Fiscal stimulus with spending reversals*

Giancarlo Corsetti
European University Institute,
University of Rome III and CEPR

André Meier
International Monetary Fund

Gernot J. Müller
University of Bonn

April 29, 2009

Abstract

The impact of fiscal stimulus depends not only on short-term tax and spending policies, but also on expectations about offsetting measures in the future. This paper analyzes the effects of an increase in government spending under a plausible debt-stabilizing policy that systematically reduces spending below trend over time, in response to rising public liabilities. Accounting for such spending reversals brings an otherwise standard new Keynesian model in line with the stylized facts of fiscal transmission, including the crowding-in of consumption and the 'puzzle' of real exchange rate depreciation. Time series evidence for the U.S. supports the empirical relevance of endogenous spending reversals.

Keywords: Fiscal policy transmission, consumption, real exchange rate, real interest rates, sticky prices, monetary policy
JEL-Codes: E62, E63, F41

*We thank our discussant Evi Pappa and the participants in the Fourth Annual Workshop on Global Interdependence, for comments. We gratefully acknowledge generous financial support from the Fondation Banque de France and the Pierre Werner Chair Programme on Monetary Union. The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF or IMF policy. Please address correspondence to giancarlo.corsetti@eui.eu, ameier@imf.org or gernot.mueller@uni-bonn.de.

1 Introduction

Faced with the prospect of a severe global recession in 2009, many governments have put forward plans of massive fiscal stimulus, and are ready to let public debt increase by several percentage points of GDP. While the relative stabilization benefits of current tax cuts and spending increases are heavily debated (see, for example, Barro (2009), Mankiw (2009) or Mountford and Uhlig (2008)), less attention is given to the nature of offsetting fiscal measures in the future. Yet whether the future is expected to bring mostly tax increases or also some spending cuts should also matter for the effects of today's stimulus. Investigating the importance of such medium-term fiscal dynamics is the key objective of this paper. Our analysis shows how, in an economy with sticky prices, a policy that systematically reduces spending over time in response to rising public debt enhances the expansionary impact of short-run fiscal stimulus.

Our main analytical innovation is to reconsider standard analyses of fiscal transmission under less restrictive assumptions about the set of debt-reducing policy options available to policymakers. In fact, existing studies commonly assume that higher current deficits lead to one-for-one tax increases in the future, while government spending does not at all respond to the level of public debt. This assumption is clearly at odds with estimates of fiscal policy rules, which show not only taxes but also spending to be sensitive to the debt stock—see, for example, Galí and Perotti (2003) and Canova and Pappa (2004). In the same vein, Chung and Leeper (2007) and Favero and Giavazzi (2007) show that omitting debt from VAR models of fiscal policy may lead to substantial bias in the estimated dynamics of government spending shocks. This combined evidence also squares well with political economy arguments whereby governments face constraints in their capacity to raise taxes.

In our analysis, as a result of allowing government spending to respond systematically to the level of public debt, current episodes of deficit spending are systematically followed by a decline of government spending below trend. We refer to these dynamics as 'spending reversals'. Our contribution consists of showing the stark implications of such spending reversals for the transmission of fiscal policy in otherwise standard economies.[1] At the core of the transmission mechanism is the behavior of long-term real interest rates under nominal rigidities. Spending reversals create expectations of a future fall in short-term real interest rates, which already affects today's long-term rates. With flexible prices, both short- and long-term real rates still cannot but rise on impact, so as to reallocate consumption from the present to future periods, when the government's claim on domestic resources falls below trend. With sticky prices, instead, real output bears a significant share of the adjustment

[1]The importance of expectations about the future policy stance for understanding fiscal transmission has been emphasized by the literature following Giavazzi and Pagano (1990)—see, for example, Bertola and Drazen (1993), Sutherland (1997), Balduzzi et al. (1997), and Perotti (1999). Yet these contributions focus on expected *large* fiscal corrections which lower the overall tax burden of the private sector. Our results, in contrast, rely on *partial* spending corrections after an initial expansion of government spending, thus characterizing endogenous fiscal dynamics in normal times.

to the fiscal expansion, so short-term rates will rise by less on impact under standard assumptions about monetary policy. As a result, long-term rates need not increase, and may actually fall in spite of the contemporaneous increase in government spending, as they are strongly driven by the anticipation of future fiscal restraint. The decline in long rates, in turn, crowds-in consumption demand and depreciates the real exchange rate.

Allowing for debt-stabilizing spending dynamics in an otherwise standard new Keynesian model thus generates predictions that accord well with a growing body of evidence on the effects of fiscal policy. Two empirical findings, in particular, have been emphasized by recent contributions as a challenge for modern macroeconomic models. First, the pioneering study by Blanchard and Perotti (2002) and subsequent work by several other authors provides evidence suggesting that fiscal expansions boost private consumption and output. While consistent with conventional Keynesian analysis, this finding contradicts the neoclassical as well as the standard new Keynesian model. Indeed, both stress that higher government spending entails a negative wealth shock for private agents: facing a larger tax burden, agents work more and consume less. Second, recent empirical work has also documented that the real exchange rate tends to depreciate in response to a rise in government spending (see, for example, Kim and Roubini (2008), Monacelli and Perotti (2006), Ravn et al. (2007)). Remarkably, this finding is at odds not only with the recent open-economy literature, but also with conventional analyses drawing on the Mundell-Fleming model—see, for example, Dornbusch (1980). As government spending is biased toward domestic goods, a fiscal expansion makes these goods relatively scarce in the world economy. This, according to standard models, should drive up their real price relative to goods produced abroad. The apparent disconnect between theory and empirics in these two dimensions has recently revived the debate on the transmission of fiscal policy, and guided theoretical attempts to amend standard models, notably by considering alternative preference specifications.[2]

Adopting a distinct strategy here, we show that a standard new Keynesian model *can* match the consumption and real exchange rate responses uncovered by the empirical literature, once fiscal policy itself is modeled more thoroughly.

The analysis of spending reversals also has a bearing on a key policy question. Fiscal stabilization is typically motivated by stressing that a significant fraction of households may face financial constraints, making monetary policy less potent. In fact, this argument is a key factor behind many economists' support for fiscal stimulus during the current financial crisis. There is, however, a concern that any potential positive contribution of government spending to the income of financially constrained households could be more than offset by a fall in consumption of unconstrained households.

[2] Monacelli and Perotti (2008), for instance, reconsider the role of non-separable GHH preferences to generate complementarity between hours worked and consumption. Ravn et al. (2007), in turn, posit the existence of 'deep habits'. While these approaches hold considerable promise, they maintain commonly employed, but restrictive assumptions on the conduct of fiscal policy, especially the assumption that any temporary rise in government spending eventually entails a one-for-one increase in the tax burden.

Drawing on Mankiw (2000) and Galí et al. (2007), we explicitly consider in our model the possibility that some households cannot borrow or save, and therefore consume their current disposable income. While such 'hand-to-mouth' consumers are not directly affected by the interest rate movements at the core of our fiscal transmission mechanism, anticipated spending reversals still play an important role. Without spending reversals, the response of aggregate consumption to fiscal expansions may be dominated by the behavior of unconstrained households, and therefore be negative. With spending reversals, by contrast, the dynamics of interest rates align the demand effects of fiscal policy across both types of households. Higher government spending thus crowds-in consumption, providing the desired expansionary effects.

In our empirical analysis, we provide evidence supporting our view of the transmission of fiscal policy. Estimating a VAR model on U.S. time series, we identify government spending shocks drawing on the methodology proposed by Blanchard and Perotti (2002), but also accounting for a recent critique by Ramey (2008). Consistent with our theoretical analysis, and in line with Chung and Leeper (2007) and Favero and Giavazzi (2007), we include public debt in the VAR. While confirming well-known findings concerning private consumption and the exchange rate, we also find that government spending exhibits statistically significant reversals, associated with a time path of real interest rates in close accord with our theoretical results.

The paper is organized as follows. Section 2 outlines our theoretical model. Section 3 provides an account of the transmission mechanism of government spending shocks and illustrates how it is affected by anticipated spending reversals. Section 4 discusses our empirical strategy and provides VAR evidence. Section 5 concludes. The appendix reports results from robustness exercises and alternative VAR specifications.

2 Model

In the following we outline a standard new Keynesian business cycle model. As the external ramifications of fiscal shocks have received considerable attention in the recent debate on the fiscal transmission mechanism, we consider an open economy version. Variants of the same model have been used extensively to discuss the transmission of fiscal policy, although several authors have noted difficulties in accounting for the time series evidence.

The basic structure of our model builds on Galí and Monacelli (2005), although we allow for the possibility that a fraction of households is excluded from financial markets, as in Galí et al. (2007) and Bilbiie et al. (2008). We also assume that markets are not complete at the international level, and posit a (negligibly) debt-elastic interest rate in order to close the model.[3] Our exposition focuses on

[3] We consider a small open economy model, which allows us to abstract from a possible feedback of domestic developments on the rest of the world. This assumption considerably simplifies the analysis and the intuitive account of the fiscal

the domestic economy and its interaction with the rest of the world, ROW, for short.

2.1 Final Good Firms

The final consumption good, C_t, is a composite of intermediate goods produced by a continuum of monopolistically competitive firms both at home and abroad. We use $j \in [0,1]$ to index intermediate good firms as well as their products and prices. Final good firms operate under perfect competition and purchase domestically produced intermediate goods, $Y_{H,t}(j)$, as well as imported intermediate goods, $Y_{F,t}(j)$. Final good firms minimize expenditures subject to the following aggregation technology

$$C_t = \left[(1-\omega)^{\frac{1}{\sigma}} \left(\left[\int_0^1 Y_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}} \right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left(\left[\int_0^1 Y_{F,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (1)$$

where σ measures the trade price elasticity, i.e., the extent of substitution between domestically produced goods and imports for a given change in the terms of trade. The parameter $\epsilon > 1$ measures the price elasticity across intermediate goods produced within the same country, while ω measures the weight of imports in the production of final consumption goods.

Expenditure minimization implies the following price indices for domestically produced intermediate goods and imported intermediate goods, respectively,

$$P_{H,t} = \left(\int_0^1 P_{H,t}(j)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}, \qquad P_{F,t} = \left(\int_0^1 P_{F,t}(j)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}. \quad (2)$$

By the same token, the consumption price index is

$$P_t = \left((1-\omega) P_{H,t}^{1-\sigma} + \omega P_{F,t}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}. \quad (3)$$

Regarding the ROW, we assume an isomorphic aggregation technology. Further, the law of one price is assumed to hold at the level of intermediate goods.

2.2 Intermediate Good Firms

Intermediate goods are produced on the basis of the following production function

$$Y_t(j) = H_t(j)^{\alpha}, \quad (4)$$

where $\alpha \in [0,1)$.[4] $H_t(j)$ measures the amount of labor employed by firm j.

transmission mechanism with spending reversals, as does abstracting from capital formation. Results from a two-country version of the model with explicit investment decisions (while requiring a somewhat more complex exposition) are in line with those reported below. They are available upon request.

[4]To rationalize decreasing returns ($\alpha < 1$), one may think of a firm-specific capital stock which is prohibitively costly to adjust at business cycle frequency.

Intermediate good firms operate under imperfect competition. We assume that price setting is constrained exogenously by a discrete time version of the mechanism suggested by Calvo (1983). Each firm has the opportunity to change its price with a given probability $1-\xi$. Given this possibility, a generic firm j will set $P_{H,t}(j)$ in order to solve

$$\max E_t \sum_{k=0}^{\infty} \xi^k \Lambda_{t,t+k} \left[Y_{t,t+k}(j) P_{H,t}(j) - W_{t+k} H_{t,t+k}(j) \right], \tag{5}$$

where $\Lambda_{t,t+k}$ denotes the stochastic discount factor of the households who own firms, i.e., the 'asset holders'; $Y_{t,t+k}(j)$ and $H_{t,t+k}(j)$ denote demand and employment in period $t+k$, respectively, given that prices have been set optimally in period t. E_t denotes the expectations operator.

