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Kirchner, M.; Cimadomo, J.; Hauptmeier, S.

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Transmission of Government Spending Shocks in the Euro Area: Time Variation and Driving Forces*

Markus Kirchner[†] Jacopo Cimadomo[‡] Sebastian Hauptmeier[§]

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Abstract

This paper applies structural vector autoregressions with time-varying parameters in order to investigate changes in the effects of government spending shocks in the euro area, and the driving forces of those changes. Our contribution is two-fold. First, we present evidence that the short-run impact of government spending on real GDP and private consumption has increased until the end-1980s but it has decreased thereafter, along with a weaker response of the real wage and a stronger response of the nominal interest rate. Moreover, spending multipliers at longer horizons have declined substantially over the period 1980-2008. Second, exploiting state dependency using second-stage inference, we show that these changes can be traced back to increasing availability of credit and rising debt-to-GDP ratios in the euro area, as well as a smaller share of government investment and a larger share of public wages in total spending.

Keywords: Government spending shocks; Fiscal transmission mechanism; Structural change; Structural vector autoregressions; Time-varying parameter models

JEL classification: C32; E62; H30; H50

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[†]University of Amsterdam, and Tinbergen Institute; address: Roetersstraat 11, 1018 WB Amsterdam, The Netherlands; tel.: +31 (0)20 525 4236; fax: +31 (0)20 525 4254; e-mail: markus.kirchner@uva.nl

[‡]European Central Bank, Fiscal Policies Division; address: Kaiserstrasse 29, 60311 Frankfurt am Main, Germany; tel.: +49 (0)69 1344 5392; fax: +49 (0)69 1344 6000; e-mail: jacopo.cimadomo@ecb.int

[§]European Central Bank, Fiscal Policies Division; address: Kaiserstrasse 29, 60311 Frankfurt am Main, Germany; tel.: +49 (0)69 1344 5092; fax: +49 (0)69 1344 6000; e-mail: sebastian.hauptmeier@ecb.int

1 Introduction

Fiscal policy has been rediscovered as a tool for short-run economic stabilization. Governments around the world have enacted unprecedented fiscal stimulus packages to counter the severe economic downturn triggered by the financial crisis. For instance, the fiscal stimulus adopted within the European Economic Recovery Plan (EERP) is expected to reach about 1% of the EU's GDP in 2009 and 0.9% in 2010, and it is largely expenditure based (see European Commission, 2009). However, there is a high degree of uncertainty concerning the macroeconomic impact of government expenditure policies. The theoretical and empirical literature on the effects of government spending shocks reflects this uncertainty and it is rather inconclusive so far, especially as regards the euro area.

Against this background, this paper offers two contributions. First, we uncover changes in the effects of government spending shocks in the euro area over the period 1980-2008 using the tools of time-varying parameters VAR (TVP-VAR) analysis.¹ Second, we provide empirical evidence on the driving forces of the observed time variation of government spending multipliers and, in a broader sense, the fiscal transmission mechanism. In particular, using regression analysis we relate spending multipliers to a set of macroeconomic indicators and to the composition of spending. The underlying idea is that time variation—caused by structural change—may reveal new facts about the macro impact of government spending shocks. To the best of our knowledge, this is the first paper which investigates time variation in the effects of government spending shocks through an application of state-of-the-art Bayesian techniques and which, in addition, provides empirical evidence on the driving factors behind the changing patterns of spending multipliers by means of a systematic exploitation of state dependency.

We focus on the euro area since sub-sample instability should be an imminent fact given significant structural changes experienced since the 1980s. Examples include the adoption of the Maastricht Treaty in 1992, the run-up to the Economic and Monetary Union (EMU), the introduction of the single currency and the single monetary policy since 1999. Such events should enhance the scope for time variation and help the identification of the driving forces of the fiscal transmission mechanism. Based on a newly available quarterly fiscal data set developed by Paredes, Pedregal, and Pérez (2009), fixed parameters VAR estimations over the full 1980-2008 sample suggest that, on average, government spending shocks have had an expansionary short-run impact and moderately contractionary long-term effects on output and the

¹These tools have been applied previously to investigate changes in the effects of monetary policy in the U.S. and the relation to the “Great Moderation” (see e.g. Cogley and Sargent, 2001, 2005; Primiceri, 2005; Benati and Mumtaz, 2007; Canova and Gambetti, 2009; Galí and Gambetti, 2009; Cogley, Primiceri, and Sargent, 2010) and the implications of structural change for macroeconomic forecasts (see D’Agostino, Gambetti, and Giannone, 2009).

components of domestic private demand in the euro area. However, our time-varying approach uncovers important changes in the macroeconomic impact of government spending shocks. In particular, short-run government spending multipliers on real GDP and private consumption have increased until the end-1980s but they have decreased thereafter. Moreover, the expansionary effects of government spending have become more short-lived over time as indicated by a substantial decrease in long-term multipliers. The contribution of spending based fiscal expansions to economic activity indeed appears to be particularly low in the current decade. In addition, we show that smaller spending multipliers coincide with a weaker response of real wages and a stronger response of the short-term nominal interest rate.

With respect to the driving forces of the fiscal transmission mechanism, our evidence points towards availability of household credit as the most important determinant of the size of contemporaneous spending multipliers. This result provides support for recent arguments suggesting that access to credit and non-Ricardian behavior by households matter for the size of fiscal multipliers. Regarding the composition of government spending, we find that a smaller share of investment expenditures and a larger wage component have led to declining short-run multipliers. Our results therefore support the view that government investment may have an additional positive aggregate supply effect in addition to the aggregate demand effect of government goods purchases. The fact that wage payments are associated with lower multipliers underpin recent arguments stating that government wage expenditures may have adverse effects in an imperfect labor market through their impact on reservation wages (see Alesina and Ardagna, 2009). Finally, we find that the level of government debt is the main determinant of the long-term effects of government spending, i.e. an increase in debt-to-GDP ratios leads to a decline in spending multipliers after five years. This result suggests that, given higher initial financing needs of euro area governments, sustained deficits after a spending shock may lead to rising concerns on the sustainability of public finances and expectations of a larger future consolidation, which depresses private demand.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes our econometric model, the estimation method, the data and the structural identification approach. Section 4 presents estimation results for both a time invariant VAR and the TVP-VAR. Section 5 discusses robustness checks on the possibility that spending shocks might be anticipated. Section 6 investigates the driving forces of the fiscal transmission mechanism. It first provides an account of existing views on the transmission mechanism and then identifies the determinants underlying the observed time variation in spending multipliers using regression analysis. Section 7 concludes.

2 Related Literature

On the theoretical side no consensus has been achieved so far concerning the impact of government spending shocks on important macroeconomic variables. General equilibrium models which are used to evaluate the effects of government spending tend to diverge in their predictions (cf. Cogan, Cwik, Taylor, and Wieland, 2009). Neoclassical models with optimizing agents and fully flexible prices typically indicate a rise in output and employment but a fall in private consumption and real wages following an exogenous increase in government goods purchases (see e.g. Baxter and King, 1993). New Keynesian sticky-price models, on the other hand, can generate an increase in real wages, depending on the monetary regime (see Linnemann and Schabert, 2003). However, basic versions of those models also tend to predict a crowding out of private consumption, unless additional features are included which dampen the negative wealth effect of a fiscal expansion. Examples include non-Ricardian consumers (Galí, López-Salido, and Vallés, 2007), imperfect substitutability between public and private consumption (Linnemann and Schabert, 2004) and small wealth effects on labor supply (Monacelli and Perotti, 2008).

On the empirical side the effects of government spending shocks are typically investigated within the structural VAR (SVAR) framework.² Alternatives include the event-study approach of Ramey and Shapiro (1998) or, more recently, Ramey (2009).³ Despite an increasing number of papers in this field, using structural VAR analysis or alternative identification methods, many open questions do remain. In particular, the effects of government spending shocks in the euro area are largely unexplored. Indeed, although fiscal policy in the euro area is still mostly a country-specific matter, the impact of fiscal policy at the euro area level is of high practical relevance for policy makers. Initiatives such as the EERP also indicate an interest in co-ordinated fiscal policy in Europe, although the impact of such actions remains uncertain.

The scarcity of empirical results for the euro area as a whole and also for euro area countries has been mainly due to the lack of quarterly fiscal data, a limitation which has been overcome recently through a newly available quarterly fiscal database for the euro area compiled by Paredes, Pedregal, and Pérez (2009). This data set, which covers the period 1980Q1-2008Q4, is coherent with official annual and quarterly national accounts data, as far as quarterly fiscal data is available from national accounts (mostly for the period 1999Q1 onwards). Based on this data set, Burriel, de Castro, Garrote, Gordo, Paredes, and Pérez (2009) show that the qualitative

²See e.g. Fatás and Mihov (2001), Blanchard and Perotti (2002), Perotti (2005), Bénassy-Quéré and Cimadomo (2006), Caldara and Kamps (2008) and Mountford and Uhlig (2009).

³Ramey and Shapiro (1998) and Ramey (2009) are concerned with the possibility that fiscal shocks might be anticipated in advance of their occurrence, which is an important challenge for the validity of SVAR results. This issue is addressed in Section 5, where we discuss several exercises related to the possible anticipation of the identified spending shocks.

responses of macroeconomic variables to fiscal shocks in a (weighted) representative euro area country compare well with results for the U.S. and previous results for some EU countries.

There is also disagreement on whether fiscal shocks, and in particular government spending increases, have lost power in stimulating economic activity over time, and if so to what extent and why. In particular, the literature lacks empirical tests of possible explanations for changing effects of government spending shocks. Blanchard and Perotti (2002) find that the size of spending multipliers on output in the U.S. varies considerably across sub-periods. Similarly, based on sub-sample or rolling-windows estimation, Perotti (2005), Bénassy-Quéré and Cimadomo (2006), Bilbiie, Meier, and Mueller (2006) and Caldara and Kamps (2008) conclude that the responses of the U.S. and of some European economies to fiscal policy shocks have become weaker in the post-1980 period. Perotti (2005) argues that relaxation of credit constraints, a stronger real interest rate response and changes in monetary policy could explain the decline in the effects of government spending on GDP and its components in OECD countries. In a general equilibrium framework, Bilbiie et al. (2006) show that the more active monetary policy in the Volcker-Greenspan period and increased asset market participation can explain declining spending multipliers in the U.S. after 1980. Overall, confronting potential explanations for changes in the effects of government spending with additional empirical evidence seems a useful extension of this literature.

3 Econometric Methodology

Our empirical approach uses the techniques of Bayesian inference. We prefer a Bayesian approach over estimation by classical statistical methods for a number of reasons. Most importantly, this approach facilitates the estimation of time variation in multivariate linear structures and stochastic volatility models. As discussed by Primiceri (2005), Bayesian methods are the natural choice for the estimation of unobserved component models of this type where the distinction between parameters and shocks is less clear than in other models. The main advantage of Bayesian techniques in this context is related to the high dimensionality of such an estimation problem. Although it would in principle be possible to write up the likelihood for the problem, it is a hard task to maximize it over a large number of parameters. By using prior information and by splitting up the original problem into a few smaller steps, Bayesian methods deal efficiently with the high dimension of the parameter space.⁴

We believe that the TVP-VAR methodology outperforms simpler methods including sub-

⁴In addition, the Bayesian approach allows for a conceptually clean way of calculating statistics of interests such as error bands for impulse responses (see Sims and Zha, 1999).

sample or rolling-windows estimation for several reasons. Most importantly, structural changes might not be easily identified a priori, or they may take the form of long-lasting or ongoing processes. In addition, fiscal multipliers might change in a non-monotonic way. Finally, dating a break and determining the size of rolling windows would have to be arbitrary to some extent. Indeed, one can think of numerous structural changes which might impact on the effectiveness of fiscal policy. A choice of sub-samples for one of them (e.g. monetary policy regime changes) is unlikely to fit another (e.g. trade integration).

3.1 Reduced-form VAR

We consider two alternative specifications of a reduced-form VAR of lag order p . The first version has fixed parameters:

$$y_t = B_1 y_{t-1} + \dots + B_p y_{t-p} + \Gamma z_t + u_t, \quad t = 1, \dots, T \quad (1)$$

where the vector y_t includes government spending, output, private consumption, the short-term interest rate and possibly other macroeconomic indicators. The B_i , $i = 1, \dots, p$, are matrices of coefficients. The vector z_t collects exogenous variables with loadings Γ . The vector of innovations u_t is assumed to be Gaussian white noise with mean zero and covariance matrix R : $u_t \sim \text{NID}(0, R)$.

In the second version of the VAR, we generalize specification (1) and allow for drifting coefficients and stochastic volatility in the innovations.⁵ Both aspects are supposed to capture structural changes such as shifts in private sector behavior and/or changes in the conduct of policy. Drifting coefficients are thought to capture changes in the propagation of shocks through the economy. Stochastic volatility is introduced in order to allow for changes in the distribution of the underlying stochastic shocks. Hence:

$$y_t = B_{1,t} y_{t-1} + \dots + B_{p,t} y_{t-p} + \Gamma_t z_t + u_t, \quad t = 1, \dots, T \quad (2)$$

where $u_t \sim \text{NID}(0, R_t)$.⁶ Stack the VAR coefficients by equations in a vector $\beta_t = \text{vec}(F_t')$, where $F_t = [B_{1,t}, \dots, B_{p,t}, \Gamma_t]$ and $\text{vec}(\cdot)$ is the column stacking operator. This state vector of

⁵Our specification of the TVP-VAR follows Cogley and Sargent (2001, 2005) and Primiceri (2005). We apply some additional restrictions on the hyperparameters which are discussed below.

⁶The fixed parameters model (1) includes an intercept and a linear-quadratic time trend in z_t in order to account for the presence of trends in real variables and the nominal interest rate. A deterministic trend becomes redundant in the TVP-VAR such that z_t in model (2) includes an intercept only.

coefficients is assumed to follow a driftless random walk:⁷

$$\beta_t = \beta_{t-1} + \varepsilon_t \quad (3)$$

where $\varepsilon_t \sim \text{NID}(0, Q)$. Further, the innovation covariance matrix can be decomposed using a triangular factorization of the form

$$R_t = A_t^{-1} H_t (A_t^{-1})' \quad (4)$$

where A_t^{-1} is lower triangular with ones on the main diagonal and H_t is diagonal. Stack the elements below the main diagonal of A_t row-wise in a vector α_t . Collect the diagonal elements of H_t in a vector h_t . Like the coefficient states, the covariance and volatility states are modeled as (geometric) random walks:⁸

$$\begin{aligned} \alpha_t &= \alpha_{t-1} + \nu_t \\ \log h_t &= \log h_{t-1} + \omega_t \end{aligned} \quad (5)$$

where $\nu_t \sim \text{NID}(0, S)$ and $\omega_t \sim \text{NID}(0, W)$. Following Primiceri (2005) both the diagonal elements and the off-diagonal elements of the reduced-form covariance matrix can drift over time, thus allowing for changes in the contemporaneous relations among the endogenous variables.

The joint distribution of shocks is postulated as $[u_t, \varepsilon_t, \nu_t, \omega_t]' \sim \text{NID}(0, V_t)$, where V_t is block diagonal with blocks R_t , Q , S and W . Notice that an unrestricted covariance matrix would drastically increase the number of parameters and complicate the estimation problem. Independence of R_t and the hyperparameters implies that innovations to the VAR parameters are uncorrelated with the VAR innovations. This assumption seems plausible since the innovations capture business cycle events, policy shocks, or measurement errors. Such short-term movements should be unrelated to long-term institutional changes and other changes in the structure of the economy, which are captured by movements in the VAR parameters. For example, the introduction of the single currency in the euro area should not have been related to technology shocks, government spending shocks, and so on.

We make the additional assumption that Q , S and W are diagonal in order to further

⁷Compared to alternative specifications such as regime switching models, the random walk specification has the advantage that it allows for smooth shifts as opposed to discrete breaks in the states of the model. Primiceri (2005) argues that regime switching models may well capture some of the rapid shifts in policy but they seem less suitable for describing changes in private sector behavior where aggregation usually smoothes most of the changes, or learning dynamics of both private agents and policy makers.

