function [equation (16)], a profit maximizing Home firm ends up choosing prices that are a constant markup over marginal costs

\[ p_t(z) = E_t p_t^* (z) = \frac{\theta}{\theta - 1} MC_t(z) \]

such that the law of one price holds. The price setting problem facing a typical Foreign firm is also identical to that of a Home firm, and it chooses prices that are a constraint markup over Foreign marginal costs.

In the short run, prices are sticky. Following Calvo (1983) we assume that each firm resets its price in any given period with probability \( 1 - \gamma \), independently of time elapsed since the last price adjustment. Each firm has to take this into account when setting its profit-maximizing price that there is a probability \( 0 < \gamma < 1 \) that it cannot revise its price setting decision made in period \( s (s < t) \) in period \( t \). When setting a new price in period \( t \), firm \( z \) seeks to maximize the present value of profits weighting future profits by the probability that the price will still be effective in period \( s \). Thus a typical Home firm seeks to maximize

\[ \max_{p_t(z), p_t^* (z)} V_t(z) = \sum_{s=t}^{\infty} \gamma^{s-t} \zeta_{t,s} \pi_t(z), \]

where \( \zeta_{s,t} = \prod_{j=s}^{t} (1 + R_j)^{-1} \) is the Home nominal discount factor. The optimal price setting strategy for a Home firm is to set the following prices

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

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

Equation (17) is the profit maximizing Home currency price of a good sold in the Home country and equation (18) governs the profit maximizing Foreign currency price of a good sold in the Foreign country. The price setting problem facing Foreign firms is again identical to that of a Home firm. The optimal Home currency price of a Foreign good sold in the Home country and Foreign currency price of a good sold in the Foreign country are, respectively
\[
\begin{align*}
\hat{p}_t(z^*) &= \left( \frac{\theta}{\theta - 1} \right) \frac{\sum_{s=t}^{\infty} \gamma^{s-t} \xi_{t,s} \left( C_s + G_s \right) \left( \frac{1}{\theta} \right)^{-\theta} MC_s^* (z^*)}{\sum_{s=t}^{\infty} \gamma^{s-t} \xi_{t,s} \left( C_s + G_s \right) \left( \frac{1}{\theta} \right)^{-\theta} / E_t}, \\
\hat{p}_t^a(z^*) &= \left( \frac{\theta}{\theta - 1} \right) \frac{\sum_{s=t}^{\infty} \gamma^{s-t} \xi_{t,s} \left( C_s^a + G_s^a \right) \left( \frac{1}{\theta} \right)^{-\theta} MC_s^* (z^*)}{\sum_{s=t}^{\infty} \gamma^{s-t} \xi_{t,s} \left( C_s^a + G_s^a \right) \left( \frac{1}{\theta} \right)^{-\theta}}.
\end{align*}
\]

### 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 implies that each period a measure of \(1 - \gamma\) of the firms reset their prices while a fraction \(\gamma\) keep their prices unchanged.

In this symmetric equilibrium, the consolidated budget constraint of the Home economy is derived by using equation (5), the government budget constraint (12) and the profits of a Home firm (14). It can be written as

\[
\delta_t D_t = D_{t-1} + p_t(z)s_t(z) + E_t p_t^a(z)s_t^a(z) c_t(z) - P_t C_t - P_t G_t.
\]

Analogously, the consolidated budget constraint of the Foreign economy is derived by using corresponding Foreign equations together with the asset-market-clearing condition

\[
- \frac{n}{1 - n} \delta_t \frac{D_t}{E_t} = - \frac{n}{1 - n} \frac{D_{t-1}}{E_t} + \hat{p}_t(z^*) x_t^a(z^*) + \frac{p_t(z^*) v_t^a(z^*)}{E_t} - P_t C_t^a - P_t G_t^a.
\]

Following previous work we consider the special case of zero net Foreign assets and equal 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 (7) and (10): \(\beta = \bar{\delta} = \left( 1 + R \right)^{-1}\), where steady-state values are marked by overbars.