2.3 Households

We assume that there is a continuum of households $[0,1]$, a fraction $1-\lambda$ of which are asset holders, indexed with a subscript 'A'. These households own firms, and may trade one-period bonds both domestically and internationally. The remaining households (a fraction λ of the total) do not participate at all in asset markets, i.e., they are 'non-asset holders', and indexed with a subscript 'N'. As in Bilbiie et al. (2008), differences between households are assumed to arise from their respective capacity to participate in asset markets, rather than from preferences.

Asset holders A representative asset-holding household chooses consumption, $C_{A,t}$, and supplies labor, $H_{A,t}$, to intermediate good firms in order to maximize

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{C_{A,t+k}^{1-\gamma}}{1-\gamma} - \frac{H_{A,t+k}^{1+\varphi}}{1+\varphi} \right) \tag{6}$$

subject to the period budget constraint

$$R_t^{-1} A_{t+1} + R_{F,t}^{-1} B_{t+1}/\mathcal{E}_t + P_t C_{A,t} = A_t + B_t/\mathcal{E}_t + W_t H_{A,t} - T_t + \Psi_t. \tag{7}$$

where W_t denotes nominal wages, and T_t denotes nominal lump-sum taxes, in per capita terms. A_t and B_t are one-period bonds denominated in domestic and foreign currency, respectively. R_t and $R_{F,t}$ denote the gross nominal interest rates on both bonds. Ψ_t is profits of intermediate good producers accruing to asset holders. $\mathcal{E}_t$ denotes the nominal exchange rate measured in units of foreign currency per domestic currency. Ponzi schemes are ruled out by assumption.

We assume that the interest rate paid or earned on foreign bonds by domestic households is given by the exogenous world interest rate, R_t^*, and a 'spread' which decreases in the real value of bond holdings scaled by Y_t, the level of output defined below. Specifically, we set

$$R_{F,t} = R_t^* - \chi \frac{B_{t+1}}{Y_t P_t}, \tag{8}$$

This assumption ensures the stationarity of bond holdings (even for very small values of χ) and thus allows us to study the behavior of the economy in the neighborhood of a deterministic steady state.[5]

Non-asset holders A representative non-asset holding household chooses consumption, $C_{N,t}$, and supplies labor, $H_{N,t}$, to intermediate good firms in order to maximize its utility flow on a period-by-period basis

$$\frac{C_{N,t}^{1-\gamma}}{1-\gamma} - \frac{H_{N,t}^{1+\varphi}}{1+\varphi} \tag{9}$$

subject to the constraint that consumption expenditure equals net income

$$P_t C_{N,t} = W_t H_{N,t} - T_t. \tag{10}$$

For non-asset holders, consumption equals disposable income in each period; hence they are also referred to as 'hand-to-mouth consumers'.

2.4 Government

We specify the conduct of monetary policy by an interest rate feedback rule. Specifically, we assume that the central bank determines the nominal short-term rate following a Taylor-type rule:

$$R_t = R + \phi(\Pi_{H,t} - \Pi_H), \tag{11}$$

where $\Pi_{H,t} = P_{H,t}/P_{H,t-1}$ measures domestic inflation. Here and in the following, variables without time subscript refer to the steady-state value of a variable. A Taylor-type rule such as (11) provides a familiar and simple way to account for the role of monetary policy in the transmission of fiscal policy. Moreover, for $\phi \to \infty$, we can use (11) to approximate the flexible-price allocation as a reference point. Intuitively, if monetary policy reacts with infinite strength to any deviation of inflation from the target, it effectively precludes price dispersion, in line with flexible-price models.

Government spending is an aggregate of domestic intermediate goods:

$$G_t = \left(\int_0^1 Y_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}.$$

We assume that intermediate goods are assembled so as to minimize costs. Thus the price index for government spending is given by $P_{H,t}$. Government spending is financed either through lump-sum

[5] Our particular specification draws on Kollmann (2002), who studies a model similar to ours. Schmitt-Grohé and Uribe (2003) consider a real model of a small open economy and suggest the above mechanism of a debt-elastic interest rate as one among several ways of 'closing small open economy models' (that is, inducing stationarity) with incomplete markets. In principle, a debt-elastic interest rate also provides a convenient, if somewhat crude, way to study another possible transmission channel of fiscal policy. Specifically, a non-negligible 'risk premium' (i.e., χ taking an economically significant value) would capture the idea that borrowers from highly indebted countries face less favorable financing conditions in international markets. This, in turn, would affect the real economic impact of higher government spending. We briefly consider this idea in the appendix to the paper.

taxes, T_t, or through issuance of nominal one-period debt, D_t. The period budget constraint of the government reads as follows

$$R_t^{-1} D_{t+1} = D_t + P_{H,t} G_t - T_t. \tag{12}$$

The time path of government spending and real taxes, $T_{R,t} = T_t / P_t$, is also determined by feedback rules, which we assume to take the following form

$$G_t = (1 - \psi_{gg}) G + \psi_{gg} G_{t-1} + \psi_{gd} \frac{D_t}{P_{t-1}} + \varepsilon_t \tag{13}$$

$$T_{R,t} = G \left(\frac{P_{H,t} G_t}{P_t G} \right)^{\psi_{tg}} + \psi_{td} \frac{D_t}{P_{t-1}}, \tag{14}$$

where ε_t measures an exogenous iid shock to government spending. The ψ-parameters capture the responsiveness of spending and taxes to government spending and debt. Note that for $\psi_{tg} = 1$, changes in government spending lead to a one-for-one increase in taxes, leaving government debt unchanged.

It is worth emphasizing that the analysis of government spending shocks has been typically conducted under the assumption that $\psi_{gd} = 0$, in which case government spending follows an exogenous process.[6] Relaxing this restriction is essential for our own analysis, as we wish to trace the implications of debt-stabilizing spending dynamics for the transmission of fiscal shocks. Note in this context that (13) need not be interpreted strictly as an institutional rule constraining the fiscal authorities. Instead, like a Taylor rule for monetary policy, it may simply provide a description of fiscal policy-making, reflecting the complex set of incentives and constraints that govern the authorities' decisions on the level of government spending.

2.5 Equilibrium

Equilibrium requires that firms and households behave optimally for given initial conditions, exogenously given developments in the ROW, and government policies. Moreover, market clearing conditions need to be satisfied. At the level of each intermediate good, supply must equal total demand stemming from final good firms, the ROW, and the government:

$$Y_t(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-\epsilon} \left((1 - \omega) \left(\frac{P_{H,t}}{P_t} \right)^{-\sigma} C_t + \omega \left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\sigma} C_t^* + G_t \right), \tag{15}$$

where $P_{H,t}^*$, P_t^*, and C_t^* denote the price index of domestic goods expressed in foreign currency, the foreign price level and foreign consumption, respectively.

[6] If, in addition $\lambda = 0$, the relative magnitude of ψ_{tg} and ψ_{td} is irrelevant for the equilibrium allocation, provided that ψ_{td} is set so as to ensure the stability of debt.

As in Galí and Monacelli (2005), it is convenient to define an index for aggregate domestic output: $Y_t = \left(\int_0^1 Y_t^{\frac{\epsilon-1}{\epsilon}}(j)dj \right)^{\frac{\epsilon}{\epsilon-1}}$. Substituting for $Y_t(j)$ using (15) gives the aggregate relationship

$$Y_t = (1-\omega) \left(\frac{P_{H,t}}{P_t} \right)^{-\sigma} C_t + \omega \left(\frac{P^*_{H,t}}{P^*_t} \right)^{-\sigma} C^*_t + G_t. \tag{16}$$

In addition, the following has to hold

$$C_t = \lambda C_{N,t} + (1-\lambda) C_{A,t} \tag{17}$$

$$H_t = \lambda H_{N,t} + (1-\lambda) H_{A,t}, \tag{18}$$

where $H_t = \int_0^1 H_t(j)dj$ is aggregate labor employed by domestic intermediate good firms.

Regarding asset markets, we assume that foreigners do not hold domestic bonds. Market clearing for domestic currency bonds therefore requires

$$(1-\lambda)A_t - D_t = 0. \tag{19}$$

The market for foreign currency bonds clears by Walras' law.

We also define the trade balance in terms of steady-state output, and the real exchange rate as follows:

$$TB_t = \frac{1}{Y} \left(Y_t - \frac{P_t}{P_{H,t}} C_t - G_t \right), \qquad Q_t = \frac{P_t \mathcal{E}_t}{P^*_t}. \tag{20}$$

Note that an increase of Q_t corresponds to an appreciation of the real exchange rate.

3 Fiscal Policy Transmission With Spending Reversals

In this section we analyze the transmission of fiscal shocks under the assumption that both future taxes and government spending respond to the level of public debt. Under this assumption, a current episode of deficit spending is expected to be partially offset through future reductions in spending below trend.

We consider an approximation of the equilibrium conditions of our model around a deterministic steady state. For this steady state we assume that trade is balanced, government debt is zero, inflation is zero, and consumption and labor supply of asset-holders and non-asset holders are identical (as a result of appropriate lump-sum transfers in steady state).

In our simulations we initially focus on a 'parsimonious' version of the model, so as to provide a close-up analysis of the transmission mechanism under a debt-stabilizing spending rule. In this version of the model, we assume that all households participate in financial markets—all agents are assets holders. Subsequently, we will study a model economy involving both asset holders and non-asset holders.

3.1 Parameterization

Table 1 summarizes all parameter choices. A period in the model corresponds to one quarter. The discount factor β is set to 0.99. We assume that the coefficient of relative risk aversion, γ, and the inverse of the Frisch elasticity of labor supply, φ, take the value of one. The trade price elasticity σ is set equal to $2/3$, which is in the range considered in the recent macroeconomic literature.[7]

Price rigidities play a key role in the transmission of government spending shocks with spending reversals. We assume that $\xi = 0.75$, implying an average price duration of four quarters, within the range of values discussed, for example, by Nakamura and Steinsson (2008), if toward the higher end. Besides price stickiness, two additional features determine the extent to which the equilibrium allocation differs from the allocation that would obtain under flexible prices (flexible-price allocation, for short). First, the returns to labor, the only variable factor of production, are assumed to be decreasing, as indicated by $\alpha < 1$. This assumption generates real rigidities. Second, the extent of these rigidities is further affected by the price elasticity of demand, measured by ϵ. Specifically, we assume that $\alpha = 0.63$ and $\epsilon = 21$, implying a steady-state markup of 5 percent and a labor share of 60 percent.[8]

Table 1: **Parameterization of the Model**

Parameters		Value
Discount factor	β	0.99
Coefficient of risk aversion	γ	1
Inverse of Frisch elasticity	φ	1
Trade price elasticity	σ	2/3
Prob. of price fixed	ξ	0.75
Production function	α	0.63
Price elasticity of demand	ϵ	21
Import share of private demand	ω	0.15
Average spending share	g_y	0.2
Autocorrelation spending	ψ_{gg}	0.9
Debt elast. of taxes	ψ_{td}	0.02
Debt elast. of spending	ψ_{gd}	-0.02
Tax finance	ψ_{tg}	0.5
Monetary policy	ϕ	1.5
Debt elast. of interest rates	χ	0.00001
Non-asset holders	λ	0, 1/3

[7] See Corsetti et al. (2008) for further discussion.

[8] See Galí et al. (2001) or Eichenbaum and Fisher (2007) for further discussion of how real rigidities interact with nominal price rigidities in the context of the new Keynesian model. Note that the latter study also considers a non-constant price elasticity of demand, which further increases the degree of real rigidities.

Regarding monetary policy, we assume that $\phi = 1.5$, a value commonly employed by the literature. Regarding fiscal policy, we assume that changes in government spending are contemporaneously financed in equal part by taxes and debt, that is, we set $\phi_{tg} = 0.5$. Further, we set $\omega = 0.15$ and the average government spending share $g_y = 0.20$. This implies that imports account for 12 percent (because government spending is assumed to fall on domestic goods only) and government spending for 20 percent of steady-state output, in line with average values for the U.S. during the period 1980–2007. The parameter ψ_{gg} is set to 0.9, capturing the persistence of government spending deviations from trend documented by many VAR studies on U.S. data.

