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Foreword

by Iain Begg, London School of Economics

The initial aim of this element of the work package was to conduct a comprehensive survey of large macroeconomic models to arrive at an understanding of what they could reveal about tax and benefit spillovers. As stated in the work programme, the intention was to elucidate "the effects of fiscal and structural policies in the EU countries under the monetary union, paying attention to both own- and cross-country effects. The survey would concentrate on the results of large multi-country macroeconometric models and as such would be a natural complement to the theoretical and empirical contribution of the three preceding steps. It would act as a robustness check of the obtained results and could provide some additional insights into the issues of impact of tax policy changes on macroeconomic aggregates and implications for policy co-ordination on the EU/eurozone level. The ambition would be to contact the model-builders and collect sets of simulation results from the major macroeconometric models in such a form that they would be comparable."

An earlier exercise by Gros and Hobza (2001) attempted to conduct a similar exercise in the context of a workshop bringing together researchers responsible for the main multi-country models. In updating this earlier work, the intention was both to revisit the same models, to discuss with the model-builders what could be learned and to widen the scope of the exercise by considering additional models. In the earlier exercise, the four models used were: NIGEM, the multi-country model developed by the NIESR in London; QUEST, the DG Ecfin model; MULTIMOD, the IMF's multi-country macroeconomic model and MARMOTTE, the model maintained by CEPII. In fact, only two of these models are now fully functional: NIGEM and QUEST. MULTIMOD is still in occasional use, but not much effort is being put into it, while MARMOTTE has essentially been 'moth-balled', because the judgement at CEPII has been that it no longer justifies the considerable resources that would be needed to keep it active. Preliminary enquiries signalled that the OECD's INTERLINK model - also subject to substantially reduced resources - was not suited to the aims of the exercise because it was more oriented to blocs of countries, and also established that the European Central Bank's (ECB) approach was to model the euro area as a whole and the large countries separately, as opposed to having a linked model. It is also noteworthy that in the introduction to a special issue of *Economic Modelling*, Hughes Hallett and Wallis (2004: 719) note that "elimination of exchange rate variability, the integration of the financial and most goods markets, and of most prices, will imply significant changes in economic behaviour - whether in pricing decisions; or in investment, employment and production decisions; or in the behaviour of interest rates, inflation and the external exchange rate. All these changes call for a new generation of macroeconomic models to analyse the key economic aggregates for welfare and forecasting purposes, at both the euro-area level and the national level."

Following discussions and telephone interviews with a number of the main model proprietors, as well as experts in the field at bodies such as the ECB and the OECD, certain conclusions emerged that bear on the present exercise. First, with the number of conventional models reduced to just two active ones, the scope of the exercise originally envisaged was much reduced, as neither MARMOTTE nor MULTIMOD could be expected to generate relevant results. Second, newer or alternative models coming on-stream (for example at the OECD, the ECB and the IMF) are qualitatively different from the four models originally envisaged. Rather than being based on large model with significant amounts of estimation, the new generation comprises models that are smaller and more theoretically-based.

Third, doubt was cast, in any case, on whether replication of the Gros/Hobza approach could be expected to yield worthwhile results. The intention of the survey had been to obtain new estimates from each of the models that could be used to compare the relevant elasticities generated by the different models. However, in discussions with the leading researchers responsible for the two active models (Ray Barrell for NIGEM and Jan in't Veld for QUEST) it became clear that obtaining a viable direct comparison of the models was unlikely to be possible because of the growing complexity of the models and their differing properties - both theoretical and empirical. As Wallis (2004: 735) observes, a key distinguishing feature is "the different degree of forward-looking behaviour incorporated in the models".

Fourth, tax and benefit spillovers are not central elements of either model and would have to be arrived at by indirect methods. Hence, despite being willing to collaborate, carrying out a convincing model comparison would require more work for the model-builders than they were prepared to offer or could reasonably be expected to provide. Consequently, although it would have been possible to obtain separate simulations that would provide some insights into what the two models revealed, it became clear that the exercise would not be particularly fruitful. The new direction taken by the IMF, the OECD and the ECB implies a different approach to model-building that can be considered as 'state-of-the-art' and offers different perspectives on tax-benefit spillovers. In the light of all these changes, it was decided to re-orientate the content of the deliverable and to focus on these DGSE models.

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Assessing Spillover Effects from Fiscal Policy in Europe: A DSGE Approach

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Abstract

This paper investigates spillover effects of fiscal policy on economic activity both within and between France and Germany. To this end, we develop a structural, two-country Dynamic Stochastic General Equilibrium (DSGE) model. Employing Bayesian inference techniques, we show that shocks to government spending increase economic activity in France and Germany. Examining the propagation of government expenditure shocks across borders, the spillover effects on economic activity are found to be very small. A positive shock to government expenditure in Germany raises output in France, whereas a positive shock to government expenditure in France results in a negative response of output in Germany. We also find a clearly negative spillover effect stemming from the reaction of the Central Bank; following an expansionary fiscal policy in France and Germany the union-wide short term interest rate increases.

JEL Classification System: E32, E62.

Keywords: Fiscal Policy, Bayesian Analysis, DSGE Modeling, Euro Area.