⁸Modeling volatilities and covariances separately instead of directly modeling the elements of the covariance matrix ensures that R_t is always positive definite.

reduce the dimensionality of the problem and to simplify inference. The assumption of (block) diagonality of S ensures that the rows of A_t evolve independently such that the covariance states can be estimated row by row (cf. Primiceri, 2005). Diagonality of W implies that the volatility states are independent such that the simple univariate algorithm of Jacquier, Polson, and Rossi (1994) can be applied to each element of u_t in order to estimate the volatility states. The reduction of estimated parameters resulting from the diagonality restrictions on Q and S helps to save degrees of freedom in our relatively short euro area data set.

3.2 Estimation method

Both versions of the reduced-form VAR are estimated by Bayesian methods. For the version with fixed parameters, our prior and posterior for the coefficient matrices B_i , $i = 1, \dots, p$, Γ , and the covariance matrix R belong to the Normal-Wishart family with a diffuse prior centered on OLS estimates over the full sample. For the TVP-VAR, we apply a variant of the Gibbs sampler (see Geman and Geman, 1984; Smith and Roberts, 1993).⁹ We briefly outline the main steps and refer to the Technical Annex for details on the estimation algorithm. The Gibbs sampler iterates on four steps, sampling in each step from lower dimensional conditional posteriors as opposed to the joint posterior of the whole parameter set.

(a) VAR coefficients. Conditional on the data and a history of covariance and volatility states, the observation equation (2) is linear with Gaussian innovations and a known covariance matrix. The VAR coefficients can thus be sampled using the Kalman filter and a backward recursion, as described in Carter and Kohn (1994) and Cogley and Sargent (2001).

(b) Elements of A_t . Conditional on the data and a history of coefficient and volatility states, equation (2) can be rewritten as $A_t u_t = v_t$, with $\text{cov}(v_t) = H_t$. This is a linear Gaussian state space system with independent equations, due to the (block) diagonal structure of S (see Primiceri, 2005). The algorithm of Carter and Kohn (1994) can thus be applied equation by equation to sample the elements of A_t on each row below the main diagonal.

(c) Elements of H_t . Conditional on the data and a history of coefficient and covariance states, the orthogonalized innovations v_t are observable. Given the diagonal structure of W , we sample the diagonal elements of H_t using the univariate algorithm of Jacquier, Polson, and Rossi (1994) element by element, following Cogley and Sargent (2005).

(d) Hyperparameters. Conditional on the data and the parameter states, the state innovations ε_t , ν_t and ω_t are observable. This allows to draw the hyperparameters (i.e. the elements of Q , S and W) from their respective distributions.

⁹See Cogley and Sargent (2001, 2005), Primiceri (2005), Benati and Mumtaz (2007), Galí and Gambetti (2009) and D'Agostino, Gambetti, and Giannone (2009) for applications of Gibbs sampling algorithms to TVP-VARs.

Under relatively weak regularity conditions (see Roberts and Smith, 1994) and after convergence, iterations on these steps produce a realization from the joint posterior distribution. We generate 60,000 draws from the Gibbs sampler, of which we burn the first 50,000 to let the Markov chain converge to its ergodic distribution. Of the remaining 10,000 draws, we keep every 10th draw in order to break the autocorrelation of draws.¹⁰ This leaves us with 1,000 draws from the joint posterior distribution of the model parameters. The Technical Annex investigates the convergence properties of the Markov chain, which are overall satisfactory.

We follow conventional choices in the TVP-VAR literature in the calibration of the priors. The choices made are similar as in Primiceri (2005) but we have a somewhat more conservative stance on the degrees of freedom of the prior distributions which we set to the minimum value allowed for the priors to be proper. The Technical Annex outlines the details on the calibration of the priors, and discusses the robustness of the results to alternative choices. Unlike most previous TVP-VAR studies, we do not impose a prior restriction on the VAR coefficients saying that draws which do not satisfy stationarity conditions are discarded. Cogley and Sargent (2001) have proposed such a restriction for U.S. monetary policy, the argument being that the Fed conducted monetary policy in a purposeful way thus ruling out unstable paths of inflation (see Cogley and Sargent, 2005). Such a point is harder to defend for aggregate euro area fiscal data since there may have been fiscal instability in some countries in the past. The potential downside of not imposing the stationarity conditions is that this may exaggerate the amount of time variation due to a potentially large number of unstable draws. We therefore check the robustness of the TVP-VAR results to the imposition of the stationarity conditions in the Technical Annex.

3.3 Data description

Our benchmark VAR includes government spending, i.e. government consumption plus investment expenditure, GDP, private consumption (all in real per capita terms) and the short-term nominal interest rate for the euro area covering the period 1980Q1-2008Q4. Real GDP is our measure of economic activity. Private consumption is included since it is the largest component of aggregate demand. Moreover, this allows to contribute to the ongoing discussion on the effects of government spending shocks on private consumption.¹¹ The short-term interest rate is added to this small-scale VAR in order to assess the impact of government spending shocks on interest

¹⁰The Gibbs sampler is a dependence chain algorithm. However, independent draws should be used when calculating statistics of interest such as posterior means and impulse responses.

¹¹See, for instance, Galí et al. (2007), Perotti (2007), Ramey (2009).

rates, and potential changes thereof.¹² We also investigate the impact of spending shocks on a broader set of macroeconomic indicators including real private investment, net taxes (i.e. total tax revenues minus transfers), the wage rate (all in real per capita terms) and the annual rate of change of the Harmonized Index of Consumer Prices (HICP).¹³ These variables are added all at once in the fixed parameters VAR. In the specification of the TVP-VAR we are constrained by the need to avoid overparameterization and exhausting available degrees of freedom. Therefore, the additional variables are added one at a time to the benchmark specification, which limits the number of variables in the VAR to a maximum of five indicators.

As Burriel et al. (2009), we use a newly available quarterly fiscal data set compiled by Paredes et al. (2009). They employ mixed-frequencies state space models estimated with available (mostly annual) national accounts data and monthly and quarterly fiscal information taken from government cash accounts, in order to obtain interpolated quarterly fiscal data for the above-mentioned period. By construction, the interpolated variables are coherent with official annual and quarterly aggregate euro area data, as far as quarterly fiscal data is available from national accounts. The main advantage of this data set is that it helps to avoid the endogenous bias which would arise if fiscal data interpolated on the basis of general macroeconomic indicators were used with macroeconomic variables to assess the impact of fiscal policies. Other macroeconomic data for the euro area are mainly taken from the ECB's Area-Wide Model database (Fagan et al., 2005). In order to enhance comparability with the previous literature, our data definitions closely follow related fiscal VAR studies.¹⁴ Details are provided in the Appendix. Figure 1 shows the data used in the benchmark specification. Both the fixed parameters VAR and the TVP-VAR are estimated in levels and prior to the estimation all variables except the interest rate and inflation were transformed into natural logarithms.

3.4 Structural interpretation

The reduced-form VAR attempts to capture a structural representation with uncorrelated shocks. The reduced-form innovations are therefore linear transformations of some underlying structural shocks e_t with $E[e_t e_t'] = I$, i.e.

$$u_t = C e_t, \quad t = 1, \dots, T$$

¹²Perotti (2005) argues that the long-term interest rate has a closer relation to private consumption and investment decisions than the short-term interest rate. Replacing the short-term interest rate by the long-term interest rate did however not lead to any significant changes in our results.

¹³We use the HICP based inflation rate to assess the response of inflation to spending shocks due to its close link to monetary policy decisions in the euro area.

¹⁴See, for instance, Blanchard and Perotti (2002), Perotti (2005), Caldara and Kamps (2008), Mountford and Uhlig (2009) and Burriel et al. (2009).

for the time invariant VAR and

$$u_t = C_t e_t, \quad t = 1, \dots, T$$

for the TVP-VAR. In particular, the residuals in the equation for government spending can be considered as linear combinations of three types of shocks (see Blanchard and Perotti, 2002): (1) The automatic response of spending to movements in the business cycle, prices and interest rates. (2) The systematic discretionary response of spending to macroeconomic developments. (3) Random discretionary innovations to spending, which are the truly structural government spending shocks of interest. Without restrictions on the matrices C and C_t and therefore the covariance matrices R and R_t , the above system is not identified since many combinations of structural shocks can generate the same reduced-form innovations.

In order to provide a structural interpretation, government spending shocks are identified assuming that government spending is predetermined in a system with output, consumption, the interest rate and possibly other macroeconomic variables, following Fatás and Mihov (2001).¹⁵ Thus, we estimate a recursive VAR where government spending is ordered first and the desired linear combination is achieved by a Cholesky decomposition, i.e. $R = CC'$ and $R_t = C_t C_t'$ where C and C_t are lower triangular matrices. All variables in the VAR are therefore allowed to respond contemporaneously to government spending shocks but government spending does not react within a quarter to shocks to other variables in the system. In the time invariant case, given draws from the posterior distributions of $R = CC'$ and the B_i , the first column of the matrix C then yields the contemporaneous responses (at horizon $k = 0$) of the endogenous variables to a one-time, unitary structural shock to government spending $e_0 = [1, 0, \dots, 0]'$, and model (1) with $u_k = [0, 0, \dots, 0]'$ can be used to calculate impulse responses at horizons $k \geq 1$. In the time-varying parameters case, we apply a local approximation to the impulse responses at time t , following e.g. Galí and Gambetti (2009). That is, the contemporaneous responses to unitary shocks $e_{t,0}$ at time t are derived from draws from the posterior distribution of reduced-form covariance matrices $R_t = C_t C_t'$, and the draws from the distribution of the $B_{i,t}$ are applied to calculate impulse responses at horizons $k \geq 1$, using model (2) with $u_{t,k} = 0$.

The fact that the definition of spending does not include interest payments justifies ordering spending before the interest rate. The fact that government spending is defined net of transfer payments justifies the assumption of acyclicity, i.e. there is no automatic reaction of spending

¹⁵See Caldara and Kamps (2008) for a comparative study of alternative identification methods including the recursive approach of Fatás and Mihov (2001), the identification scheme due to Blanchard and Perotti (2002), the sign restrictions approach of Mountford and Uhlig (2009) and the event-study approach of Ramey and Shapiro (1998). We compare the benchmark results to results generated using the sign restrictions approach in the Technical Annex.

to movements in the business cycle. Further, due to implementation lags in the policy process a discretionary fiscal response to a change in the economy is unlikely to occur.¹⁶ When more variables are included in the VAR, the assumption that government spending does not react within a quarter to shocks to those variables can be justified on similar grounds, i.e. spending is not affected contemporaneously by shocks originating in the private sector.¹⁷

In the context of an aggregate euro area data set, the natural question on the interpretation of aggregate fiscal shocks arises. In single-country studies, the identified spending shock is interpreted as the random discretionary component of government spending. Although fiscal policy in the euro area is still mostly a country-specific matter, a meaningful interpretation is still possible with aggregate data in terms of a weighted average of the corresponding components of country-specific policies.¹⁸ It should however be emphasized that this interpretation does not necessarily require fiscal policies to be alike, which might be a reasonable assumption for the late 1990s due to the Maastricht criteria but less so for the remainder of the sample. Instead, what is required is that a spending shock—country-specific or co-ordinated across a group of countries—is large enough to have an identifiable impact on aggregate euro area variables.

With this interpretation of aggregate fiscal shocks, our results are likely to be driven by shocks occurring in those countries which have the largest weight in euro area variables. Empirical support for this view is provided, for instance, by Bruneau and Bandt (2003) who show that, although fiscal shocks in France and Germany were uncorrelated during the period 1979-2000, euro area fiscal shocks were largely impelled by Germany especially in the 1990s. An investigation of time variation at the country level would be an important extension of the present study, but so far the usefulness of such an extension would suffer from the lack of fiscal data sets for euro area countries of sufficient quality and length.¹⁹

4 The Effects of Spending Shocks

We organize the discussion of VAR results as follows. Section 4.1 presents the results for the fixed parameters structural Bayesian VAR (BVAR), in order to give an impression of the impact

¹⁶Both assumptions are also made in the identification scheme due to Blanchard and Perotti (2002) and Perotti (2005), who use institutional information about the tax and transfer system in the identification of structural shocks.

¹⁷As mentioned above, a well-known criticism of the SVAR approach for the identification of fiscal policy shocks centers on the possibility that its estimated shocks are in reality anticipated by private agents (see Ramey, 2009; Leeper, Walker, and Yang, 2009a). This criticism is addressed in Section 5.

¹⁸In fact, several dynamic stochastic general equilibrium (DSGE) models and other quantitative models of the euro area do already explicitly account for aggregate fiscal variables and aggregate fiscal data. See, for example, Smets and Wouters (2003), Fagan, Henry, and Mestre (2005), Christoffel, Coenen, and Warne (2008), Ratto, Roeger, and in 't Veld (2009) and Forni, Monteforte, and Sessa (2009).

¹⁹The quality of a data set is interpreted here in terms of its consistency with official (annual or quarterly) national accounts data according to European System of Accounts standards updated in 1995 (i.e. ESA95 data).

of government spending shocks over the full sample. Section 4.2 presents evidence from the identified TVP-VAR on time variation in the effects of government spending shocks in the euro area.

4.1 Time invariant impulse responses

Figure 2 reports the estimated impulse responses due to the identified government spending shocks to the four endogenous variables y_t of equation (1) in the benchmark specification, together with their 16% and 84% probability bands. Following Blanchard and Perotti (2002), we report the responses of output, consumption and spending (and later on investment and net taxes) to the spending shock in terms of (non-accumulated) multipliers. That is, the original impulse responses are divided by the impact response of government spending and the result is divided by the ratio of government spending and the responding variable. The rescaled impulse responses can thus be interpreted to give the reaction of the responding variable, in percent of real GDP, to a spending shock leading to an initial increase in the level of government spending of size 1% of real GDP. For the time invariant BVAR the ratio is evaluated at the sample mean. For the TVP-VAR below we take the ratio in the respective quarter.²⁰

The government spending shock is estimated to induce a spending increase lasting about 20 quarters. The initial reaction of output is positive, the estimated response being 0.54% due to an increase in government spending of size 1% of GDP. The output response remains positive with 68% probability for 5 quarters after the shock and the point estimate turns negative after 8 quarters in order to drop to -0.34% in the medium run (13 quarters after the shock) before returning to the baseline. The spending shock also leads to a short-run crowding-in of private consumption. The point estimate of the impact multiplier is 0.24, and the response of consumption is estimated to be positive with 68% probability during 5 quarters after the shock. Similarly as for output, however, consumption is being crowded out in the medium run and the response drops to -0.22% of GDP after 15 quarters before slowly returning to its initial level. The nominal interest rate hardly responds to the spending shock on impact, but it then starts to rise and peaks at 0.23 percentage points 5 quarters after the shock. The interest rate response is estimated to be positive with 68% probability during around 3 years.

In a next step we extend the benchmark specification by a broader set of macroeconomic indicators which typically appear in fiscal VAR studies. The impulse responses from an estimated

²⁰The following example should clarify the concept. Suppose the spending shock leads to a 2% increase in government spending. Since the share of spending over GDP is roughly 25%, this corresponds to a spending increase of about 0.5% of GDP. Say output increases by 1% and consumption increases by 0.5%, i.e. by 0.25% of GDP since the share of consumption over GDP is approximately 50%. The share of spending over consumption is thus roughly 50%. The corresponding multipliers (increases in % of GDP due to a 1% of GDP increase in spending) would be calculated as $(1/2)/0.25 = 2$ for output and $(0.5/2)/0.5 = 0.5$ for consumption.

BVAR in government spending, output, consumption, investment, the real wage, net taxes, the HICP based inflation rate and the nominal interest rate are reported in Figure 3.