We set the two parameters that govern the responsiveness of taxes and government spending to debt equal to $\psi_{td} = -\psi_{gd} = 0.02$. The latter parameter is crucial for our account of the transmission mechanism. To the extent that contemporaneous taxes do not move one-for-one with government spending, some later response of taxes and/or spending is required to ensure public debt stability.[9] In virtually all models of fiscal transmission, taxes are assumed—without further justification—to bear the entire burden of debt stabilization, i.e., $\psi_{gd} = 0$. This effectively makes the path of debt/taxes irrelevant for the real allocation of the economy (if $\lambda = 0$).

A fundamental passage in our analysis of fiscal policy is to recognize that at least some of the dynamic adjustment to a higher debt stock will fall on spending restraint. This proposition captures the reality of institutional and/or political constraints on governments' capacity to raise taxes.[10] It also finds support in empirical estimates of policy rules, which indicate a statistically significant adjustment of both spending and taxes in response to higher debt.[11] In our parameterization with $\psi_{gd} = -0.02$ and $\psi_{td} = 0.02$, an increase in government debt by 1 percentage point of GDP causes spending/taxes to be decreased/increased by 0.02 percentage points relative to their baseline trends.

In the last line of Table 1, we report the values for the parameter λ, i.e., the extent of participation in financial markets, which we vary across model simulations. Initially, we assume that all households have access to financial markets ($\lambda = 0$). Subsequently, we relax this assumption and posit $\lambda = 1/3$. Note that this is a relatively conservative number in light of the estimates reported by Galí et al. (2007), who reconsider estimates by Campbell and Mankiw (1989), and by Bilbiie et al. (2008).

[9] Consider a linear approximation of the equilibrium conditions around a deterministic steady state with zero inflation and without debt. Abstracting from autocorrelation of government spending and any direct contemporaneous response of taxes to spending, and assuming an 'active monetary policy', debt stability obtains if the difference between ψ_{gd} and ψ_{td} does not exceed $1 - \beta$. For a general discussion see Leeper (1991).

[10] We should stress that our parameter choice does not necessarily reflect explicit debt or deficit constraints as enacted in several countries. Instead, a systematic adjustment of spending and/or taxes to the level of public debt may follow, more broadly, from political economy constraints which force fiscal adjustment to take place at some point. For instance, Canova and Pappa (2004), find a strong stabilizing response of government spending to the debt output/ratio across U.S. states, irrespective of whether state laws mandate explicit fiscal restrictions.

[11] Using annual observations, Galí and Perotti (2003), for instance, report estimates ranging from -0.04 to 0.03 for government spending, and from 0 to 0.05 for taxes, in a panel of OECD members (no breakdown by country provided for these estimates). For the U.S., Bohn (1998) reports estimates for the response of the *surplus* to debt in a range from 0.02 to 0.05.

3.2 Quantitative Analysis

In the following we analyze in detail the fiscal transmission mechanism under our specification of fiscal policy. The main finding is that, with anticipated spending reversals, the initial fiscal impulse exerts a stronger expansionary effect on output, by crowding in private consumption and depreciating the real exchange rate. This pattern of impulse responses conforms well with results from empirical studies that have long posed a challenge for macroeconomic theory. In traditional analyses based on the Mundell-Fleming model, government spending crowds-in private consumption, but also produces upward pressure on interest rates, which attracts capital inflows and thus appreciates the currency. The latter implication carries over to more recent models, whether neoclassical or new Keynesian (although the crowding-in of consumption does not!). In these models, given home bias in public demand, an increase in government spending is commonly shown to raise the international price of domestic output, i.e., appreciate the real exchange rate. The literature has recently paid increasing attention to this particular issue, as the response of real exchange rates provides a useful benchmark against which to assess models of fiscal transmission—see, for example, Ravn et al. (2007) and Monacelli and Perotti (2006).

In this spirit, this paper builds a case for refining our understanding of expenditure-side stimulus, going beyond the distinction of government spending by type (investment versus consumption, wages versus final goods—see Baxter and King (1993) and Finn (1998)) or according to the mix of tax versus deficit financing in the short run (see Ludvigson (1996)). Our main, novel argument is that much of the macroeconomic impact of fiscal stimulus depends on the own-dynamics of government spending, notably the extent to which temporary deficit spending is subsequently offset through spending cuts. In this regard, the common assumption that fiscal expansions lead to a one-for-one increase in the tax burden strikes us as an overly restrictive and implausible simplification. Indeed, by ignoring the possibility of spending reversals, macroeconomic models risk providing a distorted picture of fiscal policy transmission and the mechanics of expenditure-side stimulus.

Throughout, we consider an unanticipated increase in government spending by one percent of steady-state GDP. To focus on the core of the transmission mechanism, we report impulse responses for the following six variables: government spending, output, private consumption, short- and long-term real interest rates, and the real exchange rate. At the end of this section, we show an expanded set of impulse responses including other variables of interest.

3.2.1 Inspecting the mechanism

Figure 1 displays impulse responses for the parsimonious specification of our model where all households participate in asset markets ($\lambda = 0$). We gauge the importance of nominal rigidities by contrasting our baseline case featuring sticky prices (the corresponding impulse responses are denoted by solid lines) with a flexible-price allocation for the same economy (dashed lines).[12] In Figure 1, as well as in all the figures in the rest of this section, quantity variables are measured in percent of steady-state output; price variables (such as the real exchange rate, the interest rates, and real wages) are measured in percentage deviations from the steady-state level. Horizontal axes measure time in quarters.

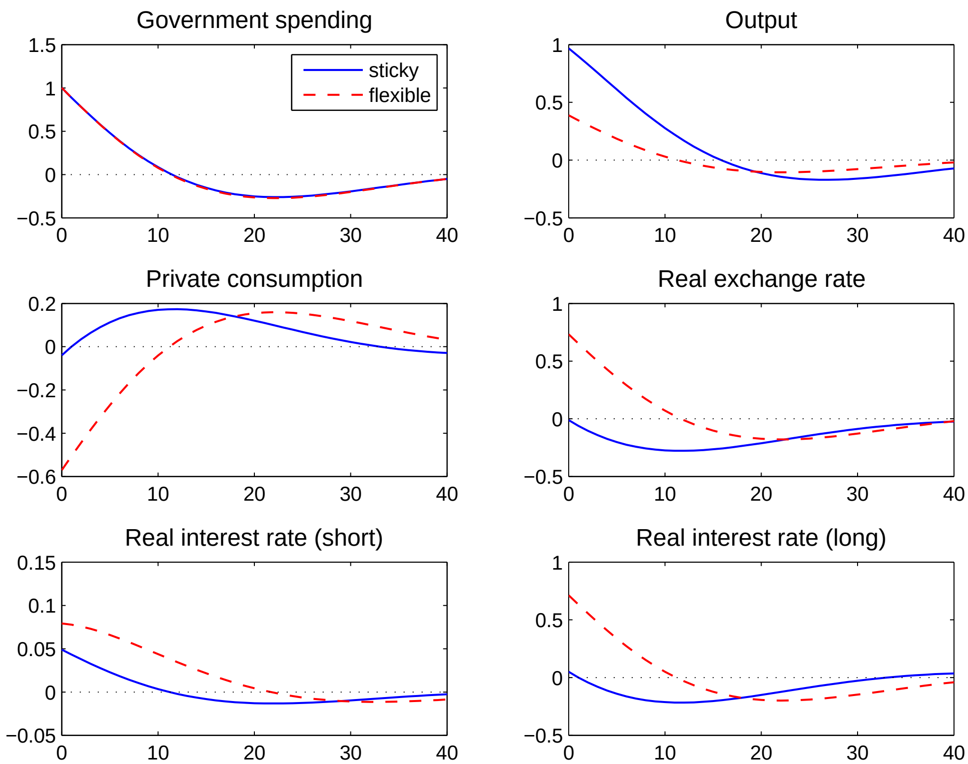

Figure 1: Effect of Government Spending Shock: Sticky Price vs. Flexible Price Allocation. Notes: Solid lines:
$\phi = 1.5$, dashed lines: $\phi = 500$. Quantity variables are measured in percent of steady-state output. Price variables are measured in percentage deviations from the steady-state level. Horizontal axes measure time in quarters.

The upper-left chart shows the dynamics of spending shocks, including a partial spending reversal. Spending rises on impact, but subsequently eases in response to higher outstanding debt and actually falls below trend levels some 12 quarters after the initial shock. To analyze the responses of all other variables, focus first on the flexible-price allocation.

The lower-left chart shows that the real short-term interest rate rises quite sharply on impact, dropping below steady-state levels no earlier than ten periods after government spending has fallen below trend. This path also drives the long-term real interest rate (shown in the lower-right chart), which

[12]The flexible-price allocation is modeled by assuming that the central bank adjusts interest rates massively in response to any deviation of inflation from the target. Specifically, we assume $\phi = 500$.

compounds the infinite series of expected future short-term rates.[13] Accordingly, the long-term rate increases considerably on impact, but then falls below steady-state levels around the time when spending drops below trend. Mirroring the path of this variable, private consumption initially drops; it recovers above trend levels not until the public spending increase has tapered off and the long rate fallen below steady-state level.[14] Following the same pattern, the real exchange rate appreciates with above-trend public spending, and depreciates with below-trend public spending.[15] Intuitively, the dynamic adjustment under flexible prices corresponds to a basic notion of efficiency, whereby prices induce a reallocation of private consumption over time, from periods when the government's claim on domestic resources is above trend, to periods when it is below.

With nominal rigidities, real output bears a greater share of the initial adjustment to the shock. In Figure 1, this is manifest in short- and long-term real interest rates (solid lines) that are lower than under flexible prices, a greater rise in domestic production, an increase in private consumption, and a fall in the real exchange rate.

Anticipation effects are key to the transmission of fiscal policy displayed in Figure 1. Intuitively, our fiscal experiment could be interpreted as the combination of two different measures: one consists in the unexpected increase in government spending in the short run; the other in the announcement of a spending contraction to be implemented in the future. Price stickiness is not too consequential for the response of *future* demand and output to the preannounced spending cuts: with staggered price adjustment, many firms will have the opportunity to re-optimize their prices incorporating the expectation of public spending restraint. In contrast, price stickiness is crucial for the *short-run* effects of the temporary spending increase. As prices do not adjust sufficiently to reflect the scarcity of current output relative to greater aggregate demand, domestic output expands much more than under flexible prices. Indeed, with the central bank following a standard Taylor-type rule, the contractionary response of monetary policy is not strong enough to raise long-term interest rate up to the point of crowding out private consumption.

These dynamics, however, hinge not only on nominal rigidities, but also, and crucially so, on the debt-sensitivity of government spending. Figure 2 draws attention to this aspect by contrasting the baseline spending reversal (where the debt-sensitivity parameter of the spending rule is set to $\psi_{gd} = -0.02$) with the case of a debt-insensitive spending rule ($\psi_{gd} = 0$). Note that across the two experiments we

[13] The long-term real rate of interest is defined as the real yield on a bond of infinite duration. Formally, the deviation of this variable from its steady-state value corresponds to the infinite sum of deviations of future ex-ante short-term real interest rates from steady state.

[14] With additive separability of preferences over time, the equilibrium consumption demand is determined exactly by the negative of the long-term real interest rate—see, for example, Woodford (2003) p. 244.

[15] With complete markets, the real exchange rate would be determined exactly by the ratio of domestic to foreign long-term real interest rates, see, for example, Corsetti and Pesenti (2005) and Galí and Monacelli (2005). Observe that our allocation turns out to be close to the one under complete markets, as shown by Figure A.1 in the Appendix—for further discussion see also Corsetti et al. (2008).

maintain the sticky-price setup of the baseline specification.

The dashed lines denote impulse responses for the debt-insensitive case. Observe that real short-term interest rates in this case never fall below their steady-state level, in marked difference from the baseline specification denoted by solid lines. Hence long-term rates in the debt-insensitive case also remain consistently above their steady-state value after the spending shock; consumption falls; and the real exchange rate appreciates (see, for example, Linnemann and Schabert (2003)).

