FISCAL STIMULUS 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 future policy adjustment. While general equilibrium models typically restrict medium-term adjustment to taxation, we highlight the importance of government spending dynamics. First, we provide time series evidence for the United States suggesting that an exogenous increase in government spending prompts a rise in public debt, followed over time by a reduction in spending below trend. Second, we show how expected spending reversals alter the short-run impact of fiscal policy in a new Keynesian model, bringing it closer in line with the evidence.

1. Introduction

The theoretical analysis of fiscal policy has made substantial progress in the past two decades, with in-depth studies of the macroeconomic transmission of government spending in a dynamic general equilibrium context (Aiyagari, Christiano, & Eichenbaum, 1992; Baxter & King, 1993; Galí, López-Salido, & Vallés, 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 endogenously to the state of public finances or, more generally, to current economic conditions. 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 (Boivin and Giannoni, 2006). It is also at odds with 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 demonstrate the importance of such dynamics. Indeed, 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 to 2007 and identify government spending shocks using two distinct approaches, proposed by Blanchard & Perotti (2002) and Ramey (2011), respectively. A number of key results are robust across identification schemes. First, an exogenous increase in government spending causes a substantial rise in aggregate output, supported by a nonnegative response of private consumption, even as private investment tends to be crowded out—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 (2010), and Ravn, Schmitt-Grohé, and Uribe (2007). Third, and most important for the idea of this paper, we find that a positive spending shock triggers a sizable buildup of public debt, followed over time by a decline of government spending below trend.

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 government spending is systematically reduced when public debt is high, and vice versa. As such, government spending supplements the debt-stabilizing behavior of taxes. This assumption is consistent with single-equation estimates of government spending rules (Galí & Perotti, 2003; Canova & Pappa, 2004). It also squares well with political economy arguments emphasizing voters’ resistance to ever-higher taxes. Finally, there is ample evidence from ongoing fiscal consolidation efforts in advanced economies that governments rely not only on tax increases but also on spending restraint to overcome the legacy of past stimulus policies. A direct implication of allowing systematic feedback from public debt to government spending is that a temporary debt-financed increase in public demand generates expectations of future retrenchment. Yet this dimension of policy adjustment is ignored in standard analyses of the fiscal transmission mechanism, as existing studies generally assume that any increase in government spending today leads eventually to a one-for-one increase in taxes. Our reading of the empirical evidence suggests that

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

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

this assumption rules out an important aspect of intertemporal fiscal dynamics: 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 already noted fiscal rules, monetary policy is 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, 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, bolstering private consumption. We show that the strength of this financial channel depends primarily on two features of the economy: the extent of nominal rigidities and the central bank’s stance on inflation. Under a plausible parameterization, the anticipated spending reversal significantly magnifies the output multiplier effect of the initial spending increase, even though private investment declines. Lower long-term interest rates, in turn, are also associated with a weaker real exchange rate. Thus, incorporating spending reversals into a standard new Keynesian model goes some way toward accounting for the time series evidence on fiscal transmission, notably the responses of key output components and the real exchange rate to a positive spending shock.\(^5\)

We also stress that wealth effects play only a minor role in explaining our results. To be sure, spending reversals mitigate the rise in the private sector’s tax burden resulting from the up-front increase in government spending. In quantitative terms, however, this impact is very limited given the temporary nature of the original spending impulse. Instead, our results identify a first-order effect of expected consolidation measures through intertemporal prices. This marks an important difference with respect to earlier work by Bertola and Drazen (1993) and others, even though our analysis shares these authors’ emphasis on the role of expectations for fiscal policy transmission.\(^6\)

The remainder of the paper is organized as follows. Section II presents our empirical strategy and revisits the evidence on the fiscal transmission mechanism. Section III outlines our theoretical model, discusses important equilibrium relationships, and explains our parameter choices. Section IV 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 V shows results for the full-fledged model. And section VI concludes.

