

Fiscal policy transmission with spending reversals*

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Abstract

The short-run effects of fiscal policy depend not only on current tax and spending choices, but also on expectations about medium-term policy adjustment. Yet standard general equilibrium models typically allow for very limited fiscal dynamics, restricting medium-term adjustment to taxation only. In this paper, we highlight the importance of incorporating endogenous spending dynamics as well. First, we provide time-series evidence for the U.S. suggesting that an exogenous increase in government spending prompts a rise in public debt, followed over time by a gradual reduction in spending below trend. Second, we study how expectations of such a spending reversal alter the short-run impact of fiscal policy in a new Keynesian model. We show that accounting for spending reversals brings the model's predictions more closely in line with a number of empirical findings regarding the effects of government spending shocks, including the "puzzle" of real exchange rate depreciation.

Keywords: Fiscal policy transmission, consumption, real exchange rate,
real interest rates, sticky prices, monetary policy

JEL-Codes: E62, E63, F41

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1 Introduction

The theoretical analysis of fiscal policy has made substantial progress in the last two decades, with in-depth studies of the macroeconomic transmission of government spending in a dynamic general equilibrium context (e.g. Aiyagari et al. 1992, Baxter and King 1993, and Galí et al. 2007). Yet, most contributions to the literature have in common a rather restrictive approach to modeling medium-term fiscal dynamics. In particular, they typically treat government spending as exogenous, abstracting from the possibility that spending might respond *systematically* to the state of public finances or, more generally, to the state of the economy. This modeling approach is in sharp contrast with standard analyses of the monetary transmission mechanism, which assume a systematic policy response to the state of the economy (e.g., Boivin and Giannoni 2006). It also seems overly restrictive in relation to empirical studies based on identified vector autoregression (VAR) models, which allow for a (possibly delayed) response of government spending to other macroeconomic variables. In this paper, we show indeed that incorporating an endogenous response of government spending to public debt substantially alters the theoretical account of the short-run effects of fiscal policy, bringing the standard new Keynesian model more closely in line with the time-series evidence.

In the first part of our analysis, we revisit the evidence on the fiscal transmission mechanism. Specifically, we estimate a VAR model on U.S. time-series for the period 1983–2007 and identify government spending shocks using two distinct approaches, proposed by Blanchard and Perotti (2002) and Ramey (2010), respectively. A number of key results are robust across identification schemes. First, an exogenous increase in government spending increases aggregate output, although it crowds out investment—two standard results documented widely in the literature. Second, the real exchange rate depreciates—a result that has also been found by several other authors, including Kim and Roubini (2008), Monacelli and Perotti (2006), and Ravn et al. (2007). Third, and most important for the idea of this paper, we find that a positive spending shock triggers a sizeable build-up of public debt over the short and medium run, and is followed by a decline of government spending below trend some time after the initial impulse.

Evidence of such “spending reversals” is the key motivation for our analysis of stylized rules describing fiscal adjustment in an otherwise standard business cycle model. We focus on a straightforward formulation, positing that, in addition to debt-stabilizing behavior of taxes, government spending is systematically reduced when public debt is high, and vice versa. This assumption is consistent with single-equation estimates of government spending rules (e.g., Galí and Perotti 2003 and Canova and Pappa 2004).¹ It also squares well with political economy arguments emphasizing voters’ resistance

¹In contrast, evidence on the responsiveness of government spending to measures of economic activity is more mixed. We do not pursue this issue in the present paper.

to ever-higher taxes.² Lastly, there is ample anecdotal evidence from ongoing fiscal consolidation efforts in advanced countries that governments rely not only on tax increases, but also on spending restraint to overcome the legacy of past stimulus policy. A direct implication of allowing for systematic feedback from public debt to government spending is that a temporary, debt-financed increase in public demand generates expectations of future retrenchment. This is a dimension of policy adjustment that is ignored in standard analyses of the fiscal transmission mechanism. Indeed, existing studies generally assume that any increase in government spending today leads eventually to a one-for-one increase in taxes, whether or not it is initially financed by debt.³ Our reading of the empirical evidence suggests that this assumption rules out an important aspect of intertemporal fiscal dynamics, i.e, the occurrence of endogenous spending reversals.

In the second part of the paper, we analyze theoretically how anticipated spending reversals alter the transmission of government spending innovations. For this purpose, we specify a two-country variant of a standard (new Keynesian) dynamic stochastic general equilibrium (DSGE) model, where prices and wages are adjusted infrequently in a forward-looking manner and, in analogy to the aforementioned fiscal rules, monetary policy is also described by a standard feedback rule. The model nests the case of a closed economy, but also allows us to address the open-economy dimension of the fiscal transmission mechanism, notably to derive predictions for the behavior of the real exchange rate.

Our main result is that spending reversals alter the short-run effects of government spending innovations through a financial channel that captures the combined effect of fiscal and monetary policy on long-term interest rates. Specifically, as the private sector expects public spending restraint to reduce future inflation and—via the reaction function of monetary policy—policy rates, this will, *all else equal*, lead to an immediate decline in long-term real interest rates and, correspondingly, an increase in private consumption. We show that the strength of this financial channel depends primarily on two features of the economy, i.e., the extent of nominal rigidities and the central bank’s stance on inflation. Under a plausible parameterization, the anticipated spending reversal significantly magnifies the size of the impact multiplier via a reduction in long-term interest rates. Moreover, as the reduction in long-term interest rates is also associated with a depreciation of the real exchange rate, incorporating spending reversals in a standard new Keynesian model goes some way toward accounting for the time-series evidence.⁴

²One striking case in point is California voters’ support for Proposition 13, which has severely constrained the state authorities’ taxing powers.

³Moreover, because taxes are commonly assumed to be lump-sum, the time path of taxation is irrelevant as long as government spending is determined exogenously.

⁴A non-negative consumption response and real exchange rate depreciation after a positive government spending shock have been documented by many empirical studies, but pose a significant challenge for modern macroeconomic theory. While consistent with conventional Keynesian analysis, the finding of a non-negative consumption response contradicts both the neoclassical and the standard new Keynesian model. An exchange rate depreciation in response to government

We also stress that while spending reversals mitigate the increase in the private sector’s tax burden resulting from an exogenous *temporary* increase in government spending, wealth effects play only a minor role in explaining our results. This marks an important difference with respect to earlier work by Bertola and Drazen (1993) and others. Although our analysis shares these authors’ emphasis on the role of expectations for fiscal policy transmission, our results identify a first-order effect of expected consolidation measures through their impact on intertemporal prices, rather than through the implied changes in private net wealth.⁵

The remainder of the paper is organized as follows. Section 2 presents our empirical strategy and revisits the evidence on the fiscal transmission mechanism. Section 3 outlines our theoretical model, discusses important equilibrium relationships, and explains our parameter choices. Section 4 presents results from simulations on the basis of a parsimonious model specification. The main purpose is to illustrate the mechanism through which spending reversals alter fiscal policy transmission. Section 5 shows results for the full-fledged model. And Section 6 concludes.

2 Time-Series Evidence

We start our analysis by revisiting the time-series evidence on the effects of government spending shocks. We focus on the U.S. economy, as this allows us to draw on a rich literature pursuing different empirical approaches. Indeed, below we will show key findings that are robust across the identification schemes proposed by Blanchard and Perotti (2002) and Ramey (2010), respectively. Relative to most earlier contributions, we put particular emphasis on the dynamics of key fiscal variables themselves. To this end, as in Chung and Leeper (2007) and Favero and Giavazzi (2007), we estimate VAR models including government debt.⁶ In addition, our VAR models include the U.S. real exchange rate. Several empirical studies have found the response of this variable—a positive government spending shock tends to cause currency *depreciation*—puzzling in light of predictions derived from standard models of the international transmission mechanism. Although we confirm the seemingly puzzling evidence here, our quantitative analysis shows how it may be understood within

spending shocks 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). These observations have revived the debate on the fiscal transmission mechanism and guided theoretical attempts to amend standard models, notably by considering alternative preference specifications (e.g. Ravn et al. 2007 and Monacelli and Perotti 2008). While these approaches hold considerable promise, they maintain commonly employed, but restrictive assumptions on the conduct of fiscal policy. Adopting a distinct strategy here, we show that the predictions of a standard new Keynesian model are in line with the evidence, once medium-term fiscal dynamics are appropriately taken into account.

⁵The importance of expectations about the future policy stance for understanding fiscal transmission has been emphasized by the literature following Giavazzi and Pagano (1990)—see, also Sutherland (1997), Balduzzi et al. (1997), and Perotti (1999). Yet these contributions focus on expected fiscal corrections which are large enough so as to lower the overall tax burden of the private sector as a result of expansionary fiscal measures today.

⁶These authors have argued 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 below lends further support to this concern, as we document how feedback from public debt to government spending alters the transmission mechanism.

the standard theoretical framework, once the interaction of fiscal and monetary policy in both the short and the medium term is properly accounted for.

2.1 VAR specification and identification

Our VAR model includes seven variables: government spending (consumption expenditures and gross investment) and GDP, each measured in logs of real per-capita amounts; measures for the ex-ante long-term real interest rate and inflation; the log of the real exchange rate; and the end-of-period stock of public debt scaled by quarterly GDP. To economize on degrees of freedom, we alternately use one of the following as the seventh variable: (i) private consumption of non-durable goods and services (baseline); (ii) investment, defined as the sum of fixed investment and durable consumption; and (iii) the trade balance. The former two variables are expressed in logs of real per-capita amounts; the trade balance is scaled by GDP. The appendix provides a detailed description of the data.

We estimate the model recursively on quarterly time-series data covering the period 1983:1–2007:4 (dependent variables), including four lags of the endogenous variables, a constant, and a linear time trend. The choice of the sample period is chiefly determined by data availability, notably with respect to data on ex-ante long-term real interest rates. However, it also has the advantage of focusing the analysis on a period in which the policy framework was arguably quite stable, and macroeconomic developments in general were characterized by relative tranquility.⁷

In order to identify government spending shocks, we employ two distinct strategies. The first strategy, following Blanchard and Perotti (2002), relies on a structural VAR approach: identification is achieved by restricting the contemporaneous relationships between government spending and the 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 are interpreted as structural innovations to government spending. Correspondingly, we compute impulse response functions pertaining to innovations in the first equation of the recursively estimated VAR model.