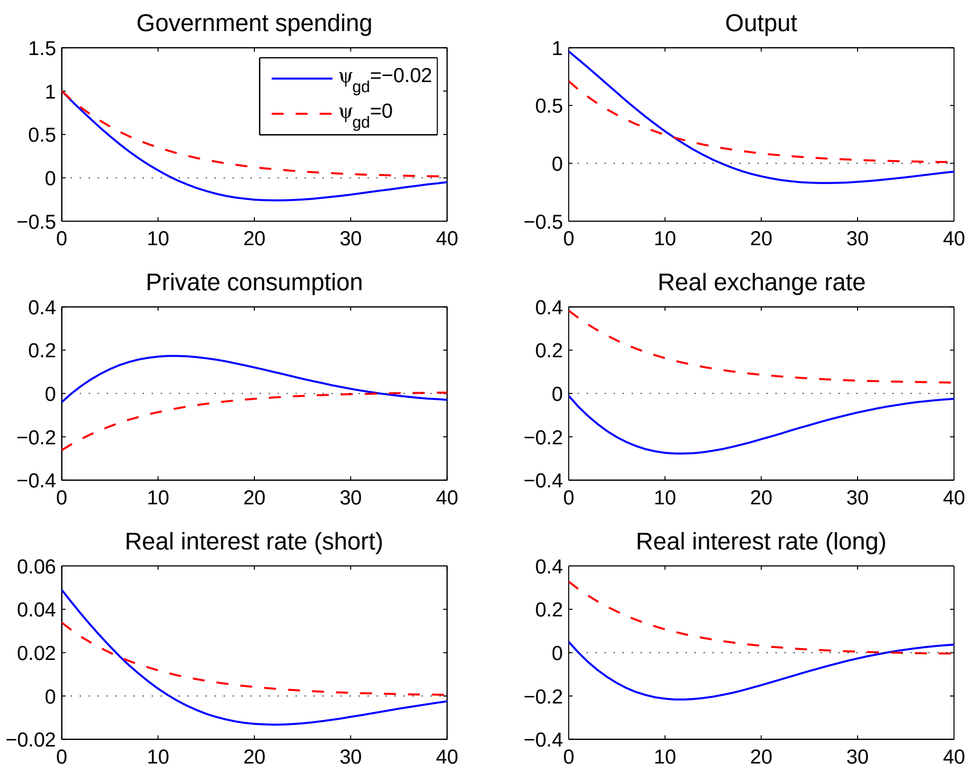

Figure 2: Effect of Government Spending Shock: Debt-Stabilizing vs. Debt-Insensitive Spending Rule. Notes: see figure 1. Solid lines: $\psi_{gd} = -0.02$, dashed lines: $\psi_{gd} = 0$.

The specification without spending reversals implies that any spending increase leads to a one-for-one rise in the expected tax burden—a key assumption in most existing quantitative studies of fiscal transmission.[16] By contrast, the debt-stabilizing spending rule puts some of the burden of adjustment on outlays, thereby reducing the need for significant tax increases. Under our parameterization, for instance, the government's claim on domestic resources diminishes noticeably (by ca. 80 percent in net present value terms, at steady-state prices), as the higher debt stock caused by the initial rise in spending feeds back into spending cuts later on.

Yet the divergence between the two scenarios shown in Figure 2 cannot be attributed simply to dif-

[16]Our specification of the tax rule implies that taxes rise, on impact, by 50 percent of the spending impulse, thus causing a deficit to emerge.

ferences in the size of the wealth shocks caused by the government's claim on resources. To clarify this point, we reconsider the same scenarios under complete markets, implying that households are explicitly insured against the higher tax burden through a complete set of internationally traded state-contingent securities. In this case, domestic consumption (relative to foreign consumption) is tightly linked to the real exchange rate. Without the spending reversal, consumption falls in response to the government spending shock, while the real exchange rate appreciates—regardless of the fact that private wealth is now insulated from the shock. With the spending reversal, the exact opposite occurs. In other words, whether or not markets are complete, our baseline specification with debt-stabilizing spending dynamics predicts a positive consumption multiplier, associated with real depreciation. These results are shown in Figure A.1 in the appendix.

Another important point is worth stressing. In our model, spending reversals give rise to budget surpluses. However, it is the path of spending, not of deficits and surpluses, that makes a difference for fiscal transmission. This becomes clear from the fact that under a debt-insensitive spending rule, the timing of taxation is entirely irrelevant, given the assumed lump-sum nature of taxes. Instead, our analysis underscores the critical role of long-term interest rates in reflecting anticipated movements in public demand relative to domestic productive capacity.

3.2.2 The model with limited participation in asset markets

We now turn to our model specification where a fraction of households is without access to financial markets ($\lambda = 1/3$). This specification captures elements of the macroeconomy that are not key to the mechanism of spending reversals but important for fiscal policy in its own right. Specifically, the presence of 'hand-to-mouth consumers' reflects credit market imperfections that constrain households' capacity to smooth consumption over time—imperfections which have come to the fore during the ongoing financial crisis and which provide a rationale for fiscal stabilization in the first place.

Figure 3 displays the impulse responses for this model economy. In addition to the variables displayed in Figures 1 and 2, Figure 3 also includes several additional variables of interest: consumption of asset holders and non-asset holders or 'hand-to-mouth consumers' (denoted by 'A' and 'N', respectively), the government budget balance, taxes, public debt, net foreign assets, the real wage, net exports, the short-term nominal interest rate, and domestic inflation (the latter two replacing the short-term real rate). As in the previous subsection, we compare a baseline case with spending reversals (solid lines) to the case of a debt-insensitive, exogenous path for spending, as commonly assumed in the literature (dashed lines).

Without spending reversals, our numerical exercise shows that the presence of 'hand-to-mouth consumers' *per se* is not sufficient to generate a positive consumption multiplier. Indeed, as the long-term real interest rate remains above its steady-state value, the sharp contraction in the consumption of as-

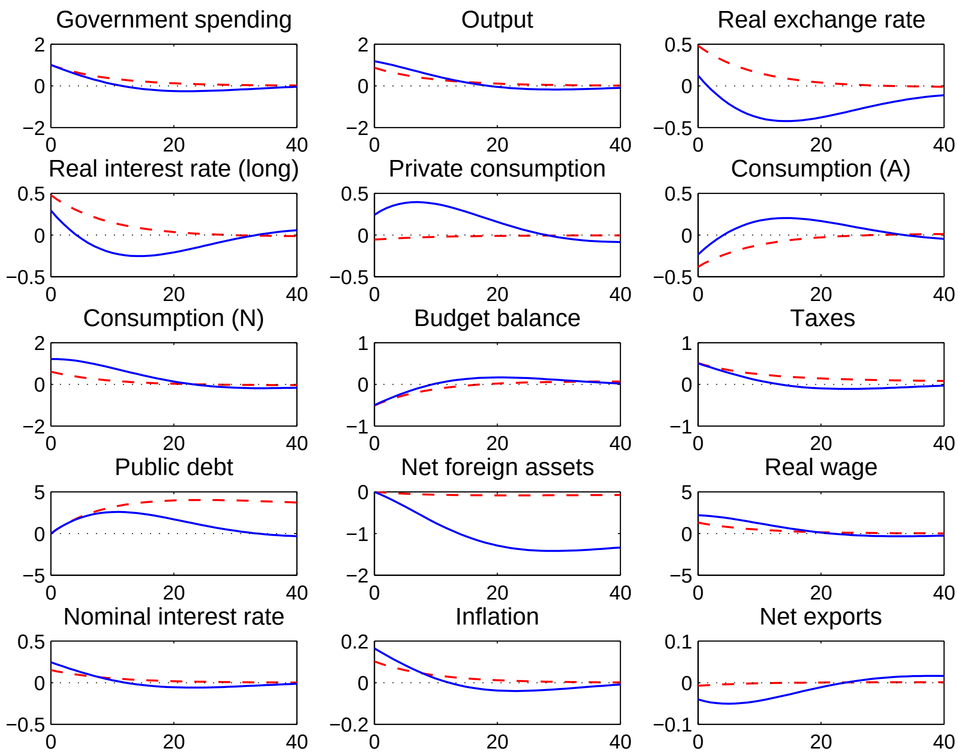

Figure 3: Effect of Government Spending Shock: Model with Limited Participation in Asset Markets. Notes: see figure 1.

set holders more than offsets the positive addition to demand from the non-asset holders. Note also that the real exchange rate appreciates, and the real wage response is positive.

With spending reversals, instead, hand-to-mouth consumers introduce important amplification effects. Private consumption rises much more on impact, implying a multiplier of about 0.4, close to the values reported by many empirical studies. Output also increases somewhat more than in the specifications shown in Figures 1 and 2. Interestingly, as the boost to aggregate demand from the fiscal stimulus is stronger, the long-term real interest rate initially rises, but this increase is short-lived, and followed by a prolonged decline below steady-state levels. The presence of hand-to-mouth consumers also alters the response of consumption, which no longer mirrors that of the long-term interest rate, and that of the real exchange rate. In particular, the strong impact increase in consumption coincides with a short-lived rise in long-term real interest rates and a brief real appreciation. Correspondingly, asset holders reduce their consumption initially, but the contraction of their demand is milder than in the case of debt-insensitive government spending.[17]

The stronger rise in private consumption reflects primarily the presence of hand-to-mouth agents,

[17] A stronger depreciation obtains if we allow for a (significantly) debt-sensitive interest rate ($\chi = 0.1$), capturing the notion that higher public debt could trigger a rise in risk premia on residents' external borrowing, see Figure A.2.

who consume more in response to the rise in current income—as real wages rise due to a shift in labor demand by firms constrained in price-setting.[18] At the same time, the basic mechanism of the spending reversal remains essential for our results. Notably, it ensures that the response of the unconstrained agents in the economy will not 'undo' the effects of a fiscal expansion on aggregate demand via the hand-to-mouth agents. Indeed, both hand-to-mouth consumers and asset holders (after a few periods of initial retrenchment) now contribute to the rise in private consumption.

Figure 3 also displays the responses of additional variables of interest obtained under the extended model specification. Net exports deteriorate together with the government budget, corresponding to the notion of 'twin deficits'.[19] The stock variables net foreign assets and public debt evolve accordingly. Real wages increase strongly on impact, and fall below steady-state levels in sync with output.[20] The shock is mildly inflationary in the first 12 quarters or so, then the inflation response changes sign. This pattern is mirrored by the nominal interest rate, set according to the Taylor-type rule specified above.

4 Time Series Evidence

Our model simulations highlight the specific role played by anticipated spending reversals in shaping the transmission of government spending shocks. When temporary expansions in public expenditure are expected to be offset at least partly by future spending cuts, an otherwise standard new Keynesian model can account for the stylized facts of fiscal transmission established by earlier empirical studies, notably the positive impact response of private consumption, and the fall in the real effective exchange rate.

In this section we provide additional time-series evidence on the transmission of spending shocks. In part, this exercise serves to replicate and confirm results from earlier studies. More important, however, is our motivation to investigate two aspects of fiscal transmission that are critical to our theoretical account but have not yet received much attention, including in empirical work. The first aspect is the very presence of spending reversals: is there empirical support for our central hypothesis that a positive government spending impulse today is followed by a period of below-trend spending at some point in the future? The second aspect is the negative response of long-term real interest rates to spending shocks. We carry out our analysis estimating a VAR model on U.S. time series covering the last three decades.

[18] See Bilbiie et al. (2008) for a more detailed account.

[19] Quantitatively, the effect is quite contained, however, in line with results reported in Corsetti and Müller (2006, 2008).

[20] The response of the real wage to government spending shocks has received considerable attention in the literature following Rotemberg and Woodford (1992), who documented an increase for U.S. data. While the neoclassical model predicts a decline in the real wage, new Keynesian models typically predict an increase. The reason is that while labor supply increases in both models, labor demand increases only in the new Keynesian setup—see Pappa (2005) for a recent investigation.

4.1 VAR Specification

Our VAR model includes six variables: the first three are government spending, aggregate output, and private consumption, all in logs and per-capita terms; we also include a measure of the ex ante long-term real interest rate and the log of the real exchange rate; the sixth variable is the end-of-period stock of public debt scaled by quarterly GDP. Chung and Leeper (2007) and Favero and Giavazzi (2007) provide evidence suggesting that the omission of debt from the VAR model may lead to substantial bias in the estimated dynamics of fiscal policy shocks. Our theoretical analysis lends further support to this concern, as we emphasize the important feedback channel between debt and government spending.

