Fiscal policy rules and current account adjustment

Bernhard Herz[a] Stefan Hohberger[a] Lukas Vogel[b]

[a] University of Bayreuth

[b] DG Economic and Financial Affairs, European Commission

This version: February 2, 2013

Abstract:

The paper uses a two-region two-sector DSGE model with nominal and real rigidities to analyse the stabilising properties of simple fiscal policy rules in a small open economy in monetary union. The focus is on rules that adjust the composition of government spending on tradable and non-tradable goods in response to business cycle indicators. The policy is budgetary neutral in the sense that the overall level of government expenditure is kept constant. Hence, the rules devise an option to achieve stabilisation even when the government's fiscal space is very limited. The paper finds that shifting government spending between tradable and non-tradable goods in response to fluctuations in unemployment or the trade balance can substantially increases household welfare. The potential welfare gain increases with the strength of adjustment frictions in the private sector. Shifting expenditure between tradable and non-tradable goods also affects relative prices of tradable goods and can stabilise external accounts over the business cycle.

JEL classification: E62, F32, F41

Keywords: fiscal policy, current account imbalances, monetary union

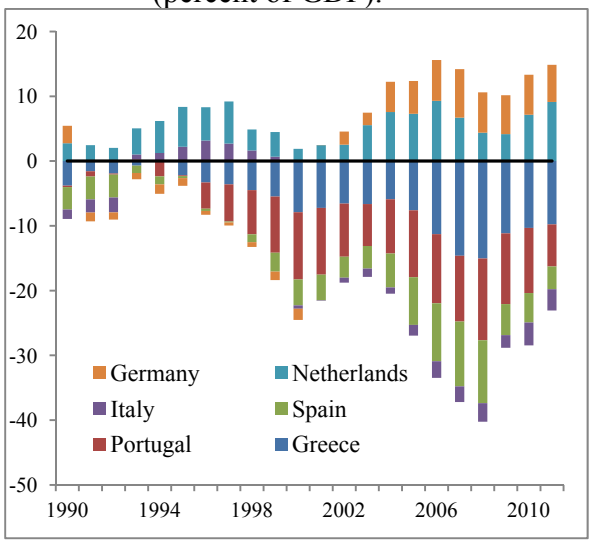
---

The views in this paper are personal and should not be attributed to the European Commission. Corresponding author: Stefan Hohberger, University of Bayreuth, Chair of Economics I, Universitätsstraße 30, 95447 Bayreuth, Germany; email: stefan.hohberger@uni-bayreuth.de

1. Introduction

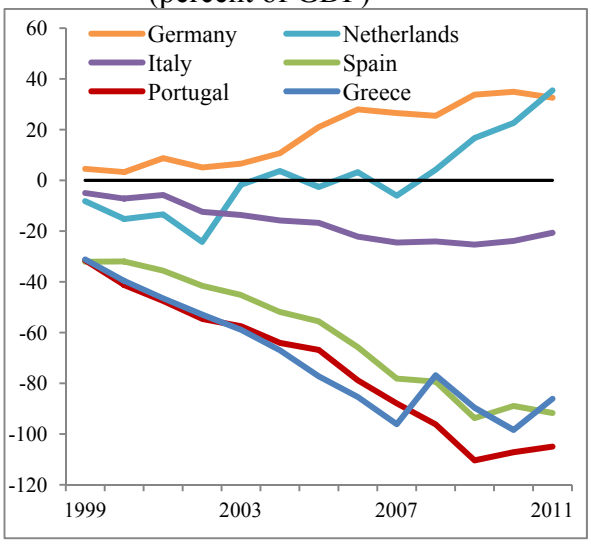
The issue of intra-European imbalances has gained increasing attention in recent years, not the least due to the ongoing twin debt and banking crisis in the euro area. Especially some southern European countries like Portugal, Italy, Greece and Spain, have developed growing and persistent current account deficits and external liabilities since the beginning of the European Monetary Union (EMU) (see figures 1 and 2).

Figure 1: Current account balances (percent of GDP).



Source: WDI online database.

Figure 2: Net foreign asset position (percent of GDP)



Source: Eurostat.

There are two complementary sets of explanations for the rising euro area imbalances. According to one view, they are related to the process of financial integration, expectations of convergence and greater optimism of future growth associated with lower savings and higher investment, supported by a decline of borrowing costs through the elimination of exchange rate risk and the disappearance of country risk premia (see Blanchard and Giavazzi, 2002; Jaumotte and Sodsriwiboon, 2010; Lane and Pels, 2012; Pagano et al., 2012). A second view emphasizes that they are caused by competitiveness problems in the borrowing countries, specifically resulting from strong growth in domestic demand with a subsequent increase in domestic prices and unit labor costs, which led to real exchange rate appreciation and a worsening of the current account (see Arghyrou and Chortareas, 2008; Zemanek et al., 2010; Belke and Dreger, 2011; Chen et al., 2012).

As the ongoing current financial crisis makes clear current account imbalances can cause far reaching damage to financial stability. In this context, macroeconomic policy faces new and pressing challenges; furthermore, the crisis reveals the poor knowledge concerning the effectiveness of fiscal interventions. As fiscal policy is the major macroeconomic policy instrument left with the individual members of EMU, it is of particular interest to analyze to what extent fiscal policy could contribute to attenuate or even prevent the emergence of current account imbalances.[1]

The relationship between fiscal policy and the external position has been subject to an extensive discussion in the literature. One strand of the literature relates to the twin deficit hypothesis that fiscal policy is a contributory factor to the emergence of external imbalances (see e.g. Corsetti and Müller, 2006; Kim and Roubini, 2008; Kumhof and Laxton, 2009b; Bouakez et al., 2011). Kumhof and Laxton (2009b) show that a permanent increase in fiscal deficits of 1 percent of GDP deteriorates the current account by around 0.5 percent of GDP in the short run and 0.75 percent of GDP in the long run for a country of the size of the US, and by 1 percent of GDP for a small open economy.[2] In the context of the European Union, Beetsma et al. (2008) point to the potential relevance of the twin deficit hypothesis as they find for 14 EU countries over the period 1970 – 2004 that an increase in public spending of 1 percent of GDP raises GDP by 1.2 percent and deteriorates the trade balance by 0.5 percent of GDP. Another strand of the literature emphasizes the role of fiscal policy in facilitating current account adjustments, regardless of the source of external imbalances (see e.g. Catalán and Lama, 2006; Ali Abbas et al., 2010; Abiad et al., 2011). Catalán and Lama (2006) provide support for the stabilization potential of fiscal policy as they show for the Spanish economy that an 1 percent exogenous fall in real government spending improves the current account balance by about 0.16 percentage points of GDP over the first year. Based on a large country sample of 124 countries, Ali Abbas et al. (2010) show that an improvement in the fiscal balance of 1 percent of GDP improves the current account balance by about 0.3 percentage point of GDP. In a study on fiscal consolidation and its implications for the current account,

[1] The issue of alternative rebalancing options through fiscal policy has gained increasing attention, since the European Commission explicitly looks with their new surveillance procedure for the prevention and correction of macroeconomic imbalances (Macroeconomic Imbalance Procedure – MIP) into the process of external imbalances (see European Commission, 2012).