The second identification strategy follows Ramey (2010), who builds on the observation that the Blanchard-Perotti identification scheme might be compromised if innovations in government spending are anticipated by agents in the economy. To address this problem, Ramey suggests using information beyond what is contained in the baseline VAR model. Specifically, by drawing on the Survey of Professional Forecasters, she computes the one-quarter-ahead forecast error for government spending growth. This forecast error arguably provides a direct measure of unanticipated innovations to

⁷We exclude data beyond end-2007, because the onset of the global financial crisis may have altered the fiscal transmission mechanism profoundly, see Corsetti et al. (2010b). Although our baseline sample comprises only post-1983 data, we also assess the robustness of our results with respect to starting the sample in 1975.

government spending, which Ramey includes as an additional variable in the VAR model.⁸ The variable is ordered first, and its dynamic effects on the remaining variables are computed by recursive estimation.⁹

In the following we report results obtained under both identification strategies. First, we estimate the baseline VAR model, identify government spending shocks à la Blanchard-Perotti (‘VAR innovations’), and trace out their effects on the economy (impulse responses). Second, we add Ramey’s shock measure (‘forecast errors’) as an additional variable, re-estimate the VAR model and compute the impulse responses. In each case we normalize the size of the shock such that government spending increases by one percent of GDP on impact.¹⁰

2.2 Results for baseline specification

Figure 1 summarizes the results obtained under the Blanchard-Perotti approach. Here, and in all figures that follow, horizontal axes indicate quarters after the spending shock; quantity variables are expressed in units of trend output, so that responses may be interpreted as multipliers; the real exchange rate is measured in percent deviations from its pre-shock level, while the responses of the long-term real interest rate and inflation are measured as deviations from the pre-shock level in quarterly percentage points. Results for all variables, with the exception of investment and net exports, are obtained for the VAR model that includes private consumption as the seventh variable.¹¹ Throughout, the solid line indicates the point estimate, and the shaded area represents a 90-percent confidence interval obtained by bootstrap sampling based on 1,000 repetitions.

The response of government spending, shown in the top left panel, is of particular interest for what follows. Observe that government spending first increases persistently, but over time undershoots its trend value in what appears to be a self-correcting (or debt-stabilizing) pattern. Both the initial increase and its subsequent reversal are statistically significant. A similar finding has been documented by Chung and Leeper (2007). These authors also compare results between a relatively small VAR model and a more comprehensive model which includes government debt. They find government spending to be ‘self-correcting’ in the more comprehensive VAR only. This underscores the

⁸This approach seems particularly suited to address concerns regarding a misalignment of the information sets of private agents and econometricians which Leeper et al. (2009) show to result from “fiscal foresight”. In the light of the results below, it is useful to observe that including asset prices such as the exchange rate may also help to tackle fiscal foresight (see Leeper et al. 2009).

⁹Building on earlier work by Ramey and Shapiro (1998) and Edelberg et al. (1999), Ramey (2010) proposes another identification strategy centered around military news, which she argues provide an exogenous source of variation in government spending. However, Ramey’s list of relevant news is dominated by events predating our post-1983 sample, notably World War II and the Korean War. Once these episodes are excluded, Ramey finds that her defense news measure has low predictive power for either defense or total government spending.

¹⁰Note that a few studies have used another alternative approach to identifying fiscal shocks based on sign restrictions, see Mountford and Uhlig (2009), Canova and Pappa (2004, 2007), and Enders et al. (2011).

¹¹However, the results are unaffected by the choice of this last variable.

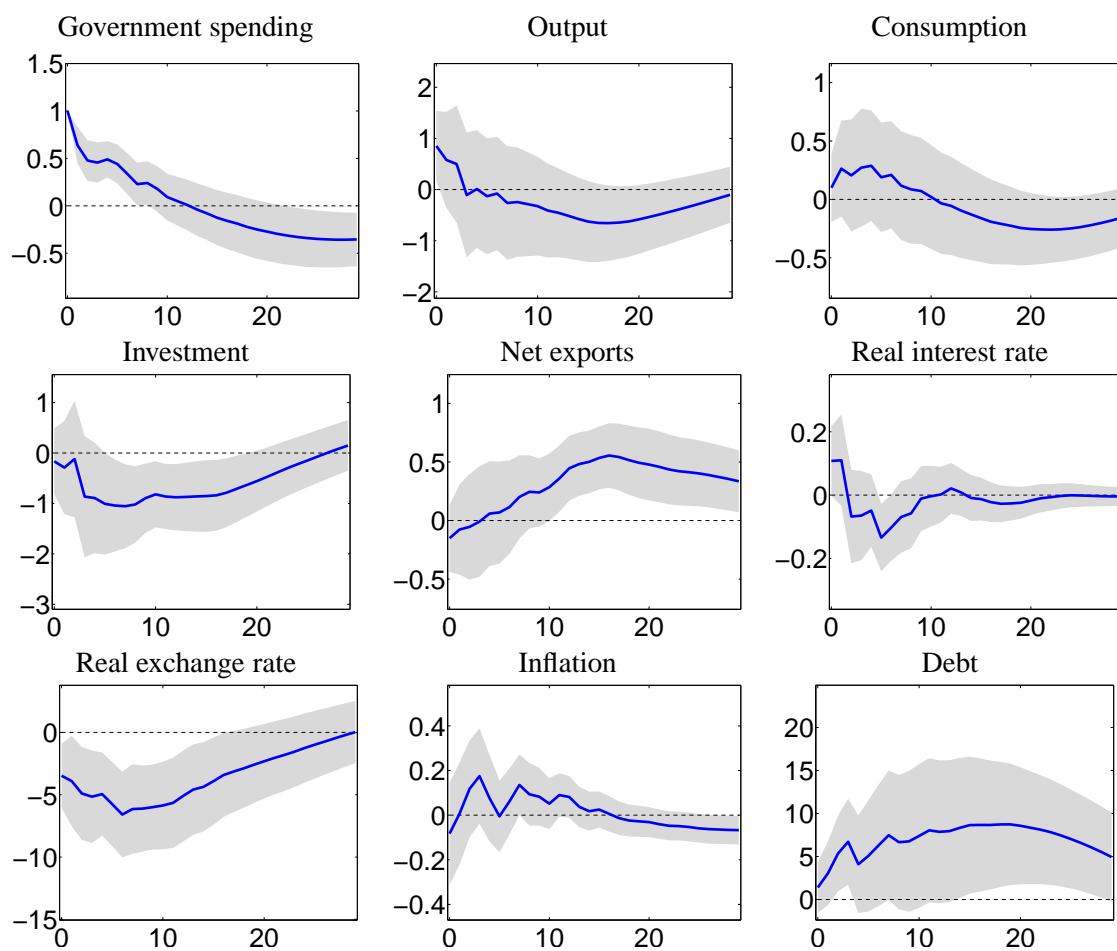


Figure 1: Effects of government spending shock: VAR innovations. Notes: solid lines indicate point estimate; grey area: 90 percent confidence interval obtained by bootstrap sampling. The horizontal axis indicates quarters, the vertical axes measure deviations from trend in percentage points of trend 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 and inflation).

importance of controlling for debt as a state variable.¹²

Output, in turn, increases in a statistically significant way with an impact multiplier of about one. Only several quarters after the impact does it fall below trend. Private consumption displays a similar pattern, although its response is not statistically significant. Moreover, the consumption response is mildly hump-shaped and peaks at about one quarter of a percent of GDP. In quantitative terms, these effects on output and consumption are smaller than those reported in studies by Blanchard and Perotti (2002) and Galí et al. (2007), based on sample periods including data since 1960. This is consistent with the findings of Perotti (2004) and Bilbiie et al. (2008), whereby the expansionary effects of government spending shocks are smaller in post-1980 data relative to earlier periods.¹³

Next, investment is seen to decline considerably, as in Blanchard and Perotti (2002), recovering its pre-shock trend only after about seven years. Net exports, in contrast, drop only briefly (and insignificantly) on impact, but then quickly start to rise. Comparable results from the previous literature are inconclusive: while Kim and Roubini (2008) document an improving current account in response to positive spending shocks, Corsetti and Müller (2006) and Monacelli and Perotti (2006) find more mixed evidence.

After rising insignificantly on impact, the interest rate falls below its pre-shock level after about two quarters. Similar findings have been reported elsewhere in the literature, but have long been regarded as difficult to reconcile with standard analyses of fiscal expansions.¹⁴ The real exchange rate, in turn, depreciates sharply and significantly, remaining below trend for a long period after the initial spending shock. Very similar results have been documented earlier by Kim and Roubini (2008), Monacelli and Perotti (2006), and Ravn et al. (2007). Enders et al. (2011) also find a fall in the real exchange rate, while using an identification scheme based on sign restrictions. Lastly, Monacelli and Perotti (2006) have documented real depreciation after a positive government spending shock not only for the U.S., but also for Australia and the UK.¹⁵

The response of inflation is barely significant. After the impact period, the point estimate rises above trend for the first three years or so, before falling below trend for an extended period. Finally, public

¹²In 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 as opposed to more comprehensive VAR systems which include public debt.

¹³Mountford and Uhlig (2009) also find no significant response of consumption to a deficit-financed government spending shock, using a sign-restrictions approach.

¹⁴Indeed, 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 (2009) 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, Laubach's 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 short-term variation in government spending on interest rates for a given monetary policy rule.

¹⁵A noteworthy exception in this literature is Beetsma et al. (2008), who document a real appreciation for a sample of European countries. Similarly, Canova and Pappa (2007) find in their analysis of U.S. states and EMU members that government spending shocks raise the state's price level relative to the union, implying real appreciation.