We estimate our VAR model on quarterly time series data covering the period 1980:1–2007:4. While the choice of the sample period is chiefly determined by data availability (in particular, data on ex ante long-term real interest rates), it also has the advantage of focusing the analysis on a period in which the policy framework has arguably been fairly stable, especially as regards monetary policy. In the appendix we provide a detailed description of the data as well as results from alternative VAR specifications.

Drawing from the debate on the identification of fiscal shocks and the empirical characterization of fiscal policy transmission, we focus on two distinct strategies that have been widely employed in the literature.[21] The first strategy, following Blanchard and Perotti (2002), relies on a structural VAR approach: identification is achieved by restricting the contemporaneous relationships between the fiscal and other variables included in the VAR. Specifically, government spending is assumed to be predetermined within the quarter. Under this assumption, the reduced-form residuals from a regression of government spending on the lags of all other variables in the VAR are identified as structural government spending shocks.

The second strategy, proposed by Ramey and Shapiro (1998), focuses on discrete fiscal policy changes related to wars and military build-ups. Indeed, these authors argue that such events come closest to economists' notion of a truly exogenous source of variation in government spending. Ramey and Shapiro (1998) identify the dates at which the relevant military initiatives were first announced and trace the dynamic response of the economy to these announcements via dummy variables. Edelberg et al. (1999) suggest an extended version of the Ramey-Shapiro approach using a VAR model.

For our own analysis, we follow recent contributions that have proposed a comprehensive framework encompassing both identification strategies—see Perotti (2007) and Ramey (2008). For a formal exposition of this framework, we draw on Monacelli and Perotti (2008). Specifically, letting g_t denote government spending and y_t a vector of additional variables of interest, we consider the following

[21] A third approach is based on sign restrictions—see Mountford and Uhlig (2008), Canova and Pappa (2004, 2007), and Enders et al. (2008). Also, more recently, Romer and Romer (2008) have used their 'narrative' approach, developed in the context of monetary policy analysis, to identify tax shocks.

model

$$
\begin{aligned}
g_t &= \kappa_{10} + \kappa_{11} t + \sum_{i=1}^{4} a_{11i} g_{t-i} + \sum_{i=1}^{4} a_{12i} y_{t-i} + \sum_{i=0}^{q_{1d}} b_{11i} d_{t-i} + u_{g,t} \\
y_t &= \kappa_{20} + \kappa_{21} t + \sum_{i=1}^{4} a_{21i} g_{t-i} + \sum_{i=1}^{4} a_{22i} y_{t-i} + \sum_{i=0}^{q_{2d}} b_{21i} d_{t-i} + u_{y,t},
\end{aligned}
$$

where κ_{i0} and κ_{i1}, for $i \in \{1, 2\}$, denote coefficients on a constant and a linear time trend, respectively; d_t denotes a variable capturing exogenous fiscal events à la Ramey and Shapiro ('military dates'); and under the assumption that g_t is predetermined relative to y_t, $u_{g,t}$ can be given a structural interpretation as a government spending shock à la Blanchard and Perotti ('VAR shock').

As is well known, results based on the Blanchard-Perotti approach have generally been found to differ from those based on the Ramey-Shapiro approach. In particular, the former approach has typically led to findings of a positive consumption response to government spending, while studies based on the latter approach have tended to document a *fall* in consumption. Ramey (2008) provides further evidence showing that results differ systematically depending on whether military dates or VAR shocks are used to identify the effects of government spending. According to her interpretation, the divergence of results suggests that Blanchard and Perotti (2002)'s structural VAR does not accurately capture the timing of spending shocks. In this view, the measured VAR innovations are but the *materialization* of changes in government spending that have already been anticipated by the private sector.

Perotti (2007), instead, attributes the differences to a particular specification choice in Ramey's analysis. Specifically, the model estimated by Ramey (2008) posits an equal number of lags for the military date variables in both of the above equations ($q_{2d} = q_{1d} = 4$). This, Perotti argues, amounts to interpreting as a result of the military shock *all* deviations of y_t from 'normal' during the entire first year following the shock. Yet such an assumption runs counter to the notion that Ramey's military dates are informative about fiscal transmission as it works under 'normal' circumstances. On these grounds, Monacelli and Perotti (2008) only allow the contemporaneous value of the military date to enter the second equation ($q_{2d} = 0$, while $q_{1d} = 6$). Estimating a model on U.S. time series, they find that under this specification, the effects of VAR shocks and military dates are quite similar: most important, the response of private consumption is positive across both methodologies.

For our own baseline VAR model we adopt the same specification as Monacelli and Perotti (2008). As it turns out, however, the number of lags with which the military variable enters the non-fiscal equations of the model is largely inconsequential in our sample, anyway.

Finally, unlike the original dummy variable approach of Ramey and Shapiro (1998), we use the 'new military variable' introduced by Ramey (2008). It is defined as a continuous variable, where the military news (previously a binary variable) is quantified using the discounted value of the resulting change in government spending (scaled by the value of nominal spending from the previous quarter) as forecasted in real time by Business Week magazine. Relative to the original 'military dates', the new series also provides a richer account of exogenous military events that induced an adjustment in government spending.[22]

4.2 Results

We begin by presenting evidence on the fiscal transmission mechanism under the 'VAR shock' approach of Blanchard and Perotti. In Figure 4, we show the effects of a VAR shock normalized such that government spending increases by one percent of GDP. The horizontal axis indicates quarters after the shock. All quantity variables are expressed in output units, so that responses may be interpreted as multipliers. The real exchange rate is measured in percent deviations from its pre-shock level, while the response of the long-term real interest rate is measured as deviations from the pre-shock level in quarterly percentage points. Throughout, the solid line indicates the point estimate, and the shaded area represents a 90-percent confidence interval obtained by bootstrap sampling.

Focus first on our main variable of interest, government spending itself. While we find a fairly persistent response, spending clearly undershoots its trend value about four years after the shock. Interestingly, both the initial increase in government spending and its subsequent reversal are statistically significant. This is a notable finding in light of our theoretical analysis of spending reversals. It also matches a similar earlier result documented by Chung and Leeper (2007). Importantly, these authors compare results from relatively small VAR systems to those from a more comprehensive VAR which includes government debt. They find that government spending appears to be partially 'self-correcting' according to the more comprehensive VAR only, underscoring the importance of controlling for debt as a state variable.[23] Our finding of a significant spending reversal also squares well with the results of Galí and Perotti (2003), documenting a responsiveness of government spending to public debt for OECD countries.

Output responds in a statistically significant way with an impact multiplier of about one. It later falls below trend, mirroring the path of government spending. Private consumption increases significantly for the first few quarters after the shock. The response is mildly hump-shaped and peaks at about 0.5 percent of GDP. From a quantitative point of view, these results for output and consumption are close to earlier findings by Blanchard and Perotti (2002) and Galí et al. (2007), among many others.

Another notable result is the response of the long-term real interest rate. After rising sharply (though insignificantly) on impact, the interest rate falls below its pre-shock level after about six quarters.

[22]In fact, as our sample starts in 1980, it would include only one of the narrow Ramey-Shapiro military events, namely an increase in defense spending following the 9/11 terrorist attacks in 2001. The new military variable data, instead, contain additional episodes, such as the fall of the Berlin Wall.

[23]In fact, Chung and Leeper (2007) apply the criterion of Fernández-Villaverde et al. (2007) to show that small VAR systems are likely to be non-invertible relative to more comprehensive VAR systems which include public debt.

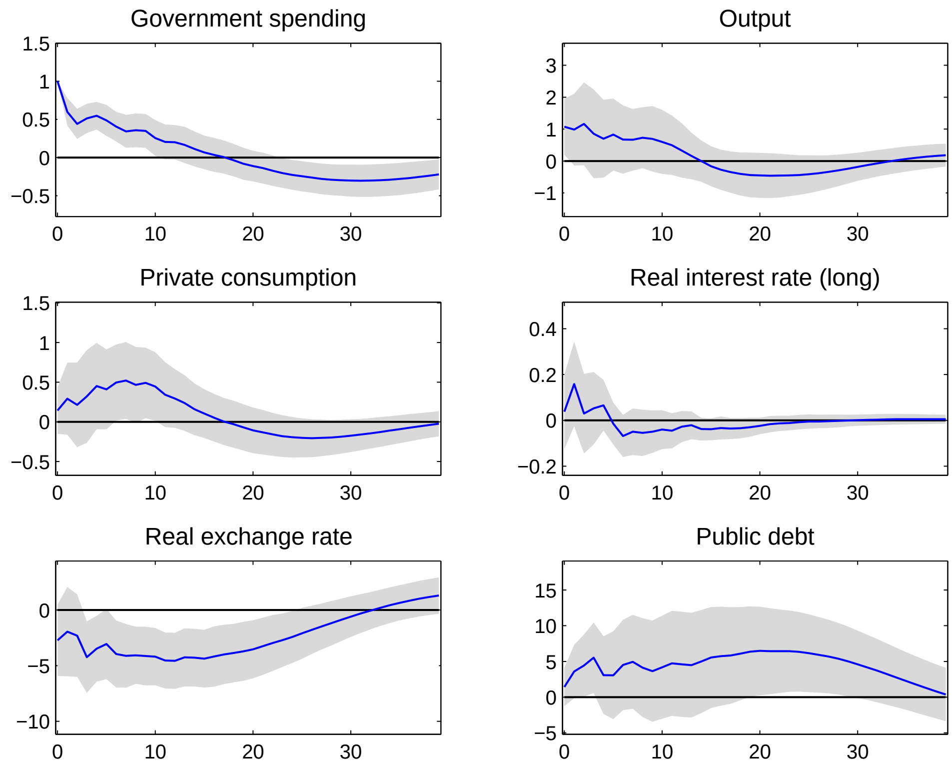

Figure 4: Fiscal Policy Transmission According to VAR Model: Effects of VAR Shock. Notes: solid lines indicate point estimate; grey area: 90 percent confidence interval obtained by bootstrap sampling. The horizontal axis indicates quarters, the vertical axes measure deviations from trend in percentage points of trend output (in case of quantities); percent deviations from the pre-shock level (real exchange rate); and deviations from the pre-shock level in terms of quarterly percentage points (real interest rate).

This finding again mirrors results that have been reported elsewhere in the literature, but have long been regarded as difficult to reconcile with the presumed theoretical case for a persistent interest rate increase.[24] By contrast, the estimated response of the real interest rate is quite consistent with the prediction of our theoretical model with government spending reversals, as shown in Figure 3.

Next, the lower-left chart shows the response of the real exchange rate, which depreciates sharply and significantly, remaining below trend for a long period after the initial spending shock. Very similar evidence has been documented earlier by Kim and Roubini (2008), Monacelli and Perotti (2006), and Ravn et al. (2007). Enders et al. (2008) also document a fall in the real exchange rate, while

[24]Indeed, the empirical response of interest rates to fiscal policy shocks has been a topic of extensive debate—see, for example, Perotti (2004) and Favero and Giavazzi (2007). Recently, Laubach (2007) has investigated the relationship between long-horizon forward interest rates in the U.S. and changes in the fiscal outlook as projected by the Congressional Budget Office. While he finds a positive and significant relationship with projected levels of government spending, his empirical strategy is explicitly geared toward neutralizing the effects of (i) the business cycle and (ii) monetary policy on interest rates. By contrast, we are primarily interested in the effect of government spending shocks on interest rates for a given monetary policy rule.

using a different identification scheme based on sign restrictions. Indeed, empirical studies have documented real depreciation after a positive government spending shock not only for the U.S., but also for Australia, and the UK.[25]

Finally, the lower-right chart shows the response of public debt, which increases significantly and persistently, peaking around five years after the occurrence of the shock. This result suggests that the increase in government spending is to a considerable extent debt-financed, in line with evidence in Galí et al. (2007), who document a significant increase in the public deficit, as well as in Bilbiie et al. (2008), who also document a significant increase in public debt. Interestingly, this significant build-up of debt also reinforces the rationale for the kind of spending reversals at the core of this paper.[26]

Overall, we find the impulse responses to a VAR shock in line with the predictions of our model. Not only do our VAR results reproduce well-known earlier findings, notably the crowding-in of private consumption and the depreciation of the real exchange rate in response to a positive government spending shock. They also lend support to the two main implications of our account of the fiscal transmission mechanism with spending reversals: i) government spending falls below trend after an initial and somewhat persistent increase, the switch occurring after about four years; ii) long-term interest rates, while rising upon impact, also fall below their pre-shock level in the second year after the shock, i.e., before the actual spending reversal. In the appendix, we also provide results from an extensive sensitivity analysis showing that our findings are robust across various alternative specifications of the VAR model: excluding debt or long-term interest rates; excluding the linear time trend; extending the sample; changing the number of lags for the military variables; and considering an alternative 'nominal' VAR model which includes the federal funds rate and inflation rather than long-term real interest rates and public debt.