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1 Introduction

The introduction of the Euro in 1999 has led to a debate about new challenges for monetary and fiscal policy in Europe. In a currency union, countries share a common central bank, which is responding to union-wide developments. As a consequence, macroeconomic policy at the national level is shifted towards fiscal policy. Whether countries belonging to the euro area should coordinate their fiscal policies depends among other things on the existence of spillover effects from fiscal policy. Spillover effects of fiscal policy can occur via the common interest rate in an integrated capital market and through international trade. In the latter case, fiscal expansions lead to increased economic activity which in turn may also increase imports from trading partners. Spillover effects arising through the interest rate channel are, however, more problematic. An expansionary fiscal policy or unsustainable government debt level in few countries may put upward pressure on domestic inflation, forcing the ECB to raise interest rates and thereby affecting all countries in the euro area.

Empirical literature - mostly using Vector Autoregressive (VAR) models - suggests that shocks to fiscal policy have positive or, at least no significant negative effects on output.[1] The evidence with regard to cross-border effects is mixed.[2] Canzoneri et al. (2002) report significant spillover effects, whereas Marcellino (2002) finds only limited evidence on spillover effects. Bénassy-Quéré et al. (2006) find a positive response of output to fiscal policy shocks, but demonstrate as well that the effectiveness of fiscal policy has decreased over time, both domestically and across borders. Beetsma and Massimo (2004) note that the fiscal stances of large countries affect the fiscal stances of small countries, but not vice versa.

A potential caveat is that most of the above-cited work on fiscal spillover effects is based on evidence obtained from Vector Autoregressive (VAR) models. Due to their non-structural modelling framework, VAR models are, however, not applicable for policy experiments. For this reason, the present paper aims to provide evidence on spillover effects based on a *structural* modelling framework that can also be applied for policy analysis. To this end, we develop and estimate Dynamic Stochastic General Equilibrium (DSGE) model to analyse the sign and size of spillover effects of fiscal policy both within

[1] Perotti (2005), Canzoneri, Cumby and Diba (2002), Mountford and Uhlig (2002), Canova and Pappa (2003) and Gali, Lopez-Salido and Valles (2003) provide empirical evidence on the multiplier effects of fiscal policy shocks.

[2] See Bénassy-Quéré, Cimadomo, and Mignon (2006) for a review of the empirical literature on cross-border effects of fiscal policy shocks.

and between countries. To keep the analysis tractable, we set up a two-country model and estimate it with French and German time series data. Our model can serve as a starting point to explore spillover effects of fiscal policy in a model with a larger number of European countries.

We suggest a microfounded model consisting of two countries of equal size constituting a currency union. In our model, monetary policy is conducted by a common central bank, which sets the interest rate for the union. Fiscal policy is implemented at the country level through government spending financed by lump-sum taxes. The model includes nominal rigidities and both country-specific and union-wide shocks.

We estimate the model with Bayesian inference techniques using French and German time series data. Estimating instead of calibrating the model allows us to make direct use of time series data. The Bayesian estimation method also allows us to formalise the use of prior information obtained from earlier studies. Including prior information improves the estimation of parameters of a DSGE model when data have a short sample period, as is the case for the euro area. In presenting our results, we discuss the parameter estimates and the transmission of a fiscal policy shock through impulse response functions.

Our results show that a positive shock to government spending increases economic activity in France and Germany. Examining the propagation of government spending shocks across borders, we find the effect on economic activity to be very small. The sign of transmission is ambiguous: while a government spending shock in Germany is found to raise output in France, a shock to government spending in France results in a negative response of output in Germany. In summary, with regard to the trade channel we obtain mixed results: a fiscal expansion results in positive and negative effects on economic activity across borders. The effect arising from the interest rate channel is clearly negative; a fiscal expansion in France and in Germany results in an union-wide interest rate increase.

Our modelling approach belongs to a new generation of New-Keynesian Dynamic Stochastic General Equilibrium (DSGE) models building on explicit microfoundations with optimising agents.[3] While the focus of this literature has been on the analysis of monetary policy, there have been contributions recently discussing the role of fiscal policy in models similar to the present one.[4] Microfounded expectation-based DSGE models provide a framework that is more suited for the analysis of macroeconomic policies, be-

[3]See, among others, Obstfeld and Rogoff (1995), Corsetti and Pesenti (2005), Benigno and Benigno (2003) and Pappa (2004).

[4]See Gali and Monacelli (2004), Ferrero (2005), Coenen and Straub (2005), and Ratto, Roeger and int'Veld (2006).

cause DSGE models are able to deliver a structural interpretation of the obtained results. In addition, major advances in estimation methodology in recent years allow the estimation of DSGE models that are able to compete with time-series models, such as Vector Autoregressions (VAR) models.[5]

The paper is organised as follows. Section 2 introduces the two-country DSGE model. Section 3 discusses the Bayesian estimation procedure. Section 4 discuss the estimation results. Section 4 concludes with some final remarks and priorities for future research.