[2] Kumhof and Laxton (2009b) point out that the effectiveness of fiscal policy significantly depends on the assumption of non-Ricardian savings behaviour. In an infinite-horizon model with 50% share of liquidity-constraint agents the short run current account deficit increases by between 0.1% of GDP for tax cuts and 0.4% of GDP for spending increases.

Abiad et al. (2011) find that a fiscal consolidation of 1 percent of GDP results in an improvement in the current account of about 0.5 percent of GDP within two years.

A recent discussion on the potential role of fiscal policy and external imbalances is given by Lane (2010a, 2010b). As a lesson from the financial crisis, Lane (2010b) argues that the stabilization role of fiscal policy should not only relate to the output cycle, but also respond to external imbalances, because of the risks to macroeconomic and fiscal stability embedded in such imbalances. These risks provide a motivation to engage in preventive operations and may justify a preventive role for fiscal policy to limit the scale of external imbalances. In order to analyze the potential role that fiscal policy could play in facilitating current account rebalancing, we need to emphasize the instruments government could use to correct or even prevent external imbalances. One way is that government could run a more positive fiscal balance in order to reduce a current account deficit. Therefore, a decrease in government spending reduces the demand for domestic goods, depreciates the real exchange rate through relative price changes and diminishes the current account deficit through the trade channel. This type of stabilization is analyzed by Herz and Hohberger (2013). They show that a countercyclical fiscal response to the current account can help stabilizing macroeconomic variables (e.g. real exchange rate and current account) at the expense of higher output variability. Therefore, fiscal policy faces a trade-off between current account and output stabilization. While Lane (2010a) argues that it might be difficult to introduce the stabilization of the current account in the objective function of policymakers, Blanchard (2007) emphasizes that fiscal policy may contribute to imbalance correction by mitigating the distortions underlying excessive current account imbalances. He argues that wage and price rigidities together with the fixed exchange rate within EMU affect the adjustment process of real wages and relative prices, which creates distortions and leads to large and persistent external imbalances. These distortions may justify policy interventions in order to prevent the appearance of current account imbalances.

The focus of our paper is to analyze how the composition of government spending on tradable and non-tradable goods affects (the correction of) current account imbalances those emerge from the combination of structural distortions/rigidities and country-specific shocks. As Lane and Milesi-Ferretti (2012) find that domestic demand compression dominates the current account adjustment in the crisis, it is interesting to consider the potential contribution of expenditure switching (from tradable to non-tradable goods sector) to imbalance correction

and prevention.[3] The policy is budgetary neutral in the sense that the overall level of government expenditure is kept constant. Hence, the rules devise an option to achieve stabilisation even when the government's fiscal space is very limited.

The analytical framework is a two-region New Keynesian DSGE model with tradable and non-tradable goods sector, price and wage stickiness and financial market frictions. The analysis of fiscal stabilisation focuses on a small member country in monetary union, which excludes feedback to monetary policy and the rest of monetary union (RoU) in the model. Our framework follows the approach by Gali and Monacelli (2008), as it is of particular interest to analyze fiscal stabilization properties in a monetary union setting.[4] Furthermore, small countries tend to be more exposed to asymmetric shocks and have less impact on union wide (monetary) policies.

The paper finds that shifting government spending between tradable and non-tradable goods in response to fluctuations in unemployment or the trade balance can substantially increases household welfare. The potential welfare gain increases with the strength of adjustment frictions in the private sector. Shifting expenditure between tradable and non-tradable goods also affects relative prices of tradable goods and can stabilise external accounts over the business cycle.

[3] Projections by Pagano et al. (2012) indicate for Spain that corrections of their imbalances will require an adjustment in domestic demand and a significant improvement in the trade balance.
[4] The small-country setting differs from previous research that has focused on fiscal policy in monetary unions of two large/symmetric countries (e.g., Beetsma and Jensen, 2004; Kirsanova et al., 2007; Ferrero, 2009).

2. Model

The analytical framework is inspired by Galí and Monacelli (2008) who discuss optimal monetary and fiscal policy in a monetary union of small open economies. Our specific model is based on Vogel et al. (2012) who investigate the potential of simple fiscal policy rules to stabilise cyclical fluctuations in monetary union. They extend the Gali/Monacelli model by a larger variety of policy instruments (government purchases, transfers, taxes), introduce physical capital and include additional frictions (wage stickiness, financial frictions, and capital adjustment costs). We augment this model by adding a non-tradable goods sector. Therefore, our model consists of two regions, i.e. a small (domestic) member country of monetary union and the rest of monetary union (RoU), and two sectors, i.e. tradable (T) and non-tradable (NT) goods sectors. The model includes monopolistic competition in goods and labour markets, nominal price and wage stickiness, liquidity constraints, capital and labour as inputs into production, and a set of fiscal variables in order to analyse the impact of the composition of government spending in T and NT goods on current account positions. The presence of intertemporal optimising consumers (NLC), i.e. households that can freely borrow and save to smooth consumption over time, and liquidity-constrained (LC) households, i.e. households without access to financial markets who consume their entire current disposable wage and transfer income in each period. The introduction of LC households can account for the positive correlation between private and government consumption at business cycle frequencies (e.g., Galí et al., 2007), and estimated macro models of the euro area (e.g., Forni et al., 2009; Ratto et al., 2009) indicate the share of LC households to be high. In light of the empirical evidence (Kollmann, 1996) we depart from the assumption of complete risk-sharing present in Beetsma and Jensen (2004), Ferrero (2009), Galí and Monacelli (2008) and Kirsanova et al. (2007) and introduce a debt-dependent country risk premium (Schmitt-Grohé and Uribe, 2003) as external closure. Goods markets are imperfectly integrated across borders in the sense that there is home bias in the demand for goods. Labour is immobile between countries. The RoU variables and monetary policy are exogenously given from the perspective of the small economy.