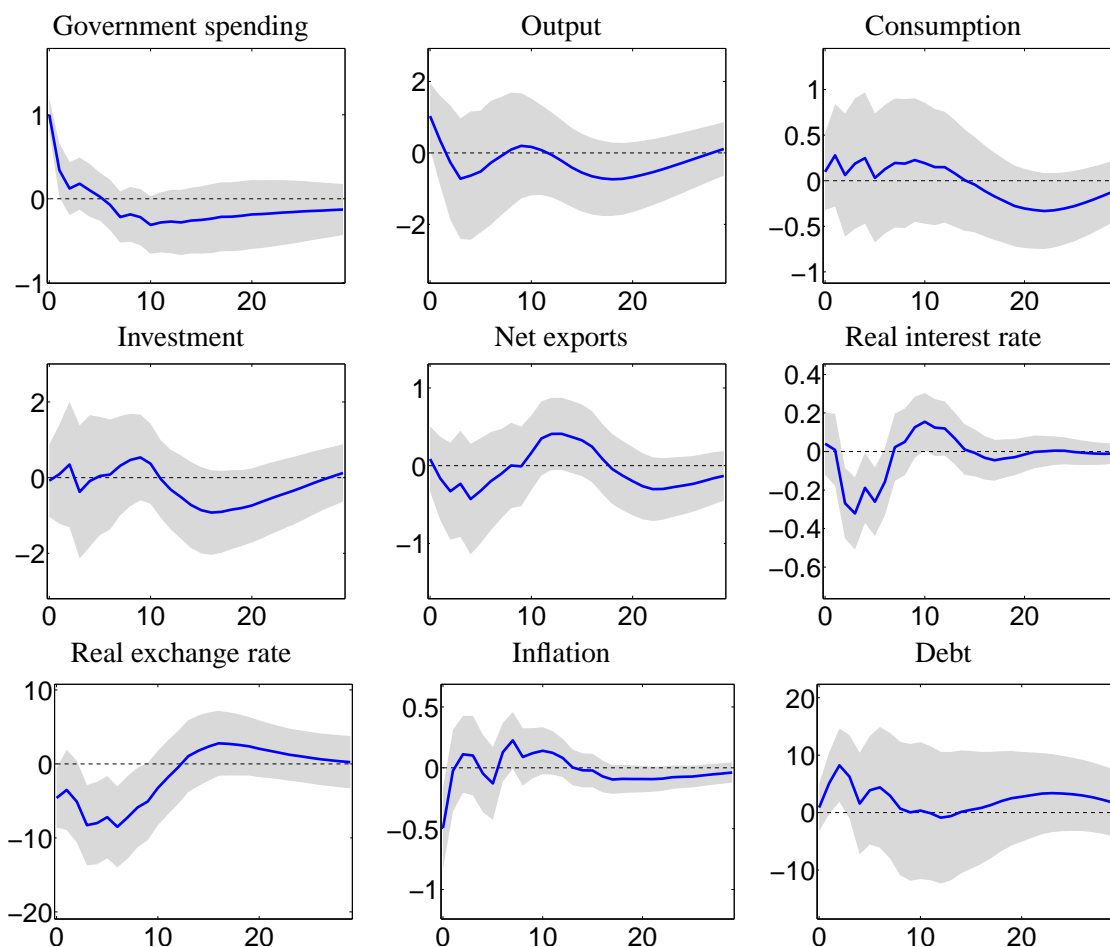


Figure 2: Effects of government spending shock: forecast errors. Notes: see figure 1; forecast errors, computed on the basis of the Survey of Professional Forecasters, are included as an additional variable in the VAR.

debt, shown in the bottom right panel, increases significantly and persistently, peaking around five years after the initial spending shock. This result suggests that the increase in government spending is to a considerable extent debt-financed, in line with results reported by Galí et al. (2007) and Bilbiie et al. (2008).

Figure 2 reports the responses for the same set of variables obtained under Ramey’s alternative identification scheme, which identifies fiscal innovations relative to earlier projections by professional forecasters. Note that our VAR model differs from Ramey’s in several respects, notably the sample length and the choice of variables included in the baseline VAR model. Nevertheless, the responses of government spending and output are fairly similar to Ramey’s results.¹⁶

¹⁶For comparison see Figure 10 in Ramey (2010). Note that Ramey normalizes the initial shock to be one percent of government spending; our shock is equal to one percent of GDP and thus about five times as large. Ramey stresses differences relative to the Blanchard-Perotti identification in terms of the response of private consumption, which declines according to her estimates. Instead, we find that consumption tends to increase, albeit insignificantly. This difference in

Overall, the results from Figure 2 display a high degree of similarity with the results shown in Figure 1. This includes the fact that under the forecast error identification scheme government spending also falls below trend after the initial surge, even though the decline is steeper and faster. The speed of this spending reversal is mirrored by the dynamics of public debt, which falls relatively quickly after an initial increase. The responses of output, consumption, and investment in Figure 2 display the same dynamic adjustment as under the identification based on VAR innovations (especially for the former two quantities), but are generally insignificant. The responses of the long-term real interest rate and the real exchange rate are once again similar to our earlier findings, if somewhat more pronounced.

2.3 Sensitivity analysis

To assess the robustness of our results, we consider a number of variations to the baseline specification of the VAR model. Results are shown in Figure 3 for the VAR innovation identification (left) and the forecast error identification (right), respectively. In each case we display the confidence bounds computed for the baseline specification (grey area) and the point estimates of the impulse responses obtained under alternative specifications. The exercises we perform are as follows. First, we allow for a quadratic trend in addition to a linear trend in the VAR model (dashed lines). Second, we replace our measure of the long-term real interest rate, with a simpler interest rate variable, i.e., the nominal interest rate on T-Bills (dashed-dotted lines). Since time-series data for this variable are available over a longer time span, we estimate, in a third experiment, the VAR model including the nominal interest rate over the sample 1975–2007 (solid lines). The beginning of this extended sample corresponds to the start of the flexible exchange rate period, omitting the first two turbulent years after the breakdown of the Bretton-Woods system. An inspection of the panels of Figure 3 reveals that the results obtained under the baseline specification are not sensitive to any of these experiments.

Across all these models, our results also remain well in line with earlier findings for the U.S. In particular, under either identification scheme, a positive government spending shock is found to cause a significant, if contained, increase in output, a strong depreciation of the real exchange rate, and a muted response of consumption. Further, very robust findings emerge for the long-term real interest rate, which tends to fall over time (three to eight quarters after the shock); public debt, which initially rises; and, last but not least, government spending itself, which tends to decline below its trend value some time after the shock. This latter finding points to the relevance of spending reversals to fiscal dynamics in the U.S.

results is due entirely to the choice of sample periods: like Ramey, we also find a decline in consumption if we consider 1975 as the starting date; see our sensitivity analysis reported in Figure 3 below.

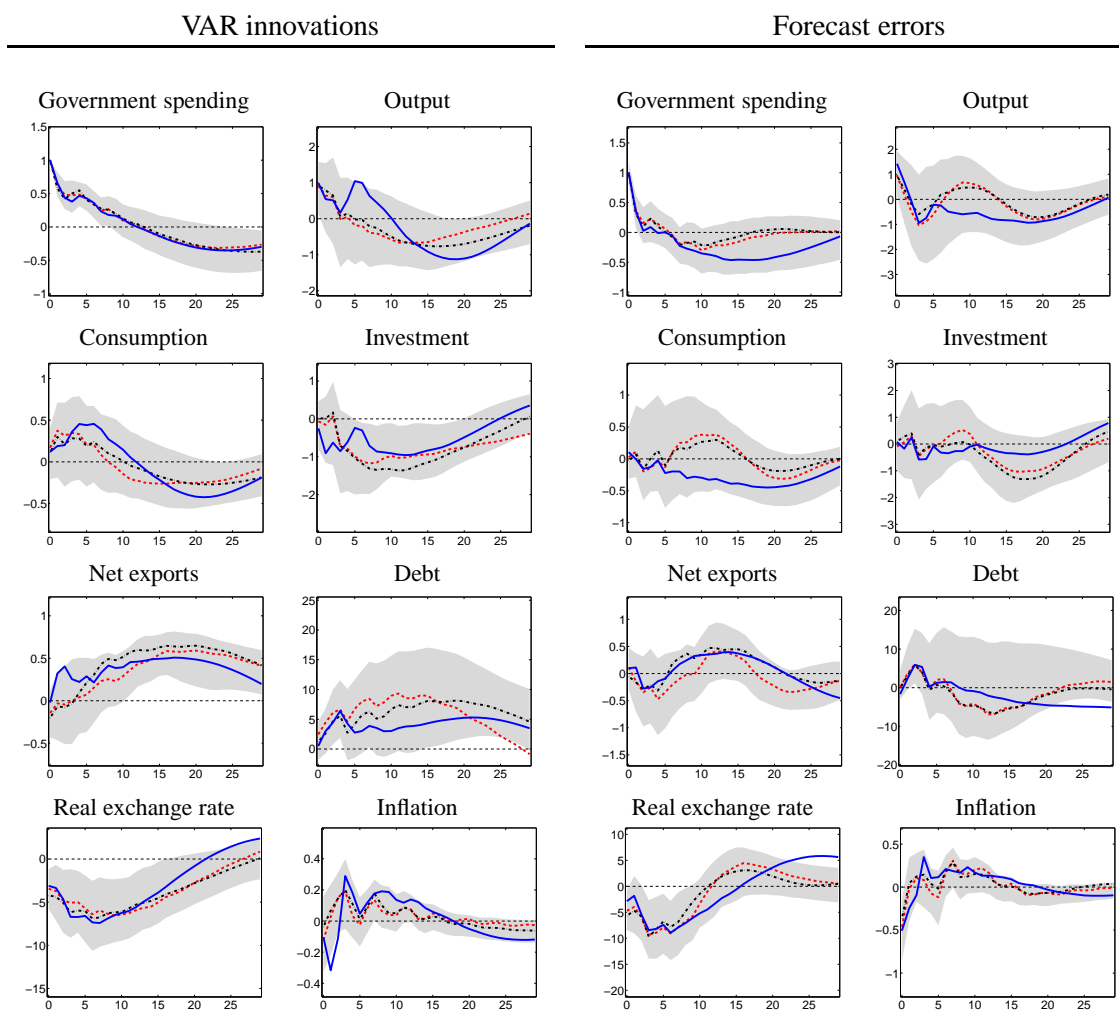


Figure 3: Effects of government spending shock: sensitivity analysis. Notes: see figure 1; left: results for identification based on VAR innovations; right: identification based on forecast errors; grey area: 90 percent confidence interval for point estimate of baseline specification (see figures 1 and 2). Dashed line: model includes quadratic trend; dashed-dotted line: measure for long-term real interest rate is replaced by nominal interest rate (T-Bill); solid line: sample starts in 1975, nominal long-term interest rate rather than real rate included in model.

3 Fiscal Policy Transmission with Spending Reversals

Standard analyses of fiscal transmission typically assume—with little justification—that the entire burden of debt stabilization is borne by taxes, whereas government spending follows some exogenous process; see, for example, Baxter and King (1993) and Linnemann and Schabert (2003). With lump-sum taxes, then, the path of debt becomes irrelevant for the real allocation of the economy (Ricardian equivalence), severely limiting the assessment of plausible budget policies. The starting point of our analysis is to recognize that at least some of the dynamic adjustment to a higher debt stock is likely to rely on spending restraint. This proposition finds support not only in the VAR evidence

presented in the previous section. It is also consistent with empirically estimated policy rules, which indicate a statistically significant adjustment of both spending and taxes in response to higher debt; see, for example, Galí and Perotti (2003). At an intuitive level, allowing for endogenous government spending captures the reality of political constraints on governments' capacity to raise taxes. Canova and Pappa (2004), for instance, document 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.