2 The Model

Building on Lubik and Schorfheide (2003, 2005), Monacelli (2005), and Justiniano and Preston (2004), the following section presents the key structural equations of the model. The model consists of two countries both specialising in the production of a continuum of goods subject to imperfect competition and price rigidities. Both countries are in a currency union, which is modelled as a closed economy. Monetary policy is conducted by a common central bank, whereas fiscal policy is conducted at the level of each member country. The economies are subject to union wide and to country specific shocks. There is a home and a foreign country, which are identical with regard to preferences, technology, and market structure, but they can differ in price-setting. In the subsequent estimation procedure we will assume Germany to be the home country and France the foreign country. International asset markets are complete. Goods produced in the home (foreign) country are denoted by H (F). The location of economic activities is indexed by a (*) for the foreign country, and no index for the home country. For additional details the reader is encouraged to consult Lubik and Schorfheide (2005).

2.1 Households

Each country is inhabited by a continuum of infinitely lived households. Household k maximises:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{\left(\left(C_t^k - H_t\right)/A_{W,t}\right)^{1-\sigma}}{1-\sigma} - N_t(k) \right) \right]. \tag{1}$$

[5]Smets and Wouter (2003) have demonstrated that DSGE models can provide a satisfactory statistical fit on main macroeconomic aggregates. Central banks have been particularly active in developing and estimating DSGE model. Prominent examples are: Bank of Canada, Ambler, Dib, and Rebei (2004); Bank of England, Harrison, Nikolov, Quinn, Ramsay, Scott, and Thomas (2005); ECB, Smets and Wouters (2003), Christiano, Eichenbaum, and Evans (2005), Coenen and Straub (2005); FED, Erceg, Guerrieri, Gust (2003); IMF, Bayoumi, (2004); Riksbank, Adolfson, Laseen, Linde, and Villani (2005a,b); European Commission, Ratto, Roeger, in't Veld and Girardi (2005).

N_t is the labour input and $H_t \equiv \gamma h C_{t-1}$ external habit taken as exogenous by the household. $0 < \beta < 1$ is the rate of time preference, σ is the inverse elasticity of intertemporal substitution (or the coefficient of relative risk aversion), γ the steady state growth rate of $\mathrm{A}_{w,t}$ and $0 \leq h \leq 1$ the habit persistence parameter. $A_{W,t}$ is a non-stationary world-wide technology shock with $z_t = A_{W,t}/A_{W,t-1}$, $z_t = \rho_t z_{t-1} + \epsilon_{z,t}$ and $\{\epsilon_{z,t}\}$ white noise. C_t is a composite consumption index consisting of foreign and domestically produced goods:

$$C_t^k \equiv \left((1-\alpha)^{\frac{1}{\eta}} \left(C_{H,t}^k \right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(C_{F,t}^k \right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}, \tag{2}$$

where $0 \leq \alpha < 1$ is the ratio of imported goods and $\eta > 0$ is the intratemporal elasticity of substitution between home-produced and imported goods. $C_{H,t}^k$ and $C_{F,t}^k$ are Dixit-Stiglitz aggregates of the domestic and imported goods:

$$C_{H,t}^k \equiv \int_0^1 C_{H,t}^k(i)^{\frac{\varepsilon-1}{\varepsilon}} di^{\frac{\varepsilon}{\varepsilon-1}}, \tag{3}$$

$$C_{F,t}^k \equiv \int_0^1 C_{F,t}^k(i)^{\frac{\varepsilon-1}{\varepsilon}} di^{\frac{\varepsilon}{\varepsilon-1}}, \tag{4}$$

where $\varepsilon > 0$ gives the elasticity of substitution between types of differentiated domestic or foreign goods.

The optimisation of household k is subject to the flow budget constraint:

$$P_{H,t}C_{H,t} + P_{F,t}C_{F,t} + E_t\{Q_{t,t+1}D_{t+1}\} \leq D_t + W_t N_t + T_t, \tag{5}$$

for all $t > 0$. The price indices $P_{H,t}$, $P_{F,t}$ and P_t correspond to domestic goods prices, foreign goods prices and domestic CPI, respectively and are formally defined below. We assume that households have access to a complete set of contingent claims, traded across the union. $Q_{t,t+1}$ is the stochastic discount rate on nominal payoffs common across countries, $D_{t,t+1}$ is the nominal payoff on a portfolio held at the end of period and $E_t\{Q_{t,t+1}D_{t,t+1}\}$ is the price of portfolio purchases at time t. W_t is the nominal wage and T_t denote lump-sum taxes and transfers. All households in the domestic economy receive an equal fraction of domestic firm profit. Labour income risk is pooled across agents. As a consequence, households face an identical decision problem, so that $C_t = \int C_t^k dk = C_t^k$. k is dropped henceforth.