As a consequence of a government spending shock leading to a rise in the level of government spending of size 1% of GDP, net taxes increase by about 0.8% of GDP on impact indicating an overall fiscal expansion since the aggregate primary deficit increases. Net taxes also return more quickly to baseline than the level of spending such that the shock remains expansionary over the full horizon of the impulse response. Output again tends to rise in the short to medium run before declining below its initial level, and similarly for private consumption and investment. The responses of output and the components of private demand are however estimated with relatively little precision, compared to the benchmark VAR. The point estimates of the impact multipliers are 0.55 (output), 0.23 (consumption) and 0.03 (investment).²¹ The real wage increases by approximately 0.15% on impact and remains above its initial level during more than 12 quarters after the shock. Inflation shows a muted response in the initial two quarters but it starts to increase thereafter. Monetary policy reacts by increasing the nominal interest rate, whose response resembles that in the benchmark specification.

Overall, these results indicate that, on average over the period 1980-2008, government spending shocks have had expansionary short-term effects on output, consumption, investment and real wages in the euro area. In the medium to long run output declines as consumption and investment are being crowded out. The estimated increase in the nominal interest rate is consistent with an offsetting reaction of monetary policy to the fiscal expansion in order to reduce inflationary pressure. In general these results compare well with the results of previous SVAR studies on the euro area. In particular, they are broadly similar to those of Burriel et al. (2008), the main previous fiscal VAR study for the euro area as a whole using a similar data set. Burriel et al. (2008) also find a positive impact of government spending shocks on GDP and private consumption in the short run and a decline in the medium to long run, an increase in the aggregate primary government deficit and a relatively persistent increase in interest rates.

4.2 Uncovering time variation

The time-varying nature of model (2) allows to compute state-dependent impulse responses for each quarter in the sample. We start by examining three selected quarters at the beginning, towards the middle and at the end of the sample, i.e. 1980Q4, 1995Q4 and 2008Q4, with results

²¹Next to statistical errors, an output multiplier smaller than one combined with (marginally) positive point estimates for consumption and investment could be explained by a decline in net exports, although we have not included this variable in the VAR. This explanation is consistent with SVAR results for a panel of 14 EU countries discussed in Beetsma, Giuliodori, and Klaassen (2008), who show that the trade balance falls by 0.5% of GDP on impact due to a 1% of GDP increase in government spending.

for output, consumption and the interest rate reported in Figure 4.²² The results show that the contemporaneous responses of output and consumption are larger in the initial period. The point estimates of the impact multipliers are 0.72 (output) and 0.37 (consumption) in 1980Q4 compared to 0.42 (output) and 0.28 (consumption) in 2008Q4. Moreover, the responses of output and consumption have clearly lost persistence over time. The effect of a spending shock on output was positive during 6 to 7 quarters in 1980Q4, but only during 4 to 5 quarters in 1995Q4 and 3 to 4 quarters in 2008Q4.

The time-varying techniques thus uncover increasingly contractionary long-run consequences of the fiscal expansion. The response of GDP at a horizon of five years was -0.69% in 1980Q4, but it has declined to -1.62% in 2008Q4. A less expansionary effect on output goes along with a substantially larger medium to long term crowding out of consumption. Furthermore, while the estimated impact multipliers are positive with 68% probability in the initial period, the probability bands include the zero line at the end of the sample, whereas long-term multipliers turned significantly negative. We also note a change in the response of the nominal interest rate. The initial reaction of the interest rate to a spending shock was negative in 1980Q4, close to zero in 1995Q4, and positive in 2008Q4.

The conclusions from Figure 4 are confirmed in Figure 5, which shows state-dependent median impulse responses over the whole sample.²³ The figure reveals that the expansionary short-run effect on output and consumption peaks towards the end of the 1980s before declining until the most recent decade. Long-term multipliers have steadily declined over the observed sample. It is also obvious that the shape of the response of government spending to the spending shock has remained rather stable over time. The persistence of spending does not show any important time variation.

In Figure 6 we plot the impulse responses of all variables over time at selected horizons, i.e. the contemporaneous responses, the responses after one year and the responses after five years. The impact multiplier on output was slightly below one in the period 1980-1985, it increased above one in the period 1985-1990, and it then decreased to values below 0.5 until 2008. At a horizon of five years the multipliers on output and consumption tend to have declined substantially from values between -0.7 and -1 in the 1980s to values between -1.4 and -1.7 in the recent decade. In general the output multiplier follows the movements of the multiplier on private consumption. The initial reaction of the interest rate was negative until around 1999-2002, and it turned positive afterwards. The medium to long run response of the interest rate

²²As in the time invariant case, shocks are normalized to lead to an initial increase in the level of spending of size 1% of GDP at each point of time.

²³Only the fourth-quarter response in each year is reported such that the first impulse response reported refers to 1980Q4 while the last one refers to 2008Q4.

has also increased over time. A stronger response of the nominal interest rate thus seems to have contributed to the observed decline in spending multipliers.

In order to test differences in the above responses over time, we compute the joint pairwise distributions of impulse responses at two selected horizons.²⁴ That is, in Figure 7 (sorted) draws from the posterior distribution of output and consumption multipliers and the interest rate response in 1980Q4 are plotted against draws for 2008Q4.²⁵ The responses on impact and the one-year and five-year responses are reported. Each point in the respective panels represents a draw from the joint distribution for 1980Q4 and 2008Q4. Thus, combinations near the 45 degree line represent pairs for which there was little or no change over time and those above (below) the 45 degree line are pairs where the response of the respective variable has increased (decreased). The lower tails of the distributions of the output and consumption multipliers have shifted downwards significantly, especially at longer horizons, whereas the upper tails appear comparably stable. Therefore, the median estimates have shifted downwards as well. With respect to the interest rate, both time variation in its impact response and the response after five years turn out to be important.

We also investigate time variation in the effects of government spending shocks on a broader set of macroeconomic indicators, adding one at a time private investment, net taxes, the real wage and the HICP based inflation rate to the estimated VAR. Figure 8 shows the estimated state-dependent median impulse responses. We observe a small positive short-term effect on private investment and a medium to long-term crowding out. Similarly as the multipliers on output and consumption, the multiplier on private investment was larger in the first part of the sample. Yet the decline in the estimated multiplier has started to take place somewhat later after the year 2000. The reaction of net taxes to government spending shocks has remained comparably stable over time, and throughout the response is smaller than 1% of GDP indicating that the primary deficit has always increased due to the spending shock. A smaller overall fiscal expansion can thus not hold as an explanation for smaller spending multipliers.

The response of the real wage is estimated to be positive for several quarters after the shock throughout the sample, but it shows a larger initial reaction and a more persistent response in the first part of the sample, towards the end-1980s. The initial response of inflation was close to zero throughout, but we observe a stronger medium-term response during the 1980s and most of the 1990s. Since the nominal interest rate reacts more strongly to government spending shocks, this result implies that the real interest rate response has tended to increase over time. Agents

²⁴A similar exercise is implemented in Cogley et al. (2010).

²⁵There are many alternative pairs of quarters to choose from, but the results reported below are not particularly sensitive to this choice, as long as the periods used are sufficiently distant from each other.

save more and consume and invest less such that private demand decreases. Firms respond by decreasing output. If prices are sticky, real wages tend to increase after an expansionary spending shock but, given a weaker response of private demand, they have done so less in more recent times. Disposable income would therefore respond less strongly and, especially if liquidity constraints play a role, consumers would tend to consume less which reinforces the negative effect on private demand. This and other possible explanations of the observed time variation in spending multipliers will be addressed further in Section 6.

5 Robustness: Anticipation Effects

An important criticism of the SVAR approach for identifying fiscal shocks centers on the fact that this approach often yields qualitatively different results for the U.S. than the event-study approach of Ramey and Shapiro (1998), which builds on military episodes in order to identify exogenous spending shocks. SVAR studies often find a rise in consumption and real wages whereas the military events approach usually predicts the opposite. Ramey (2009) points out that these differences can be traced back to differences in the timing with which news about spending increases arrives, if such spending increases are anticipated in advance of their implementation.

The challenge posed by fiscal anticipation effects to SVAR methods is that they may not only mismeasure the timing of shocks but their moving average representation may have non-fundamental roots such that structural fiscal shocks cannot be recovered from past fiscal data (see Leeper, Walker, and Yang, 2009a). However, an event-study approach is difficult to apply in the context of the euro area since comparably large and easily identified (military or other) spending increases as in the U.S. have been absent over the observed sample.²⁶ Instead, in order to check the potential influence of anticipation effects, this section presents evidence from two robustness exercises. Section 5.1 discusses results produced on lower frequency data, since anticipation effects should in principle play a smaller role at longer horizons. In addition, Section 5.2 confronts the SVAR shocks with macroeconomic forecasts, to see whether the identified shocks are potentially predictable.²⁷

²⁶Other alternatives to SVAR methods include an approach based on flipping non-fundamental roots using Blaschke matrices suggested by Mertens and Ravn (2009) and a DSGE model based approach suggested by Kriwoluzky (2009) who estimates a vector moving average model in order to circumvent the issue of non-invertibility.

²⁷Additional robustness checks on the TVP-VAR results are provided in the Technical Annex, i.e. (i) application of an alternative sign restrictions identification approach, (ii) imposing stationarity conditions on the time-varying coefficients, (iii) using an alternative training sample to initialize the priors and (iv) reduction of the scaling factors which parameterize the priors on the shocks in the state equations.

5.1 Lower frequency data

The fixed parameters SVAR exercise is repeated using bi-annual and annual data, following e.g. Perotti (2007) and Beetsma, Giuliodori, and Klaassen (2008).²⁸ The idea is that, if changes in government spending are mostly anticipated by one or two quarters, then the estimated shocks are more likely to be unanticipated over a horizon of two or four quarters. As emphasized by Perotti (2007), the downside is that the recursive identification approach relies on decision lags in order to identify exogenous shocks, i.e. government spending does not respond to macroeconomic news within a quarter. This identifying assumption is less plausible with lower frequency data. However, if government spending is used as a countercyclical tool, the recursive approach would then impart a *negative* bias in the estimated responses of output and consumption.²⁹

Figures 9 and 10 show that the (time invariant) SVAR results with bi-annual and annual data closely resemble the results for quarterly data reported in Figure 2.³⁰ Most importantly, in both cases the (impact) response of consumption is positive at the 68% probability level. The main dynamics are also similar as with quarterly data, although the impulse responses are estimated with less precision as a consequence of the reduced number of observations. The results are thus broadly robust to the use of lower frequency data, which suggests that anticipation effects should not affect our main conclusions, if anticipation typically occurs within the year.

5.2 Forecast data

As an additional check of whether anticipation effects could affect our results, if anticipation horizons are longer than a few quarters, we provide results from a similar exercise as in Ramey (2009). Performing Granger causality tests for real federal government spending in the U.S. and professional forecasts thereof, she shows that SVAR spending shocks are forecastable.³¹ In particular, the SVAR shocks are Granger-caused by forecasts made one to four quarters earlier. This evidence suggests that, due to the forecastability of shocks to U.S. defense spending and other (notable) federal spending projects, SVAR shocks would not capture the “true” shocks with respect to the available macroeconomic information.

Based on forecast data for the euro area, we thus perform Granger causality tests between various variables conveying information about the future, i.e. policy actions and macro developments, and the time series of SVAR based spending shocks from Section 5.1. We use both

²⁸We do not repeat the TVP-VAR estimation here since the use of lower frequency data would reduce the sample size too drastically for such an exercise.

²⁹Beetsma et al. (2008) provide extensive validity checks of the assumption that government spending does not react within a year to unexpected output shocks.

³⁰The VAR specification adopted here is identical to the benchmark specification from Section 4.1.

³¹Similarly to the approach adopted here, Ramey (2009) identifies SVAR spending shocks by a Choleski decomposition in which government spending is ordered first.

survey data obtained from Consensus Economics, as in Ramey (2009), and publicly available short-term forecasts produced by the European Commission. The Consensus data summarizes the predictions of professional forecasters (mostly banks and other financial institutions), and should therefore be closely related to market participants' expectations on future macroeconomic developments. The European Commission forecasts do not directly reflect such expectations and they are somewhat less detailed, but they cover a longer period than the survey data, which increases the power of the Granger tests.³² Given these facts, we decided to use both data sets although they do imply different forecasts.

Figure 11 shows the identified shocks together with the annual growth rate of government spending. Figure 12 shows the ratio of the aggregate euro area government budget deficit over GDP and annual real GDP growth over the period 1982-2006, as well as the European Commission's autumn forecasts from the previous year. Figure 13 shows the real annual growth rates of the aggregate government budget deficit, GDP, private consumption and the short-term nominal interest rate over the period 1992-2008, as well as the corresponding one-year ahead mean predictions of professional forecasters made in the previous year, in terms of the Consensus Economics surveys. For years for which no aggregate forecasts were available, such forecasts were constructed from individual country forecasts using as weights constant GDP at market prices for 1995, consistent with the methodology adopted in the construction of the Area-Wide Model database. Further details on data definitions are provided in the Appendix.

The results of the Granger causality tests are reported in Table 1. Following Ramey (2009), the SVAR shock in period t is regressed on a constant, its own lag and various forecasts made in period $t - 1$ for period t .³³ In each case, the null hypothesis is that the forecasts do not Granger-cause the SVAR shocks.³⁴ The first panel of Table 1 shows that the null hypothesis cannot be rejected for any of the European Commission's forecasts in isolation, on the deficit-to-GDP ratio and real GDP growth, and also not if both forecasts are included as right-hand side variables. Similarly, the second panel shows that the null hypothesis cannot be rejected for the professional forecasts on the growth rates of the budget deficit, GDP and private consumption, and the short-term interest rate.

As an additional test, we check whether the Commission's forecasts on the deficit-to-GDP

³²The European Commission provides forecasts in November of every year for the following year since the 1970s for a number of European countries. See Melander, Sismanidis, and Grenouilleau (2007) for details. Consensus Economics provides monthly forecasts from 1990 onwards, for the year 1991. Forecasts on the budget deficit are only available from 1993 onwards, for the year 1994.

³³The results are robust to the use of additional lagged values of the left-hand side and/or the right-hand side variables, as well as the addition of the period t variables (and their lagged values) which are included in the VAR on the right-hand side.

³⁴In this form, the Granger causality test is identical to an F-test of the null hypothesis that the unrestricted model, which includes the forecasts, does not provide a better fit than the restricted model, which excludes the forecasts.

ratio and professional forecasts on the budget deficit Granger-cause realized spending growth. This is the case for the Commission’s forecasts, where we do reject the null hypothesis with 5% significance, but not the professional forecasts. The professional forecaster’s predictions—which to our knowledge is the best available information on macroeconomic expectations—thus have no significant information content on actual (and identified) spending changes. In addition, although the Commission’s forecasts do predict realized spending, indicating sufficient power of the Granger test, they do not predict the SVAR spending shocks. Overall, this exercise does not provide strong reasons to cast doubt on the validity of the identification approach due to possible anticipation effects, in the context of the present study.

6 The Fiscal Transmission Mechanism

This section exploits the results obtained in the previous step with the aim of providing empirical evidence on the determinants of the effects of fiscal policy in the euro area. Section 6.1 summarizes existing views on the fiscal transmission mechanism, focusing on (i) the level of government debt, (ii) asset market participation and credit availability, (iii) the degree of trade openness, (iv) the share of government investment in total spending and (v) the wage component of total spending. Section 6.2 relates these factors to the estimated spending multipliers using regression analysis. We chose not to set up a structural model in order to connect our results to specific theories a priori. Instead, the exercise in this section is thought to identify patterns in the data which could help to discriminate among several alternative theories of the fiscal transmission mechanism which are discussed below.

6.1 Views on the transmission mechanism

(i) Government debt. Experience from past fiscal consolidations suggests the possibility that in times of fiscal stress an economy’s response to fiscal shocks changes. That is, positive consumption growth was observed after prolonged and substantial deficit cuts. This is the hypothesis of “expansionary fiscal contractions” brought about by Giavazzi and Pagano (1990).³⁵ For a panel of 19 OECD countries, Perotti (1999) finds that the effect of spending shocks on consumption can be positive if the initial financing needs of the government are small, arguing that this outcome is due to the convexity of tax distortions: a (larger) expected increase in taxation tomorrow causes a (larger) decline in wealth and a (larger) fall in consumption today.