As discussed above, our VAR model encompasses the 'military variable' approach pioneered by Ramey and Shapiro. In the VAR shock approach which we have focused on thus far, these military variables serve as additional controls. However, we now turn to Ramey's full-fledged alternative, in which military events are the only identified source of fiscal shocks. Figure 5 displays the estimated responses to such a military event.

Remarkably, we find that government spending actually falls in response to the military event, rising

[25] A noteworthy exception in this literature is Beetsma et al. (2008), who document a real appreciation for a sample of European countries. Also, in their analysis of U.S. states and EMU member countries, Canova and Pappa (2007) document that government spending shocks rise the price level relative to the union—thus suggesting real appreciation. In Corsetti et al. (2009), we explore systematically the role of the exchange rate regime for the fiscal transmission mechanism.

[26] Favero and Giavazzi (2007) add government debt to a VAR model estimated on U.S. data and compare results for 1960–1979 and 1980–2006. For the later sample, they find no spending reversals during the first 20 quarters after the shock (for which responses are reported), but the response of government spending to spending shocks is considerably less persistent relative to a VAR model without debt. Moreover, they find a significant negative response of government spending to the change in debt, while taxes tend to increase, i.e., *both* adjust to stabilize debt.

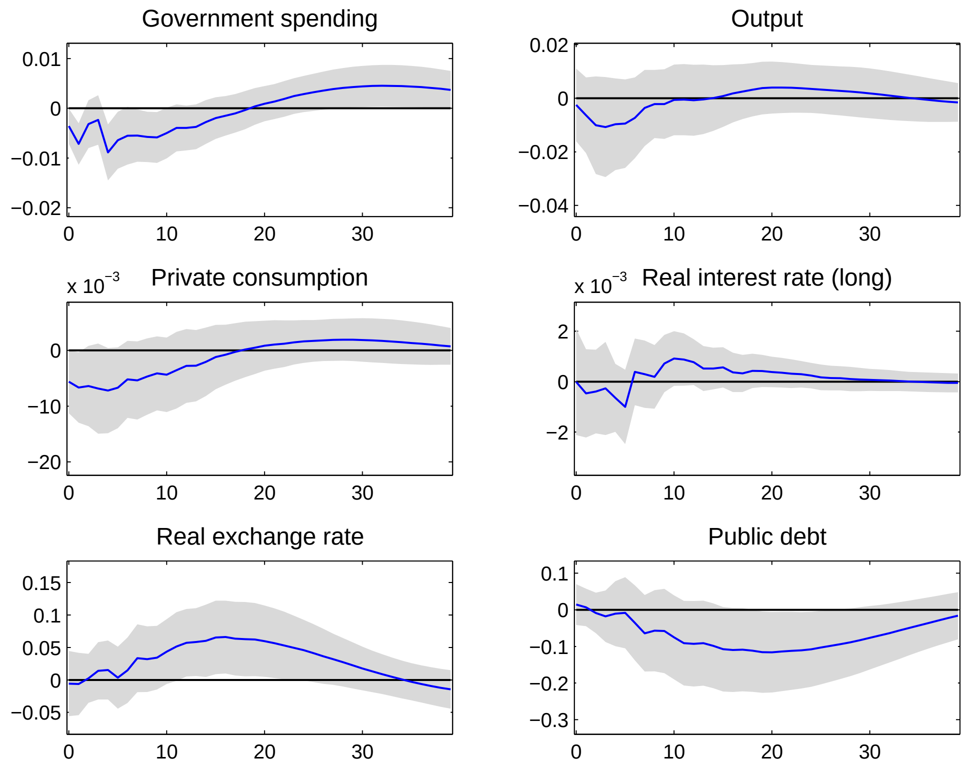

Figure 5: Fiscal Policy Transmission According to VAR Model: Effects of Military Event. Notes: see figure 4.

back above its trend level only after about 20 quarters. This finding may seem paradoxical, as the military events are meant to capture episodes of defense-related fiscal expansions. What estimates for our sample suggest instead is that any increase in military expenditure that may be associated with the military event tends to be more than offset by simultaneous expenditure cuts elsewhere. Although surprising, such intratemporal spending dynamics are certainly conceivable, perhaps even reflecting the same kind of overall financing constraints that we see at the root of *inter*temporal spending reversals. In any case, given this initial result, it is important to interpret all other estimated impulse responses as responses to a negative, rather than positive, spending shock. Indeed, the time path of government spending in Figure 5 is essentially a mirror image (with flipped sign) of the 'VAR shock' path studied earlier, including the occurence of a spending reversal after some four to five years.

With this in mind, observe that the responses of the other variables in Figure 5 are quite consistent with those obtained for the VAR shock, i.e., the co-movement of these other variables with government spending is quite similar across identification schemes. In particular, consumption falls initially, and the real exchange appreciates. Likewise, the responses of public debt and the long-term interest rate mirror those obtained under the VAR shock approach. Together, this set of responses further confirms key predictions from our theoretical model: the dynamics of fiscal transmission with spending reversals appears to match the time-series evidence, whether it is based on the identification scheme of Blanchard and Perotti (2002) or that of Ramey and Shapiro (1998).

Some additional comments on the robustness of the results using the military-event approach are in order. To begin with, the finding that government spending falls in response to a military event is not specific to our analysis: Ramey (2008) herself also reports a significant decline of government spending. However, in her analysis, government spending starts to rise more quickly again, and peaks between 4 and 8 quarters after the military date. We find that the difference relative to our own findings is explained by three factors. The first is the sample period, as Ramey considers time series starting in the 1940s. The second factor is the number of lags of the military event variable. While our results are quite robust to allowing for more lags of this variable in the non-spending equations of the VAR model, the inclusion of more lags has a mild impact on the time at which government spending is seen to start rising above trend; with more lags of the military variables, this happens after about 16 quarters, instead of 20 quarters (see Figure A.4 in the appendix). The third factor is the inclusion of public debt and the real exchange rate in the model, consistent with our theoretical account of the transmission mechanism. In particular, the real exchange rate may proxy for fluctuations in long-term real rates which effectively drive consumption decisions.[27] Moreover, public debt is arguably a key determinant for future adjustments of government spending. In sum, to the extent that the results we obtain under the military dates approach are sensitive to some specification choices, there are good reasons for the particular choices we consider.

5 Conclusion

In this paper, we contribute to the ongoing debate about the effects of fiscal policy by highlighting the role of medium-term fiscal dynamics for the transmission of government spending shocks. Existing theoretical studies on fiscal policy typically assume that any change in today's level of government spending gives rise to a one-for-one change in the tax burden. This completely ignores the realistic possibility that current spending increases may also be offset by a reduction of spending below trend levels in the future. Theorists' apparent disregard for this possibility is surprising given that anticipation effects tend to feature prominently elsewhere in economics. Moreover, ignoring expectations about possible spending reversals comes at the price of missing important aspects of fiscal policy transmission.

Our analysis is cast in the framework of an otherwise standard new Keynesian model. This ensures that our results are not driven by unconventional assumptions about preferences. It also facilitates

[27] Monacelli and Perotti (2006) also include the real exchange rate in the VAR model and find a significant decline in government spending in response to the Regan-Carter military build-up.

comparison with existing theoretical work on fiscal transmission. Our novel contribution is to show that the economy's response to a contemporaneous spending increase depends indeed strongly on agents' expectations about offsetting fiscal measures in the future. Specifically, if agents expect today's deficit spending to be at least partly offset through subsequent spending cuts, private consumption will rise, and the real exchange rate depreciates in response to the initial spending shock. These two predictions accord well with a growing body of empirical evidence on the effects of fiscal policy but have previously proven difficult to generate in standard theoretical models. In our model, they follow from the impact of expected spending reversals on long-term real interest rates—for which nominal rigidities play a key role.

To further corroborate this account of the fiscal transmission mechanism, we present empirical results from a VAR for U.S. data covering the last three decades. Consistent with our theoretical predictions, the VAR provides evidence of spending reversals, i.e., a tendency for government spending to fall below trend levels several quarters after an initial spending increase. The VAR also replicates other authors' findings of a positive consumption multiplier and negative real exchange rate response, combined with a path for real interest rates in accord with our theoretical predictions.

In emphasizing the importance of spending reversals for fiscal transmission, we also take comfort from recent research into empirical fiscal rules. Indeed, such research has documented a tendency for spending processes to be responsive to public debt levels. One plausible interpretation of this evidence is the fact that the fiscal authorities face significant political constraints, notably voters' resistance to higher taxes. That said, we do not claim that expected spending reversals are relevant everywhere and at all times. Comparing evidence across countries and across time periods strikes us, in fact, as a promising direction for further research.

Finally, our analysis also bears on the current policy debate about the effectiveness of fiscal stimulus. In particular, our results suggest that for expenditure-side stimulus to be most effective, policymakers should combine a current fiscal expansion with a credible commitment to downward adjustment of expenditure over the medium term. Although such commitment may often be difficult to achieve, there are arguably means of making spending reversals more credible ex ante. A prime example is the decision to stimulate the economy by bringing forward investment projects that had already been programmed for later years. Implementing these projects today will significantly boost current government outlays while implying a credible prospect of expenditure-side consolidation over the medium term. Given the limited share of investment in government expenditure across most countries, the room for such measures is admittedly limited. Where available, however, they represent an attractive policy option in light of the results developed in this paper.

References

P. Balduzzi, G. Corsetti, and S. Foresi. Yield-curve movements and fiscal retrechments. *European Economic Review*, 41:1675–1685, 1997.

R. Barro. Government spending is no free lunch. Wall Streat Journal (online January 22), 2009.

M. Baxter and R. G. King. Fiscal policy in general equilibrium. *American Economic Review*, 83(3): 315–334, June 1993.

R. Beetsma, M. Giuliodori, and F. Klaasen. The effects of public spending shocks on trade balances in the European Union. *Journal of the European Economic Association*, 6(2-3):414–423, 2008.

G. Bertola and A. Drazen. Trigger points and budget cuts: Explaining the effects of fiscal austerity. *American Economic Review*, 83(1):11–26, 1993.

F. O. Bilbiie, A. Meier, and G. J. Müller. What accounts for the changes in U.S. fiscal policy transmission? *Journal of Money, Credit, and Banking*, 40(7):1439–1469, 2008.

O. J. Blanchard and R. Perotti. An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *Quarterly Journal of Economics*, 117(4):1329–1368, November 2002.

H. Bohn. The behavior of U.S. public debt and deficits. *Quarterly Journal of Economics*, 113: 949–963, 1998.

G. Calvo. Staggered prices in a utility maximizing framework. *Journal of Monetary Economics*, 12: 383–398, 1983.

J. Y. Campbell and G. Mankiw. Consumption, income, and interest rates: Reinterpreting the time series evidence. In O. J. Blanchard and S. Fischer, editors, *NBER Macroeconomics Annual 1989*, pages 185–216. MIT Press, 1989.

F. Canova and E. Pappa. Does it cost to be virtuous? the macroeconomic effects of fiscal constraints. In R. Clarida, J. Frenkel, and F. Giavazzi, editors, *NBER International Macroeconomic Annual*. MIT Press, 2004.

F. Canova and E. Pappa. Price differentials in monetary unions: The role of fiscal shocks. *Economic Journal*, 117:713–737, March 2007.