Households

The household sector consists of a continuum of households *i*. The welfare of household *i* is the discounted sum of the period utilities:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma} (C_t^i)^{1-\sigma} + \frac{\chi}{1-\sigma} G_t^{1-\sigma} - \frac{\kappa}{1+\varphi} (L_t^i)^{1+\varphi} \right) \tag{2.1}$$

Household utility is additive in private consumption C_t^i, government purchases G_t and work L_t^i. The parameters β, χ, 1/σ, κ and 1/φ are the discount factor, the utility weight of government purchases, the intertemporal elasticity of substitution, the disutility weight work, and the elasticity of labour supply. The benchmark model assumes log consumption utility, i.e. σ=1.

The households decide about private consumption and labour supply given their respective budget constraints. Government consumption enters household utility, but is not a choice variable of the households. Instead, the level of government consumption is chosen by the government as described below.

NLC households, who are a fraction 1-*slc* of the population, make optimal intertemporal choices given their intertemporal budget constraint:

$$\begin{aligned} &(1-\tau_t^w) W_t^i L_t^i + (1+i_{t-1}) B_{t-1} + \left(1 + i_{t-1}^* - \omega \frac{B_{H,t-1}^*}{4 P_{GDP,t-1} Y_{t-1}} + \varepsilon_t^r \right) B_{t-1}^* + TR_t + (1-\tau_t^k) i_t^k K_{t-1}^i \\ &+ \tau_t^k \delta P_t K_{t-1}^i + PR_t = (1+\tau_t^c) P_t C_t^{NLC} + P_t I_t^i + B_t + B_{H,t}^* + \gamma_w / 2 (\pi_t^{w,i})^2 P_t L_t + TAX_t \end{aligned} \tag{2.2}$$

The revenue side includes the nominal wage income $W_t^i L_t^i$ net of the (linear) labour income tax τ_t^w, the payment on maturing one-period domestic government bonds B_{t-1} including interest i_{t-1}, the repayment of one-period net foreign assets $B_{H,t-1}^*$ including interest, which is the sum of the foreign rate i_{t-1}^*, the endogenous part of the risk premium $-\omega B_{H,t-1}^* / (4 P_{GDP,t-1} Y_{t-1})$ and the exogenous component ε_t^r, lump-sum transfers from the government TR_t, the return to capital $(1-\tau_t^k) i_t^k K_{t-1}^i + \tau_t^k \delta P_t K_{t-1}^i$ net of capital taxes τ_t^k and depreciation allowances $\tau_t^k \delta$, where $K_t^i \equiv K_{T,t}^i + K_{NT,t}^i$, and profit income PR_t from firm

ownership. The expenditure side combines nominal consumption $P_t C_t^{NLC}$ taxed at rate τ_t^c, where P_t is the consumer price index (CPI), nominal investment in the tradable and non-tradable sector $P_t I_t^i$, where $I_t^i \equiv I_{T,t}^i + I_{NT,t}^i$, financial investment in domestic bonds and (net) foreign assets, and quadratic costs γ_w of wage adjustment ($\pi_t^{w,i} \equiv W_t^i / W_{t-1}^i - 1$), where $P_{GDP,t} = P_{TH,t} + P_{NT,t}$ is the price level of domestic output, i.e. the GDP deflator. Finally, TAX_t is a lump-sum tax levied only on NLC households and introduced to provide a hypothetical non-distortionary benchmark for the fiscal closure rule.

The accumulation of physical capital in the tradable and non-tradable goods sector follows the law of motion:

$$K_{T,t}^i = I_{T,t}^i + (1-\delta)K_{T,t-1}^i - \frac{\gamma_k}{2}\left(\frac{I_{T,t}^i}{K_{T,t-1}^i} - \delta\right)^2 K_{T,t-1}^i \tag{2.3}$$

$$K_{NT,t}^i = I_{NT,t}^i + (1-\delta)K_{NT,t-1}^i - \frac{\gamma_k}{2}\left(\frac{I_{NT,t}^i}{K_{NT,t-1}^i} - \delta\right)^2 K_{NT,t-1}^i$$

including capital depreciation at rate δ and quadratic cost γ_k of capital stock adjustment.

The NLC households maximise (2.1) given equations (2.2) and (2.3), which provides the first-order conditions (FOC) for consumption, financial asset holdings and real capital investment:

$$1/(C_t^{NLC})^\sigma - (1+\tau_t^c)\lambda_t^{NLC} = 0 \tag{2.4}$$

$$\lambda_t^{NLC} / P_t - \beta(1+i_t)E_t(\lambda_{t+1}^{NLC} / P_{t+1}) = 0$$

$$\frac{\lambda_t^{NLC}}{P_t} - \beta\left(1 + i_t^* - \omega\frac{B_{H,t-1}^*}{4P_{H,t-1}Y_{t-1}} + \varepsilon_t^r\right)E_t\left(\frac{\lambda_{t+1}^{NLC}}{P_{t+1}}\right) = 0$$

$$P_t\lambda_t^{NLC} - \mu_t\left(1 - \gamma_k NI_{T,t}^i\right) = 0$$

$$P_t\lambda_t^{NLC} - \mu_t\left(1 - \gamma_k NI_{NT,t}^i\right) = 0$$

$$\beta E_t \lambda_{t+1}^{NLC}\left(\left(1-\tau_{t+1}^{k}\right)i_{t+1}^{k}+\tau_{t+1}^{k}\delta P_{t+1}\right)-\mu_t+\beta E_t \mu_{t+1}\left(1-\delta-\frac{\gamma_k}{2}(NI_{T,t+1}^{i})^2+\gamma_k NI_{T,t+1}^{i}\frac{I_{T,t+1}^{i}}{K_{T,t}^{i}}\right)=0$$

$$\beta E_t \lambda_{t+1}^{NLC}\left(\left(1-\tau_{t+1}^{k}\right)i_{t+1}^{k}+\tau_{t+1}^{k}\delta P_{t+1}\right)-\mu_t+\beta E_t \mu_{t+1}\left(1-\delta-\frac{\gamma_k}{2}(NI_{NT,t+1}^{i})^2+\gamma_k NI_{NT,t+1}^{i}\frac{I_{NT,t+1}^{i}}{K_{NT,t}^{i}}\right)=0$$

where E_t is the expectations operator, λ_t^{NLC} is the Lagrange multiplier associated with (2.2), μ_t is the Lagrange multiplier associated with (2.3) and $NI_{u,t}^{i} \equiv I_{u,t}^{i} / K_{u,t-1}^{i} - \delta$, for $u = T, NT$.