³⁵See also Giavazzi, Jappelli, and Pagano (2000). Giavazzi and Pagano (1990) study episodes of large fiscal consolidations in Denmark during 1983-1986 and in Ireland during 1987-1989. In these episodes the cyclically adjusted deficit as a share of GDP declined by 9.5% and 7.2% relative to the preconsolidation year and yet private consumption increased by 17.7% and 14.5% cumulatively. Alesina and Perotti (1996) identify similar episodes in several other European countries and Canada during the 1980s.

(ii) Credit. In standard general equilibrium models, expansionary spending shocks tend to generate a crowding out of private consumption. The reason is the negative wealth effect induced by higher future tax payments, which increases consumer saving due to the consumption smoothing objective. However, credit constraints and limited asset market participation may dampen this effect. For example, Galí et al. (2007) show that a government spending shock can generate an increase in aggregate consumption in a New Keynesian model conditional on having a relatively large fraction of liquidity constrained consumers. In addition, it has recently been argued that fiscal stabilization policy may be more effective during recessions, since credit constraints might then bind across a wider range of agents. Roeger and in 't Veld (2009) allow for credit constrained households along the lines of the financial accelerator literature, thus allowing the stringency of credit constraints to vary over the cycle, and show that fiscal stabilization policy becomes more effective since the propensity to consume out of current income increases during recessions.³⁶

(iii) Openness. It is often claimed that fiscal multipliers depend on the degree of openness to trade.³⁷ In very open economies, domestic output will remain largely unaffected by a fiscal expansion since a large fraction of the intended stimulus falls on imports.³⁸ With respect to time variation in fiscal multipliers, the effects of an increase in spending on GDP are then expected to be smaller the higher the degree of openness. Below we use the import share as a proxy for the degree of openness since imports are the relevant channel through which openness to trade should affect fiscal multipliers.

(iv) Government investment. Although not all empirical studies find a growth-enhancing effect of public capital, there is now more consensus than in the past that public capital furthers economic growth.³⁹ A corresponding change in the composition of spending may therefore contribute to changing spending multipliers. General equilibrium models which account for public capital typically predict that increases in government investment can generate larger fiscal multipliers than increases in government consumption, due to the beneficial aggregate supply effect of productive public capital.⁴⁰ On the other hand, Leeper, Walker, and Yang (2009b)

³⁶Tagkalakis (2008) provides empirical evidence for asymmetric effects of fiscal policy for a panel of nineteen OECD countries over the period 1970-2002. He shows that a spending shock has a larger effect on private consumption in downturns than in upturns.

³⁷See, for instance, Perotti (2005) who however argues that the increase in openness is probably too small to account for the decline in spending multipliers in OECD economies.

³⁸For instance, Beetsma, Giuliodori, and Klaassen (2008) show that a 1% of GDP increase in public spending in the EU leads to a fall of the trade balance by 0.5% of GDP on impact and a peak fall of 0.8% of GDP.

³⁹See Romp and de Haan (2007) for a survey of empirical studies on the link between public capital and economic growth.

⁴⁰See, for instance, Baxter and King (1993), Pappa (2005) and Straub and Tchakarov (2007).

have recently provided evidence that government investment projects in the U.S. are subject to substantial implementation lags. Private investment and employment are then postponed until the public capital is on line, leading to a smaller or negative short-term multipliers.

(v) Wage component. More than half of government consumption in the euro area consists of wage payments to government employees, whereas less than half consists of goods purchases. Several studies emphasize that this distinction matters when assessing the impact of spending shocks on the macroeconomy. For example, Finn (1998) shows that in a neoclassical model government employment shocks raise the real wage and thus act as a transfer to households, which dampens the wealth effects on consumption and labor supply.⁴¹ Using SVAR analysis, Perotti (2007) shows that employment shocks in the U.S. have larger effects on output and private consumption than goods spending shocks. In addition, in an imperfect labor market a decrease in government employment reduces job finding probabilities, and a decrease in government wages decreases incomes of workers in the public sector. In both cases, reservation utilities and wages demanded for private sector workers decrease, increasing profits, investment and competitiveness (see Alesina and Ardagna, 2009).

6.2 Driving forces of time variation

Several testable hypotheses can be derived from Section 6.1. First, the effects of spending shocks on output and consumption are expected to be smaller the higher the initial debt-to-GDP ratio. Second, spending multipliers can be higher if households are more restricted in their access to credit, or if actual output is below potential output. Third, a higher share of imports over GDP is expected to lead to smaller spending multipliers. Fourth, a higher government investment share can lead to higher spending multipliers but if implementation lags play a role short-term multipliers can be smaller. Fifth, a higher wage share can result in larger or smaller effects on economic activity depending on the degree of labor market competitiveness.

The above hypotheses are addressed by means of regression analysis. We apply Bayesian linear regressions, using the estimated time-varying spending multipliers on output and consumption as dependent variables.⁴² We distinguish both short-run effects on contemporaneous multipliers and long-term effects on multipliers after five years. Further, since the dependent

⁴¹Pappa (2005) demonstrates that government employment shocks have similar effects in a New Keynesian model.

⁴²We specify diffuse normal priors with mean zero and standard deviation 10^6 for the regression coefficients. In all regressions we control for a constant and a linear trend, in order to address potential concerns of spurious causation. Using a linear-quadratic trend instead of a linear trend did not lead to significant changes in the results reported below. We furthermore account for the possible presence of heteroskedastic disturbances using diffuse priors on the variance terms. The regressions are estimated using a Gibbs sampling algorithm with 1,100 draws dropping the first 100 draws, see Geweke (1993) for details.

variables are themselves estimated parameters, the standard errors of the regression coefficients are adjusted in order to account for the uncertainty in the dependent variables. Not doing so might give a biased view on the importance of the restrictions implied by the explanatory variables and artificially produce significant effects even when the “true” ones are negligible (see Canova and Pappa, 2006). This issue is addressed by using each of 1,000 posterior draws of multipliers from the identified TVP-VAR in turn as dependent variable. We then generate 1,100 draws of regression coefficients by Gibbs sampling and omit the first 100 draws for each regression. This leaves us with 1,000,000 posterior draws from the posterior distribution of regression coefficients, conditional on the full posterior distribution of estimated multipliers, from which we compute means and posterior probabilities.⁴³

Figure 14 shows the explanatory variables used in the regression analysis. The lagged aggregate euro area debt-to-GDP ratio is used to measure the initial financing needs of euro area governments. Availability of credit is measured by the lagged ratio of credit to households over GDP. The state of the business cycle is approximated by the lagged HP-filtered output gap. Lagged values are used to address potential reverse causation from spending multipliers on output and the business cycle. The ratio of imports over GDP (in lagged terms) is used to assess the impact of changes in the degree of openness. Finally, we include the contemporaneous shares of government investment and employee compensation over total spending in order to assess the impact of changes in the composition of spending.⁴⁴ The results for contemporaneous multipliers and long-term spending multipliers, respectively, are reported in Tables 2 and 3.⁴⁵

The results in Table 2 show that, on average, an increase in the ratio of government debt over GDP has a negative but small effect on short-term multipliers. On the other hand, a rise in the credit ratio is estimated to have a larger impact, a one percentage point increase leading on average to a decline in the spending multiplier on output (consumption) between 0.04 and 0.06 points (between 0.02 and 0.04 points). The credit ratio has increased from 30% in 1980 to almost 60% in 2008, such that increasing credit availability is estimated to have contributed substantially to the estimated decline in contemporaneous multipliers. The output gap enters with a positive sign, whereas a rise in the import share is estimated to have a negative but mostly insignificant effect on the size of spending multipliers. The estimated impact of an increase in the share of government investment in total spending is positive whereas an increase in the share

⁴³Regression results which were produced without the standard error adjustment are documented in the Technical Annex.

⁴⁴The debt-to-GDP ratio and imports are taken from the Area-Wide Model database and consumer credit figures were obtained from the Bank of International Settlements macroeconomic series. Spending items are provided in disaggregated form in the Paredes et al. (2009) data set. See the Appendix for details.

⁴⁵The point estimates of the regression coefficients are the means of their posterior distribution. The statistical significance of the regression coefficients is measured in terms of the posterior probability that they are non-positive (non-negative) if their point estimates are positive (negative).

of wage payments in total spending leads to a decline in spending multipliers. In the largest regression model for the output (consumption) multiplier, a unitary increase of the investment share is estimated to cause an average increase in the multiplier by 0.07 points (0.04 points). A unitary increase in the wage share leads to a decrease in the multiplier by 0.04 points (0.03 points).

The evidence presented in Table 3, on the other hand, suggests that the ratio of government debt over GDP is the main driving force of long-term multipliers. For both output and consumption, a one percentage point increase in the debt ratio leads on average to a decline by 0.01 points in the associated multipliers, the effect being negative with at least 95% probability in all regression models. The coefficients on some of the remaining variables do have the expected signs, but none of them are different from zero with more than 90% probability.

To summarize, the second-stage regressions indicate that (i) the level of government debt has an adverse impact on the size of spending multipliers in the long run whereas its short-term impact is less important. (ii) The ratio of credit over GDP is the main driving force of the observed time variation in contemporaneous spending multipliers. However, this effect does not feed through to a higher effect of government spending on output or consumption during recessions. The output gap has the expected negative effect on spending multipliers in the long run, but this effect is not significant. (iii) The degree of openness—measured by the share of imports over GDP—does not seem to be an important driving force of spending multipliers. With respect to compositional effects, (iv) a higher share of government investment in total spending has a positive effect on the size of short-term spending multipliers. Finally, (v) a larger wage component of government spending leads to smaller short-term spending multipliers.

7 Conclusions

This paper has estimated vector autoregressions with drifting coefficients and stochastic volatility for the euro area, with the aim of investigating changes in the effects of government spending shocks over the period 1980-2008 and, based on second-stage inference, revealing the driving forces of the fiscal transmission mechanism.

Our results indicate that—despite a stable total fiscal impulse—the effectiveness of spending shocks in stimulating economic activity has decreased over time. Short-run spending multipliers increased until the late 1980s when they reached values above unity, but they started to decline afterwards to values closer to 0.5 in the current decade. Long-term multipliers show a more than two-fold decline since the 1980s. These results suggest that other components of aggregate demand are increasingly being crowded out by spending based fiscal expansions. In particular,

the response of private consumption to government spending shocks has become substantially weaker over time. We also document a weaker response of real wages, whereas the nominal interest rate shows a stronger reaction.

With respect to the driving forces of time variation, our evidence points towards availability of credit as one of the main determinants of short-term spending multipliers. This finding lends empirical support to the view that access to credit matters for the effectiveness of discretionary fiscal stimulus. The result that real wages show a weaker response to spending shocks seems also consistent with this view. Furthermore, a lower share of government investment and a larger wage component in total spending may have contributed to the observed decline in short-term multipliers. These findings support the argument that government investment may have an additional positive aggregate supply effect in addition to the aggregate demand effect of government goods purchases. However, implementation lags do not seem to affect the size of spending multipliers since in that case we would expect a smaller short-term impact and larger long-term effects. The negative effect of wage payments on spending multipliers is consistent with arguments on the potential adverse consequences of increases in government employment and wages in an imperfect labor market.

Finally, our results suggest that rising government debt is the main reason for declining spending multipliers at longer horizons, and thus increasingly negative long-run consequences of fiscal expansions. We interpret this finding as an indication that further accumulating debt after a spending shock leads to rising concerns on the sustainability of public finances, such that agents may expect a larger fiscal consolidation in the future which depresses private demand and output. We also find that a stronger response of the short-term nominal interest rate goes along with declining spending multipliers. This result is consistent with an increasingly offsetting reaction of monetary policy to the expansionary fiscal shock.

An interesting direction for future research would be to investigate the cross-country dimension of time variation in fiscal multipliers, when and where fiscal data sets of sufficient quality and length are available. Such an investigation would contribute to the present study by adding variation in fiscal multipliers as well as explanatory variables and facilitate the identification of the factors which determine the effectiveness of fiscal policy, from an empirical point of view. In addition, it would be interesting to address some of our findings in a structural model of the euro area in order to tightly connect our results to specific theories, thus helping to further enhance our understanding of the fiscal transmission mechanism.

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Appendix: Data Definitions

This appendix provides details on data definitions used in the main text. Throughout, AWM refers to the Area-Wide Model database (Fagan et al., 2005), BIS to the Bank of International Settlements macro-economic series, CE to the Consensus Economics survey data, EC to the European Commission forecasts and PPP to the data set provided by Paredes et al. (2009), to which we refer for details on the construction of the fiscal variables. All quarterly series are provided in seasonally adjusted terms from the original sources, except for the HICP of which we take annual differences.

- *Government spending*: Sum of nominal general government final consumption expenditure (variable GCN in PPP) and nominal general government investment (variable GIN in PPP), euro area aggregates, scaled by GDP deflator plus labor force and transformed into natural logarithms.
- *GDP*: Aggregate euro area real gross domestic product, variable YER in the AWM database, where it is calculated as a weighted average of national variables. The original source of GDP and its components in AWM is Eurostat; the variables are then re-scaled to the ECU-euro corrected level of 1995 and backdated with rates of growth of the original AWM series.⁴⁶
- *Private consumption*: Aggregate euro area private consumption, constructed by multiplying real private consumption (variable PCR in AWM) times the private consumption deflator (variable PCD in AWM), divided by GDP deflator plus labor force and transformed into natural logarithms.
- *Interest rate*: Weighted euro area short-term nominal interest rate, variable STN in AWM, where it is calculated as a weighted average of national variables taken from the ECB Monthly Bulletin and backdated with the corresponding series contained in the original database (source: Bank of International Settlements and European Commission’s AMECO database).
- *Private investment*: Aggregate euro area total economy gross investment minus general government government investment (nominals), scaled by GDP deflator plus labor force and transformed into natural logarithms. Total economy investment corresponds to the variable ITR in AWM, government investment is the variable GIN in PPP.
- *Wage rate*: Nominal hourly wage per head (variable WRN in AWM) divided by GDP deflator. The nominal wage in AWM is calculated as a weighted average of national variables.
- *Net taxes*: Non-interest nominal general government revenue (variable TOR in PPP) minus transfers, which include all expenditure items except government consumption, government investment and interest payments (variable INP in PPP), scaled by GDP deflator plus labor force and transformed into natural logarithms. The general government primary balance is therefore the difference between net taxes and government spending.
- *Inflation rate*: Annual rate of change of the Harmonized Index of Consumer Prices, i.e. variable HICP in AWM, where it is calculated as a weighted average of national variables using 1995 HICP weights.

⁴⁶The weights used in AWM are based on constant GDP at market prices for the euro area for 1995.

- *GDP deflator*: Index with base year 1995, variable YED in AWM. Deflators in AWM are taken directly from the corresponding ECB Monthly Bulletin series, which are compiled by ECB staff as a weighted average of the national deflators using purchasing power parity adjusted weights.
- *Labor force*: Total euro area labor force, persons, variable LFN in AWM.⁴⁷
- *Debt-to-GDP ratio*: Ratio of the outstanding (end-of-period) aggregate euro area stock of nominal public debt over nominal annual euro area GDP, variable GDN.YEN in AWM.
- *Imports-to-GDP ratio*: Ratio of nominal quarterly aggregate euro area imports (variable MTR times MTD in AWM) over nominal quarterly euro area GDP.
- *Credit to households over GDP*: Outstanding total euro area (end-of-period) stock of bank loans to households, variable BISM.Q.COVA.XM.03 in BIS, divided by the sum of nominal euro area GDP of the last four consecutive quarters.
- *Government budget deficit-to-GDP ratio, forecast (EC)*: (Minus) general government balance as percentage of GDP, one-year ahead forecasts by EC published in November of the previous year. Forecasts for the euro area are available from 1999 onwards; for previous years up to 1982, aggregate forecasts are constructed from forecasts for Belgium, France, Germany, Greece, Ireland, Italy, Luxembourg and the Netherlands by aggregating the individual country series using as weights constant GDP at market prices for 1995.
- *GDP growth, forecast (EC)*: Annual real GDP growth rate, one-year ahead forecasts by EC published in November of the previous year. Forecasts for the euro area are only available from 1999 onwards; for previous years up to 1982, aggregate forecasts are constructed as described above.
- *Government budget deficit growth, forecast (CE)*: Consensus mean forecast of (minus) the general government budget balance, converted into growth rates, minus the Consensus mean forecast of consumer price inflation. Both forecasts are computed as the average of one-year ahead forecasts made in each month of the previous year. Forecasts for the euro area are available from 2003 onwards; for previous years up to 1994, aggregate forecasts are constructed from forecasts for France, Germany and Italy by aggregating the individual country series using as weights constant GDP at market prices for 1995.
- *GDP growth, forecast (CE)*: Consensus mean forecast of the annual real GDP growth rate, computed as the average of one-year ahead forecasts made in each month of the previous year. Forecasts for the euro area are available from 2003 onwards; for previous years up to 1992, aggregate forecasts are constructed as described above.
- *Consumption growth, forecast (CE)*: Consensus mean forecast of the annual real private consumption growth rate, computed as described above.
- *Interest rate, forecast (CE)*: Consensus mean forecast of the short-term (3-month) nominal interest rate, computed as described above.