II. 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, we will show key findings that are robust across the identification schemes proposed by Blanchard and Perotti (2002) and Ramey (2011), 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.\(^7\) 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 the standard theoretical framework once the interaction of fiscal and monetary policy over the short and medium terms is properly accounted for.

A. VAR Specification and Identification

Our VAR model has seven variables: government spending (consumption expenditures and gross investment) and GDP, each measured in logs of real per capita amounts; measures

\(^5\)Two widely documented findings, a nonnegative consumption response and real exchange rate depreciation, have long posed a challenge for modern macroeconomic theory. While consistent with conventional Keynesian analysis, a nonnegative consumption response contradicts both the neoclassical and the standard new Keynesian model. Exchange rate depreciation is at odds not only with the recent open economy literature but also with conventional analyses drawing on the Mundell-Fleming model (see, e.g., Dornbusch, 1980). This state of affairs has guided recent attempts to amend standard theoretical models, notably by considering alternative preference specifications (Ravn et al., 2007; Monacelli & Perotti, 2008). Although these approaches hold considerable promise, they maintain common employment, but restrictive assumptions on the conduct of fiscal policy, notably the assumption of exogenous government spending. Adopting a distinct strategy here, we show that the predictions of a standard new Keynesian model can be brought in line with the evidence once medium-term fiscal dynamics are appropriately taken into account.

\(^6\)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 also Sutherland, 1997; Balduzzi, Corsetti, & Foresi, 1997; Perotti, 1999). Yet these contributions focus on expected fiscal corrections that are large enough so as to lower the overall tax burden of the private sector.

\(^7\)These 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.
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 alternate use one of the following as the seventh variable: (a) private consumption of nondurable goods and services (baseline), (b) investment, defined as the sum of fixed investment and durable consumption, and (c) the trade balance. The first 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 to 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.\(^8\)

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 (2011), who builds on the observation that the Blanchard-Perotti identification scheme might be compromised if innovations to 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, she draws on the Survey of Professional Forecasters to compute the one-quarter-ahead forecast error for government spending growth. This forecast error arguably provides a direct measure of unanticipated innovations to government spending, which Ramey includes as an additional variable in the VAR model.\(^9\) The variable is ordered first, and its dynamic effects on the remaining variables are computed by recursive estimation.\(^10\)

In the following we report results obtained under both identification strategies. First, we estimate the baseline VAR model, identify government spending shocks according to 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, reestimate the VAR model, and compute the impulse responses. In each case we normalize the size of the shock such that government spending increases by 1% of GDP on impact.\(^11\)

### B. 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 percentage deviations from its preshock level; and the responses of the long-term real interest rate and inflation are measured as deviations from the preshock 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.\(^12\) Throughout, the solid line indicates the point estimate, and the shaded area represents a 90% 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, it 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 & Leeper (2007), who also compare results between a relatively small VAR model and a more comprehensive model that includes government debt. They find government spending to be “self-correcting” in the more comprehensive VAR

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\(^8\) We exclude data beyond end-2007 because the onset of the global financial crisis may have altered the fiscal transmission mechanism profoundly (see Corsetti, Meier, & Müller, 2010). 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.

\(^9\) This approach seems particularly suited to address concerns regarding a misalignment between the information sets of private agents and econometricians that Leeper, Walker, and Yang (2009) show to result from “fiscal foresight.” In light of the results below, it is useful to note that including asset prices such as the exchange rate may also help to tackle fiscal foresight (see Leeper et al., 2009).

\(^10\) Building on earlier work by Ramey and Shapiro (1998) and Edelberg, Eichenbaum, & Fischer (1999), Ramey (2011) proposes another identification strategy centered around military news, which she argues provides 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. It thus appears that the shocks identified through such defense news differ significantly in nature or size from those identified on the basis of the Blanchard-Perotti scheme.

\(^11\) Note that a few studies have used another alternative approach to identifying fiscal shocks based on sign restrictions (see Mountford & Uhlig, 2009; Canova & Pappa, 2004, 2007; Enders et al., 2011).