The household optimisation problem requires allocation of expenditures across all types of domestic and foreign goods both intratemporally and intertemporally. The resulting demand for each domestic and foreign consumption good with the associated price indexes for the domestic and foreign consumption bundle is given by:

$$C_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}} \right)^{-\varepsilon} C_{H,t}, \tag{6}$$

$$C_{F,t}(i) = \left(\frac{P_{F,t}(i)}{P_{F,t}} \right)^{-\varepsilon} C_{F,t}. \tag{7}$$

The respective price indexes are given by:

$$P_{H,t} \equiv \left[\int_0^1 P_{H,t}(i)^{1-\varepsilon} di\right]^{\frac{1}{1-\varepsilon}}, \quad (8)$$

$$P_{F,t} \equiv \left[\int_0^1 P_{F,t}(i)^{1-\varepsilon} di\right]^{\frac{1}{1-\varepsilon}}. \quad (9)$$

The optimal allocation of expenditure is given by the following demand functions:

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t, \quad (10)$$

$$C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t. \quad (11)$$

The parameter α is (inversely) related to the degree of home bias in preferences, and is thus a natural measure of openness.

$$P_t = \left[(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}, \quad (12)$$

denotes the consumer price index. The optimality condition for the household is given by:

$$A_{W,t}\lambda_t P_t = (C_t - H_t)^{-\sigma} - h\gamma\beta E_t\left[\frac{A_{W,t}}{A_{W,t+1}}(C_{t+1} - H_{t+1})^{-\sigma}\right]. \quad (13)$$

Optimal portfolio choice implies:

$$Q_{t,t+1} = \beta E_t \frac{P_t}{P_{t+1}}\frac{\lambda_{t+1}}{\lambda_t}. \quad (14)$$

Taking conditional expectations on both sides and rearranging terms gives the conventional Euler equation:

$$\beta R_t^{Union} E_t\left\{\left(\frac{P_t}{P_{t+1}}\right)\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\right\} = 1, \quad (15)$$

where $R_t^{Union} = \frac{1}{E_t\{Q_{t,t+1}\}}$ is the gross nominal return on a riskless one-period discount bond paying off the (gross) nominal interest rate. Below we assume that the union's central bank uses that interest rate as its main instrument of monetary policy. We further assume that home and foreign economies are symmetric in terms of preferences and technology, but they can differ in price-setting. The equations describing the foreign economy are therefore the same as for home, with 'starred' variables.

2.2 Domestic Producers

Each country produces a continuum of goods. Each good is produced by a separate firm, $j \in [0,1]$, using a linear technology production function with labour as its only input:

$$Y_t(j) = A_{W,t}A_{H,t}N_t(j), \quad (16)$$

where $A_{H,t}$ is a stationary and country-specific technology shock, while $A_{W,t}$ is a non-stationary shock occurring at the union level. $A_{W,t}$ is assumed to grow in the steady state with rate γ. $A_{H,t}$ follows an AR (1) process, which can be written in logs as:

$$a_{H,t} = \rho_a a_{H,t-1} + \epsilon_{a,t}, \tag{17}$$

where $a_{H,t} \equiv \log A_{H,t}$, $\rho_a \in [0,1]$ and $\{\epsilon_{a,t}\}$ is white noise. Firms set prices in a staggered fashion, as assumed in Calvo (1983). A measure of $(1-\theta)$ of randomly selected firms reoptimise prices each period. The factor θ_H^{T-t} is the probability that the firm will not be able to adjust the price in the next $(T-t)$ periods. The firms that are able to reoptimise their price in period T maximise the current value of its profits facing a sequence of demand constraints:

$$E_t[\sum_{T=t}^{\infty} \theta_H^{T-t} Q_{t,T} Y_{H,T}(i) \left[P_{H,T}(i)\pi^{t-T} - P_{H,t} MC_{H,t}\right]], \tag{18}$$

subject to:

$$Y_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\sigma} (C_{H,t} + G_{H,t} + C^*_{H,t} + G^*_{H,t}). \tag{19}$$

The products of each firm are demanded by private domestic consumers, $C_{H,t}$, the domestic government, $G_{H,t}$, and from consumers abroad, $C^*_{H,t}$, and the foreign government, $G^*_{H,t}$. $MC_T = W_T/P_{H,T}$ is the real marginal cost function for each firm common to all producers due to perfectly competitive labour markets. Firms evaluate revenues by the same stochastic discount factor, $Q_{t,T}$, as households. The solution implies that the domestic firm sets prices as a time-varying markup over marginal costs resulting in a Phillips-curve relationship between domestic inflation and marginal costs.

2.3 Definitions

The terms of trade (TOT) between the domestic and the foreign economy are defined as the price of exported goods in terms of imported goods:

$$S_t \equiv \frac{P_{H,t}}{P_{F,t}}, \tag{20}$$

The real exchange rate is defined as:

$$Q_t = \frac{\overline{E} P^*_t}{P_t}, \tag{21}$$

where P_t and P^*_t are the CPI indices of the domestic and the foreign economy, respectively. $\overline{E}$ denotes the nominal exchange rate, which is 1 since both countries share a common currency.