⁴⁷The labor force is used as a proxy for total population, since quarterly data on total population is not available from AWM for the entire sample period.

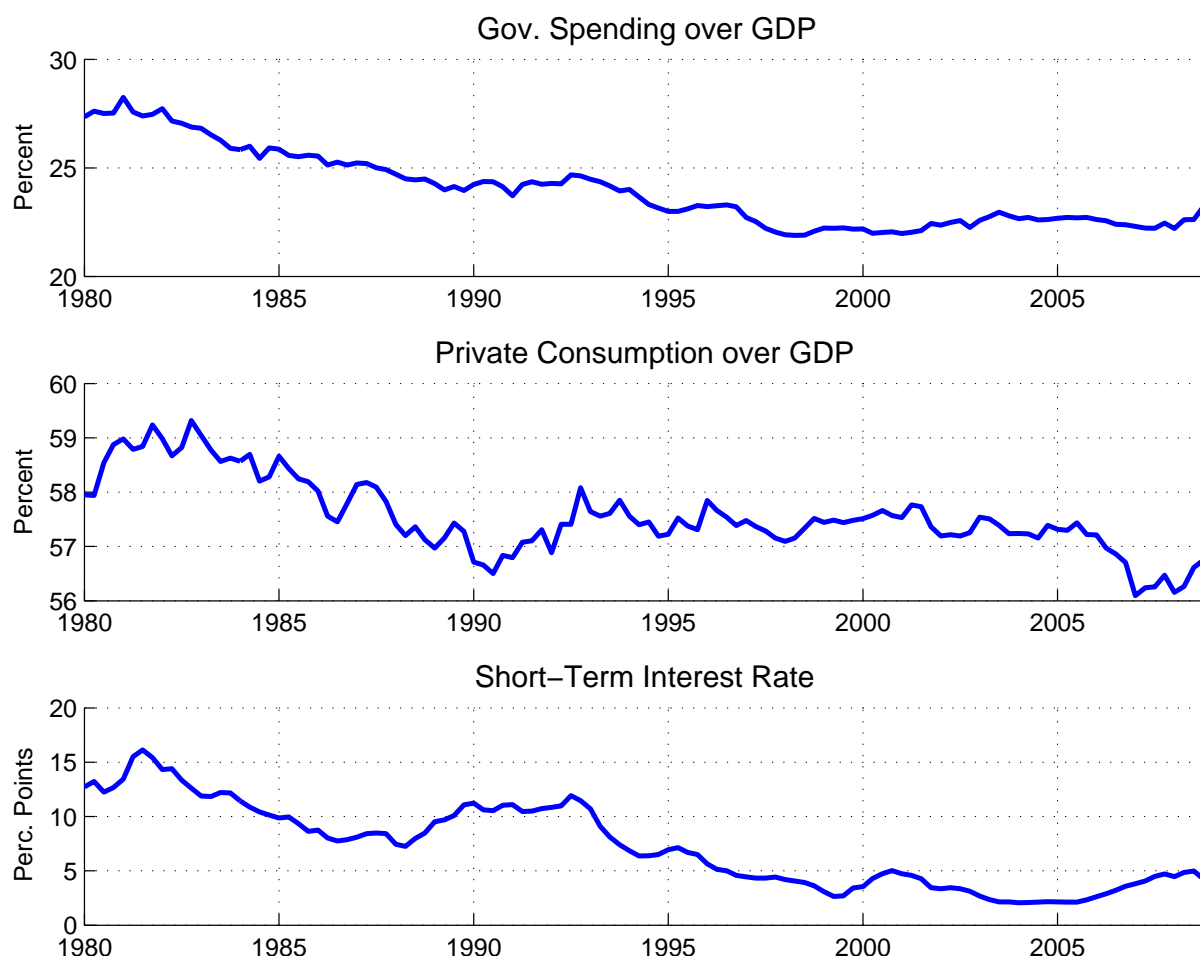


Figure 1: Data used in the benchmark VAR. *Notes.* Government spending is final general government consumption plus government investment; gov. spending and private consumption are expressed as nominal shares of GDP; the short-term nominal interest rate is measured in annual terms; source of fiscal data: Paredes, Pedregal, and Pérez (2009); source of remaining data: ECB's Area-Wide Model database.

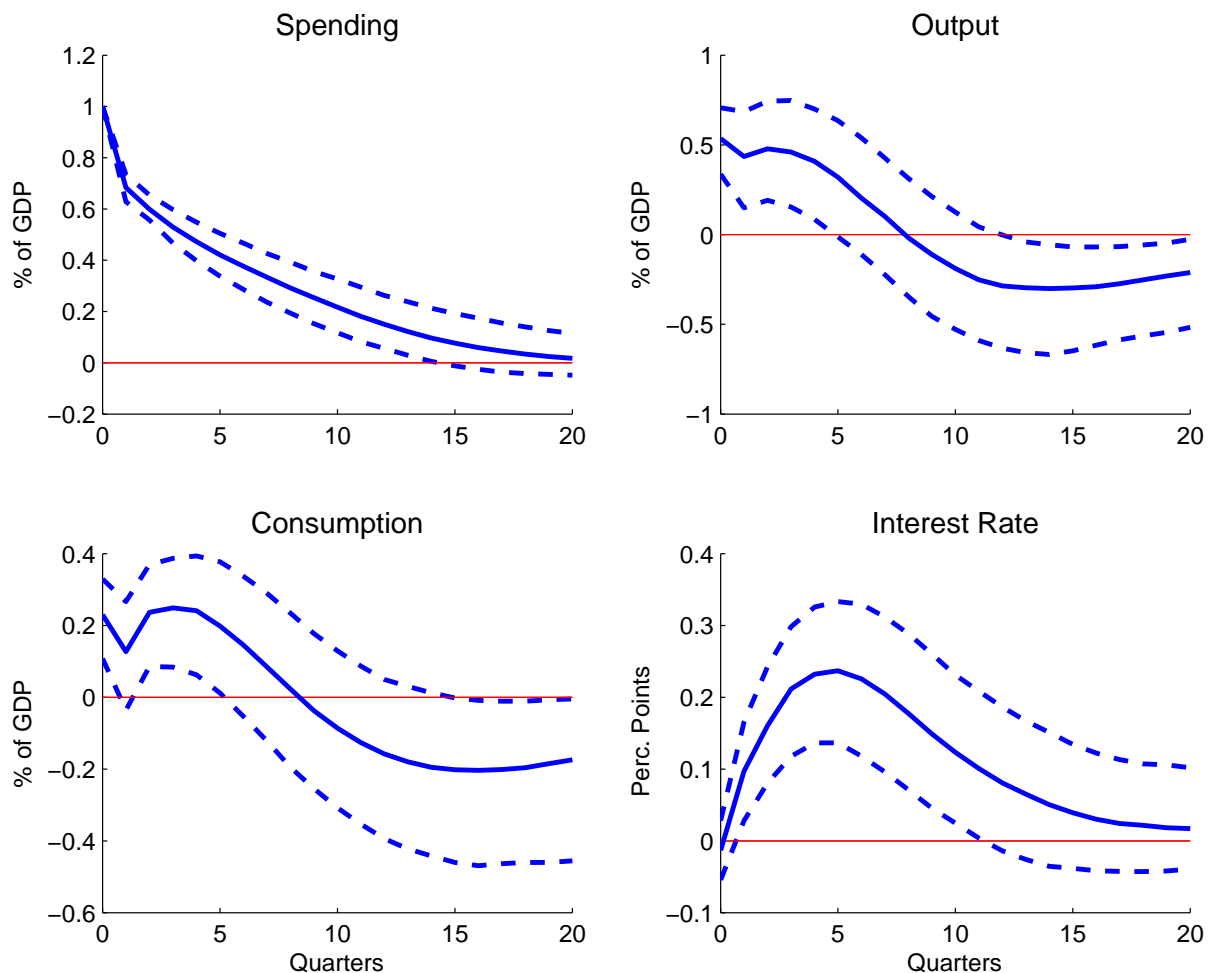


Figure 2: Impulse responses to a spending shock, benchmark time invariant BVAR. *Notes.* Median impulse responses are reported with 16% and 84% probability bands; the responses of output, consumption and spending are measured in % of GDP to a 1% of GDP spending shock, i.e multiplier at horizon $k =$ responding variable's response at horizon $k / (\text{spending response at horizon } 0 \times \text{average ratio of spending to responding variable over sample})$; the response of the interest rate is measured in percentage points to a 1% spending shock.

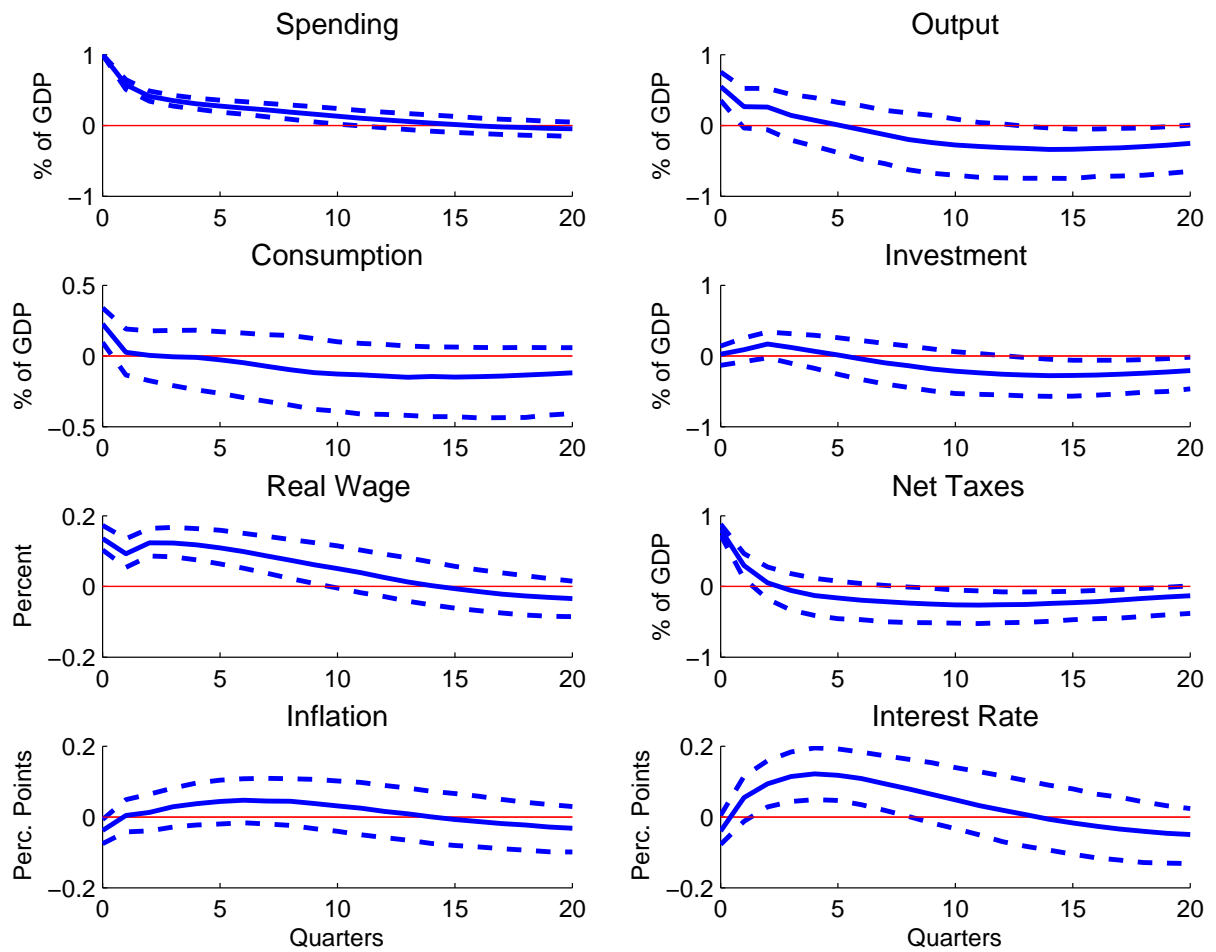


Figure 3: Impulse responses to a spending shock, extended time invariant BVAR. *Notes.* See Figure 2.

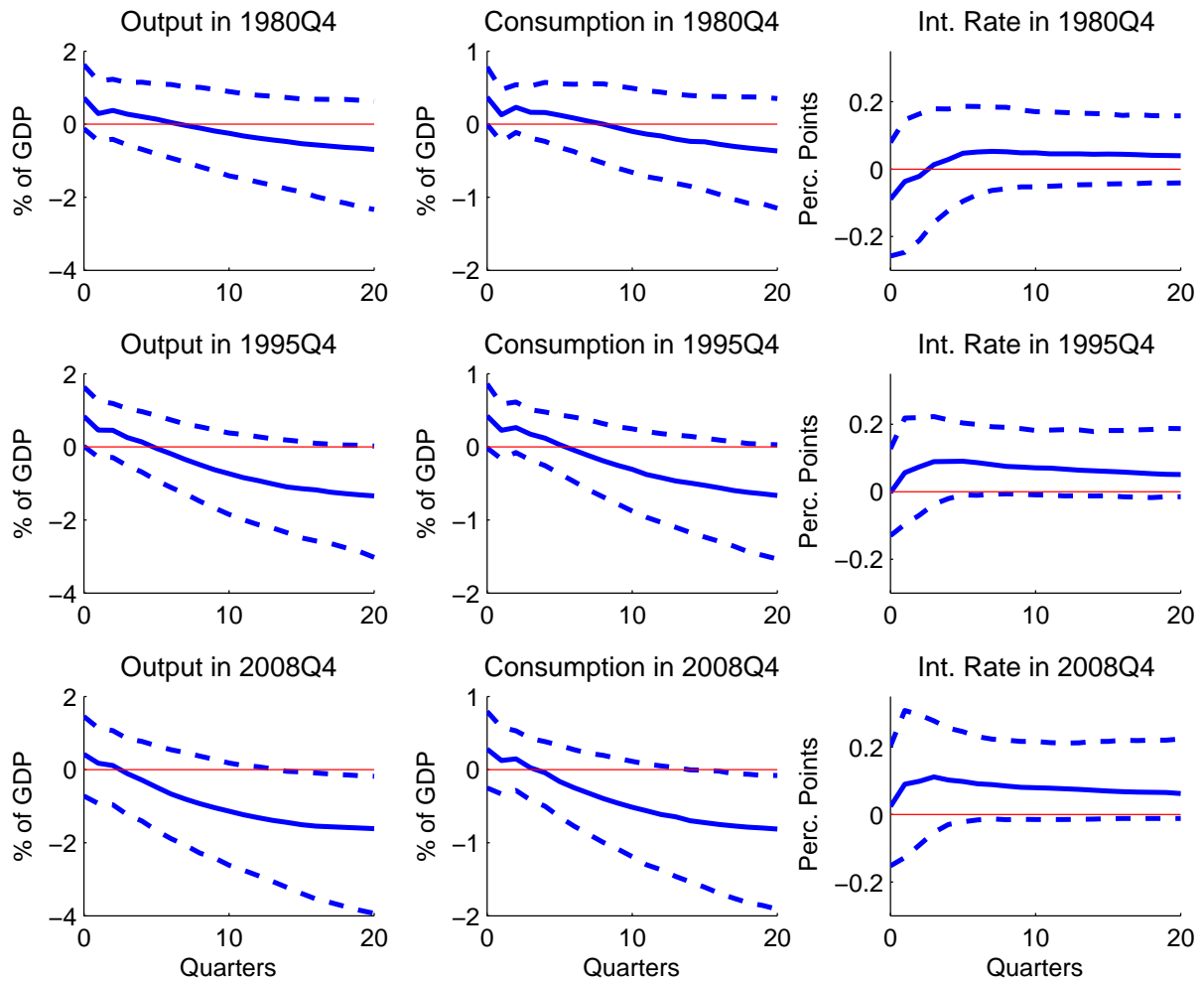


Figure 4: Impulse responses to a spending shock in selected quarters, benchmark TVP-VAR. *Notes.* Median impulse responses are reported with 16% and 84% probability bands; the responses of output and consumption are measured in % of GDP to 1% of GDP spending shocks, i.e. multiplier at time t and horizon $k = \text{responding variable's response at time } t \text{ and horizon } k / (\text{spending response at time } t \text{ and horizon } 0 \times \text{ratio of spending to responding variable at time } t)$; the response of the interest rate is measured in percentage points to 1% spending shocks.