Combining the first two FOCs gives the Euler equation for the optimal path of NLC consumption:

$$\beta E_t\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\frac{P_t}{P_{t+1}}\left(\frac{C_t^{NLC}}{C_{t+1}^{NLC}}\right)^{\sigma}\right)=\frac{1}{1+i_t} \tag{2.5}$$

Combing the second and third FOC for domestic bonds and foreign assets gives an interest parity condition including the risk premium:

$$i_t = i_t^* - \omega\frac{B_{H,t-1}^{*}}{4P_{GDP,t-1}Y_{t-1}}+\varepsilon_t^r \tag{2.6}$$

with ω>0 and the exogenous AR(1) risk-premium shock:

$$\varepsilon_t^r = \rho_r \varepsilon_{t-1}^r + \nu_t^r \tag{2.7}$$

where ρ_r is the shock persistence and ν_t^r an innovation with zero mean and standard deviation σ_r. Note that equation (2.6) does not include an exchange rate term as we consider regions in a monetary union.

The period budget constraint of LC households constituting the share *slc* of the population is:

$$(1-\tau_t^w)W_t^i L_t^i + TR_t = (1+\tau_t^c)P_t C_t^{LC} + \gamma_w / 2(\pi_t^{w,i})^2 P_t L_t^{LC} \tag{2.8}$$

Real consumption by LC households is constrained by the disposable labour and transfer income and equals:

$$(1+\tau_t^c)P_tC_t^{LC} = (1-\tau_t^w)W_t^i L_t^i + TR_t - \gamma_w / 2(\pi_t^{w,i})^2 P_t L_t \tag{2.9}$$

The marginal value of the LC households' income is analogous to the FOC for NLC households:

$$1/(C_t^{LC})^\sigma - (1+\tau_t^c)\lambda_t^{LC} = 0 \tag{2.10}$$

The per-capita level of consumption in the aggregate is the weighted average of NLC and LC consumption:

$$C_t \equiv (1-slc)C_t^{NLC} + slcC_t^{LC} \tag{2.11}$$

Private demand combines domestically produced tradable ($C_{TH,t}^i, I_{TH,t}^i$), non-tradable ($C_{NT,t}^i$, $I_{NT,t}^i$) and imported ($C_{TF,t}^i, I_{TF,t}^i$) goods. Assuming the same trade price elasticity for consumption and investment demand, we can aggregate $Z_t \in (C_t^{NLC}, C_t^{LC}, I_t)$ and define Z_t as a CES aggregate of tradable ($Z_{T,t}^i$) and non-tradable goods ($Z_{NT,t}^i$):

$$Z_t = \left[(\phi)^{\frac{1}{\psi}} (Z_{T,t})^{\frac{\psi-1}{\psi}} + (1-\phi)^{\frac{1}{\psi}} (Z_{NT,t})^{\frac{\psi-1}{\psi}} \right]^{\frac{\psi}{\psi-1}} \tag{2.12}$$

where ϕ and ψ is the share of tradable goods and the elasticity of substitution between tradable and non-tradable goods, respectively. $Z_{T,t}$ is a composite index of domestically produced tradable goods ($Z_{TH,t}$) and imported goods ($Z_{TF,t}$) defined by:

$$Z_{T,t} = \left[(h)^{\frac{1}{\eta}} (Z_{TH,t})^{\frac{\eta-1}{\eta}} + (1-h)^{\frac{1}{\eta}} (Z_{TF,t})^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{2.13}$$

where h represents the steady-state home bias and η indicates the elasticity of substitution between domestically produced goods and imports. $Z_{TH,t}$, $Z_{TF,t}$ and $Z_{NT,t}$ are aggregates of the continuum of varieties j given by:

$$Z_{TH,t} = \left(\int_0^1 (Z_{TH,t}^j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}, \; Z_{TF,t} = \left(\int_0^1 (Z_{TF,t}^j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}, \; Z_{NT,t} = \left(\int_0^1 (Z_{NT,t}^j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad (2.14)$$

where ε is the elasticity of substitution between these varieties. Each variety is produced by a specialised firm *j*.

The domestic consumer price index (P_t) is given by:

$$P_t = \left[(\phi)(P_{T,t})^{1-\psi} + (1-\phi)(P_{NT,t})^{1-\psi} \right]^{\frac{1}{1-\psi}} \quad (2.15)$$

where the domestic country price index for tradable goods ($P_{T,t}$) has the following form:

$$P_{T,t} = \left[(h)(P_{TH,t})^{1-\eta} + (1-h)(P_{TF,t})^{1-\eta} \right]^{\frac{1}{1-\eta}} \quad (2.16)$$

The optimal allocation for any given expenditure yields the demand for each category of goods *j*:

$$Z_{TH,t}^j = \left(\frac{P_{TH,t}^j}{P_{TH,t}} \right)^{-\varepsilon} Z_{TH,t}, \; Z_{TF,t}^j = \left(\frac{P_{TF,t}^j}{P_{TF,t}} \right)^{-\varepsilon} Z_{TF,t}, \; Z_{NT,t}^j = \left(\frac{P_{NT,t}^j}{P_{NT,t}} \right)^{-\varepsilon} Z_{NT,t} \quad (2.17)$$

The elasticity ε determines the price setting power of individual firms. The pricing margin of firms declines with increasing ε, because higher values of ε magnify the impact of deviations from competitor prices on firm *j*'s market share.

Finally, the optimal allocation of expenditures between traded and non-traded goods and between traded domestically produced and imported goods is:

$$Z_{T,t} = \phi \left(\frac{P_{T,t}}{P_t} \right)^{-\psi} Z_t \quad (2.18)$$

$$Z_{NT,t} = (1-\phi) \left(\frac{P_{NT,t}}{P_t} \right)^{-\psi} Z_t \quad (2.19)$$

$$Z_{TH,t} = h\left(\frac{P_{TH,t}}{P_{T,t}}\right)^{-\eta} Z_{T,t} \tag{2.20}$$

$$Z_{TF,t} = (1-h)\left(\frac{P_{TF,t}}{P_{T,t}}\right)^{-\eta} Z_{T,t} \tag{2.21}$$

The households *i* supply labour services L_t^i to both tradable and non-tradable goods sectors:

$$L_t^i = L_{T,t}^i + L_{NT,t}^i \tag{2.22}$$

We assume that labour is mobile across both sectors, which equalises wages between the tradable and non-tradable goods sector. Total labour is a composite of the differentiated labour services:

$$L_t = \left(\int_0^1 (L_t^i)^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}} \tag{2.23}$$

with θ being the elasticity of substitution between the varieties of labour services. The minimisation of labour costs by firms gives the demand function for variety *i* as:

$$L_t^i = \left(\frac{W_t^i}{W}\right)^{-\theta} L_t \tag{2.24}$$

The market power of worker *i* declines with increasing θ, because higher values of θ amplify the fall in the relative demand for L_t^i in response to higher individual wage claims.