2.4 Risk-Sharing, Market-Clearing and General Equilibrium

The assumption of complete international asset markets and perfect capital mobility implies perfect risk-sharing between the domestic and the foreign economy. The price of the risk-free bond must be the same in the domestic and in the foreign economy, that is, $E_t Q_{t+1} = E_t(Q^*_{t+1})$. Under this relationship, one can equate the intertemporal optimality condition of the domestic and the foreign economy giving the following risk-sharing condition:

$$\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{P_t}{P_{t+1}} = Q_{t,t+1} = \beta \frac{\lambda^*_{t+1}}{\lambda^*_t} \frac{P^*_t}{P^*_{t+1}}. \tag{22}$$

Without loss of generality, we assume symmetric initial conditions, zero net foreign asset holdings and an *ex-ante* identical environment. This implies balanced trade in value terms in the steady state and no net asset accumulation by both country. Goods market-clearing requires that:

$$Y_{H,t} = C_{H,t} + G_{H,t} + C^*_{H,t} + G^*_{H,t}, \tag{23}$$

$$Y^*_{F,t} = C^*_{F,t} + G^*_{F,t} + C_{F,t} + G_{F,t}. \tag{24}$$

2.5 Fiscal Policy

The government has the same preferences as the consumers so that its demand has the same functional form. The public consumption index is given by domestic and foreign-produced goods:

$$G_{H,t} \equiv \left(\int_0^1 G_{H,t}(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{25}$$

$$G_{F,t} \equiv \left(\int_0^1 G_{F,t}(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{26}$$

where $G_{H,t}$ and $G_{F,t}$ are the quantities of domestic and foreign goods purchased by the government. Government purchases are entirely financed by lump-sum taxes paid by domestic residents. For simplicity, we assume that there are no government debts in this model implying a balanced budget in each period.

$$G_{H,t} + G_{F,t} \leq T_t, \tag{27}$$

where all quantities are expressed in real per-capita terms. The same equations hold for the foreign economy, with 'starred' variables. In the spirit of the public finance literature, we assume that the total amount of public spending in a country is given exogenously in each period by G_t.[6] Government expenditure follows an AR(1) process at home and

[6]See Sargent and Ljungqvist (2004).

abroad, which is described by:

$$G_t = \rho_g G_{t-1} + \epsilon_{g,t}, \tag{28}$$

$$G_t^* = \rho_{g^*} G_{t-1}^* + \epsilon_{g^*,t}, \tag{29}$$

where $\{\epsilon_{G,t}\}$ and $\{\epsilon_{g^*,t}\}$ are exogenous shocks to government spending following a white noise process.

2.6 Monetary Policy

To close the model, we specify the behaviour of the monetary authority. Since both countries constitute a currency union, there is only one monetary authority. The central bank sets the interest rate in response to deviations of inflation and output growth from their steady-state level. The monetary policy rule is given by:

$$R_{Union,t} = \rho_r R_{Union,t-1} + (1-\rho_r)(\phi_1 \pi_{Union,t} + \phi_2 \Delta y_{Union,t}) + \epsilon_{R_{Union},t}, \tag{30}$$

where ρ_r is the degree of interest-rate smoothing and ϕ_1 and ϕ_2 are the relative weights on inflation and output growth. Instead of responding to the output gap, the central bank responds to deviations of output growth from the mean growth rate γ. $\pi_{Union,t}$ is a weighted measure of inflation rates of both countries and $\Delta y_{Union,t}$ is a weighted measure of output growth rates of both countries.

3 Bayesian Estimation

Before we list our specific assumptions and report our estimations results, we briefly justify the Bayesian methodology that we utilise. Substantial improvements in computational technology have led to a remarkable increase in the use of Bayesian methods in recent years.[7] We adopt this empirical approach and estimate the DSGE model employing Bayesian inference methods to assess how the variables of the model respond to a positive shock to government spending. The Bayesian approach allows us to formalise the use of prior knowledge we may have on structural parameters. On a more practical level, it also helps to stabilise the nonlinear minimisation algorithm which we use for the optimisation. We briefly sketch below the adopted approach and describe the data and the prior distributions used in its implementation. We then present our estimation results.

[7] Recent examples include Smets and Wouters (2003), Justiniano and Preston (2004), and Lubik and Schorfheide (2003, 2005).

1. The model is linearised around its deterministic steady state and written in its state space representation. The model in its linearised form is summarised in the Appendix of the paper.

2. The likelihood function is built via the state space representation and evaluated using a Kalman filter.

3. Let $p(\theta)$ denote the prior distribution of the parameter vector, $\theta \in \Theta$ and $L(Y_T|\theta)$ the likelihood function for the observed data $Y_T = \{y_t\}_{t=1}^{T}$. The posterior distribution of the parameter vector θ, is then obtained by combining the likelihood and the prior distribution:
$$p(\theta|Y_T) \propto L(Y_T|\theta)p(\theta). \tag{31}$$

4. The Random Walk Metropolis Hastings algorithm generates 30,000 of posterior draws for the parameters of the model.

5. Based on the posterior draws, point estimates and error bands for the parameters, and impulse responses functions are computed. We then study the dynamics of a shock to government spending through impulse response functions.

4 Empirical Analysis

We now consider the results and underlying assumptions of the estimation. The two-country DSGE model is estimated with French and German data. We then study the spillover effects of fiscal policy by assessing how the variables of the model respond to a positive shock to government spending.