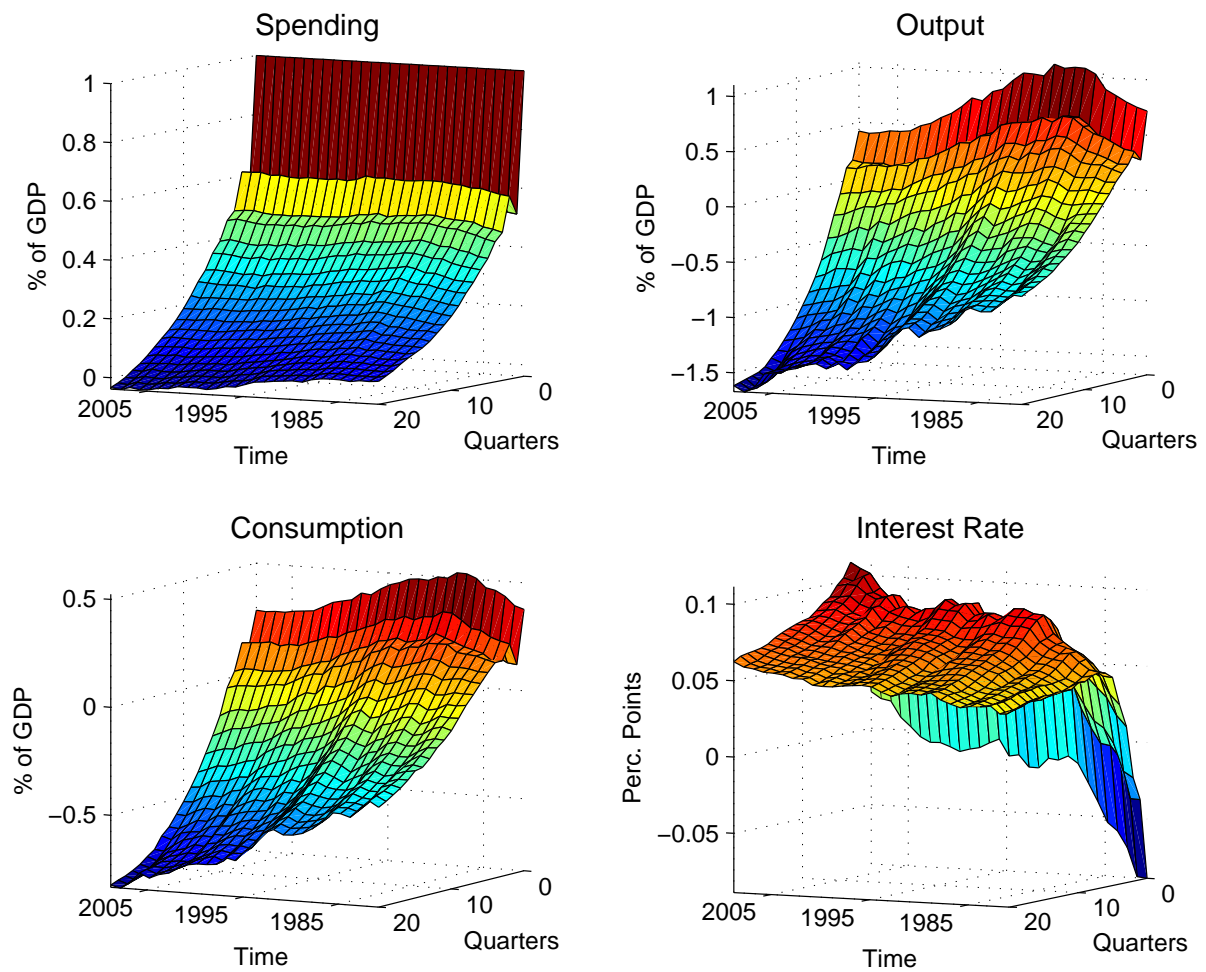


Figure 5: Impulse responses to a spending shock in each year of the sample, benchmark TVP-VAR. *Notes.* See Figure 4; median impulse responses are reported.

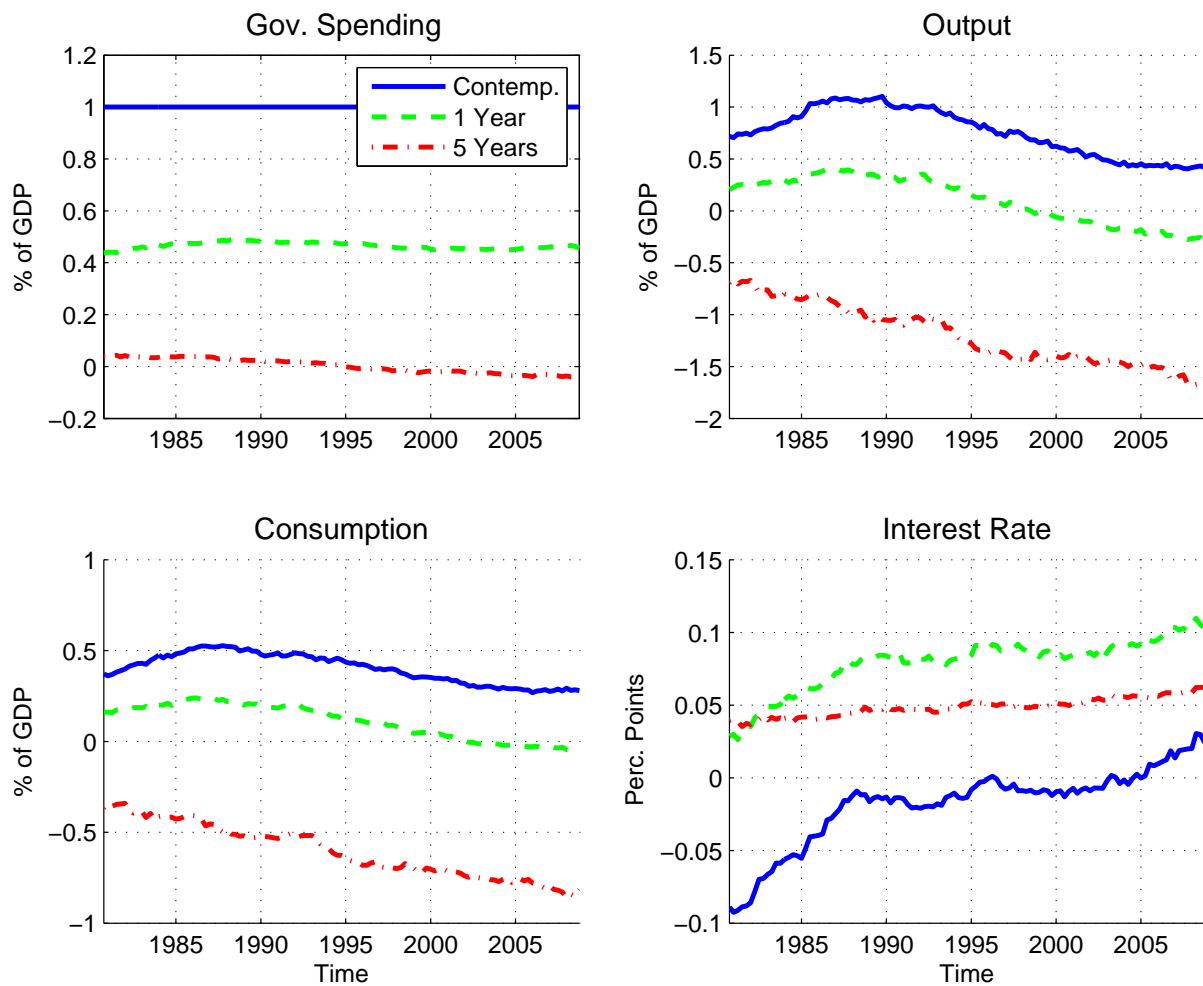


Figure 6: Impulse responses to a spending shock at selected horizons, benchmark TVP-VAR. *Notes.* See Figure 4; k -th horizon impulse responses are reported for $k = 0, 4, 20$.

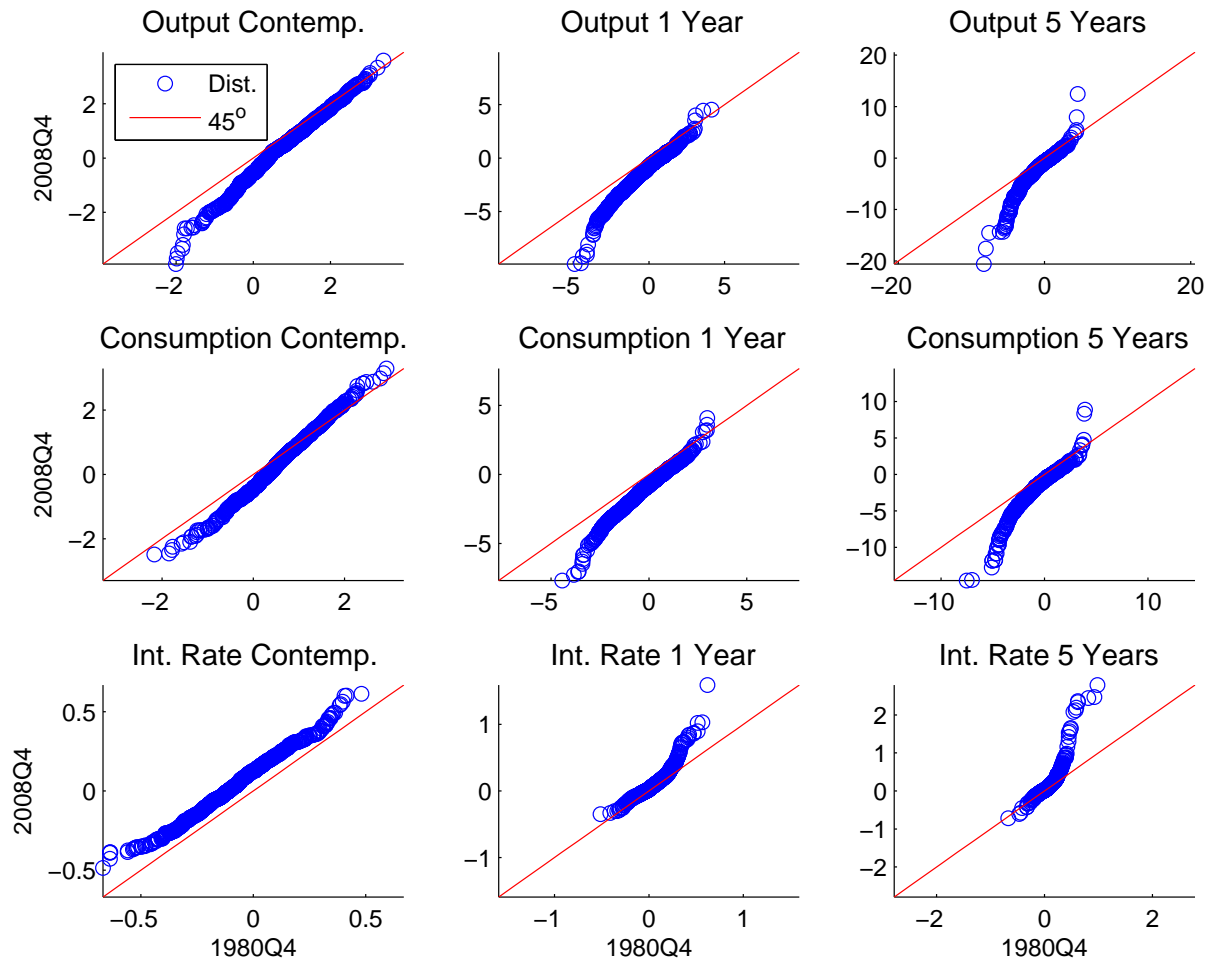


Figure 7: Joint pair-wise distributions of impulse responses at selected horizons, benchmark TVP-VAR. *Notes.* See Figure 4; pair-wise responses of output, consumption (in % of GDP) and the interest rate (in percentage points) are reported, computed across their posterior distribution at horizon $k = 0, 4, 20$.

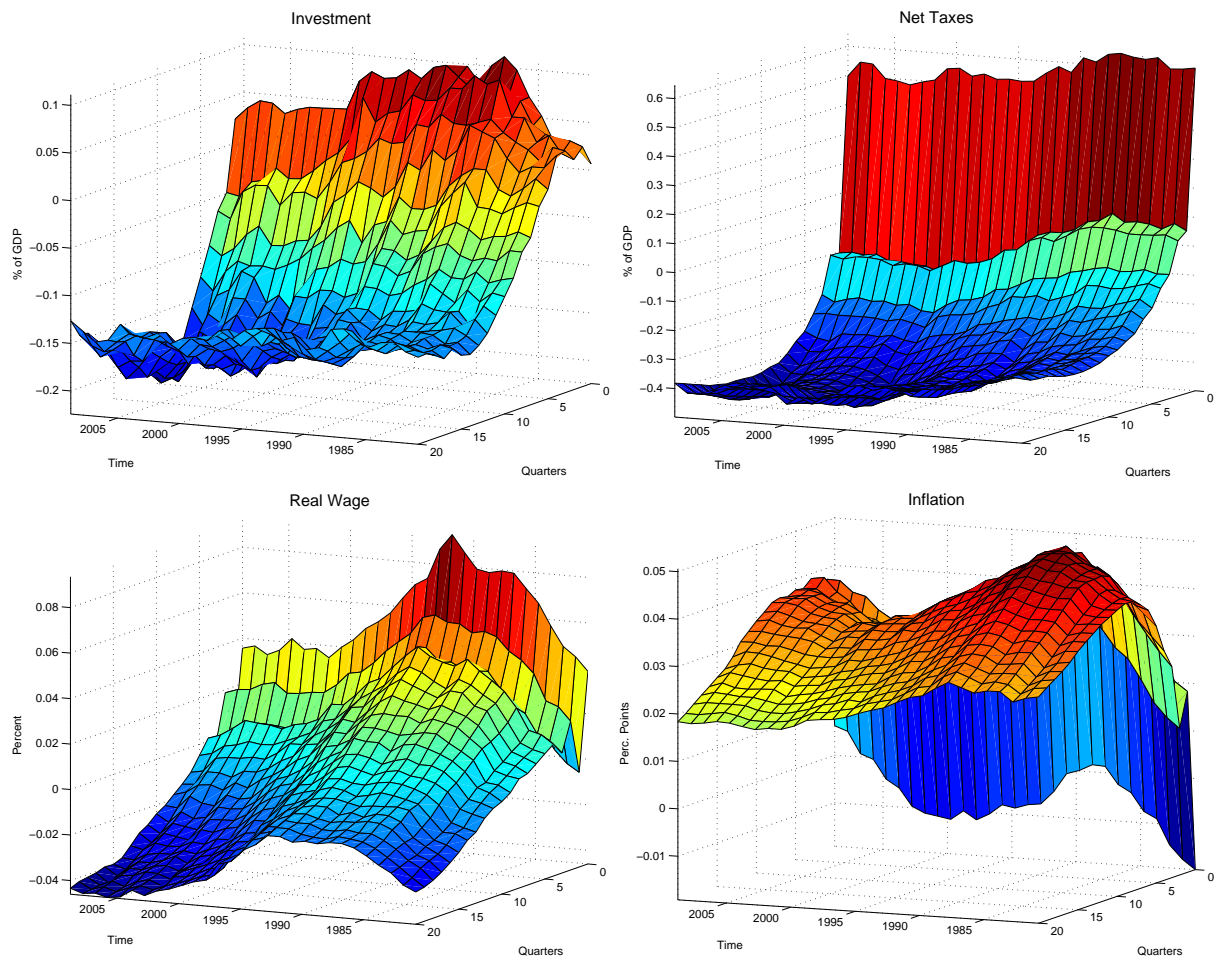


Figure 8: Impulse responses of private investment, net taxes, the real wage and the HICP based inflation rate to a spending shock in each year of the sample, extended TVP-VAR. *Notes.* See Figure 4; median impulse responses are reported.