The labour services are distributed equally across NLC and LC households, and specialised labour unions represent the different types of labour services *i* in the wage setting. The wage setting is subject to quadratic adjustment costs, which provide an incentive to smooth the wage adjustment and lead to nominal wage stickiness. Since we assume identical wages W_t^i for both sectors, the optimisation problem of the labour union representing the labour service *i* is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(-\frac{\kappa}{1+\varphi}(L_t^i)^{1+\varphi} + \lambda_t^i (1-\tau_t^w) \frac{W_t^i}{P_t} L_t^i - \lambda_t^i \frac{\gamma_w}{2} (\pi_t^{w,i})^2 \frac{P_{TH,t}}{P_t} L_t \right) \tag{2.25}$$

The optimal wage maximises (2.25) given labour demand (2.24) and the marginal value of NLC income (2.4) and LC income(2.10). NLC and LC households receive the same wage, and the unions average the marginal value of NLC and LC income according to the population share of the two types of households.

The optimisation problem is symmetric across unions *i*, which implies identical wages ($W_t^i = W_t$) and labour demand ($L_t^i = L_t$) across households. Hence, the aggregate wage setting equation is:

$$(1-\tau_t^w)\frac{W_t}{P_t} = \frac{\theta}{\theta-1}\frac{\kappa L_t^{\varphi}}{\lambda_t^{tot}} - \frac{\gamma_w}{\theta-1}\frac{W_t}{W_{t-1}}\frac{P_{TH,t}}{P_t}\pi_t^w + \frac{\gamma_w}{\theta-1}\beta E_t\left(\frac{\lambda_{t+1}^{tot}}{\lambda_t^{tot}}\frac{W_{t+1}}{W_t}\frac{P_{TH,t+1}}{P_{t+1}}\frac{L_{t+1}}{L_t}\pi_{t+1}^w\right) \tag{2.26}$$

with

$$\lambda_t^{tot} \equiv (1-slc)\lambda_t^{NLC} + slc\lambda_t^{LC} \tag{2.27}$$

where the gross wage claims increase with increasing labour taxation (τ_t^w) for given levels of employment.

Firms

The economy consists of a continuum of monopolistically competitive firms in the tradable and non-tradable sector. Firms are owned by NLC households, which consequently receive the firms' profits. Each firm *j* in each sector u produces a differentiated good $Y_{u,t}^j$ with capital $K_{u,t-1}^j$, labour $L_{u,t}^j$ and Cobb-Douglass production technology:

$$Y_{T,t}^j = A_{T,t}(K_{T,t-1}^j)^{\alpha}(L_{T,t}^j)^{1-\alpha} \tag{2.28}$$

$$Y_{NT,t}^j = A_{NT,t}(K_{NT,t-1}^j)^{\alpha}(L_{NT,t}^j)^{1-\alpha}$$

The sector-specific total factor productivity $A_{u,t}$ is identical across firms and follows the AR(1) process:

$$\ln A_{u,t} = (1-\rho_a)\ln \bar{A} + \rho_a \ln A_{u,t-1} + \nu^a_{u,t} \tag{2.29}$$

where ρ_a indicates the shock persistence and $\nu^a_{u,t}$ is a sector-specific innovation with zero mean and standard deviation σ_a.

The cost-minimal combination of capital and labour is given by:

$$\frac{L^j_{u,t}}{K^j_{u,t-1}} = \frac{1-\alpha}{\alpha}\frac{i^k_t}{W_t} \tag{2.30}$$

which implies for the nominal marginal costs $MC^j_{u,t}$ of the optimising firm:

$$MC^j_{u,t} = \frac{(i^k_t)^{\alpha} W_t^{1-\alpha}}{A_{u,t}\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \tag{2.31}$$

and $MC^j_{u,t} = MC_{u,t}$. The firms in each sector u face quadratic price adjustment costs γ_p and set prices $P^j_{TH,t}$ and $P^j_{NT,t}$ to maximise the discounted expected profit. For the tradable sector and non-tradable sector firms profit maximization has the following form:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda^{NLC}_t}{\lambda^{NLC}_0}\left(\frac{P^j_{TH,t}}{P_{GDP,t}} Y^j_{T,t} - \frac{MC^j_{T,t}}{P_{GDP,t}} Y^j_{T,t} - \frac{\gamma_p}{2}(\pi^{p,j}_{TH.t})^2 Y_{T,t}\right) \tag{2.32}$$

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda^{NLC}_t}{\lambda^{NLC}_0}\left(\frac{P^j_{NT,t}}{P_{GDP,t}} Y^j_{NT,t} - \frac{MC^j_{NT,t}}{P_{GDP,t}} Y^j_{NT,t} - \frac{\gamma_p}{2}(\pi^{p,j}_{NT.t})^2 Y_{NT,t}\right)$$

The FOC with respect to $P^j_{TH,t}$ ($P^j_{NT,t}$) given the demand functions (2.17) and (2.42), the production technology (2.28) and the marginal utility of wealth of NLC households (2.4) describes the pricing behaviour of firm *j* in the tradable (non-tradable) sector:

$$P_{TH,t} = \frac{\varepsilon}{\varepsilon - 1 + \gamma_p \frac{P_{TH,t}}{P_{TH,t-1}} \pi_{TH,t} - \gamma_p \beta E_t \left(\frac{\lambda_{t+1}^{NLC}}{\lambda_t^{NLC}} \frac{P_{TH,t+1}}{P_{TH,t}} \frac{Y_{t+1}}{Y_t} \pi_{TH,t+1} \right)} MC_{T,t} \tag{2.33}$$