The linearization 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 normalized by consumption. Equilibrium is sequences of variables that (i) clear the labour, goods and money markets in each region in each period, (ii) satisfy the optimality conditions for consumption evolution, (iii) satisfy the optimal pricing rules and (iv) satisfy the intertemporal budget constraints.
2.6 The Choice of Parameters

The choice of parameter values follows Sutherland (1996). The main assumptions underlying the choice of parameter values are as follows. The elasticity of substitution between differentiated goods $\theta$ is set to 6, a value consistent with a 20 percent mark-up in the steady state. The subjective discount factor $\beta$ is set to 1/1.05. Parameter $\gamma$, 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. We 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 $\rho$ is set to one due to the fact that government spending shocks are permanent.

In addition, to highlight the consequences of productive government spending, we need parameter value for $\alpha$. We 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 productivity of public capital of 0.39. The majority of later studies have found estimates of the productivity of public capital that are between zero and Aschauer’s (1989) estimate.\(^3\) For example, Ai and Cassou’s (1995) estimates of the output elasticity of public capital are in the range of 0.15 to 0.26. Our baseline choice is $\alpha = 0.2$. In order to numerically solve the model, we use the method developed by Klein (2000) and software written by McCallum (2001).\(^4\)

3 The International Transmission of Fiscal Shocks

3.1 The Implications of Productive Government Spending

We begin by discussing the dynamic effects of an unanticipated permanent increase in Home government spending on a number of economic variables. We consider two alternative cases, in one case government spending affects productivity and in the other case government spending is pure waste. Figures 1 illustrate the impulse responses to a 1 percent unilateral increase in Home government spending. In Figures, the horizontal axes show time and the vertical axes show the variables’ percentage deviations from the initial steady state.\(^5\) In addition, the CPI-based real exchange rate is defined as

$$\text{Real exchange rate} = \frac{E_t P_{t^*}}{P_t}.$$  

\(^3\)See Glomm and Ravikumar (1997).
\(^4\)I am grateful to Christian Pierdzioch for providing some Matlab code.
\(^5\)Since those variables, whose initial steady-state value is zero are normalized by consumption, home bond holdings show deviation as a percentage of initial consumption level.
As can be seen from Figure 1, a rise in Home government spending causes Home and Foreign output to move in the same direction immediately after the shock. Home consumption falls and Foreign consumption rises, so that the cross country comovement of consumption levels is negative.

A rise in Home government spending increases the demand for both Home and Foreign goods, but domestic households foot the taxes that finance it. Higher taxes lead to an immediate fall in Home wealth and consumption, but because households respond by substituting into work out of 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 labor supply is similarly permanent.

When public services enter into the production function, government spending has a direct positive effect on Home output. At the same time, productive government spending decreases the marginal costs of Home firms allowing the firms to sell their products at lower prices. It is not shown that in the case of the pure waste, the increase in labor supply lowers the real wage. But when government spending is sufficiently productive, the real wage does not fall. As in Linnemann and Schabert (2006), despite higher employment the marginal product of labor can increase because of the productivity effect of government spending. The positive response of real wages to a rise in government spending is supported by empirical evidence (Blanchard and Perotti 2002, Canzoneri et al. 2003 and Gali et al. 2004).

The nominal exchange rate depreciates because the relative consumption change lowers the relative demand for Home money. If government spending is productive, the relative consumption change is smaller and consequently the nominal exchange rate depreciates by less. As shown by Betts and Devereux (2000), under LCP, exchange rate overshooting can occur in response to economic shocks. Panel (e) in Figure 1 highlights that the nominal exchange rate overshoots its long-run level. As in Betts and Devereux (2000), exchange rate overshooting (undershooting) occurs in response to a fiscal shock if the consumption elasticity of money demand is smaller (greater) than one. The interest rate must fall to clear the Home money market and a fall in the Home interest rate is possible if the exchange rate is expected to appreciate. The exchange rate, therefore, has to overshoot 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.

When prices are sticky and denominated in the currency of the buyer, the movement in the nominal exchange rate translates into a real depreciation.\footnote{In the Obstfeld-Rogoff model, the nominal exchange rate jumps immediately to its long-run level. Also in Sutherland’s (1996) calibrated model, which introduces staggered price setting into the Obstfeld-Rogoff model, the nominal exchange rate makes a once-and-for-all step change in response to monetary and fiscal shocks.}
If government spending is productive, due to a smaller nominal exchange rate depreciation the real exchange rate depreciates by less than in the pure waste case. As prices can be adjusted, the real exchange 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 in the long run.