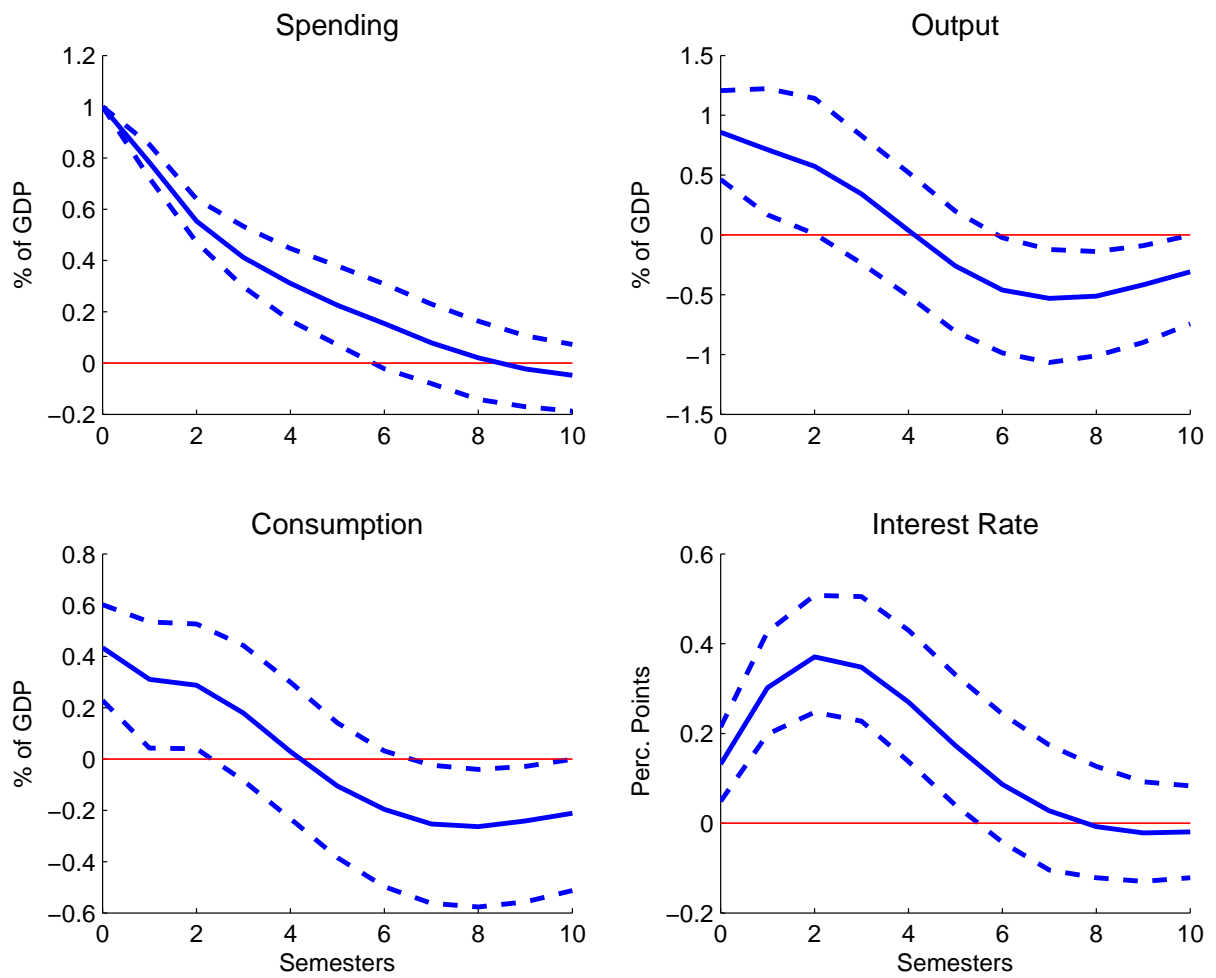


Figure 9: Impulse responses to a spending shock, time invariant BVAR estimated on bi-annual data. *Notes.* See Figure 2.

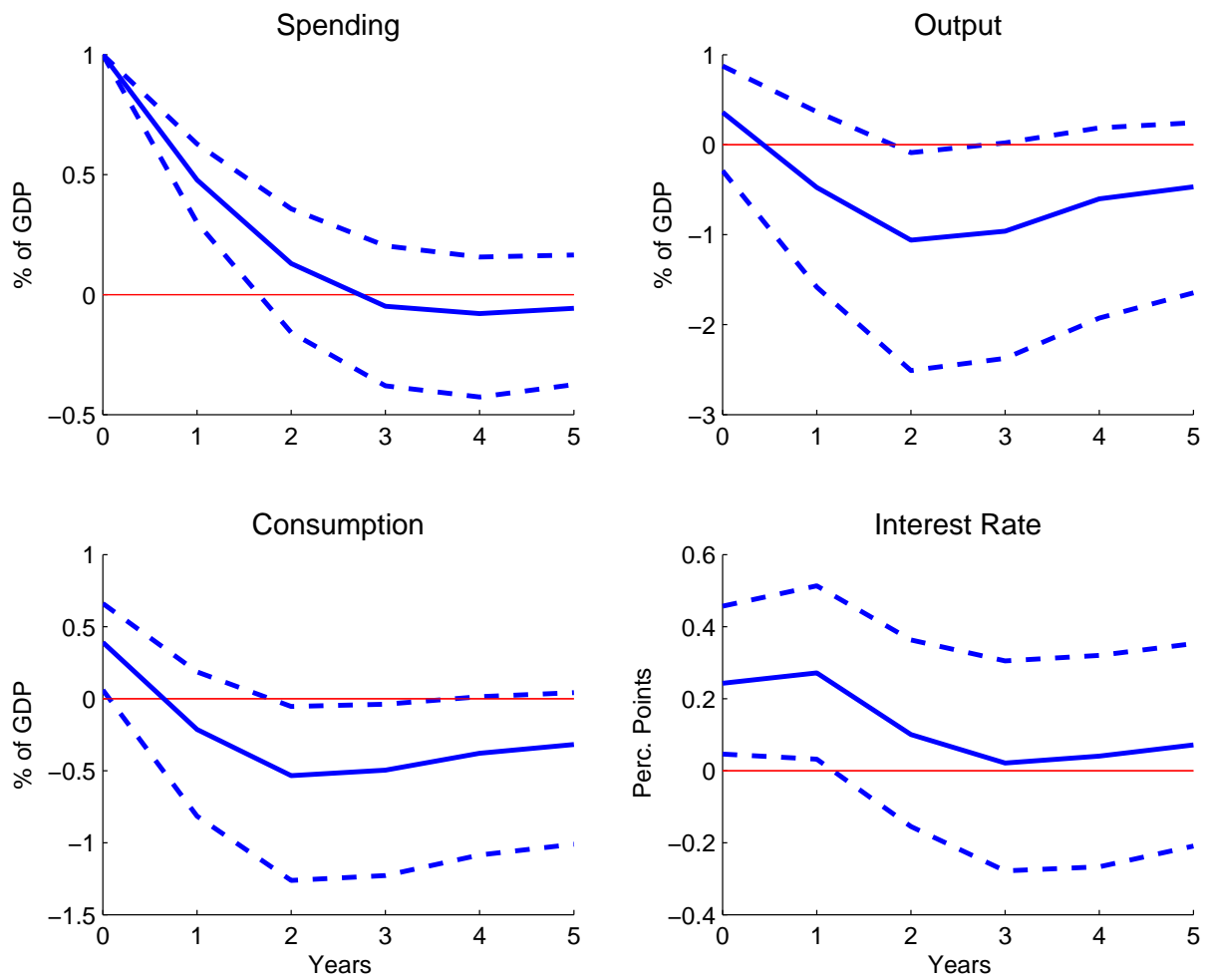


Figure 10: Impulse responses to a spending shock, time invariant BVAR estimated on annual data. *Notes.* See Figure 2.

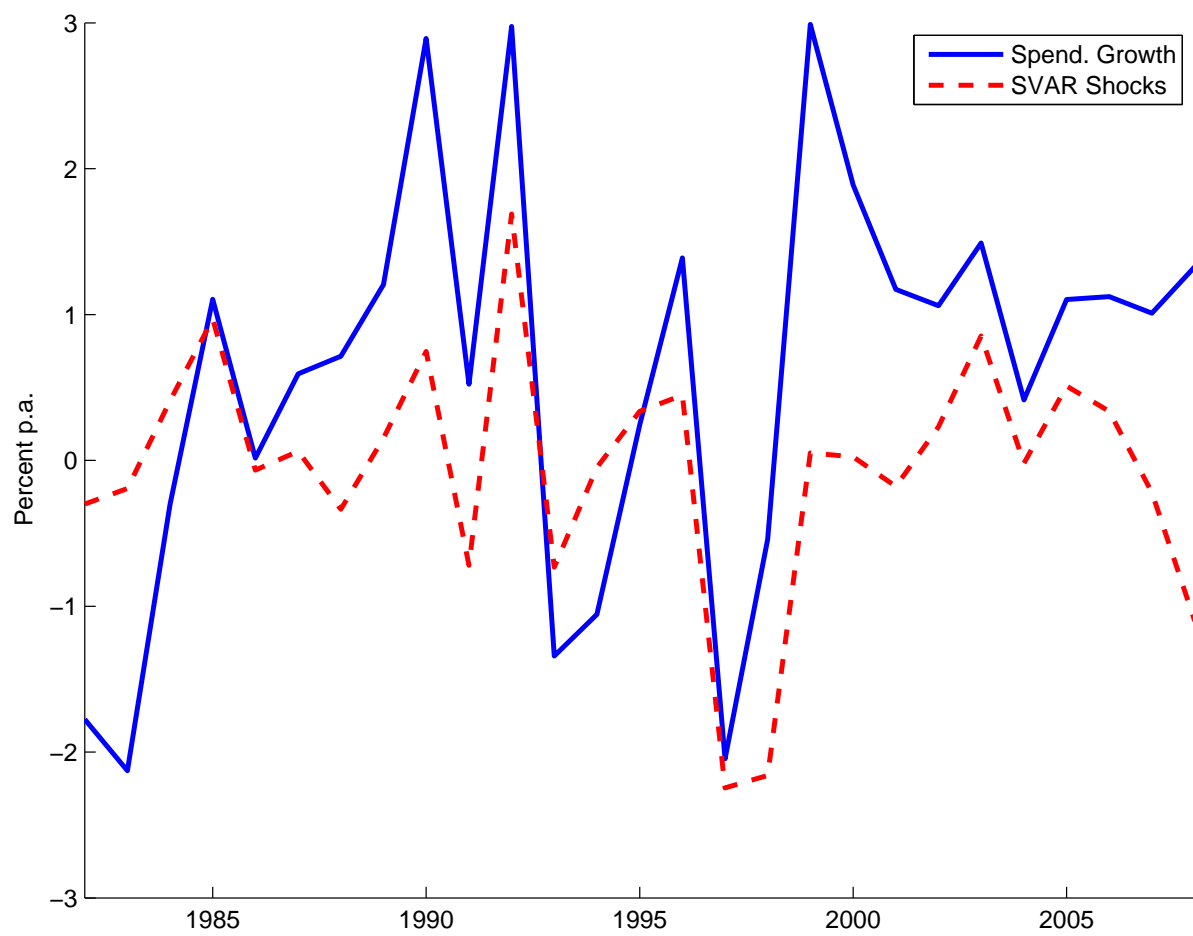


Figure 11: Actual spending growth and SVAR spending shocks, time invariant BVAR estimated on annual data. *Notes.* Spending growth and spending shocks are measured in percent per annum.

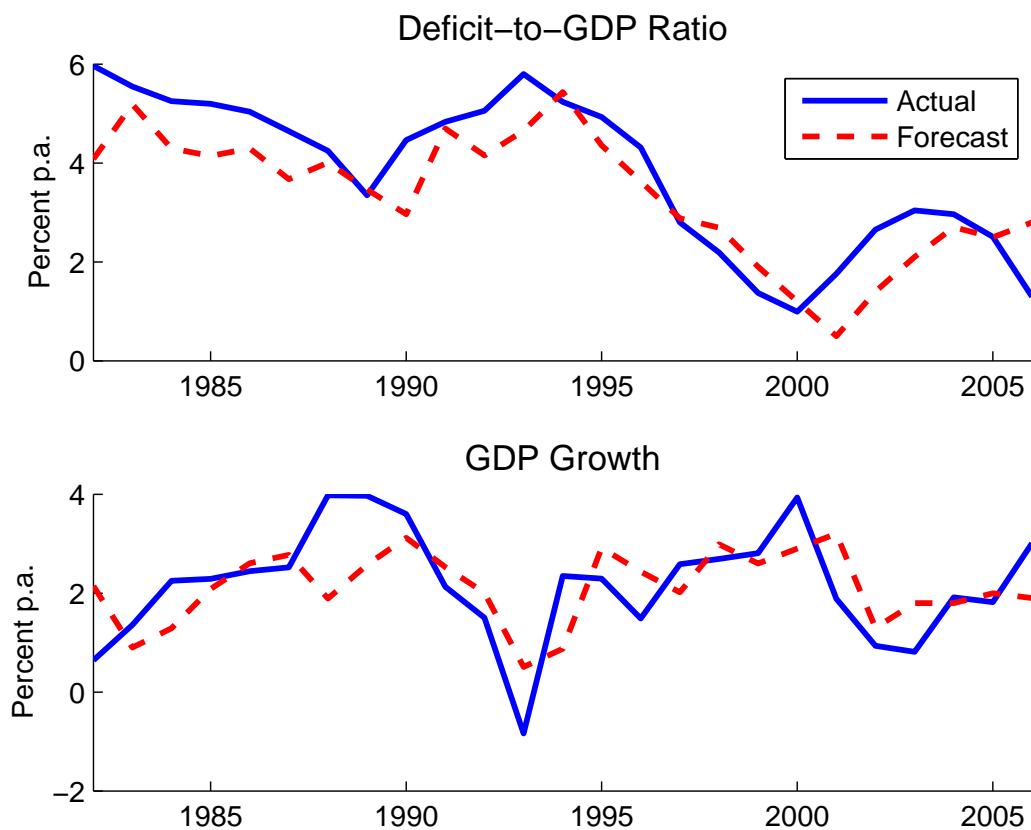


Figure 12: Government budget deficit over GDP and real GDP growth, actual data and one-year ahead forecasts (European Commission). *Notes.* The deficit-to-GDP ratio is computed from nominal variables, real GDP growth is the annual growth rate (both in percent); the forecasted variables are forecasts for a given year made in the previous year; if euro area forecasts were not available, aggregate forecasts were constructed from forecasts for Belgium, France, Germany, Greece, Ireland, Italy, Luxembourg and the Netherlands, by aggregating the individual country series using as weights constant GDP at market prices for 1995; source of forecast data: European Commission; source of actual data: Paredes, Pedregal, and Pérez (2009) and ECB's Area-Wide Model database.