$$P_{NT,t} = \frac{\varepsilon}{\varepsilon - 1 + \gamma_p \frac{P_{NT,t}}{P_{NT,t-1}} \pi_{NT,t} - \gamma_p \beta E_t \left(\frac{\lambda_{t+1}^{NLC}}{\lambda_t^{NLC}} \frac{P_{NT,t+1}}{P_{NT,t}} \frac{Y_{t+1}}{Y_t} \pi_{NT,t+1} \right)} MC_{NT,t}$$

with $\pi_{TH,t} \equiv P_{TH,t} / P_{TH,t-1} - 1$ and $\pi_{NT,t} \equiv P_{NT,t} / P_{NT,t-1} - 1$ as the percentage change of the sectoral price deflator in the tradable and non-tradable sector.[5] Contrary to the Calvo model of staggered price setting which implies price dispersion, the pricing behaviour under quadratic adjustment is symmetric across firms at each period in time, so that firm-level output in both sectors u can be aggregated easily to total domestic production:

$$Y_t = \int_0^1 A_{u,t} (K_{u,t-1}^j)^{\alpha} (L_{u,t}^j)^{1-\alpha} dj = A_{u,t} K_{u,t-1}^{\alpha} L_{u,t}^{1-\alpha} \tag{2.34}$$

The nominal GDP is the sum of domestically produced tradable and non-tradable output:

$$P_{GDP,t} Y_t = P_{TH,t} Y_{T,t} + P_{NT,t} Y_{NT,t} \tag{2.35}$$

Government sector

The government collects labour, capital, consumption and lump-sum taxes and issues one-period bonds to finance government purchases, general and targeted transfers and the servicing of outstanding debt B_{t-1}:

$$\tau_t^w W_t L_t + \tau_t^k (i_t^k - \delta) K_{t-1} + \tau_t^c P_t C_t + TAX_t + B_t = P_t G_t + TR_t + (1 + i_{t-1}) B_{t-1} \tag{2.36}$$

[5] Kumhof and Laxton (2009a) use inflation adjustment instead of price adjustment costs in their discussion of simple fiscal policy rules for open economies. Contrary to the standard *price* adjustment costs implying purely forward-looking inflation dynamics, *inflation* adjustment costs are a mechanism to generate endogenous inflation persistence.

Government purchases are an aggregate of tradable and non-tradable goods as well as domestically produced traded and imported goods analogously to private demand in (2.12) and (2.14):[6]

$$G_t^{(\psi-1)/\psi} = \phi^{1/\psi} G_{T,t}^{(\psi-1)/\psi} + (1-\phi)^{1/\psi} G_{NT,t}^{(\psi-1)/\psi} \tag{2.37}$$

$$G_{T,t}^{(\eta-1)/\eta} = h^{1/\eta} G_{TH,t}^{(\eta-1)/\eta} + (1-h)^{1/\eta} G_{TF,t}^{(\eta-1)/\eta} \tag{2.38}$$

$$G_{TH,t} = \left(\int_0^1 (G_{TH,t}^j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}, \; G_{TF,t} = \left(\int_0^1 (G_{TF,t}^j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}, \; G_{NT,t} = \left(\int_0^1 (G_{NT,t}^j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{2.39}$$

which gives equivalent demand functions for the alternative bundles and varieties j:

$$G_{TH,t} = h(P_{TH,t} / P_t)^{-\eta} G_{T,t} \tag{2.40}$$

$$G_{TF,t} = (1-h)(P_{TF,t} / P_t)^{-\eta} G_{T,t} \tag{2.41}$$

$$G_{TH,t}^j = \left(\frac{P_{TH,t}^j}{P_{TH,t}} \right)^{-\varepsilon} G_{TH,t}, \; G_{TF,t}^j = \left(\frac{P_{TF,t}^j}{P_{TF,t}} \right)^{-\varepsilon} G_{TF,t}, \; G_{NT,t}^j = \left(\frac{P_{NT,t}^j}{P_{NT,t}} \right)^{-\varepsilon} G_{NT,t} \tag{2.42}$$

In order to analyze the stabilizing properties of different government spending compositions for the current account, the long-term fiscal position should be budgetary neutral. Therefore, the government needs to adjust tax revenue or expenditure to stabilise government debt and deficits around target values. The government can adjust purchases between the tradable and non-tradable goods sector in response to cyclical fluctuations. The policy takes the form of simple fiscal instrument rules[7] that are similar to simple interest rate rules in monetary policy:

[6] The EU's internal market and public procurement policies have weakened the case for the alternative assumption of strong/full home bias in government consumption.

[7] The emphasis on simple instrument rules owes to their practical advantages over fully optimal policy solutions. Contrary to the fully optimal policy solution, simple rules use a limited set of information. Compliance with simple rules is, consequently, easier to monitor than the commitment to fully optimal policy, and the feasibility of compliance monitoring mitigates the credibility/time-consistency problem. Credibility is crucial, because it determines the policy maker's ability to anchor the expectations of households and firms.

$$\frac{G_{T,t}}{G_t} = \rho \frac{G_{T,t-1}}{G_{t-1}} + (1-\rho)\left(1 - \frac{T}{Y}\right) + (1-\rho)\left(res_L\left(1 - L_{NT}\right) + res_{TB}\left(\frac{TB_t}{Y_t}\right)\right) \tag{2.43}$$

The instrument rule (2.43) responds with one quarter delay to economic conditions, i.e. includes a recognition/implementation lag as in Kirsanova et al. (2007).[8] The instrument rule (2.43) implies a shift of government spending from the tradable to non-tradable sector to fluctuations in the employment (L) and the trade balance to GDP (TB/Y).

The government adjusts tax transfer payments or taxes to stabilise government debt and the budget deficit at their target levels. In the simulations we first consider lump-sum taxes as instrument in the budgetary closure rule:

$$\frac{TAX_t}{Y_t} = \frac{TAX_{t-1}}{Y_{t-1}} + \xi_b\left(\frac{B_{t-1}}{4P_{GDP,t-1}Y_{t-1}} - btar\right) + \xi_d \Delta \frac{B_{t-1}}{4P_{GDP,t-1}Y_{t-1}} \tag{2.44}$$

where TAX_t is levied only from NLC households and *btar* is the target debt-to-GDP ratio. The lump-sum closure (2.44) is standard in the literature. It provides a theoretically appealing benchmark, because it has neither distortionary nor relevant income effects for NLC or LC households.