Due to LCP, there is no exchange rate pass-through to import prices and thus the depreciation of the nominal exchange rate does not affect the relative price of Home and Foreign goods in either country. 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, instead of altering relative prices, have important implications for the revenues of firms [recall equations (14) and (15)]. When firms price their goods in terms of local currency, the depreciation raises the revenues of Home firms measured in Home 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 Home consumption relative to Foreign consumption. However, this effect is more than offset by higher taxes and thus this effect only diminishes the fall in Home consumption.

Panel (g) in Figure 1 shows some wealth accumulation by Foreign households immediately after the shock and that productive government spending reinforces the impact of a fiscal shock on the bond holdings of Foreign households. Foreign output increases in the short run. Therefore, to smooth consumption, Foreign households save and lower current consumption. Panel (d) displays that if government spending is productive a fiscal shock induces a greater tilt in the path of output. Thus, Foreign households accumulate more wealth. A permanent improvement in the bond holdings of Foreign households implies allows for a permanent trade balance deficit which is financed by income from interest. This trade balance deficit make possible higher Foreign consumption.

As can be seen from panel (h), the Home terms of trade deteriorates. The reason for the deterioration is the increase in relative Home output. Lower wealth via the current account leads to some increase in work effort, but the main reason for the increase in Home output is the higher tax burden. The negative wealth effects increase relative Home output thus causing a permanent deterioration in its terms of trade. If government spending is productive, the Home terms of trade deteriorates by more because Home firms sell their extra production at lower prices.

Panel (c) in Figure 1 shows that the influence of productive Home government spending on Foreign consumption is positive. The reason behind this is that when government spending is productive both higher Foreign wealth and the improvement in the Foreign terms of trade allow Foreign
households to increase their consumption. A closer look at Panel (d) reveals that a fiscal shock is predicted to slightly decrease Foreign output in the new steady state. The reason is that with higher wealth (consumption), Foreign households shift out of work into leisure. If the impact on Foreign aggregate output is small, the composition of output changes as the country’s export sector expands.

Panel (d) also reveals that the introduction of productive government spending has a negative spillover effect on Foreign output in the long run. Higher consumption, which pushes Foreign households to consume more leisure, explains why the consequence of productive Home government spending on Foreign output is negative in the long run. This impact is certainly very small.

Arin and Koray (2006) study how U.S. fiscal expansions in the U.S. affect the U.S. economy and these expansions are transmitted to the Canadian economy. Using a semi-structural VAR model, the authors find that U.S. fiscal expansions have a beggar-thy-neighbor effect on Canada and that expansions are transmitted by international trade and capital movement through interest rate and exchange rate channels. Furthermore, the authors show that the decrease in Canadian output is significantly different from zero after the 4th quarter. This is roughly consistent with the predictions of this model; a fiscal expansion however increases Foreign output immediately after the shock.

The analysis of this section suggests that the macroeconomic effects of fiscal policy are not sensitive to the introduction of productive government spending. The introduction of production government spending does not cause qualitative changes; the consequences on the macroeconomic variables are purely quantitative. The next step is to conduct a sensitivity analysis to study whether the international effects of a fiscal shock are sensitive to the value of the productivity of government spending.

3.2 Sensitivity Analysis: Crowding Out and Crowding In?

To complement the numerical analysis, we conduct a sensitivity analysis to investigate to what extent the international effects of a fiscal shock are sensitive to the choice of one key parameter: the productivity of government spending. We do not show sensitivity analyses with respect to other parameter values because the macroeconomic effects of a fiscal shock are not sensitive the choice of other parameter values. To show how the effects of a fiscal shock depend on the positive effect that government spending induces, we set a high production elasticity of government spending 0.5, a parameter value that is also used in Linnemann and Schabert (2006).

Figure 2 displays the dynamic effects of a fiscal shock in two cases. The solid lines depict the case where \( \alpha = 0.2 \) and the dashed lines depict the case where \( \alpha = 0.5 \). Note the response of the Home nominal interest rate is
measured as percentage point deviation from initial equilibrium. The Figure shows that increasing the productivity of government spending causes some interesting qualitative changes. First, if the productivity of government spending is sufficiently high, a fiscal shock tends to increase Home consumption. Second, if the productivity of government spending is high, a fiscal shock appreciates the nominal and real exchange rate. Third, a rise in government spending can increase the interest rate if the productivity government spending is high.