4.1 Priors

In Table 1, the prior distributions for the model parameters are presented. Each prior distribution is indicated by the density, median and standard deviation. The priors for the price stickiness parameters θ are chosen based on microeconomic studies of price-setting behaviour. Following Angeloni et al. (2004), we set the prior mean for θ at 0.75 for both Germany and France. The prior mean for the intertemporal substitution elasticity σ is set at 2 and the intratemporal elasticity η at 1 with a large standard deviation to account for the uncertainty about the location of these parameters. The priors for the coefficients in the monetary policy rule are set for values typically associated with the Taylor rule. For the share of imported goods in the consumption basket, α, we choose 0.2 and a large standard deviation reflecting our uncertainty. In Germany, the import share of imported goods from France is 8.7%, whereas in France, 18.9% of imports are of German origin. However, we neglect trade relations with other countries due to the two-country structure of our model. We are agnostic on the sources of persistence and business cycle fluctuations and therefore choose rather uninformative priors for the autoregressive parameters and standard deviations of all shocks. The discount factor β is fixed at 0.99. Beta distributions were chosen for parameters that are constrained on the unit-interval. Gamma and normal distributions were selected for parameters in $\Re^+$. The inverse gamma distribution is used for the precision of the shocks. We assume that the priors on the models parameters are independent of each other.

4.2 Data

We estimate the model using six observable time series corresponding to French and German output and inflation as well as the real exchange rate between both countries and the union-wide nominal interest rate. All data are in quarterly frequency and the sample ranges from 1991q1 to 2005q4. The data are downloaded from the OECD database and from the International Financial Statistics (IFS).

1. Output growth (quarter-to-quarter, percent): based on French and German real GDP per capita.

2. Inflation (annualised, percent): based on the French and German Consumer Price Indices (CPI).

3. Nominal interest rate (annual, percent): euro short-term nominal interest rate (from 1999-2005), obtained from the euro area database underlying the Area-Wide Model (AWM) of the European Central Bank. Since euro area data are only available from 1999 onwards, we use the German short-term interest rate from 1991-1999. Monetary policy in Europe was guided by the Bundesbank within a system of fixed exchange rates.

4. Real exchange rate between Germany and France (quarter-to-quarter, percent): obtained from the IFS database, divided by the wholesale price indices for both countries.

4.3 Estimation Results

4.3.1 Posterior Parameter Estimates

Based on the two independent Markov Chains, we compute the posterior median and the 95% probability intervals for each of the parameters, with results reported in Table 2. Recall that the domestic and the foreign economies are symmetric in terms of preferences and technology. As a consequence, the following parameters are the same for both countries: $\sigma, h, \rho_z, \gamma, \pi^A$ and σ_z. We will briefly document the parameter estimates below. We find evidence for habit persistence with a estimated parameter value of $h = 0.3387$, which is consistent with the estimate of Smets and Wouters (2003) and Lubik and Schorfheide (2005) for the euro area. Inverse elasticity of intertemporal substitution, $\sigma = 2.7666$, is high, but within the limits typically assumed in calibration studies. The parameters for the monetary policy rule, $\phi_1 = 1.6407$ and $\phi_2 = 0.1238$, are in the range of usual Taylor-rule estimates. The low value for ϕ_2 seems rather low and indicates the focus of the ECB to maintain price stability. On the other hand, the degree of interest smoothing, $\rho_r = 0.8374$, is quite high, reflecting the long period of sticky interest rates. The estimated Calvo parameters are $\theta_H = 0.3387$ for Germany and $\theta_{H^*} = 0.5087$ for France, implying an annual duration between prize optimisation of 1 to 2 quarters for Germany and 2 quarters for France.[8] These values are usually obtained for US data,[9] whereas microeconomic studies find prices to be more sticky in Europe.[10]

4.3.2 Impulse Response Analysis

Figure 1 and Figure 2 display the impulse response function with 95% error bands. In France and in Germany, we observe a positive multiplier effect in response to to one-standard deviation government spending shock. In France, Figure 1, output increases on impact by 0.4%, remaining positive for three quarters, before returning back to the steady state. In Germany, Figure 2, the increase of output in response to shock in government spending is 2%. Output returns back to equilibrium after 3 quarters. The main result is, however, that the spillover effect on economic activity across borders is very small. Moreover, the sign of the effect is ambiguous. A positive shock to government spending

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[8] The average duration of price contracts is determined as follows: $Duration = \frac{1}{1-\theta_i}$.

[9] See Bils and Klenow (2004).

[10] To compare estimates, see also Rabanal and Rubio-Ramirez (2005), Lubik and Schorfheide (2003, 2005), Smets and Wouters (2003). Note, however, that differences in model specifications can make a direct comparison of estimates difficult.

in Germany triggers a positive response of economic activity (0.018%) in France. On the other hand, a positive shock to government spending in France depresses output (-0.02%) in Germany. The union-wide interest rate increases in response to expansionary fiscal policy in both countries. The interest rate hike is stronger in response to a fiscal shock in Germany (0.12%) than to a fiscal shock in France (0.03%).