H. Chung and E. M. Leeper. What has financed government debt? mimeo Indiana University, 2007.

G. Corsetti and G. J. Müller. Twin deficits: Squaring theory, evidence and common sense. *Economic*

Policy, 48:598–638, 2006.

G. Corsetti and G. J. Müller. Twin deficits, openess, and the business cylce. *Journal of the European Economic Association*, 6(2-3):404–413, 2008.

G. Corsetti and P. Pesenti. International dimensions of optimal monetary policy. *Journal of Monetary Economics*, 52(2):281–305, 2005.

G. Corsetti, L. Dedola, and S. Leduc. International risk-sharing and the transmission of productivity shocks. *Review of Economic Studies*, 75(2):443–473, 2008.

G. Corsetti, A. Meier, and G. J. Müller. Fiscal policy transmission in open economies. mimeo EUI, 2009.

R. Dornbusch. Exchange rate economics: Where do we stand. *Brookings Papers on Economic Activity*, 1:143–185, 1980.

W. Edelberg, M. Eichenbaum, and J. D. M. Fischer. Understanding the effects of a shock to government purchases. *Review of Economic Dynamics*, 2:166–206, 1999.

M. Eichenbaum and J. D. Fisher. Estimating the frequency of price re-optimization in calvo-style models. *Journal of Monetary Economics*, 54:2032–2047, 2007.

Z. Enders, G. J. Müller, and A. Scholl. How do fiscal and technology shocks affect real exchange rates? New evidence for the U.S. CFS Working paper 2008-22, 2008.

C. Favero and F. Giavazzi. Debt and the effects of fiscal policy. NBER Working Paper 12833, 2007.

J. Fernández-Villaverde, J. Rubio-Ramírez, T. J. Sargent, and M. W. Watson. A, B, C's (and D's) for understanding VARs. *American Economic Review*, 97(3):1021–1026, June 2007.

M. G. Finn. Cyclical effects of government's employment and goods purchases. *International Economic Review*, 39(3):635–657, August 1998.

J. Galí and T. Monacelli. Monetary policy and exchange rate volatility in a small open economy. *Review of Economic Studies*, 72:707–734, 2005.

J. Galí and R. Perotti. Fiscal policy and monetary integration in Europe. *Economic Policy*, 37: 534–572, 2003.

J. Galí, M. Gertler, and J. D. López-Salido. European inflation dynamics. *European Economic Review*, 45:1237–1270, 2001.

J. Galí, J. D. López-Salido, and J. Vallés. Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, pages 227–270, 2007.

F. Giavazzi and M. Pagano. Can severe fiscal contractions be expanstionary? Tales of two small European countries. *NBER Macroeconomics Annual*, 5:75–111, 1990.

S. Kim and N. Roubini. Twin deficit or twin divergence? Fiscal policy, current account, and real exchange rate in the U.S. *Journal of International Economics*, 74(2):362–383, 2008.

R. Kollmann. Monetary policy rules in the open economy: effects on welfare and business cycles. *Journal of Monetary Economics*, 49:989–1015, 2002.

T. Laubach. New evidence on the interest rate effects of budget deficits and debt. *Journal of the European Economic Association*, forthcoming, 2007.

E. M. Leeper. Equilibria under 'active' and 'passive' monetary and fiscal policies. *Journal of Monetary Economics*, 27(1):129–147, February 1991.

L. Linnemann and A. Schabert. Fiscal policy and the new neoclassical synthesis. *Journal of Money, Credit and Banking*, 35(6):911–929, 2003.

S. Ludvigson. The macroeconomic effects of government debt in a stochastic growth model. *Journal of Monetary Economics*, 38:25–45, 1996.

N. G. Mankiw. The savers-spenders theory of fiscal policy. *American Economic Review*, 90(2): 120–125, 2000.

N. G. Mankiw. Is government spending too easy an answer? New York Times (online January 10), 2009.

T. Monacelli and R. Perotti. Fiscal policy, the trade balance and the real exchange rate: Implications for international risk sharing. mimeo, 2006.

T. Monacelli and R. Perotti. Fiscal policy, wealth effects, and markups. NBER Working paper 14584, 2008.

A. Mountford and H. Uhlig. What are the effects of fiscal policy shocks? NBER Working paper 14551, 2008.

E. Nakamura and J. Steinsson. Five facts about prices: A reevaluation of menu cost models. *Quarterly Journal of Economics*, 123:1415–1464, 2008.

E. Pappa. New-Keynesian or RBC transmission? the effects of fiscal shocks in labor markets. *International Economic Review*, forthcoming, 2005.

R. Perotti. Estimating the effects of fiscal policy in oecd countries. mimeo, 2004.

R. Perotti. In search of the transmission mechanism of fiscal policy. NBER Working paper 13143, 2007.

R. Perotti. Fiscal policy in good times and bad. *Quarterly Journal of Economics*, 114(4):1399–1436, November 1999.

V. A. Ramey. Identifying government spending shocks: It‘s all in the timing. mimeo UC San Diego, 2008.

V. A. Ramey and M. D. Shapiro. Costly capital reallocation and the effects of government spending. *Carnegie Rochester Conference on Public Policy*, 48:154–194, 1998.

M. O. Ravn, S. Schmitt-Grohé, and M. Uribe. Explaining the effects of government spending on consumption and the real exchange rate. NBER Working Paper 13328, 2007.

C. D. Romer and D. H. Romer. The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks. mimeo UC Berkely, 2008.

J. Rotemberg and M. Woodford. Oligopolistic pricing and the effects of aggregate demand on economic activity. *Journal of Political Economy*, 100(6):1153–1207, 1992.

S. Schmitt-Grohé and M. Uribe. Closing small open economy models. *Journal of International Economics*, 61:163–185, 2003.

A. Sutherland. Fiscal crisis and aggregate demand: can high public debt reverse the effects of fiscal policy? *Journal of Public Economics*, 65:147–162, 1997.

M. Woodford. *Interest & Prices*. Princeton University Press, Princeton, New Jersey, 2003.

A More Simulation Results

In the following, we document the effects of government spending shocks for alternative model specifications. Figure A.1 shows results for our model under the assumption that international financial markets are complete. Figure A.2 shows results obtained under the assumption that interest rates on foreign bonds are highly debt-sensitive.

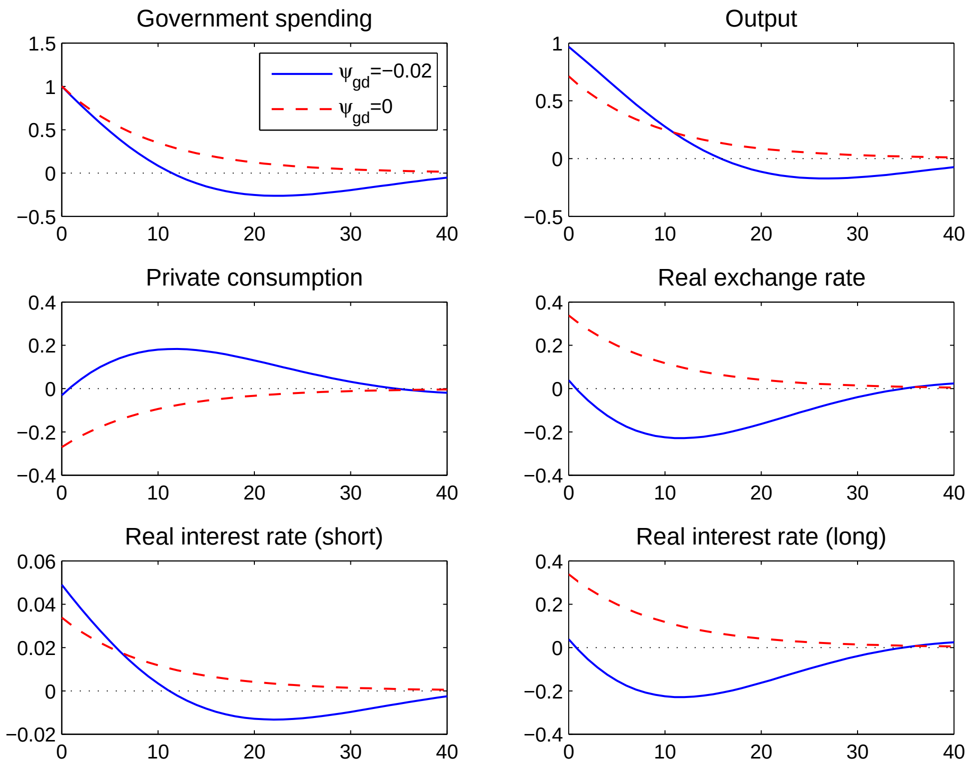

Figure A.1: Effect of Government Spending Shocks: Debt-Stabilizing vs. Debt-Insensitive Government Spending under Complete Markets. Notes: see Figure 1. Solid lines: debt-stabilizing spending rule; dashed lines: debt-insensitive spending rule.

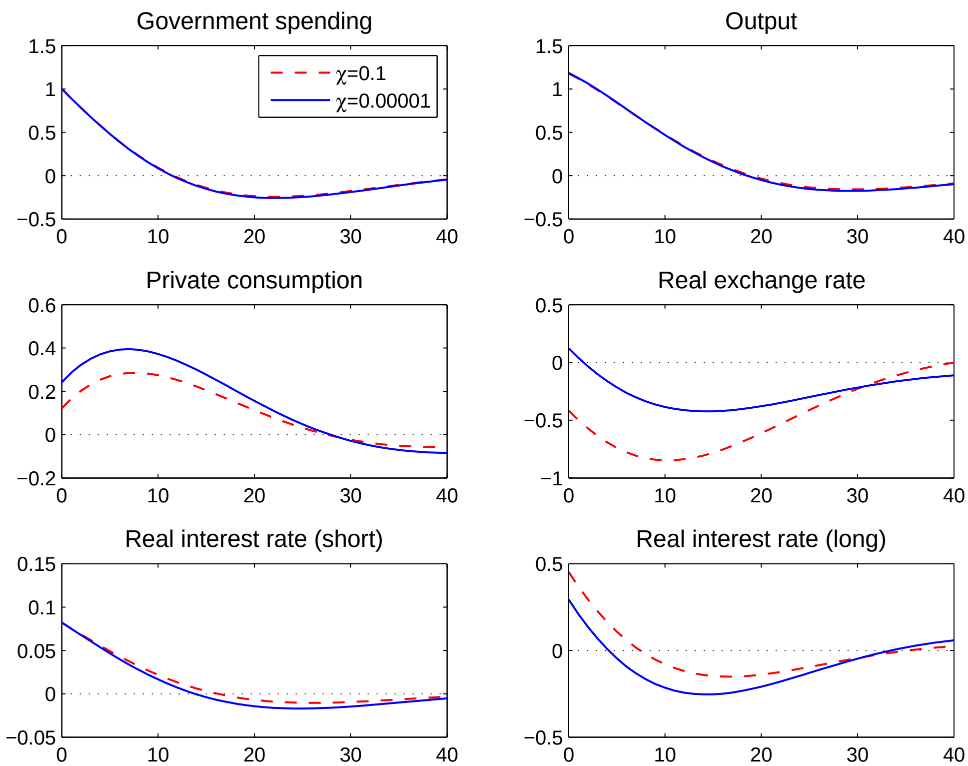

Figure A.2: Effect of Government Spending Shocks: High Debt Elasticity of Interest Rates vs. Baseline. Notes: see Figure 1. Dashed lines: high debt elasticity of interest rates; solid lines: baseline.

B Data

Quantity variables are obtained from the National Income and Product Accounts (NIPA) provided by the Bureau of Economic Analysis and deflated with the GDP deflator. Government spending comprises consumption expenditure and gross investment; private consumption is personal consumption expenditure on non-durable goods and services. Population figures are also obtained from NIPA. The real exchange rate is provided by the OECD and measured in terms of consumer prices (CPI); an increase corresponds to an appreciation of the domestic currency. The ex ante long-term real interest rate is constructed from the nominal yield on 10-year U.S. treasuries and a corresponding time series of 10-year-ahead inflation expectations. The latter is constructed by combining data from Blue Chip Economic Indicators (1980Q1-1991Q1), Livingston Survey (1990Q2-1991Q2), and Survey of Professional Forecasters (1991Q4-2007Q4), all obtained from the Philadelphia Fed, with linear interpolation for missing quarters in the first part of the sample. Debt is federal debt held by the public (FYGFDPUN), and the federal funds rate is the effective federal funds rate (FEDFUNDS), both obtained from the FRED database at the St. Louis Fed. Inflation is measured in year-on-year terms on the basis of the GDP deflator. Inflation and interest rates are expressed in percent per quarter.