In what follows, we examine how a fuller account of government spending dynamics alters the transmission of fiscal policy in a two-country new Keynesian business cycle model. Allowing for a systematic feedback from public debt into government spending implies a characteristic pattern whereby short-term deficit spending becomes partially self-correcting. Specifically, an upfront debt-financed increase in government spending will subsequently cause spending to fall below trend (or steady-state) levels for some time. We refer to this dynamic adjustment path as a “spending reversal”. Our main finding is that, because of the anticipated spending reversal, the initial exogenous increase in government spending exerts a stronger expansionary effect on output, limits the crowding out of private consumption, and depreciates the real exchange rate. Thus, our account of the transmission mechanism provides an explanation for the time-series evidence presented in Section 2.¹⁷ The prediction of real exchange rate *depreciation* is noteworthy, as it runs counter not only to traditional analyses based on the Mundell-Fleming model, but also to real business cycle theory (Backus et al. 1994) as well as the new Keynesian model (in the absence of spending reversals), all of which predict that higher government spending *appreciates* the real exchange rate. We also stress the important role played by nominal rigidities—the model features both price and wage stickiness—in generating our key results.

3.1 Model structure

We assume that there are two countries, referred to as H (Home) and F (Foreign), each producing a variety of country-specific intermediate goods, with the number of intermediate good producers normalized to unity. A fraction n of firms is located in Home, the remaining firms $(n, 1]$ is located in Foreign. Analogously, Home accounts for a fraction $n \in [0, 1]$ of the global population. Intermediate goods are traded across borders, while final goods, which are bundles of intermediate goods, are not. Prices of intermediate goods are sticky in producer-currency terms. Households supply labor and capital services only within the country where they reside, but trade a complete set of state-

¹⁷To the extent that medium-term fiscal adjustment patterns are shown to be an essential dimension of the transmission mechanism, this paper also 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 by source of short-term financing (taxes versus deficit; see Ludvigson 1996).

contingent assets internationally. Like prices, wages are also adjusted infrequently. Below, we focus our exposition on Home. When necessary, we refer to foreign variables by means of an asterisk. We first describe the problems faced by final and intermediate good firms, as well as by households; we then specify fiscal and monetary policy in terms of feedback rules and state the market clearing conditions.

3.1.1 Final good firms

Final goods, which are not traded across borders, are bundles of domestically produced and imported intermediate goods, used for both consumption, C_t , and investment, X_t . Let A_t and B_t denote bundles of domestically produced and imported intermediate goods. The final good F_t (F_t^*) is produced using the following aggregation technology

$$F_t = \left[(1 - (1 - n)\omega)^{\frac{1}{\sigma}} A_t^{\frac{\sigma-1}{\sigma}} + ((1 - n)\omega)^{\frac{1}{\sigma}} B_t^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{1-\sigma}}, \quad (1)$$

$$F_t^* = \left[(n\omega)^{\frac{1}{\sigma}} (A_t^*)^{\frac{\sigma-1}{\sigma}} + (1 - n\omega)^{\frac{1}{\sigma}} (B_t^*)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{1-\sigma}}, \quad (2)$$

where σ measures the terms of trade elasticity of the relative demand for domestically produced goods, and $\omega \in [0, 1]$ provides a measure for home bias.¹⁸ The bundles of domestically and imported intermediate goods are defined as follows

$$A_t = \left[\left(\frac{1}{n} \right)^{\frac{1}{\epsilon}} \int_0^n A_t(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}}, \quad B_t = \left[\left(\frac{1}{1-n} \right)^{\frac{1}{\epsilon}} \int_n^1 B_t(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}}, \quad (3)$$

where $A_t(j)$ and $B_t(j)$ denote intermediate goods produced in H and F , respectively, and ϵ measures the elasticity of substitution between intermediate goods produced within the same country.

As final good firms operate under perfect competition, the objective of the representative firm is to minimize expenditures subject to $F_t = C_t + X_t$ along with the aggregation technologies (1) and (3). The optimality condition implicitly defines a demand function for intermediate goods. Specifically, let $P(j)$ denote the price of an intermediate good expressed in domestic currency and \mathcal{E}_t the nominal exchange rate (the price of domestic currency in terms of foreign currency). We assume that the law of one price holds, so that $P^*(j) = \mathcal{E}_t P(j)$. Assuming that government consumption, G_t , is a bundle isomorphic to final goods, but consisting of domestically produced goods only, global demand for a

¹⁸This specification follows Sutherland (2005) and De Paoli (2009). With $\omega = 1$, there is no home bias: if the relative price of foreign and domestic goods is unity, the fraction of domestically produced goods which ends up in the production of final goods is equal to n , while imports account for a share of $1 - n$. Importantly, final goods are identical across countries in this case. A lower value of ω implies that the fraction of domestically produced goods in final goods exceeds the share of domestic production in the world economy. If $\omega = 0$, there is no trade in goods across countries.

generic intermediate good produced in H and F is, respectively:

$$Y_t^D(j) = \left(\frac{P_t(j)}{P_{At}} \right)^{-\epsilon} \left\{ \left(\frac{P_{At}}{P_t} \right)^{-\sigma} \left[(1 - (1 - n)\omega)(C_t + X_t) + (1 - n)\omega Q_t^{-\sigma}(X_t^* + C_t^*) \right] + G_t \right\}, \quad (4)$$

$$Y_t^D(j)^* = \left(\frac{P_t^*(j)}{P_{Bt}^*} \right)^{-\epsilon} \left\{ \left(\frac{P_{Bt}^*}{P_t^*} \right)^{-\sigma} [n\omega Q_t^\sigma(C_t + X_t) + (1 - n\omega)(X_t^* + C_t^*)] + G_t^* \right\}, \quad (5)$$

where price indices are given by

$$P_{At} = \left[\frac{1}{n} \int_0^n P_t(j)^{1-\epsilon} dj \right]^{\frac{1}{1-\epsilon}}, \quad P_{Bt} = \left[\frac{1}{1-n} \int_n^1 P_t(j)^{1-\epsilon} dj \right]^{\frac{1}{1-\epsilon}}, \quad (6)$$

$$P_t = \left[(1 - (1 - n)\omega)P_{At}^{1-\sigma} + ((1 - n)\omega)P_{Bt}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \quad (7)$$

$$P_t^* = \left[n\omega(P_{At}^*)^{1-\sigma} + (1 - n\omega)(P_{Bt}^*)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \quad (8)$$

and $Q_t = P_t \mathcal{E}_t / P_t^*$ measures the real exchange rate.

3.1.2 Intermediate good firms

Producers of differentiated intermediate goods engage in monopolistic competition, facing the demand function (4). The production function is Cobb-Douglas:

$$Y_t(j) = K_t(j)^\alpha H_t(j)^{1-\alpha}, \quad (9)$$

where $K_t(j)$ and $H_t(j)$ denote, respectively, domestic capital and domestic labor services employed by firm $j \in [0, n]$ in period t .

Labor and capital are immobile internationally, but can be adjusted freely in each period within a country. Letting W_t denote the nominal wage rate and R_t the rental rate of capital, cost minimization implies $H_t(j)/K_t(j) = (1 - \alpha)R_t/(\alpha W_t)$ such that marginal costs are independent of the level of production and identical across firms: $MC_t = W_t^{1-\alpha} R_t^\alpha / (\alpha^\alpha (1 - \alpha)^{1-\alpha})$.

We assume that prices are set in the currency of the producer and that price setting is constrained exogenously à la Calvo, so that in each period only a fraction of intermediate good producers $(1 - \xi_P)$ may adjust its price. When firm j has the opportunity, it sets $\tilde{P}_t(j)$ to maximize the expected discounted value of net profits:

$$\max E_t \sum_{s=0}^{\infty} \frac{\xi_P^{t+s} \rho_{t,t+s} Y_{t+s}^D(j)}{P_{t+s}} \left[\tilde{P}_t(j) - MC_{t+s} \right] \quad (10)$$

subject to the demand function (4) and the production function (9). As households own the firms, profits are discounted with $\rho_{t,t+s}$, which equals households' marginal rate of substitution between consumption in period t and $t + s$.

3.1.3 Households

Households supply differentiated labor services. Within each country, they are indexed according to labor types on the unit interval, see Erceg et al. (2000). Households engage in monopolistic competition, but their ability to set wages is restricted in the same way as intermediate good firms are restricted in their ability to reoptimize prices: in each period only a fraction $(1 - \xi_W)$ of households may adjust its wage. Differentiated labor services $H_t(h), \in [0, 1]$ are bundled into aggregate labor services according to the following technology

$$H_t = \left(\int_0^1 H_t(h)^{\frac{\nu-1}{\nu}} dh \right)^{\frac{\nu}{\nu-1}}. \quad (11)$$

Letting $W_t(h)$ denote the wage rate for labor services of type h , the unit cost of domestic labor services, i.e. the aggregate wage index, is given by

$$W_t = \left(\int_0^1 W_t(h)^{1-\nu} dh \right)^{\frac{1}{1-\nu}}. \quad (12)$$

Optimal bundling of differentiated labor services implies the demand function

$$H_t(h) = \left(\frac{W_t(h)}{W_t} \right)^{-\nu} H_t. \quad (13)$$

Letting $C_t(h)$ denote consumption of household h , its utility functional is given by

$$E_t \sum_{s=0}^{\infty} \beta^s \left(\ln C_{t+s}(h) - \vartheta \frac{H_{t+s}(h)^{1+\varphi}}{1+\varphi} \right), \quad (14)$$

where β is the discount factor, ϑ is a constant determining labor supply in steady state, and φ is the inverse of the Frisch elasticity of labor supply.

Households own and invest in domestic capital, facing investment adjustment costs as in Christiano et al. (2005):

$$K_{t+1}(h) = (1 - \delta)K_t(h) + [1 - \Psi(X_t(h)/X_{t-1}(h))]X_t(h), \quad (15)$$

where δ denotes the depreciation rate. The function Ψ governs the transformation of current and past investment into new installed capital. Restricting $\Psi(1) = \Psi'(1) = 0$ and $\chi = \Psi''(1) > 0$ ensures that the steady-state capital stock is independent of investment adjustment costs.