\(^12\) However, the results are unaffected by the choice of this last variable.
only. This underscores the importance of controlling for debt as a state variable.\textsuperscript{13}

Output increases in a statistically significant way with an impact multiplier of about 1. 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 $1/4\%$ 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), which are based on sample periods starting in 1960. This is consistent with the findings of Perotti (2004) and Bilbiie, Meier, and Müller (2008), whereby

\textsuperscript{13}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 noninvertible as opposed to more comprehensive VAR systems which include public debt.

Next, investment is seen to decline considerably, as in Blanchard and Perotti (2002), recovering its preshock 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 (2010) find more mixed evidence.

After rising insignificantly on impact, the interest rate falls below its preshock level after about two quarters. Similar findings have been reported elsewhere in the literature but have

\textsuperscript{14}Mountford and Uhlig (2009) also find no significant response of consumption to a deficit-financed government spending shock, using a sign-restrictions approach.
long been regarded as difficult to reconcile with standard analyses of fiscal expansions. 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 by Kim and Roubini (2008), Monacelli and Perotti (2010), 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. Finally, Monacelli and Perotti (2010) have documented real depreciation after a positive government spending shock not only for the United States, but also for Australia and the United Kingdom.

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 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, 

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15 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). More recently, Laubach (2009) has investigated the relationship between long-horizon forward interest rates in the United States 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 the business cycle and 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.

16 A noteworthy exception in this literature is Beetsma, Giuliodori, and Klaasen (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.
which identifies fiscal innovations relative to earlier projections by professional forecasters. Note that our VAR model differs from Ramey’s in several respects, notably 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.\textsuperscript{17} Overall, the results from figure 2 display a high degree of similarity with the results shown in figure 1. This includes the fact that government spending falls below trend after the initial surge, even though the decline is steeper and faster under the forecast error identification scheme. The speed of this spending reversal is mirrored by the dynamics of public debt, which falls relatively quickly after the 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.

C. 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 (gray 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, that is, 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 to 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 specifications, our results also remain well in line with earlier findings for the United States. 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 government spending itself, which tends to decline below its trend value at some time after the shock. This last finding points to the relevance of spending reversals for fiscal dynamics in the United States.

III. A Theoretical Model with Spending Reversals

Standard analyses of fiscal transmission typically assume—with little attempt at justification—that the entire burden of debt stabilization is borne by taxes, whereas government spending follows some exogenous process (see, e.g., 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 response 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 (Gali & 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, regardless 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 up-front 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 (a) does not crowd out consumption, (b) exerts a stronger expansionary effect on output, and (c) depreciates the real exchange rate. Thus, our account of the transmission mechanism provides an explanation for the time series evidence presented in section II.\textsuperscript{18} The prediction of real

\textsuperscript{17} For comparison, see figure XII in Ramey (2011). Note that Ramey normalizes the initial shock to be 1% of government spending; our shock is equal to 1% 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 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).

\textsuperscript{18} To 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 & King, 1993, and Finn, 1998) or by source of short-term financing (taxes versus deficit; see Ludvigson, 1996).
exchange rate depreciation is noteworthy; it distinguishes our model not only from traditional analyses based on the Mundell-Fleming model but also from real business cycle theory (Backus, Kehoe, & Kydland, 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. In the same vein, our model generates a nonnegative consumption response in line with standard empirical findings without resorting to ad hoc features like “hand-to-mouth” consumers.

A. 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 goods producers normalized to unity. A fraction $n$ of firms is located in Home, and the remaining firms ($n, 1$) are located in Foreign. Analogously, Home accounts for a fraction $n \in [0, 1]$ of the global population. Intermediate goods are traded across borders; 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 they trade a complete set of state-contingent assets internationally. Like prices, wages are also adjusted infrequently. 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 goods firms, as well as by households; we then specify fiscal and monetary policy in terms of feedback rules and state the market clearing conditions.