C Sensitivity Analysis of VAR Results

In the following we report results from various alternative specifications of the VAR model. In a first set of experiments, we i) drop public debt from the VAR model; ii) drop the long-term real interest rate from the model and extend the sample period to 1975–2007; iii) consider Ramey's lag specification for the military variable ($q_{2d} = 4$); and iv) consider the baseline model, but do not allow for a linear time trend. Figures A.3 and A.4 show the results for the VAR shock and the military date identification, respectively. In each case, the shaded area covers the 90 percent confidence bounds of our baseline specification discussed above.

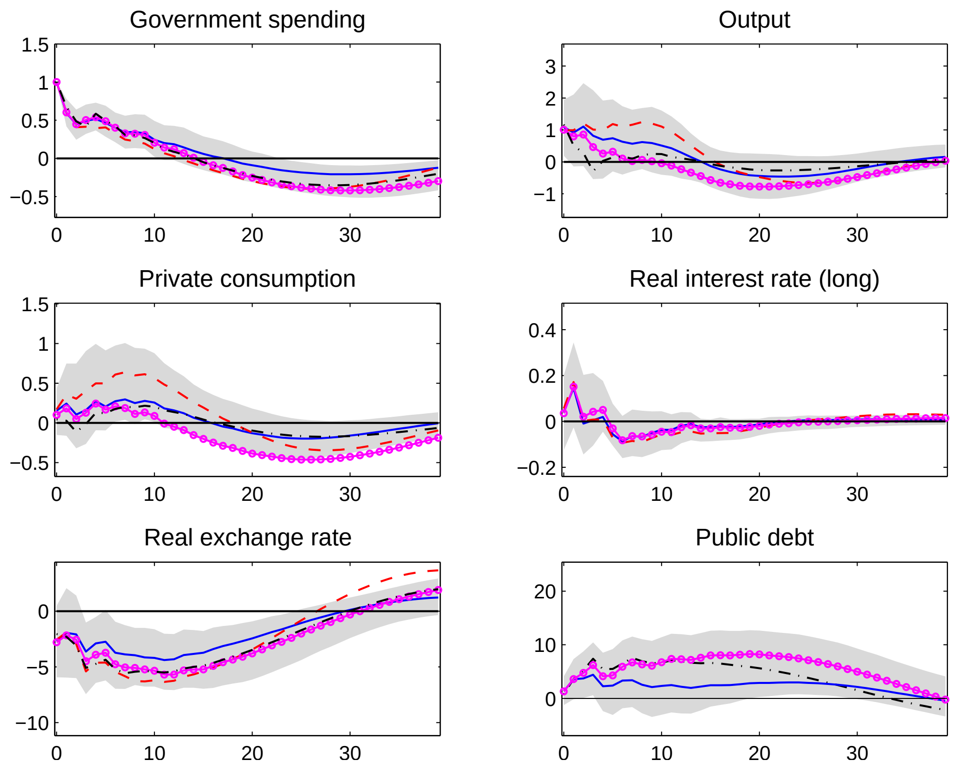

Figure A.3: Fiscal Policy Transmission According to VAR Model: Effects of VAR Shock. Sensitivity Analysis. Notes: 90 percent confidence area obtained by bootstrap under baseline specification; dashed lines: no debt in VAR model; dashed-dotted lines: no long-term real rate in model, sample starts in 1975; solid lines: like baseline but $q_{1d} = q_{2d} = 4$; solid lines with circles: like baseline but no time trend included.

Next, we consider a 'nominal' VAR model where we include the federal funds rate and inflation rather than long-term real interest rates and debt. In this case, we modify our identification scheme assuming a contemporaneous response of government spending to inflation.Regarding identification, Perotti (2004) argues that real government spending responds contemporaneously to inflation surprises, because government spending is not fully indexed to inflation. We follow Perotti and assume

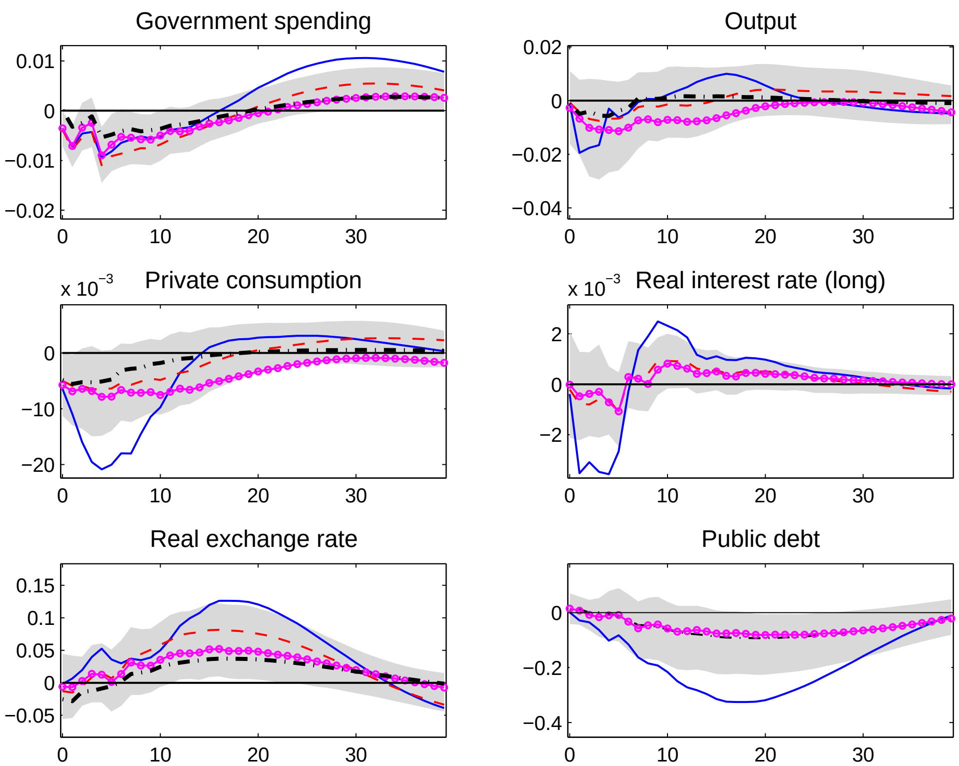

Figure A.4: Fiscal Policy Transmission According to VAR Model: Effects of Military Event. Sensitivity analysis. Notes: see Figure A.3.

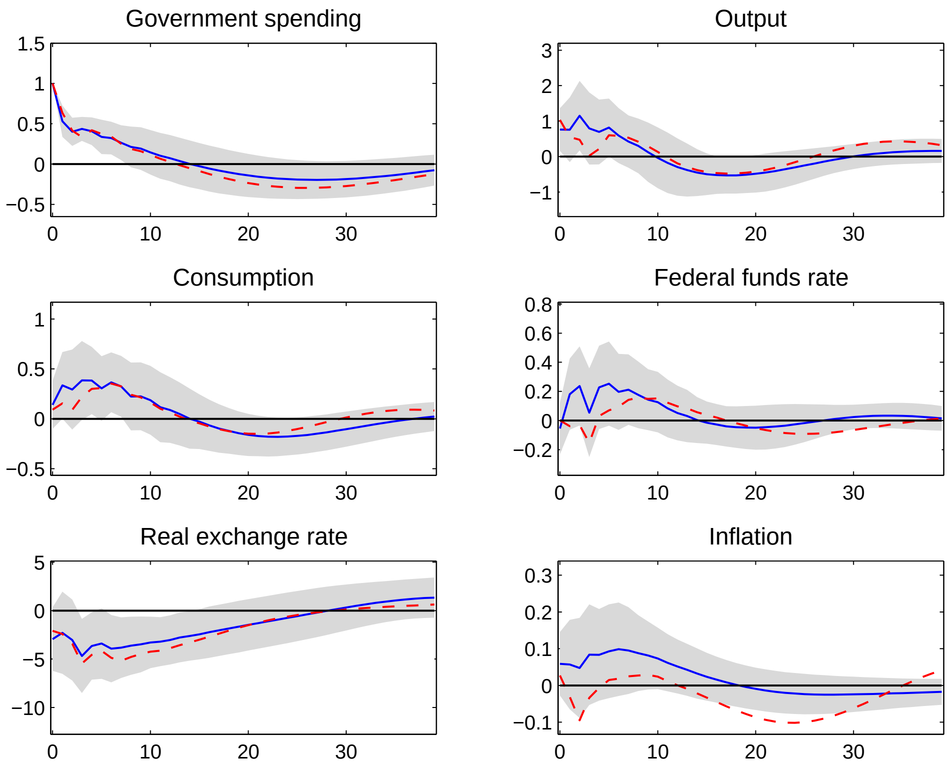

Figure A.5: Fiscal Policy Transmission According to VAR Model: Effects of VAR Shock in Nominal VAR. Notes: Solid lines: results for 1980–2007; dashed lines: results for 1975–2007; 90 percent confidence area obtained by bootstrap sampling for short sample.

an inflation elasticity of real government spending of -0.5 and employ an instrumental variable approach to retrieve recursively the structural shocks from the estimated reduced-form residuals. Note that we find that variations of this value leave the responses of variables other than inflation virtually unaffected. Figures A.5 and A.6 show results for two sample periods: 1980–2007 vs. 1975–2007.

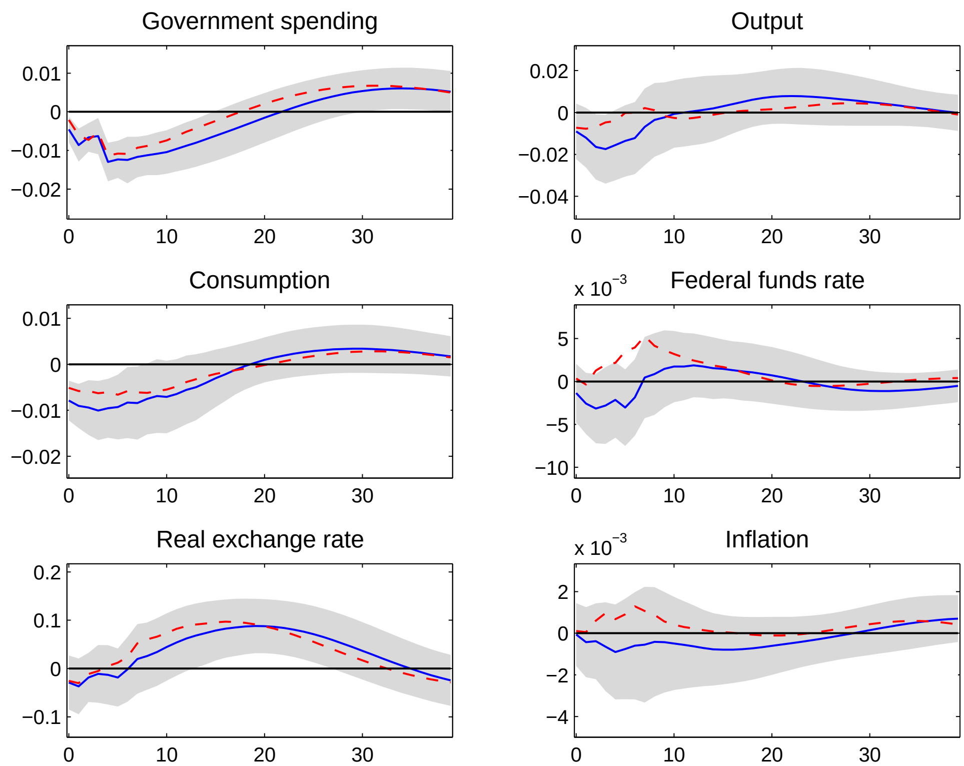

Figure A.6: Fiscal Policy Transmission According to VAR Model: Effects of Military Event in Nominal VAR. Notes: see Figure A.5.