5 Conclusion

The introduction of the Euro in 1999 has led to a debate about intensifying the fiscal coordination between countries in the Eurozone. In this context it has been argued that spillover effects of fiscal policy across borders provide a rationale for fiscal coordination. To contribute to this ongoing debate, the present paper has analysed multiplier and spillover effects of fiscal policy within and between two countries belonging to the euro area, France and Germany. For this purpose, we developed a two-country Dynamic Stochastic General Equilibrium (DSGE) model. While the existing literature is based mainly on evidence from non-structural VAR model, our structural approach is also applicable for policy analysis. Using French and German data, we estimated the model using a Bayesian inference approach. Our results suggest that spillover effects of fiscal policy on economic activity are very small and their sign ambiguous. In summary, the evidence on spillover effects stemming from the trade channel is negligible and and our results do not motivate the case on enhanced fiscal policy coordination in the Eurozone that goes beyond the already existing frameworks. On the other hand, the effect arising from the interest rate channel is clearly negative; a fiscal expansion in France and in Germany results in an union-wide interest rate increase that could subsequently depress economic activity. The increase of the union wide interest rate stemming from fiscal expansion supports the case for a strict adherence to the rules of fiscal discipline laid down in the Maastricht Criteria.

To facilitate a comparison with our results, we discuss below the work of Bénassy-Quéré (2006) and Bénassy-Quéré, Cimadomo and Mignon (2006). While our paper adopts a dynamic modelling approach, Bénassy-Quéré (2006) develops a static two-country model. She finds that a government spending expansion produces positive spillovers on foreign output provided the central bank accommodates the fiscal policy shock. In case the central bank does not accommodate the shock, the spillovers of a fiscal expansion are negative, whereas our paper finds negative spillover only in case of a transmission from France to Germany. Bénassy-Quéré, Cimadomo and Mignon (2006) study spillover effects from fiscal policy in a non-structural VAR framework. As we do in our paper, they find positive multiplier effects of government spending in France and Germany. However, in opposite to our findings, they observe a stronger impact of fiscal policy shocks on economic activity. In their analysis, a fiscal expansion originating in Germany raises output in France. Although the result is not discussed explicitly, a fiscal expansion in France has a negative impact on economic activity in Germany, a result corresponding to the findings in our paper.

We understand our model as a starting point to explore spillover effects of fiscal policy in a model with a larger number of European countries. The approach suggested by Gali and Monacelli (2004) could serve as a starting point. Gali and Monacelli (2004) develop an N-country model of a monetary union assuming the n-th country to be infinite small. At the current stage, their framework precludes the study of spillover effects between countries due to the small open economy assumption. Further, adding distortionary taxation and government debt to the fiscal policy sector would allow us to study spillover effects that arise from the income side of government finances. Hradisky, Girardi, Liska and Ratto (2006) analyse the effect of distortionary taxation into a one-country small open economy model, which they estimate with Czech data. Their approach could be extended to a two-country setting. Finally, relaxing the assumption of complete markets and introducing Non-Ricardian households would allow us to analyse of the role of fiscal policy as a cross-country insurance tool. We will pursue this approach in future work.

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A Log-linearized Model

$$\widetilde{\pi}_{H,t} = \beta E_t \widetilde{\pi}_{H,t+1} + \left[\frac{1-\theta_H}{\theta_H}(1-\theta_H\beta)\right]\widetilde{mc}_t \tag{32}$$

$$\widetilde{mc}_t = -\widetilde{\lambda}_t - \alpha\widetilde{q}_t - \widetilde{A}_t \tag{33}$$

$$\widetilde{R_t} = \rho_r \widetilde{R}_{t-1} + (1-\rho_r)[\psi_1\widetilde{\pi}_t + \psi_2(\Delta\widetilde{y}_t + \widetilde{z}_t) + \epsilon_{r,t}] \tag{34}$$

$$-\widetilde{\lambda}_t = \frac{\sigma}{1-h\beta}(C_t - H_t) - \frac{h\beta}{1-h\beta}E_t[\sigma\widetilde{C}_{t+1} + \widetilde{z}_{t+1}] \tag{35}$$

$$(1-h)\widetilde{C}_t = \widetilde{c}_t - h\widetilde{c}_{t-1} + h\widetilde{z}_t \tag{36}$$

$$-\widetilde{\lambda}_t = -E_t\widetilde{\lambda}_{t+1}(\widetilde{R}_t - E_t\widetilde{\pi}_{t+1}) + E_t\widetilde{z}_{t+1} \tag{37}$$

$$\widetilde{\pi}_t = \alpha\widetilde{\pi}_{F,t} + (1-\alpha)\widetilde{\pi}_{H,t} \tag{38}$$

$$\widetilde{s}_t = \widetilde{s}_{t-1} + \widetilde{\pi}_{H,t} - \widetilde{\pi}_{F,t} \tag{39}$$

$$\widetilde{q}_t = -(1-\alpha)\widetilde{s}_t - \widetilde{s}^*_t \tag{40}$$

$$\widetilde{\lambda}_t = \widetilde{\lambda}^*_t - s_t \tag{41}$$

$$\widetilde{y}_{H,t} = \widetilde{c}_t - \widetilde{g}_t - \frac{\alpha}{\sigma}\widetilde{q}_t - \alpha(1-\alpha)\eta(\widetilde{s}_t - \widetilde{s}^*_t) \tag{42}$$

$$\widetilde{z}_t = \triangle\ \widetilde{A}_{W,t} \tag{43}$$

$$\widetilde{z}_t = \rho_z\widetilde{z}_{t-1} + \epsilon_{z,t} \tag{44}$$

$$\widetilde{a}_t = \rho_a\widetilde{a}_{t-1} + \epsilon_{a,t} \tag{45}$$

$$\widetilde{a}^*_t = \rho_{a^*}\widetilde{a}^*_{t-1} + \epsilon_{a^*,t} \tag{46}$$

$$\widetilde{g}_t = \rho_g\widetilde{g}_{t-1} + \epsilon_{g,t} \tag{47}$$

$$\widetilde{g}^*_t = \rho_{g^*}\widetilde{g}^*_{t-1} + \epsilon_{g^*,t} \tag{48}$$