**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, respectively. The final good $F_t = (F_t^*)$ is produced using the following aggregation technology,

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

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

where $\sigma$ 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.\(^{19}\)

The bundles of domestically and imported intermediate goods are defined as

$$A_t = \left[\frac{1}{n} \int_0^1 A_t(j)^{\frac{1}{1 - \xi}} dj\right]^{\frac{1}{1 - \xi}},$$

$$B_t = \left[\frac{1}{1 - n} \int_1^1 B_t(j)^{\frac{1}{1 - \xi}} dj\right]^{\frac{1}{1 - \xi}}, \quad (3)$$

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

As final goods 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 equations (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 $E_t$ 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 $P^*_t(j) = E_t P(j)$. Assuming that government consumption, $G_t$, is a bundle isomorphic to final goods but consisting of domestically produced goods only, global demand for a generic intermediate good produced in $H$ and $F$ is, respectively:

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

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

where price indices are given by

$$P_{At} = \left[\frac{1}{n} \int_0^1 P(j)^{1 - \xi} dj\right]^{\frac{1}{1 - \xi}},$$

$$P_{Bt} = \left[\frac{1}{1 - n} \int_1^1 P(j)^{1 - \xi} dj\right]^{\frac{1}{1 - \xi}}, \quad (6)$$

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

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

and $Q_t = P_tE_t/P_t^*$ measures the real exchange rate.

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

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

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: $MC_t = W_t^{1 - \sigma} R_t^{\alpha} / \alpha^2 (1 - \alpha)^{1 - \sigma}$.

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

$$
\max E_t \sum_{s=0}^{\infty} \frac{\xi_{P+1}^s P_{t+s}^D(j)}{\hat{P}_{t+s}} [\hat{P}(j) - MC_{t+s}],
$$

(10)

subject to the demand function, equation (4), and the production function, equation (9). As households own the firms, profits are discounted with $\rho_{t+1}$, which equals households' marginal rate of substitution between consumption in periods $t$ and $t+s$.

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

$$
H_t = \left( \int_0^1 H_t(h)^{1-\xi} dh \right)^{1/(1-\xi)}.
$$

(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

$$
W_t = \left( \int_0^1 W_t(h)^{1-\xi} dh \right)^{1/(1-\xi)}.
$$

(12)

Optimal bundling of differentiated labor services implies the demand function

$$
H_t(h) = \left( \frac{W_t(h)}{W_t} \right)^{1-\xi} H_t.
$$

(13)

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

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

(14)

where $\beta$ is the discount factor, $\theta$ is a constant determining labor supply in steady state, and $\psi$ is the inverse of the Frisch elasticity of labor supply.

Households own and invest in domestic capital, facing investment adjustment costs as in Christiano, Eichenbaum, and Evans (2005):

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

(15)

where $\delta$ denotes the depreciation rate. The function $\Psi$ 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 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 $\rho_{t+1}$ denoting the stochastic discount factor, the budget constraint of the household is given by

$$
W_t(h)H_t(h) + R_tK_t(h) + \gamma_t - T_t - P_t(C_t(h) + X_t(h)) = E_t[\rho_{t+1} \Xi_{t+1}(h)] - \Xi_t(h),
$$

(16)

where $T_t$ and $\gamma_t$ denote lump-sum taxes and profits of intermediate goods firms, respectively. Both are levied and distributed uniformly 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, $\Lambda_t$, a household that is allowed to reoptimize its wage sets $W_t(h)$ to meet the following objective,

$$
\max E_t \sum_{s=0}^{\infty} \beta^s \left( \Lambda_{t+s}H_{t+s}(h)W_t(h) - \frac{H_{t+s}(h)^{1+\psi}}{1+\psi} \right),
$$

(17)

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

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

$$
\frac{D_{t+1}}{1+i_t} + T_t = D_t + P_A G_t,
$$

(18)

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

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 the time subscript refer to steady-state values, we specify the following feedback rules:

$$
G_t = (1-\rho)G + \rho G_{t-1} - \Psi_G D_{Rt} + \epsilon_t, \quad T_{Rt} = \Psi_T D_{Rt},
$$

(19)

We 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 equation (14).
where \( \epsilon_t \) represents an exogenous i.i.d. shock to government spending. The \( \psi \)-parameters, which we posit to be nonnegative throughout, capture a systematic feedback effect of public debt on government spending (negative) and taxes (positive). We assume that either parameter is sufficiently large to ensure the nonexplosiveness 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 also allowing a feedback channel from debt to government spending, we obtain richer and more realistic dynamics in the model economy.