In practice, lump-sum taxation is rare; most tax revenue comes from direct taxes. A more realistic budget closure is:

$$\tau^w_{ds,t} = \tau^w_{ds,t-1} + \xi_b\left(\frac{B_{t-1}}{4P_{GDP,t-1}Y_{t-1}} - btar\right) + \xi_d \Delta \frac{B_{t-1}}{4P_{GDP,t-1}Y_{t-1}} \tag{2.45}$$

with $\tau^w_t \equiv \tau^w_{cs,t} + \tau^w_{ds,t}$. If the closure rule (2.45) is active, the government increases the labour tax rate to collect additional revenue if debt and/or deficit levels exceed the target values. The labour tax closure increases the complexity of the model dynamics by affecting the labour supply decision of workers and the disposable period income and consumption demand of LC households.

[8] In contrast, Beetsma and Jensen (2004), Ferrero (2009), and Galí and Monacelli (2008) assume contemporaneous feedback.

External accounts

The total demand for domestic output is the sum of final domestic demand, net exports and the wage/price adjustment costs ADC_t:

$$Y_t = \frac{P_t}{P_{GDP,t}}(C_t + I_t + G_t) + X_t - \frac{P_{TF,t}}{P_{GDP,t}}(C_{TF,t} + I_{TF,t} + G_{TF,t}) + ADC_t \tag{2.46}$$

$$ADC_t \equiv \frac{\gamma_w}{2}(\pi_t^w)^2 L_t + \frac{\gamma_p}{2}(\pi_{TH,t})^2 Y_{T,t} + \frac{\gamma_p}{2}(\pi_{NT,t})^2 Y_{NT,t}$$

Exports X_t correspond to the import demand of the RoU analogously to equation (2.21):

$$X_t = (1-h)\zeta(P_{TH,t} / P_{TF,t}^*)^{-\eta} Y_t^* \tag{2.47}$$

which uses the fact that the tradable prices in the RoU and the prices of RoU-produced tradables are (almost) identical from the perspective of the small domestic economy. The parameter $\zeta \equiv \bar{Y} / \bar{Y}^*$ captures the relative size of the two regions and ensures consistency of the trade flows. We exclude price discrimination between countries, i.e. the law of one price holds.

Combining the budget constraints of the private sector, i.e. (2.2) and (2.8), and the government (2.36) with the revenue-side definition of GDP as the sum of factor and profit income gives the aggregate resource constraint of the domestic economy:

$$B_{H,t}^* = (1+i_{t-1})B_{H,t-1}^* + P_{GDP,t}Y_t - P_t(C_t + I_t + G_t) - P_{GDP,t}ADC_t \tag{2.48}$$

which is also the law of motion for the net foreign asset (NFA) position. The current account reflects the change in net foreign assets:

$$CA_t = B_{H,t}^* - B_{H,t-1}^* \tag{2.49}$$

As specified in (2.6), the nominal interest rate in the domestic economy depends on the NFA position to rule out explosive NFA dynamics (see Schmitt-Grohé and Uribe, 2003) and the exogenous risk-premium shock.

Rest of monetary union

The RoU is treated as one single block. Trade with the small country is negligible in relation to output and domestic demand, so that we approximate the RoU as closed economy. The welfare function parallels the one for households in the small member country:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma} (C_t^{i*})^{1-\sigma} + \frac{\chi}{1-\sigma} (G_t^*)^{1-\sigma} - \frac{\kappa}{1+\varphi} (L_t^{i*})^{1+\varphi} \right) \tag{2.50}$$

The equivalent budget constraints imply analogous consumption, investment and labour supply decisions:

$$1/(C_t^{NLC*})^{\sigma} - (1+\tau_t^{c*})\lambda_t^{NLC*} = 0$$

$$\lambda_t^{NLC*} / P_t^* - \beta(1+i_t^*) E_t(\lambda_{t+1}^{NLC*} / P_{t+1}^*) = 0$$

$$P_t^* \lambda_t^{NLC*} - \mu_t^* (1 - \gamma_k NI_{T,t}^{i*}) = 0$$

$$P_t^* \lambda_t^{NLC*} - \mu_t^* (1 - \gamma_k NI_{NT,t}^{i*}) = 0$$

$$\beta E_t \lambda_{t+1}^{NLC*} ((1-\tau_{t+1}^{k*}) i_{t+1}^{k*} + \tau_{t+1}^{k*} \delta P_{t+1}^*) - \mu_t^* + \beta E_t \mu_{t+1}^* \left(1 - \delta - \frac{\gamma_k}{2} (NI_{T,t+1}^{i*})^2 + \gamma_k NI_{T,t+1}^{i*} \frac{I_{T,t+1}^{i,*}}{K_{T,t}^{i,*}} \right) = 0$$

$$\beta E_t \lambda_{t+1}^{NLC*} ((1-\tau_{t+1}^{k*}) i_{t+1}^{k*} + \tau_{t+1}^{k*} \delta P_{t+1}^*) - \mu_t^* + \beta E_t \mu_{t+1}^* \left(1 - \delta - \frac{\gamma_k}{2} (NI_{NT,t+1}^{i*})^2 + \gamma_k NI_{NT,t+1}^{i*} \frac{I_{NT,t+1}^{i,*}}{K_{NT,t}^{i,*}} \right) = 0$$

$$(1+\tau_t^{c*}) P_t^* C_t^{LC*} = (1-\tau_t^{w*}) W_t^{i*} L_t^{i*} + TR_t^* - \gamma_w / 2 (\pi_t^{w,i*})^2 L_t^* \tag{2.51}$$

$$C_t^* \equiv (1-slc) C_t^{NLC*} + slc C_t^{LC*} \tag{2.52}$$

$$(1-\tau_t^{w*}) \frac{W_t^*}{P_t^*} = \frac{\theta}{\theta-1} \frac{\kappa (L_t^*)^{\varphi}}{\lambda_t^{tot*}} - \frac{\gamma_w}{\theta-1} \frac{W_t^*}{W_{t-1}^*} \pi_t^{w*} + \frac{\gamma_w}{\theta-1} \beta E_t \left(\frac{\lambda_{t+1}^{tot*}}{\lambda_t^{tot*}} \frac{W_{t+1}^*}{W_t^*} \frac{L_{t+1}^*}{L_t^*} \pi_{t+1}^{w*} \right) \tag{2.53}$$

The government budget constraint is:

$$\tau_t^{w*} W_t^* L_t^* + \tau_t^{k*}(i_t^{k*} - \delta)K_{t-1}^* + \tau_t^{c*} P_t^* C_t^* + B_t^* = P_t^* G_t^* + TR_t^* + (1 + i_{t-1}^*)B_{t-1}^* \tag{2.54}$$

where $B_t^* \equiv B_{H,t}^* + B_{F,t}^*$. The fraction $B_{H,t}^*$ equals the NFA position of the small domestic economy and $B_{F,t}^*$ is RoU government debt held by RoU households.