We assume that households trade a complete set of state-contingent securities. Let $\Xi_{t+1}(h)$ denote the payoff in units of currency H in period $t + 1$ of the portfolio held by household h at the end of period t . With $\rho_{t,t+1}$ denoting the stochastic discount factor, the budget constraint of the household is given by

$$W_t(h)H_t(h) + R_t K_t(h) + \Upsilon_t - T_t - P_t(C_t(h) + X_t(h)) = E_t \{ \rho_{t,t+1} \Xi_{t+1}(h) \} - \Xi_t(h), \quad (16)$$

where T_t and Υ_t denote lump-sum taxes and profits of intermediate good firms, respectively. Both are levied/distributed equally across households.

Under complete financial markets, households fully insure against the idiosyncratic income risk that results from their limited ability to adjust wages in each period. Households are, therefore, homogeneous with respect to consumption, investment decisions, and asset holdings. By contrast, households are heterogeneous with respect to labor supply as a result of infrequent wage adjustments. Given the household's marginal utility of nominal income, Λ_t , a household that is allowed to reoptimize its wage sets $\tilde{W}_t(h)$ to meet the following objective

$$\max E_t \sum_{s=0}^{\infty} (\beta \xi_W)^s \left[\Lambda_{t+s} H_{t+s}(h) \tilde{W}_t(h) - \vartheta \frac{H_{t+s}(h)^{1+\varphi}}{1+\varphi} \right], \quad (17)$$

subject to the demand for its labor service (13).

3.1.4 Fiscal and monetary policy

Government consumption is financed either through lump-sum taxes, T_t , or through the issuance of nominal debt, D_t , denominated in domestic currency.¹⁹ The period budget constraint of the government reads as follows

$$\frac{D_{t+1}}{1+i_t} + T_t = D_t + P_{At} G_t, \quad (18)$$

where $(1+i_t)$ is the gross return on a one-period nominally riskfree bond, which is equal to $1/E_t \rho_{t,t+1}$.

Define $D_{Rt} = D_t/P_{t-1}$ as a measure for real beginning-of-period debt, and $T_{Rt} = T_t/P_t$ as taxes in real terms. Letting variables without time subscript refer to steady-state values, we specify the following feedback rules

$$G_t = (1-\rho)G + \rho G_{t-1} - \psi_G D_{Rt} + \varepsilon_t, \quad T_{Rt} = \psi_T D_{Rt}, \quad (19)$$

where ε_t represents an exogenous iid shock to government spending. The ψ -parameters, which we posit to be non-negative throughout, capture a systematic feedback of public debt on government spending (negative) and taxes (positive). We assume that either parameter is sufficiently large to ensure the non-explosiveness of public debt. For instance, if $\psi_G = 0$ we posit that taxes are raised sufficiently strongly in response to higher outstanding debt. Note, however, that $\psi_G = 0$ implies Ricardian equivalence, so the specific time path of taxes, for a given time path of government spending, is irrelevant for the real allocation in the economy. As outlined above, this restrictive assumption is typical in standard analyses of fiscal transmission; by relaxing the assumption and allowing for a

¹⁹We assume that government consumption does not alter production possibilities, although it may enhance private welfare. Even then, because preferences are assumed to be additively separable in government consumption, we do not explicitly consider it as an argument in (14).

feedback channel from debt to government spending, we allow for richer and more realistic dynamics in the model economy.

Turning to monetary policy, we assume flexible exchange rates and specify policymaking by means of an interest rate feedback rule:

$$\ln(1+i_t) = \rho_i \ln(1+i_{t-1}) + (1-\rho_i) \left(\ln(1+i) + \phi_\Pi (E_t \Pi_{At+k} - \Pi_A) + \phi_Y \frac{E_t Y_{t+k} - Y}{4Y} \right), \quad (20)$$

where $\Pi_{At} = P_{At}/P_{At-1}$ measures domestic (producer price) inflation, and Y_t denotes a measure of aggregate output defined below. The parameter $k \geq 0$ measures the extent to which policy rates are adjusted in response to expected deviations of inflation and/or output from steady state.

3.1.5 Equilibrium

In equilibrium, firms and households optimally choose prices and quantities subject to their respective constraints, initial conditions, and policy rules, while markets clear. At the level of intermediate goods we have $Y_t(j) = Y_t(j)^D$, where demand is given by (4). Defining an index for aggregate output $Y_t = \left(\int_0^1 Y_t^{\frac{\epsilon-1}{\epsilon}}(j) dj \right)^{\frac{\epsilon}{\epsilon-1}}$, we obtain

$$Y_t = \left(\frac{P_{At}}{P_t} \right)^{-\sigma} [(1 - (1-n)\omega)(C_t + X_t) + (1-n)\omega Q_t^{-\sigma}(C_t^* + X_t^*)] + G_t. \quad (21)$$

Factor markets clear if

$$H_t = \int_0^n H_t(j) dj, \quad K_t = \int_0^n K_t(j) dj. \quad (22)$$

Finally, asset markets clear by Walras' law. Observe that, for $n \rightarrow 1$, Home comes to represent the entire world economy and is thus equivalent to a generic closed economy. In this case, expression (21) implies: $Y_t = C_t + X_t + G_t$, as $P_t = P_{At}$.

3.2 Some useful equilibrium relationships

Before turning to model simulations, we briefly discuss a few equilibrium relationships that critically shape the fiscal transmission mechanism in our model. We focus, in particular, on how current economic activity and the real exchange rate are driven by long-term interest rates and hence, via the channel we highlighted in this paper, by expectations about future policymaking. Optimal household behavior implies that the following Euler equation will be satisfied in equilibrium:

$$\frac{1}{C_t} = (1+i_t) E_t \left[\beta \frac{P_t}{P_{t+1}} \frac{1}{C_{t+1}} \right], \quad (23)$$

Abstracting from permanent shocks,²⁰ and integrating forward under our preference specification, we obtain

$$\frac{C}{C_t} = \lim_{T \rightarrow \infty} \prod_{s=0}^T E_t \left[\beta^s \frac{1 + i_{t+s}}{\Pi_{t+1+s}} \right]. \quad (24)$$

This expression shows that current consumption is negatively related to the weighted product of all future short-term real interest rates. The latter is, by the expectations hypothesis, equivalent to the real rate of return on a bond of infinite duration (see, for example, Woodford 2003, p. 244).

Movements in long-term interest rates are, in turn, at the heart of the transmission mechanism through which fiscal and monetary policy influence aggregate demand. Long-term rates reflect not only the current stance of policies, but also expectations about their future course. As such, they “telescope” anticipated future policy stances into today’s financial conditions, unfolding immediate macroeconomic effects. By way of example, if households come to expect tight fiscal policy over the medium run, they anticipate correspondingly lower future policy rates. These translate into an upfront drop in long-term rates, boosting current consumption. The opposite is true if households anticipate a combination of loose fiscal and tight monetary policy.

Beyond these ramifications for domestic demand, long-term real rates are also a key driver of real exchange rate movements. To illustrate this point, we rely on a well-known implication of complete international risk-sharing, i.e., the fact that the real exchange rate moves proportionately to the ratio of marginal utility of consumption in Home and Foreign. Specifically, we have

$$\kappa Q_t = \frac{C_t^*/C^*}{C_t/C}, \quad (25)$$

where κ is a positive constant.²¹ Intuitively, under complete financial markets, foreign consumption will be high relative to home consumption whenever the latter is relatively expensive, i.e. whenever the real exchange rate is appreciated.

Combining (24) with (25), it immediately follows that the real exchange rate is equal to the cross-border differential in long-term real rates. Substituting for consumption and using its counterpart in Foreign, we have

$$\kappa Q_t = \lim_{T \rightarrow \infty} \prod_{s=0}^T E_t \left[\beta^s \frac{1 + i_{t+s}}{\Pi_{t+1+s}} \right] / \prod_{s=0}^T E_t \left[\beta^s \frac{1 + i_{t+s}^*}{\Pi_{t+1+s}^*} \right]. \quad (26)$$

By virtue of this equilibrium relationship, it is straightforward to see how the expected future policy mix drives movements in the real exchange rate today, namely via changes in long-term interest rates. For instance, the anticipation of future fiscal retrenchment in the Home country, which (as

²⁰Note that $\lim_{s \rightarrow \infty} 1/C_{t+s} = 1/C$, i.e. with complete markets the economy always reverts back to its steady state after temporary shocks.

²¹A detailed derivation is provided in the appendix (available on request); see also Chari et al. (2002).

discussed above) translates into lower long-term rates and boosts current demand, also depreciates today's real exchange rate (other things equal). This result is by no means specific to complete-market economies. For standard model calibrations, it carries over virtually unchanged to the case of a bond-only economy (see Corsetti et al. 2009).

Overall, the above equilibrium relationships illustrate a key financial channel through which medium-term fiscal adjustment is likely impact on the fiscal transmission mechanism and thus on the size of the short-run multiplier. The role of this channel has not been fully appreciated in the literature. Namely, as a result of the frequently made assumption that government spending follows an exogenous autoregressive process (combined with offsetting changes in lump-sum taxes), the model typically generates a rise in long-term interest rates and real appreciation—in conflict with the time-series evidence. Below we show how modelling fiscal regimes in a richer and arguably more realistic way may provide important insights into the fiscal transmission, precisely via their implications for the financial channel just described.

3.3 Model parameterization

In what follows, we consider a linear approximation of the model's equilibrium conditions around a deterministic steady state in which government debt and inflation are zero and trade is balanced. We use model simulations to analyze the fiscal transmission mechanism in detail.

We assign parameter values for our baseline scenario on the basis of observations for the U.S. (for the period 1983–2007) and estimates established by relevant earlier studies. A period in the model corresponds to one quarter. We assume $\epsilon = 11$, so that markups in steady state are 10 percent. Under this assumption, $\alpha = 0.4$ implies a labor share of 55 percent. We set $\beta = 0.988$, thus fixing quarterly output at ten times the capital stock. The depreciation rate δ is set so as to account for an investment-output ratio of 24 percent, corresponding to the average value during the above period; note that investment is defined as the sum of private fixed investment and durable consumption. For χ we assume a value of 2.48, the point estimate reported by Christiano et al. (2005). For the Frisch elasticity of labor supply we assume a value of one-third by setting $\varphi = 3$; see Domeij and Flodén (2006) for recent evidence. Given these assumptions, we set ϑ to ensure that agents spend on average one-third of their time endowment working.