Turning to monetary policy, we assume flexible exchange rates and specify an interest rate feedback rule,

\[
\ln(1 + i_t) = \rho_i \ln(1 + i_{t-1}) + (1 - \rho_i) \times \left( \ln(1 + i) + \phi_H(E_t \Pi_{t+1} - \Pi_A) + \phi_Y \frac{E_t Y_{t+1} - Y_t}{4Y} \right),
\]

where \( \Pi_A = P_{A_t}/P_{A_{t-1}} \) 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 output from steady state.

**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 equation (4). Defining an index for aggregate output \( Y_t = \left( \int_0^1 j Y_t^{1-j} (dj) \right)^{\frac{1}{1-j}} \), we obtain

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

Factor markets clear if

\[
H_t = \int_0^n H_t(j)(dj), \quad K_t = \int_0^n K_t(j)(dj).
\]

Finally, asset markets clear by Walras’s 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 \( P_1 = P_A \).

**B. 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 highlight in this paper, by expectations about future policymaking. Optimal household behavior implies that the following Euler equation will be satisfied in equilibrium:

\[
\frac{1}{C_t} = (1 + i_t)E_t \left[ \frac{\beta_t P_1}{P_{t+1}} \frac{1}{C_{t+1}} \right].
\]

Abstracting from permanent shocks\(^{21}\) and integrating forward under our preference specification, we obtain

\[
\frac{C_t}{C_0} = \lim_{T \to \infty} \prod_{t=0}^T E_t \left[ \beta_t^{1+i_{t+1}} \Pi_{t+1+s} \right].
\]

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, e.g., Woodford, 2003).

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 up-front 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: the fact that the real exchange rate moves proportionately to the ratio of marginal utility of consumption in Home and Foreign.

Specifically, we have

\[
\kappa Q_t = C_t^* / C_t^*,
\]

where \( \kappa \) is a positive constant.\(^{22}\) 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 equation (24) with equation (25), it immediately follows that the real exchange rate is equal to the

\(^{21}\) Note that \( \lim_{s \to \infty} 1/C_{t+s} = 1/C \), that is, with complete markets, the economy always reverts back to its steady state after temporary shocks.

\(^{22}\) A detailed derivation is available on request; see also Chari, Kehoe, and McGrattan (2002).
cross-border differential in long-term real rates. Substituting for consumption and using its counterpart in Foreign, we have

\[
kQ_t = \lim_{T \to \infty} \prod_{s=0}^{T} E_t \left[ \beta_s \left( 1 + \frac{i_{t+s}}{\Pi_{t+s}} \right) \right] / \prod_{s=0}^{T} E_t \left[ \beta_s \left( 1 + \frac{i_{t+s}^F}{\Pi_{t+s}^F} \right) \right].
\]

(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 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, Meier, & Müller, 2009).

In sum, the above equilibrium relationships illustrate a key financial channel through which expectations about medium-term fiscal adjustment affect the transmission mechanism and thus the size of the short-run fiscal multiplier. The role of this channel has been underappreciated in the literature, reflecting the common assumption of exogenous government spending processes. Under this restrictive assumption, positive spending shocks typically cause a rise in long-term interest rates and real exchange rate appreciation, contrary to the time series evidence. Below we show how modeling spending dynamics in a somewhat richer fashion helps to align the model with key empirical results about fiscal transmission.