In the case where $\alpha = 0.5$, the response of consumption to a rise in government spending is positive as output increases substantially. The higher the productivity of the government spending, the more Home output increases. If government spending generates a sufficiently strong effect on private production, a fiscal shock does not need to lead a reduction in wealth and private consumption. As mentioned, a rise in government spending tends to decrease consumption due to the rise in taxes. On the other hand, when government spending is productive, a rise in government spending has a direct positive effect on output and consequently consumption. When government spending generates a sufficiently strong effect on production, the latter effect dominates and consumption increases. In this case, the increase in the real wage, not a fall in consumption, induces an increase in labor supply.

Figure 2 displays that fiscal shock can appreciate the nominal and real exchange rate if government spending is productive. A fiscal shock appreciates the nominal exchange rate if the relative consumption change increases the relative demand for Home money. In the case where $\alpha = 0.5$, Home consumption increases more than Foreign consumption. Thus the relative consumption change increases the relative demand for Home money and consequently the nominal exchange rate appreciates. Under LCP, the appreciation of the nominal exchange rate translates into a real appreciation.

Panel (h) shows that a high productivity of government spending implies that a fiscal shock can increase the interest rate. When the productivity of government spending is sufficiently productive, a fiscal shock increases global private consumption. Higher consumption implies higher money demand. Thus higher government spending temporarily increases the global interest rate.

In this section it is shown that if the productive of government spending is sufficiently high a rise in government spending increases Home consumption, appreciates the exchange rate and increases the interest rate at the same time. This does not have to be the case. A fiscal shock increases the interest rate if the global money demand increases. This does not require an increase in Home consumption. If we increase the productivity of government spending, the response of Home consumption also becomes positive. This however does not yet imply an appreciation of the exchange rate. The appreciation of the exchange rate requires such high productivity of
government spending that Home consumption increases more than Foreign consumption.

As emphasized 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. A typical finding in the NOEM literature is, however, that a rise in government spending causes a fall in domestic private consumption, a depreciation of the exchange rate and a decrease in the interest rate. In this section it is shown that if we allow for productive government spending, a rise in government spending will not necessarily cause these effects.

4 Conclusions

Virtually all NOEM models, that address fiscal policy issues, can be criticized for the assumption that government spending is does not affect productivity or utility. This paper develops a model in which government spending affects productivity. The paper attempts to fill a gap in the literature by analyzing the consequences of productive government spending on the international transmission of fiscal policy.

We show that the introduction of productive government spending tends to have a positive effect on domestic consumption and output, compared with the pure waste case, as in Linnemann and Schabert (2006). The introduction of productive government spending also has a positive effect of foreign consumption, notwithstanding that the effect on foreign output is negative soon after the shock. This is due to the fact that the introduction of productive government spending reinforces the impact of a fiscal shock on the current account. A higher foreign current account surplus reduces labor supply but allows for a higher level of consumption, relative to the pure waste benchmark.

We also demonstrate that the assumption of productivity government spending has notable implications for the response of the nominal and real exchange rate to a fiscal shock. Relative consumption changes affect the exchange rate by changing relative money demand. If the productivity of government spending is low or zero, a fiscal shock induces a fall in consumption because of higher taxes. In this case, the relative consumption change decreases the relative demand for domestic money and consequently the nominal exchange rate depreciates. In addition, the nominal depreciation translates into a real depreciation. On the other hand, when the productivity of government spending is sufficiently high, the expansion of production possibilities offsets the fall in wealth induced by higher taxes. It is possible that a fiscal shock increases domestic consumption more than foreign consumption. In this case, the relative consumption change increases the relative demand for domestic money and consequently the exchange rates.
appreciate.
References


Figure 1: Productive government spending – the impulse responses to an unexpected permanent rise in Home government spending
Figure 2: Sensitivity analysis, varying the productivity of government spending

(a) Home consumption

(b) Home output

(c) Foreign consumption

(d) Foreign output

(e) Nominal exchange rate

(f) Real exchange rate

(g) Home bond holdings

(h) Home interest rate