As will become clear below, nominal rigidities play a key role in the transmission of government spending shocks with spending reversals. We assume that $\xi_P = 0.75$, implying an average price duration of four quarters—within the range of values discussed, for example, by Nakamura and Steinsson (2008), if somewhat toward the higher end. Regarding wage rigidities we set $\xi_W = 0.83$ so that the average wage duration is six quarters; this is in line with evidence reported by Barattieri et al. (2009). For the specification of monetary policy we rely on estimates reported by Clarida et al. (2000) for

a post-1982 sample. Specifically, we assume that the interest rate rate is set in a forward-looking manner ($k = 1$) and that $\phi_\pi = 1.58$, $\phi_y = 0.14$, and $\phi_i = 0.91$.

Table 1: Parameter values used in baseline model simulations

<i>Parameter</i>		Value	Target/Source
Price elasticity of demand: goods	ϵ	11	Steady-state markup: 10%
Price elasticity of demand: labor	ν	11	Steady-state markup: 10%
Production function	α	0.4	Labor share: 55%
Discount factor (steady state)	β	0.988	Output-capital-ratio: 10
Depreciation rate	δ	0.024	Investment-output-ratio: 0.24
Investment adjustment	χ	2.48	Christiano et al. (2005)
Inverse of Frisch elasticity	φ	3	Domeij and Flodén (2006)
Utility weight of hours	ϑ	73.9	Steady-state hours: 0.33
Prob. of price fixed	ξ_P	0.75	Average price duration: 4 quarters
Prob. of wages fixed	ξ_W	0.83	Average wage duration: 6 quarters
Policy rate response to inflation	ϕ_Π	1.58	Clarida et al. (2000)
Policy rate response to output gap	ϕ_Y	0.14	Clarida et al. (2000)
Policy rate smoothing	ϕ_i	0.91	Clarida et al. (2000)
Size	n	0.2	Share of U.S. GDP in world output
Home bias	ω	0.185	Import-output-ratio: 0.12
Trade price elasticity	σ	0.66	Corsetti et al. (2008)
Average spending share	G/Y	0.19	Sample average 1983–2007
Autocorrelation spending	ρ	0.9	VAR evidence
Debt-sensitivity of spending	ψ_G	0.02	Debt stabilization
Debt-sensitivity of taxes	ψ_T	0.02	Debt stabilization

Notes: Parameter values are chosen symmetrically for the domestic and foreign economy, with the exception of country size.

Further, we posit $n = 0.2$ so that the domestic economy accounts for 20 percent of world production, a value in line with PPP-adjusted data for the year 2008. We also set $\omega = 0.185$ to target an average import share of 12 percent. The trade price elasticity σ is set equal to 0.66, a value in the (admittedly wide) range considered in the recent macroeconomic literature; see Corsetti et al. (2008) for further discussion.

The steady-state share of government spending is assumed to be 19 percent, corresponding to the period average. The parameter ρ is set to 0.9, capturing the persistence of government spending deviations from trend documented by many VAR studies on U.S. data. Finally, we set $\psi_G = \psi_T = 0.02$, implying a systematic feedback from higher public debt to lower government spending and higher taxes. These parameter values not only ensure debt-stabilizing fiscal policy over time, but also assign some role in this to spending restraint. Specifically, an initial increase in government spending

would be followed after some time by a fall in spending below trend, in line with the VAR evidence.²² Table 1 summarizes all parameter values defining the full-fledged model.

4 The transmission mechanism with spending reversals: insights from a parsimonious model

We now turn to model simulations to analyze the fiscal transmission mechanism with a focus on the regime governing fiscal (and monetary) adjustment in the medium term. To enhance clarity, we will do so in incremental steps, taking advantage of the fact that our framework nests, as special cases, benchmark models amply discussed in the literature. So, in this section, we will highlight the mechanism through which spending reversals alter the fiscal transmission mechanism, using a parsimonious version of our model. Initially, we will focus on the closed economy, which by and large corresponds to a variant of the textbook new Keynesian model (e.g. Galí 2008). At the second stage, we will also explore the open economy dimension, thus extending the analysis to a baseline two-country new Keynesian model (see e.g. Corsetti et al. 2010a). An analysis of the full-fledged model is instead provided in section 5 below.

For the parsimonious version of the model we assume that there are no investment dynamics (i.e., the capital stock is constant); and we simplify the interest rate rule, setting $k = 0$, and assuming that there is no interest rate smoothing ($\phi_i = 0$), and no response to the output gap ($\phi_Y = 0$), and a conventional value for the inflation coefficient ($\phi_\pi = 1.5$). In a first subsection, we let the home economy in the model account for the entire world population ($n = 1$). In a second subsection, we instead set $n = 0.2$ to study the domestic economy as part of a global economy. All other parameters remain at the values specified in Table 1 in both subsections. Throughout we analyze the dynamic adjustment of the economy to an exogenous increase of government spending by one percent of GDP.

4.1 A closed-economy new Keynesian benchmark

Consider the parsimonious closed-economy version of our model just described. In the baseline scenario, as specified in Table 1, fiscal policy features endogenous spending reversals by virtue of a systematic feedback from debt to public expenditure ($\psi_G = 0.02$). We start our analysis by contrasting the transmission mechanism under this baseline fiscal regime with that under two alternative regimes. In one of them, there is no endogenous feedback effect on spending ($\psi_G = 0$), so that public

²²Using annual observations to estimate spending and tax rules, Galí and Perotti (2003) report estimates for the coefficient on debt 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 the U.S., Bohn (1998) reports estimates for the response of the *surplus* to debt in a range from 0.02 to 0.05. To see that our parameter choice ensures the solvency of the government—fiscal policy is ‘passive’ in the sense of Leeper (1991)—consider a linear approximation of the equilibrium conditions around the steady state: abstracting from autocorrelation of government spending and assuming an ‘active monetary policy’, debt stability holds if $1 - \psi_G - \psi_T < \beta$.

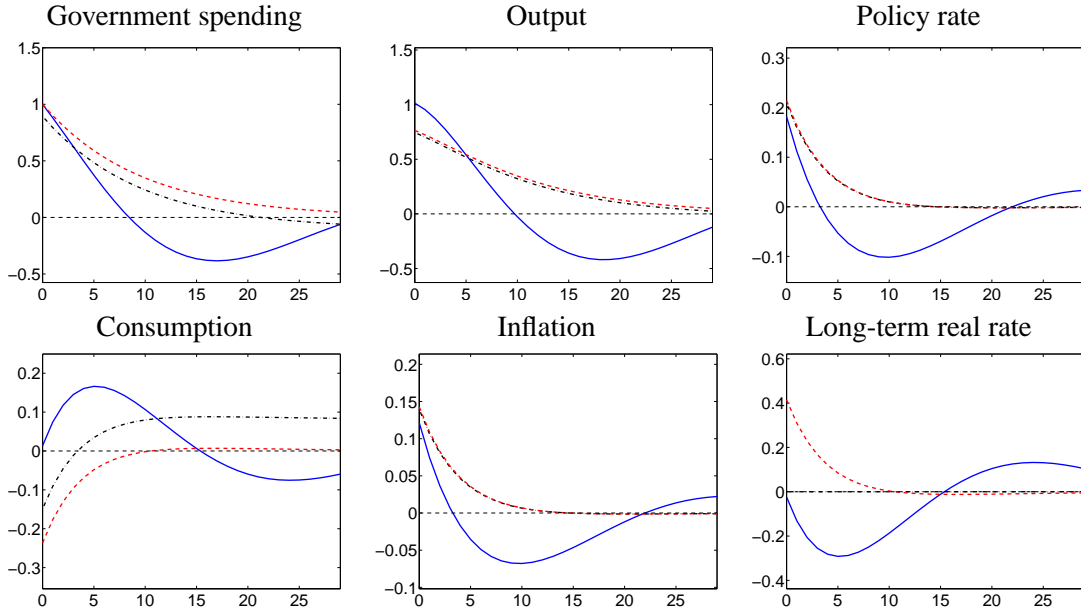


Figure 4: Effects of government spending shock in parsimonious closed-economy model. Notes: responses are shown for fiscal baseline scenario with endogenous spending reversal (solid lines), no-reversal scenario (dashed lines), and unchanged tax burden scenario (dashed-dotted lines); parameterization otherwise as in Table 1, except for $n = 1$, no investment dynamics, and simplified interest rate rule. Responses are measured in deviations from steady state: in output units for quantities; and in percent for interest rates and inflation. Horizontal axes measure time in quarters.

demand is driven by an autoregressive process and debt is stabilized exclusively through higher taxes (no spending reversal).²³ This is the regime typically assumed in the literature. Under the other fiscal regime, we maintain that government spending is exogenous, but assume that the initial temporary spending increase is offset, in present value terms, by a small permanent reduction in government spending that takes effect immediately. Consequently, the upfront fiscal stimulus has no effect at all on the tax burden borne by the private sector under this regime (unchanged tax burden).

Figure 4 displays the impulse responses of selected variables to an exogenous increase in government spending by one percent of GDP. The solid lines show the adjustment of the model economy under the baseline specification with endogenous spending reversal, while the dashed lines display the results for the no-reversal case ($\psi_G = 0$). The dashed-dotted lines, in turn, indicate the scenario with an unchanged overall tax burden. Here, and in what follows, responses are measured in deviations from steady state: in output units for all quantities, and in percent for interest rates and inflation. Horizontal axes measure time in quarters.

Focus initially on the first two regimes, with and without the endogenous spending reversal. Under our baseline, government spending increases on impact, but subsequently eases in response to the

²³As taxes are lump-sum and government spending is exogenous, the particular time path of taxes is irrelevant for the allocation in the economy (Ricardian equivalence).

rising debt stock, to the point of falling below trend some eight quarters after the initial shock. This is in sharp contrast to the no-reversal regime, in which government spending remains above steady-state levels throughout, accompanied by an increase in taxes. The two regimes imply markedly different consumption and output dynamics. The reversal case features a significant initial increase in consumption, followed by a decline in later periods. Without reversal, instead, private consumption declines strongly on impact before returning to steady state after about 10 quarters. The impact response of output is correspondingly stronger in the reversal case, revealing a greater expansionary effect for the same upfront fiscal impulse.