C. 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 United States (for the period 1983–2007) and estimates established by relevant earlier studies. A period in the model corresponds to one quarter. The assumption of a bond-only economy (see Corsetti, Dedola, & Leduc, 2008, for further discussion). In sum, the above equilibrium relationships illustrate a key financial channel through which expectations about medium-term fiscal adjustment affect the transmission mechanism and thus the size of the short-run fiscal multiplier. The role of this channel has been underappreciated in the literature, reflecting the common assumption of exogenous government spending processes. Under this restrictive assumption, positive spending shocks typically cause a rise in long-term interest rates and real exchange rate appreciation, contrary to the time series evidence. Below we show how modeling spending dynamics in a somewhat richer fashion helps to align the model with key empirical results about fiscal transmission.

As will become clear below, nominal rigidities play a key role in the transmission of government spending shocks with spending reversals. We assume that \( \xi_r = 0.75 \), 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, Basu, & Gottschalk (2009). For the specification of monetary policy, we rely on estimates reported by Clarida, Galí, & Gertler (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 \( \phi_n = 1.58, \phi_y = 0.14 \), and \( \phi_t = 0.91 \).

Further, we posit \( n = 0.2 \) so that the domestic economy accounts for 20% 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%. The trade price elasticity \( \sigma \) is set equal to 0.66, a value in the (admittedly wide) range considered in the recent macroeconomic literature (see Corsetti, Dedola, & Leduc, 2008, for further discussion).

The steady-state share of government spending is assumed to be 19%, corresponding to the period average. The parameter \( \rho \) 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 into 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.23 Table 1 summarizes all parameter values defining the full-fledged model.

IV. Inspecting the Transmission Mechanism: Insights from a Parsimonious Model

We now turn to model simulations to analyze the fiscal transmission mechanism. To enhance clarity, we do so in incremental steps, taking advantage of the fact that our framework nests, as special cases, benchmark models that have been prominently discussed in the literature. In this section, we confine attention to a parsimonious version of our model that serves to elucidate the basic mechanism through which spending reversals affect the real economy. An analysis of the full-fledged model is provided in section V.

23 Using 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 United States, 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 \( 1 - \psi_G - \psi_T < 0 \).
For the parsimonious version of the model, we assume that there are no investment dynamics (i.e., the capital stock is constant). We also simplify the interest rate rule, setting \( k = 0 \), and assuming that there is no interest rate smoothing \((\phi_i = 0)\), no response to the output gap \((\phi_Y = 0)\), and a conventional value for the inflation coefficient \((\phi_\pi = 1.5)\). In a first step, we let the home economy account for the entire world population \((n = 1)\). This closed-economy framework corresponds by and large to the textbook new Keynesian model (e.g., Gali, 2008). In a second step, we instead set \( n = 0.2 \), thus extending the analysis to a baseline two-country new Keynesian model (see e.g., Corsetti, Dedola, & Leduc, 2010). All other parameters remain at the values specified in table 1. Throughout, we analyze the dynamic adjustment of the economy to an exogenous increase of government spending by 1% of GDP.

### 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 alternative regimes. In one of them, there is no endogenous feedback effect on spending \((\psi_G = 0)\), so that public demand is driven by an autoregressive process and debt is stabilized exclusively through higher taxes (no spending reversal).\(^{24}\) 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 up-front 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 1% 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 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 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, private consumption declines strongly on impact before returning to steady state after about ten quarters. The impact response of output is correspondingly stronger in the reversal case, revealing a greater expansionary effect for the same up-front 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.\footnote{This 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.}

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 up-front 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% of GDP), reflecting the size of the permanent cut in government spending.\footnote{The 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).}

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 sizable fall in inflation below steady-state rates a few quarters after the initial spending shock. Disinflation induces a 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, whereas it increases persistently in the absence of endogenous spending reversals.\footnote{For the third fiscal regime, we do not display the long-term real interest rate because it is not well defined in case of permanent deviations from steady state (see section IIIB).}

- Panel for government spending
- Panel for output
- Panel for policy rate
- Panel for consumption
- Panel for inflation
- Panel for long-term real rate