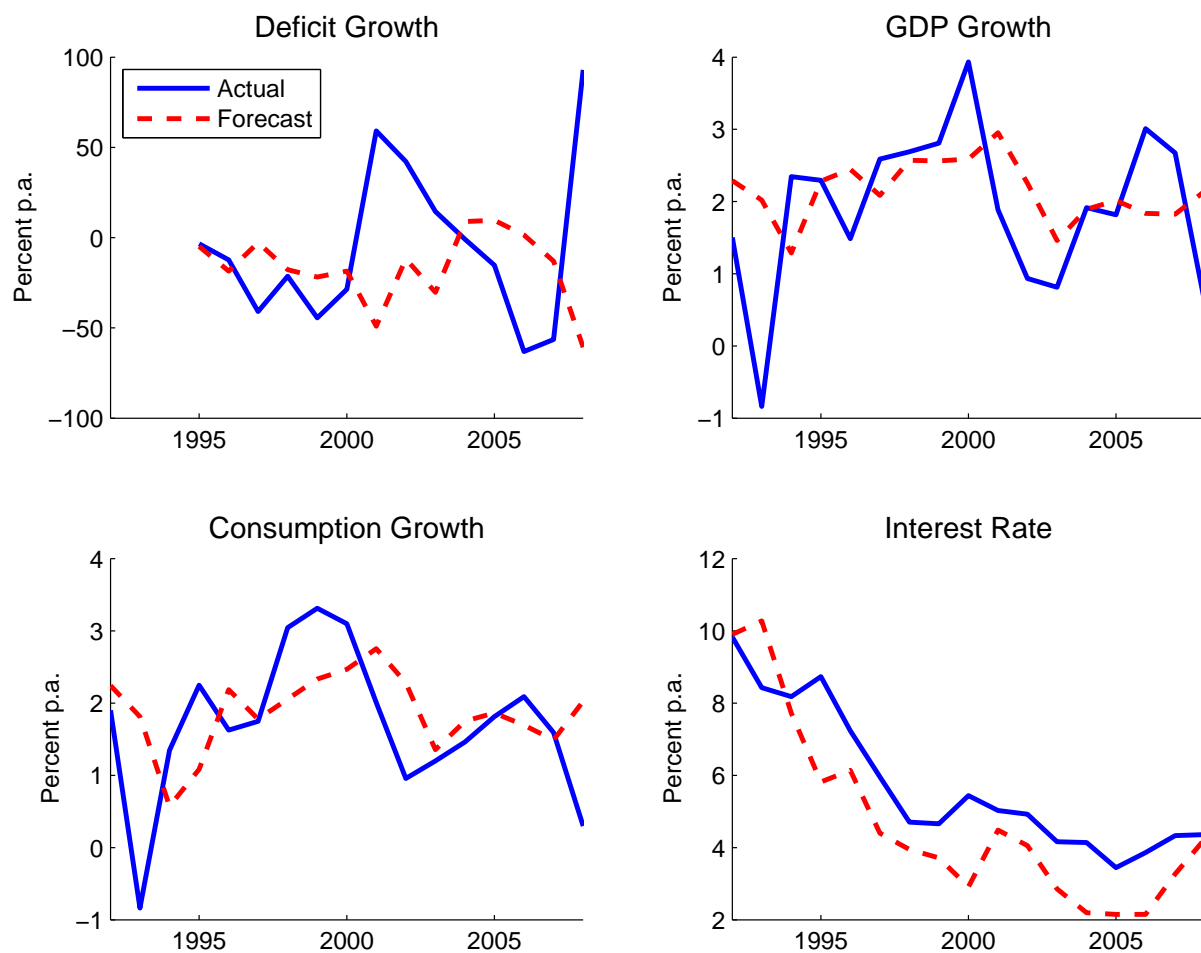


Figure 13: Real government budget deficit growth, real GDP growth, private consumption growth and short-term interest rate, actual data and one-year ahead forecasts (Consensus Economics). *Notes.* Budget deficit, GDP and consumption are reported as annual growth rates, the interest rate is measured in nominal terms (all in percent); the forecasted variables are average monthly forecasts made in a given year for the following year; if euro area forecasts were not available, aggregate forecasts were constructed from forecasts for France, Germany and Italy by aggregating the individual country series using as weights constant GDP at market prices for 1995; source of forecast data: Consensus Economics; source of actual data: Paredes, Pedregal, and Pérez (2009) and ECB's Area-Wide Model database.

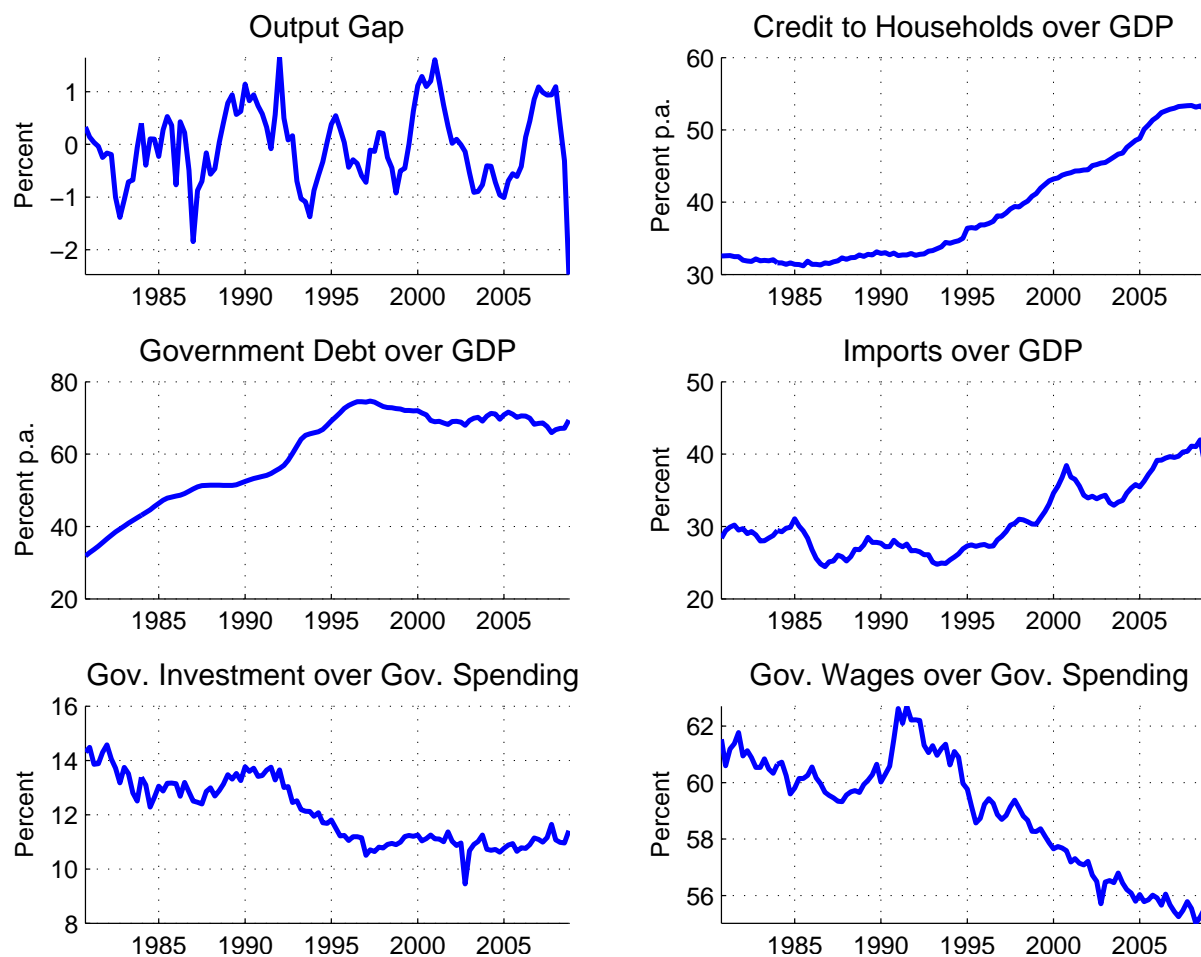


Figure 14: Potential determinants of spending multipliers. *Notes.* Debt-to-GDP ratio is in nominal annual terms; ratio of credit to households over GDP is outstanding (end-of-period) loans to households divided by the sum of nominal GDP of the last four consecutive quarters; output gap $outgap_t$ is measured as quarterly percentage deviation from trend real GDP, trend is based on HP-filter with smoothing parameter 1600; ratio of imports over GDP and shares of government investment and wage expenditures in total spending are based on quarterly nominal data; source of fiscal data: Paredes, Pedregal, and Pérez (2009); source of remaining data: ECB's Area-Wide Model database and Bank of International Settlements macroeconomic series (data on loans).

Table 1: Granger causality tests, 1982-2006 (European Commission forecasts) and 1992-2008 (Consensus Economics forecasts).

Hypothesis Test ^{a,b}	F-statistic	10% Critical Value	Conclusion (p-value)
<i>European Commission Forecasts</i>			
Deficit-to-GDP ratio forecasts → actual spending growth	4.894	2.949	Yes (0.038)
Deficit-to-GDP ratio forecasts → SVAR shocks	0.004	2.949	No (0.949)
GDP growth forecasts → SVAR shocks	0.001	2.949	No (0.973)
All forecasts → SVAR shocks	0.002	2.575	No (0.998)
<i>Consensus Economics Forecasts</i>			
Deficit growth forecasts → actual spending growth	0.320	3.225	No (0.320)
Deficit growth forecasts → SVAR shocks	0.027	3.225	No (0.872)
GDP growth forecasts → SVAR shocks	0.373	3.102	No (0.551)
Consumption growth forecasts → SVAR shocks	0.155	3.102	No (0.700)
Interest rate forecasts → SVAR shocks	0.785	3.102	No (0.391)
All forecasts → SVAR shocks	0.049	2.693	No (0.995)

^a The first variable at time t is regressed on a constant, its own lag at time $t - 1$ and the forecast made at time $t - 1$ of the second variable for period t . The null hypothesis is that the second variable does not Granger-cause the first variable.

^b For the European Commission forecasts, GDP is measured as real annual growth rate and the deficit-to-GDP ratio is measured in nominal terms. For the Consensus Economics forecasts, all variables except the interest rate are measured as real annual growth rates, using consumer prices as deflators, and the interest rate is measured in nominal terms. See the Appendix for details.

Table 2: Bayesian linear regressions, dependent variables are contemporaneous multipliers.^{a,b,c,d}

	Multiplier on Output						Multiplier on Consumption					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Gov. Debt over GDP (-1)	0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.00 (0.01)	-0.00 (0.01)	0.00 (0.01)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.00* (0.01)	-0.00 (0.01)
Credit over GDP (-1)		-0.06*** (0.02)	-0.06*** (0.02)	-0.04*** (0.02)	-0.04** (0.02)	-0.06*** (0.02)		-0.04*** (0.01)	-0.03*** (0.01)	-0.02** (0.01)	-0.02** (0.01)	-0.04*** (0.01)
Output Gap (-1)			0.03** (0.02)	0.05*** (0.02)	0.04** (0.02)	0.03*** (0.02)			0.02** (0.01)	0.02*** (0.01)	0.03** (0.02)	0.02** (0.01)
Imports over GDP (-1)				-0.02* (0.01)	-0.01* (0.01)	-0.01 (0.01)				-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Investment Share					0.03* (0.02)	0.07** (0.04)					0.01 (0.02)	0.04** (0.02)
Wage Share						-0.04** (0.03)						-0.03** (0.02)
Constant	0.71 (1.37)	3.11*** (1.10)	2.99*** (1.09)	2.96*** (1.07)	2.11** (1.23)	4.52** (2.29)	0.78 (0.94)	2.09*** (0.78)	2.00*** (0.78)	1.98*** (0.76)	1.71*** (1.02)	3.48*** (2.01)
Trend	-0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01** (0.00)	0.01*** (0.00)	-0.01** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.00** (0.00)	0.00** (0.00)	0.01*** (0.00)
Observations	112	112	112	112	112	112	112	112	112	112	112	112

^a Bayesian regressions allow for heteroskedastic errors following Geweke (1993). Standard error adjustment proceeds by using each of 1,000 multipliers in the posterior distribution from the identified TVP-VAR as dependent variable. All regressions are then estimated using a Gibbs sampling algorithm with 1,100 draws and 100 omitted draws. This leaves us with 1,000,000 posterior draws of regression coefficients.

^b Multiplier at time t and horizon k = responding variable's response at time t and horizon k / (spending response at time t and horizon 0 \times ratio of spending to responding variable at time t).

^c Point estimates are posterior means of the posterior distribution. Standard deviations are reported in parentheses. Asterisks indicate posterior probabilities that the regression coefficients are non-positive if the point estimates are positive or non-negative if the point estimates are negative (*less than 10%, **less than 5%, ***less than 1%.)

^e Explanatory variables are measured in percent.

Table 3: Bayesian linear regressions, dependent variables are multipliers after five years.^{a,b,c,d}

	Multiplier on Output						Multiplier on Consumption					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Gov. Debt over GDP (-1)	-0.00 (0.02)	-0.01** (0.02)	-0.01** (0.02)	-0.01** (0.02)	-0.01** (0.02)	-0.01** (0.02)	-0.00 (0.02)	-0.01** (0.01)	-0.01** (0.01)	-0.01** (0.01)	-0.01** (0.03)	-0.01** (0.03)
Credit over GDP (-1)		-0.02 (0.09)	-0.02 (0.09)	-0.03 (0.10)	-0.03 (0.09)	-0.02 (0.08)		-0.01 (0.06)	-0.01 (0.06)	-0.02 (0.08)	-0.02 (0.08)	-0.02 (0.07)
Output Gap (-1)			-0.01 (0.10)	-0.02 (0.11)	-0.02 (0.11)	-0.01 (0.12)			-0.01 (0.11)	-0.02 (0.11)	-0.02 (0.08)	-0.02 (0.09)
Imports over GDP (-1)				0.01 (0.03)	0.01 (0.04)	0.01 (0.04)				0.01 (0.06)	0.01 (0.05)	0.01 (0.05)
Investment Share					-0.00 (0.13)	-0.01 (0.12)					0.00 (0.19)	-0.01 (0.14)
Wage Share						0.01 (0.08)						0.01 (0.09)
Constant	-0.67 (1.96)	0.02 (3.24)	0.03 (2.86)	0.05 (2.87)	0.08 (2.92)	-0.36 (4.50)	-0.56 (1.69)	-0.10 (1.76)	-0.09 (1.60)	-0.07 (1.54)	-0.10 (3.70)	-0.82 (7.34)
Trend	-0.01*** (0.02)	-0.01*** (0.01)	-0.01** (0.01)	-0.01** (0.01)	-0.01** (0.01)	-0.01** (0.01)	-0.01*** (0.02)	-0.01*** (0.01)	-0.01** (0.01)	-0.01** (0.01)	-0.01** (0.02)	-0.01** (0.02)
Observations	112	112	112	112	112	112	112	112	112	112	112	112

^a Bayesian regressions allow for heteroskedastic errors following Geweke (1993). Standard error adjustment proceeds by using each of 1,000 multipliers in the posterior distribution from the identified TVP-VAR as dependent variable. All regressions are then estimated using a Gibbs sampling algorithm with 1,100 draws and 100 omitted draws. This leaves us with 1,000,000 posterior draws of regression coefficients.

^b Multiplier at time t and horizon $k =$ responding variable's response at time t and horizon k / (spending response at time t and horizon 0 \times ratio of spending to responding variable at time t).

^c Point estimates are posterior means of the posterior distribution. Standard deviations are reported in parentheses. Asterisks indicate posterior probabilities that the regression coefficients are non-positive if the point estimates are positive or non-negative if the point estimates are negative (*less than 10%, **less than 5%, ***less than 1%.)

^d Explanatory variables are measured in percent.