As the overall tax burden on households is higher in the absence of spending reversals, it is natural to think that differences in consumption (and output) behavior across the two scenarios are driven by the effect of alternative public spending paths on private wealth. Such “wealth effects”, caused by changes in government spending, have indeed received considerable attention in the literature. However, their quantitative relevance is readily seen to be limited in the case of a temporary fiscal expansion considered here.²⁴ Our third fiscal regime is specified precisely to illustrate this point. Under this regime, private agents face no change in the present value of taxes and hence no adverse wealth effect from the upfront increase in government spending. Nonetheless, consumption drops on impact and the response of output is hardly discernible from the no-reversal scenario. In fact, consumption exceeds that in the no-reversal scenario by a small amount only (about 0.06 percent of GDP), reflecting the size of the permanent cut in government spending.²⁵

If wealth effects do not account for the differences in adjustment dynamics across the three fiscal regimes, the true driver is intertemporal substitution. Indeed, the specific pattern of government spending under each of the fiscal regimes interacts with monetary policy to generate a distinct path for real interest rates, which in turn pins down intertemporal consumption choices. To clarify this point, Figure 4 includes panels for inflation, the policy rate, and the long-term real rate. While the responses of these variables are virtually identical under the two fiscal regimes without endogenous spending reversal, the baseline scenario is distinguished by a sizeable fall in inflation below steady-state rates a few quarters after the initial spending shock. Disinflation, in turn, induces a commensurate decline of the (nominal) policy rate; and because the Taylor principle is satisfied, the ex-ante real short-term interest rate declines as well (not shown). By the logic of the expectations hypothesis, this anticipated decline in future short-term rates is immediately reflected in current long-term rates. Specifically, the long-term real rate declines below steady-state levels in our baseline scenario,

²⁴This is a direct implication of the permanent income hypothesis. Thus, while Baxter and King (1993) stress that an increase in government spending “has a negative wealth effect on private individuals” (p. 321), they also make clear that the size of this effect depends critically on the persistence of the government spending shock.

²⁵The same point is stressed by Hall (2009), who uses a slightly different setup to neutralize the tax burden of a temporary spending increase. He finds the implications for the consumption response “trivial in magnitude” (p. 213).

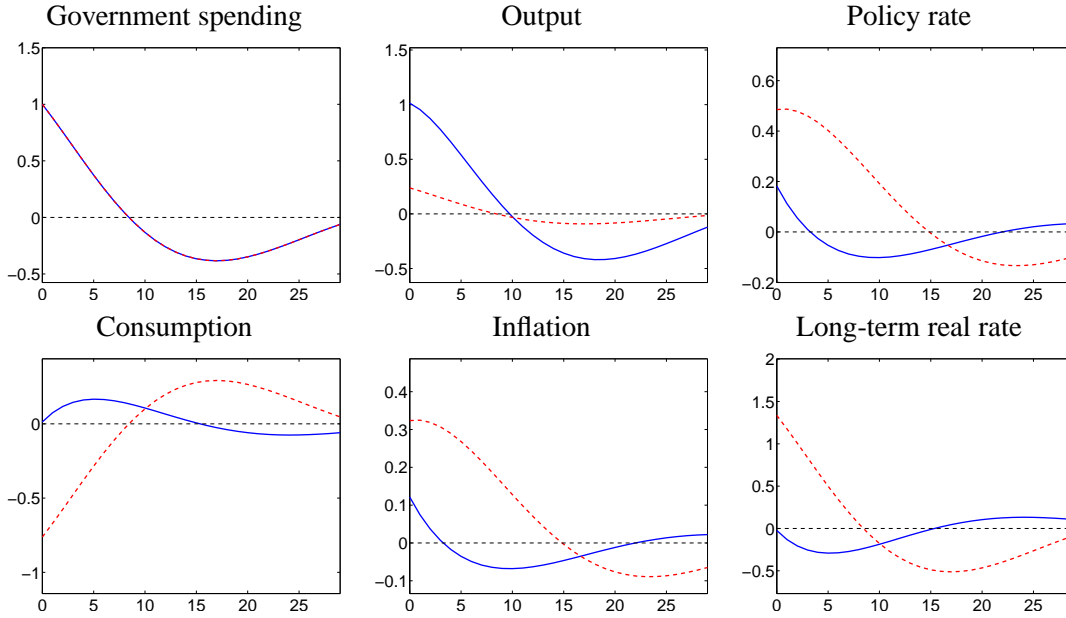


Figure 5: Effects of government spending shock under endogenous spending reversal with (solid lines) and without nominal rigidities (dashed lines). Notes: see Figure 4.

whereas it increases persistently in the absence of endogenous spending reversals.²⁶ Lower long-term rates account, finally, for the stronger initial expansion of consumption and output in the reversal scenario, as discussed in Section 3.2 above.

So far, we have highlighted the important role of medium-term fiscal adjustment patterns in driving long-term interest rates and hence intertemporal allocation decisions. However, the specific time path of real interest rates also depends on the price-setting behavior of the private sector as well as the precise response function of the central bank. To elucidate this point, we now contrast predictions of our model economy with and without nominal rigidities—letting prices and wages be fully flexible ($\xi_P = \xi_W = 0$)—keeping unchanged the fiscal regime with endogenous spending reversals. So, any difference from our baseline results can be naturally attributed to the absence of nominal rigidities. At the same time, the experiment provides a measure for the extent to which monetary policy fails to maintain the “natural” allocation under the baseline scenario, i.e. the allocation which prevails in the absence of nominal rigidities.

Figure 5 presents the results, comparing our baseline specification with nominal rigidities (solid lines) to the new specification with flexible prices and wages (dashed lines). Without nominal rigidities, two crucial characteristics of the baseline reversal scenario are absent. In particular, private consumption now mirrors perfectly the dynamics of government spending (top left panel): consumption falls on impact when government spending is high (and overall resources are correspondingly scarce), and

²⁶For the third fiscal regime, we do not display the long-term real interest rate, as it is not well defined in case of permanent deviations from steady state (see section 3.2).

peaks when government spending reaches its through (implying relatively abundant resources); it does not return to its steady-state level until the public spending increase has tapered off. These dynamics reflect a path for real interest rates that accurately signals the relative scarcity of resources over time: in the absence of nominal rigidities, the long-term real rate increases considerably on impact, depressing consumption, and falls below steady-state levels exactly when government spending drops below trend, thus crowding in private demand.

Compared to this flexible-price/wage allocation, nominal rigidities imply that more of the initial expansion in demand will be accommodated by an endogenous increase in output. Specifically, with sticky prices and wages and a standard Taylor rule, the rise in consumption materializes well ahead of the fall in public spending, causing a larger upfront increase in output. The key to these dynamics is the anticipation of the spending reversal and its implication for price-setting and monetary policy. Since prices and wages are set in a staggered fashion, the looming fiscal retrenchment already exerts a disinflationary effect before actual spending is cut: all else equal, firms and households find it optimal to reduce prices and wages some time ahead of the spending reversal. Lower inflation, in turn, induces an earlier reduction in policy rates, bringing forward the switch to an expansionary monetary stance. As a result, the long-term real rate declines on impact, boosting consumption. These effects are naturally absent when prices and wages are fully flexible. Alternatively, in the presence of nominal rigidities, a more aggressive monetary stance—geared towards neutralizing the effects of nominal rigidities and captured by a higher inflation coefficient—also induces an impact increase of long-term rates and prevents the stimulating effect of anticipated reversals on impact.²⁷

The key insight from our inspection of the model so far can thus be summarized as follows: the impact of short-term fiscal stimulus depends critically not only on the particular policy measure taken today, but also on expectations about the future course of fiscal and monetary policy. In particular, anticipation of a future government spending reversal can raise the expansionary impact of upfront fiscal stimulus by crowding in private consumption. Wealth effects, from a lower future tax burden, are unimportant for this result. Instead, the crowding-in is driven by intertemporal substitution, as households respond to a drop in long-term real interest rates. For this to happen, anticipation of fiscal retrenchment in the future must translate into sufficiently strong expectations of future interest rate cuts, requiring nominal rigidities and a monetary authority that does not respond too aggressively to inflation.²⁸

²⁷Results from model simulations are available on request. Note, however, that monetary policy is generally unable to fully maintain the natural allocation if prices *and* wages are adjusted infrequently.

²⁸See Woodford (2010) for a lucid analysis of the role of monetary policy in fiscal policy transmission without spending reversals.

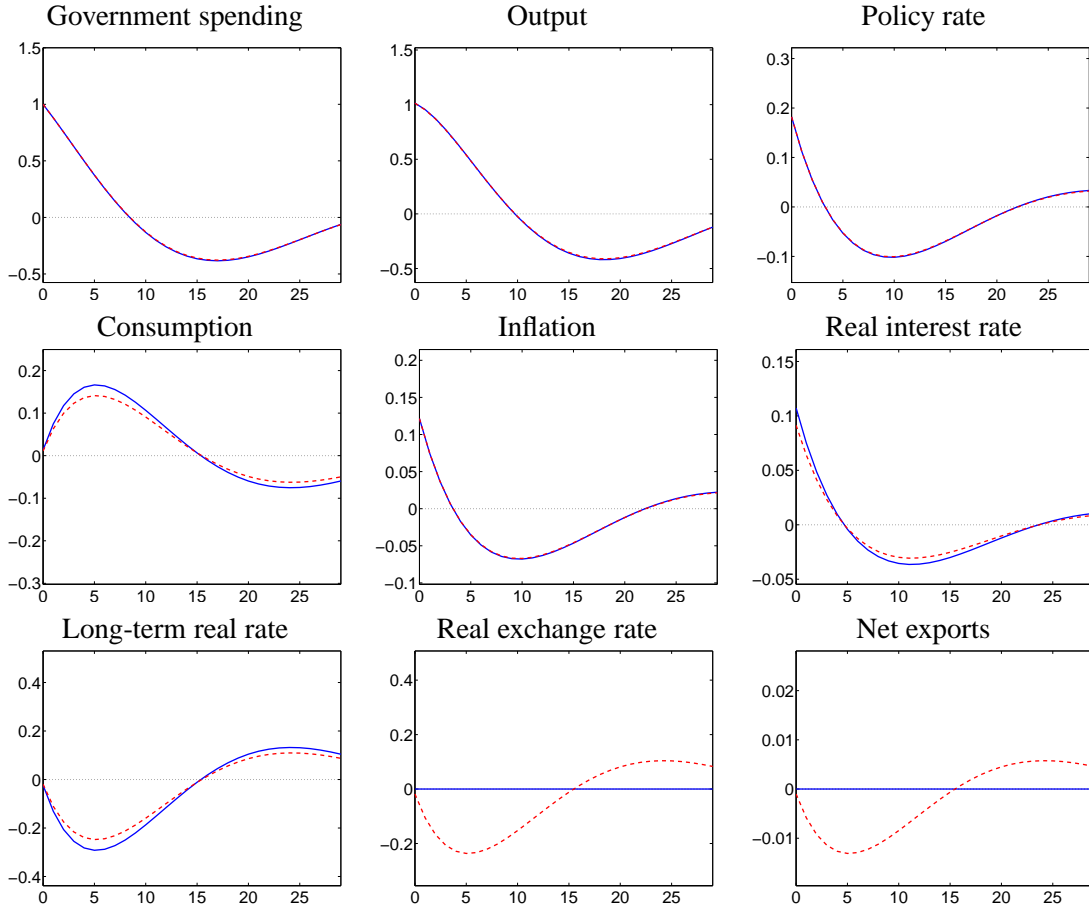


Figure 6: Effects of government spending shock in parsimonious model: closed vs open economy. Notes: solid lines denote baseline reversal scenario in a closed economy ($n = 1$); dashed lines: open economy ($n = 0.2$) version with spending reversal.