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.
that prices and wages are fully flexible ($\xi_P = \xi_W = 0$). The fiscal regime, meanwhile, remains unchanged. Hence, 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 that 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 peaks when government spending reaches its trough (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 and 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 up-front 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, even in the presence of nominal rigidities, a very aggressive monetary stance, as captured by a higher inflation coefficient, would also induce an immediate rise in long-term rates and prevent the stimulative effect of anticipated spending reversals.28

The key insight from our inspection of the model so far can thus be summarized as follows: the impact of a 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 up-front 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.\textsuperscript{29}

\textbf{B. 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 notion that the domestic economy accounts for only 20\% 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 B, the two variables move in lockstep: as the long-term real rate eases in response to the spending shock, the real

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure6.png}
\caption{Effects of Government Spending Shock in Parsimonious Model: Closed versus Open Economy}
\end{figure}

\textsuperscript{29} See Woodford (2011) for a lucid analysis of the role of monetary policy in fiscal policy transmission without spending reversals.
exchange rate depreciates. This result is important insofar as it replicates qualitatively the evidence from our VAR analysis in section II 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, which tends to feature prominently in the policy debate, though it is not necessarily consistent with the available evidence. Indeed, our own VAR analysis does not suggest strong evidence of weaker external balances following an expansion of domestic public spending.

V. Simulation Results for Full-Fledged Model

We are now 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, 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-fledged model, which incorporates a

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30 The 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, given that the domestic economy accounts for 20% of global output only. Results are available on request.
response to the output gap as well as interest rate smoothing. As a result, 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 still induce a decline in long-term real interest rates that coincides with a rise in consumption and a depreciation of the real exchange rate.31

Second, the richer specification of our full model allows us to provide insights into 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 now improve in both scenarios, although the effect is quite contained. This prediction further improves the empirical relevance of our model, as the absence of twin deficits (along with real depreciation) accords well with the qualitative evidence discussed in section II.32

VI. 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 future spending restraint. 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.33

Our formal analysis confirms that endogenous spending dynamics represent an important dimension of the fiscal transmission mechanism. First, estimating a VAR on U.S. data, we document a tendency for government spending to fall below trend levels some time after an initial increase. Second, we find that allowing for such spending reversals profoundly alters the short-run effects of government spending innovations in an otherwise standard new Keynesian model. Specifically, expected spending reversals magnify the expansionary effect of temporary government spending increases through a reduction in long-term interest rates, which bolsters private consumption even as investment is crowded out. In addition, the real exchange rate falls in response to the up-front spending increase, matching a prominent qualitative result from the empirical literature. As such, spending reversals help to bring the model’s predictions more closely in line with the time series evidence.

Given our focus on post-1975 U.S. 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 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.

REFERENCES


31 Whether monetary policy aims to stabilize CPI inflation or domestic inflation proves to be of little quantitative importance. Results are available on request.

32 The above results are also robust with respect to a number of variations in our setup. First, we consider the case where lump sum taxes are replaced with a distortionary income tax that adjusts gradually in response to deviations of public debt from steady state. This change hardly affects our findings; results are available on request. Second, as shown in the working paper version of this paper (Corsetti et al., 2009), assuming incomplete financial markets or limiting asset market participation also leaves intact the effect of spending reversals on the fiscal transmission mechanism.

33 For a generalization of our analysis to the case in which monetary policy rates are at the zero lower bound in the short run, see Corsetti, Kuester, Meier, & Müller (2010).
FISCAL STIMULUS WITH SPENDING REVERSALS


APPENDIX

Data Sources

Quantity variables are obtained from the National Income and Product Accounts (NIPA) provided by the BEA and deflated with the GDP deflator. Government spending comprises consumption expenditure and gross investment; private consumption is personal consumption expenditure on nondurable 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 ten-year U.S. treasuries and a corresponding time series of ten-year-ahead inflation expectations. The latter is constructed by combining data from Blue Chip Economic Indicators (1980Q1–1991Q1), the Livingston Survey (1990Q2–1991Q2), and the Survey of Professional Forecasters was kindly provided by Valerie Ramey.