B Implementation

Table 1: Prior Distributions

Parameter	Density	Mean	Standarddeviation
h	Beta	0.40	0.1
σ	Gamma	2.00	0.5
η	Gamma	1.00	0.5
α	Gamma	0.2	0.05
Θ_H	Beta	0.75	0.15
Θ_{H^*}	Beta	0.75	0.15
ϕ_1	Gamma	1.50	0.25
ϕ_2	Gamma	0.25	0.25
ρ_r	Beta	0.50	0.20
ρ_a	Beta	0.80	0.10
ρ_g	Beta	0.80	0.1
ρ_{a^*}	Beta	0.60	0.20
ρ_{g^*}	Beta	0.80	0.10
ρ_z	Beta	0.60	0.15
σ_a	InvGamma	1.25	$[0, \infty]$
σ_g	InvGamma	1.25	$[0, \infty]$
σ_r	InvGamma	0.50	$[0, \infty]$
σ_{a^*}	InvGamma	0.50	$[0, \infty]$
σ_{g^*}	InvGamma	1.25	$[0, \infty]$
σ_z	InvGamma	0.63	$[0, \infty]$

Table 2: Posterior Estimates using 30,000 Markov Chains

Parameter	Prior Mean	Posterior Median	95% Interval
h	0.40	0.34	[0.18, 0.62]
σ	2.00	2.77	[2.26, 3.55]
η	1.00	0.31	[0.06, 0.59]
α	0.20	0.22	[0.16, 0.30]
θ_H	0.75	0.34	[0.18, 0.62]
θ_{H^*}	0.75	0.51	[0.39, 0.63]
ϕ_1	1.50	1.64	[1.17, 2.10]
ϕ_2	0.25	0.12	[0.03, 0.16]
ρ_r	0.50	0.84	[0.80, 0.91]
ρ_a	0.80	0.87	[0.76, 0.94]
ρ_g	0.80	0.91	[0.76, 0.92]
ρ_{a^*}	0.60	0.93	[0.87, 0.98]
ρ_{g^*}	0.80	0.94	[0.88, 0.97]
ρ_z	0.66	0.39	[0.24, 0.64]
σ_a	1.25	1.03	[0.60, 1.78]
σ_g	1.25	2.37	[2.06, 2.70]
σ_r	0.5	0.18	[0.13, 0.21]
σ_{a^*}	0.5	0.87	[0.38, 1.46]
σ_{g^*}	1.25	0.46	[0.37, 0.55]
σ_z	0.63	0.66	[0.45, 0.82]

Figure 1: Shock to Government Expenditure in Germany

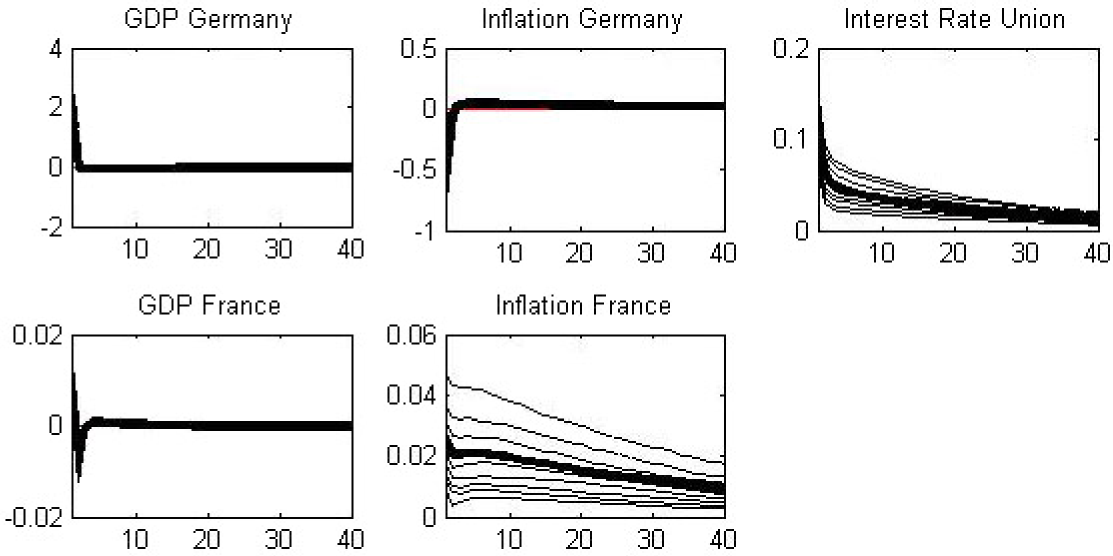

Figure 2: Shock to Government Expenditure in France