4.2 The open economy

Having analyzed the fiscal transmission mechanism in a parsimonious closed-economy setting, we now turn to the open economy dimension. For now, we maintain the relative parsimony of the model analyzed in the previous section, but introduce the open-economy dimension assuming that the domestic economy accounts for 20 percent of the world economy. Figure 6 displays the impulse responses (dashed lines). To visualize the effect of openness, the graphs also report the responses for our earlier closed-economy baseline (solid lines).

Overall, the impulse responses for the open economy are quite similar to those of the closed economy. The only detectable difference concerns consumption, which increases somewhat less on impact in the open economy. Intuitively, to the extent that domestic households consume both domestically produced and imported goods, the level of consumption fluctuates less in response to domestic shocks. Yet there are two new results. First, the lower panels of Figure 6 show the responses of the long-term

real interest rate and the real exchange rate. As foreshadowed in Section 3.2 above, the two variables move in lockstep: as the long-term real rate eases in response to the spending shock, the real exchange rate depreciates.²⁹ This result is important insofar as it replicates qualitatively the evidence from our VAR analysis in Section 2 and from other empirical studies. To be sure, the depreciation shown in Figure 6 is comparatively modest in quantitative terms. Still, the simulated response aligns more closely with the empirical evidence than standard theoretical models, which predict almost uniformly that a positive spending shock cannot but appreciate the real exchange rate.

Second, the model predicts a deterioration of net exports, together with the increase in public debt. The model thus lends support to the notion of twin deficits, often informing the policy debate, but not necessarily consistent with the evidence. Indeed, in our VAR, we do not find strong evidence of an external imbalance following a spending expansion.

5 Simulation results for full-fledged model

We are finally in a position to discuss simulation results for the fully specified model, which allows for investment dynamics and an empirically plausible specification of the interest rate feedback rule (Table 1). Results are displayed in Figure 7. We contrast responses for the endogenous spending reversal case (solid lines) with those obtained in the absence of reversals (dashed lines). In general, the results are similar to those depicted in Figures 4 and 6 above, suggesting that the mechanisms discussed above still govern the dynamic adjustment to government spending innovations in a substantially more complex model.

There are nonetheless two important differences. A first notable difference arises from the specification of monetary policy in the full model, which incorporates a response to the output gap and interest-rate smoothing. As a result of smoothing, the policy rate exhibits a hump-shaped adjustment path, which partly carries over to real interest rates, consumption, and the real exchange rate. We stress, however, that the richer and arguably more realistic specification of monetary policy does not affect our main conclusion: anticipated spending reversals do induce a decline in long-term real interest rates that coincides with a rise in consumption and a depreciation of the real exchange rate.³⁰ Second, the richer specification of our full model allows us to provide insights on the joint dynamics of investment and net exports. Specifically, we find that the initial fiscal expansion systematically crowds out investment in the short run, irrespective of what is assumed about government spending reversals. As a consequence, and in contrast to our earlier results displayed in Figure 6, net exports

²⁹The high co-movement also indicates that foreign long-term real rates are not much affected by the domestic shock. This is generally the case for foreign variables, reflecting that the domestic economy accounts for 20 percent only. Results are available on request.

³⁰Note that whether monetary policy aims to stabilize CPI rather than domestic inflation is of little quantitative importance. Results are available on request.

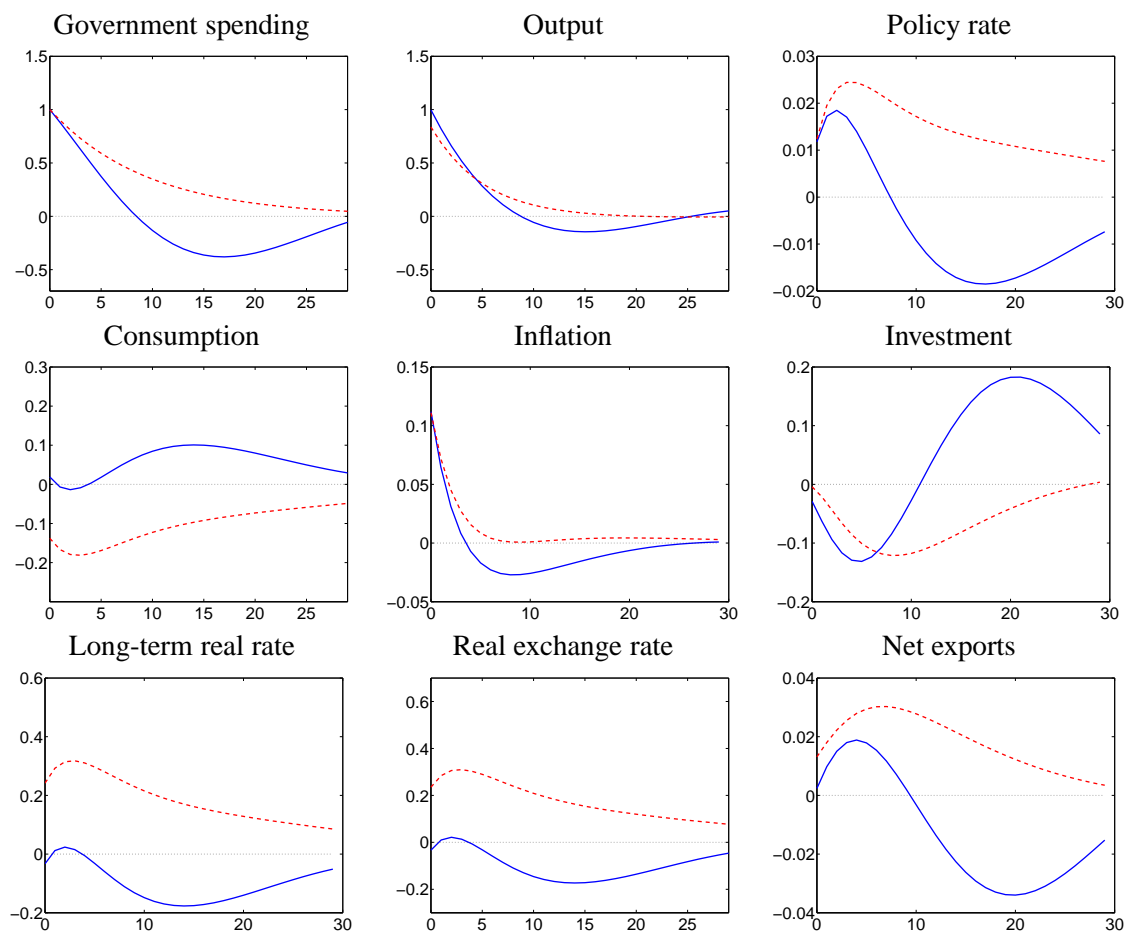


Figure 7: Effects of government spending shock in fully specified two-country model. Notes: responses are measured in deviations from steady state in units of output; solid lines: fiscal policy with spending reversal; dashed lines: no reversal.

now improve in both scenarios, although the effect is quite contained. Also in this dimension, the model's prediction of no crowding-out of net exports (along with real depreciation) accords well with the empirical evidence discussed in Section 2.³¹

6 Conclusion

This paper contributes to the ongoing debate on the short-run effects of fiscal policy by highlighting the crucial role of medium-term fiscal adjustment patterns. 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 assumption rules out the possibility that current spending increases may also be offset, at least in part, by a reduction of spending below trend levels in the future. Yet, such endogenous spending dynamics are highly plausible, given practical limits to debt accumulation and voters' resistance to ever-higher taxes. One obvious point in case is the experience of many advanced economies today, as governments curtail spending in a bid to stabilize the large debt stocks resulting from earlier stimulus policies adopted in response to the global financial crisis.

Our formal analysis shows indeed that ruling out fiscal consolidation via spending restraint is bound to miss an important aspect of the fiscal transmission mechanism. First, estimating a VAR on U.S. data, we confirm the empirical relevance of spending reversals, i.e., a tendency for government spending to fall below trend levels a few quarters after an initial increase, thus contributing to debt stabilization. Second, we find that allowing for such spending reversals alters profoundly the short-run effects of government spending innovations within an otherwise standard new Keynesian model. Specifically, expected spending reversals tend to magnify the expansionary effect of temporary government spending increases via a reduction in long-term interest rates and to induce a decline of the real exchange rate. They thereby help to align the model's predictions with the time-series evidence.

Given our focus on post-1975 US data in this paper, one interesting question for future research is to what extent spending reversals can also be found across other countries and time periods, and how their presence may relate to economic or institutional factors, such as the initial level of indebtedness. In any event, one fairly general conclusion from our study concerns the need for economic models to encompass sufficiently rich dynamics in policy adjustment. On the fiscal side, this entails, in particular, recognizing how medium-term spending and tax choices are circumscribed by the overall health of public finances—a topic on which the current experience of advanced countries is bound to provide important further lessons in the period ahead.

³¹The above results are also robust with respect to a number of variations in our setup. First, assuming that there is a distortionary income tax rather than lump-sum taxes which adjusts gradually in response to deviations of public debt from steady state hardly affects our results. Results are available on request. Second, as shown in the working paper version of this paper, assuming incomplete financial markets or limiting asset-market participation also leaves the effect of spending reversals on the fiscal transmission mechanism intact (see Corsetti et al. 2009).

A Data sources

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; investment is gross private domestic investment and personal consumption expenditures on durable goods. Net exports of goods and services are scaled by GDP. 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 T-Bill rate is the quarterly average of the monthly observations (TB3MS), both obtained from the FRED database at the St. Louis Fed. Inflation is measured as the quarterly change of the GDP deflator. Inflation and interest rates are expressed in percent per quarter. The measure of ‘defense news’ computed on the basis of the Survey of Professional Forecasters was kindly provided by Valerie Ramey.

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