The government adjusts labour income taxes when public debt and deficits deviate from the target levels:

$$\tau_t^{w*} = \tau_{t-1}^{w*} + \phi_b \left(\frac{B_{t-1}^*}{4P_{t-1}^* Y_{t-1}^*} - btar \right) + \phi_d \Delta \frac{B_{t-1}^*}{4P_{t-1}^* Y_{t-1}^*} \tag{2.55}$$

Fiscal authorities in the RoU may also react to cyclical fluctuations. However, given our focus on the small domestic member country and the availability of monetary policy at the aggregate RoU level, we abstract from countercyclical fiscal rules in the RoU.

The central bank sets interest rates according to the simple rule:

$$i_t^* = \psi_i i_{t-1}^* + (1-\psi_i)(1-\beta)/\beta + (1-\psi_i)(\psi_y \Delta \ln Y_{t-1}^* + \psi_\pi \pi_{t-1}^*) \tag{2.56}$$

The RoU firms face a profit maximisation problem analogous to firms in the small domestic economy, which determines the foreign price level:

$$P_{TH,t}^* = \frac{\varepsilon}{\varepsilon - 1 + \gamma_p \dfrac{P_{TH,t}^*}{P_{TH,t-1}^*} \pi_{TH,t}^* - \gamma_p \beta E_t \left(\dfrac{\lambda_{t+1}^{NLC*}}{\lambda_t^{NLC*}} \dfrac{P_{TH,t+1}^*}{P_{TH,t}^*} \dfrac{Y_{t+1}^*}{Y_t^*} \pi_{TH,t+1}^* \right)} MC_{T,t}^* \tag{2.57}$$

$$P_{NT,t}^* = \frac{\varepsilon}{\varepsilon - 1 + \gamma_p \dfrac{P_{NT,t}^*}{P_{NT,t-1}^*} \pi_{NT,t}^* - \gamma_p \beta E_t \left(\dfrac{\lambda_{t+1}^{NLC*}}{\lambda_t^{NLC*}} \dfrac{P_{NT,t+1}^*}{P_{NT,t}^*} \dfrac{Y_{t+1}^*}{Y_t^*} \pi_{NT,t+1}^* \right)} MC_{NT,t}^* \tag{2.58}$$

With $\pi_{TH,t}^* \equiv P_{TH,t}^* / P_{TH,t-1}^* - 1$ and $\pi_{NT,t}^* \equiv P_{NT,t}^* / P_{NT,t-1}^* - 1$. Total production is the aggregate of firm-level production in both sectors u:

$$Y_t^* = \int_0^1 A_{u,t}^* (K_{u,t-1}^{j*})^\alpha (L_{u,t}^{j*})^{1-\alpha} dj = A_{u,t}^* (K_{u,t-1}^*)^\alpha (L_{u,t}^*)^{1-\alpha} \tag{2.59}$$

Demand in the RoU region is the sum of private consumption, investment, government purchases and adjustment costs:

$$Y_t^* = C_t^* + I_t^* + G_t^* + ADC_t^* \tag{2.60}$$

$$ADC_t^* \equiv \frac{\gamma_w}{2}(\pi_t^{w*})^2 L_t^* + \frac{\gamma_p}{2}(\pi_{TH,t}^*)^2 Y_{T,t}^* + \frac{\gamma_p}{2}(\pi_{NT,t}^*)^2 Y_{NT,t}^*$$

The NFA position of the RoU is the mirror image of the small domestic economy's NFA position. However, given that $\zeta \equiv \bar{Y}/\bar{Y}^*$ is very small, the NFA position can be neglected in the aggregate resource constraint of the RoU.

Calibration

The model parameters and exogenous variables have to be given numerical values to simulate the model, which are summarised in Table 1. The data for the calibration are taken from the European Commission's AMECO and the OECD Main Economic Indicator (MEI) database.

The parameter that determine the steady-state ratios are chosen to replicate the average share of private consumption (60%), investment (20%) government purchases (20%) in euro area GDP and the average capital stock of 300% of annual GDP during 1999-2009. The model treats all investment as private investment in the tradable goods sector. We set the share of tradable goods in total consumption to Φ=0.5 in order to get a steady-state ratio of tradable goods to GDP of 60% (e.g. Lombardo and Ravenna, 2012).

The tax rates on consumption, labour and capital income are euro area averages for 1999-2009 from the European Commission's Taxation Trends in the European Union database. Given the level of government purchases and the distortionary tax revenue, the steady-state volume of lump-sum transfers is chosen to stabilise government debt at 70% of GDP, which is the euro area average 1999-2009. The parameters of the debt-stabilisation rule imply tax rate increases of 0.001 (1.0) percentage points per percentage-point increase in government debt-to-GDP (deficit-to-GDP) ratios beyond their target levels. The parameters of the monetary policy rule are standard and without bearing on our results.

Table 1: Parameters and steady-state ratios of the model

Parameter	Symbol	Value
Consumption	C/Y	0.60
Investment	I/Y	0.20
Government purchases	G/Y	0.20
Tradable goods	T/Y	0.60
Capital stock	K/Y	12.0
Consumption tax rate	τ^c	0.18
Labour tax rate	τ^w	0.35
Capital tax rate	τ^k	0.44
Lump-sum tax	TAX/Y	0.00
General transfers	TR/Y	0.12
Debt-to-GDP target	btar	0.70
Fiscal reaction to debt	ξ_b	0.001
Fiscal reaction to deficits	ξ_d	1.00
Fiscal instrument persistence	ρ	0.50
Interest rate persistence	ψ_i	0.75
Coefficient on output growth	ψ_y	0.05
Coefficient on inflation	ψ_π	1.15
Cobb-Douglass parameter	α	0.40
Discount factor	β	0.994
Country risk premium	ω	-0.0025
Steady-state TFP level	A	0.47
Substitution elasticity for goods varieties j	ε	6.0
Substitution elasticity between T/NT goods	ψ	0.5
Substitution elasticity for labour services i	θ	6.0
Home bias	h	0.17
Weight of utility of government purchases	χ	0.33
Weight of labour disutility	κ	1.79
Intertemporal elasticity of substitution	$1/\sigma$	1.00
Labour supply elasticity	$1/\varphi$	0.25
Share LC households	slc	0.40
Share of tradable goods on consumption	Φ	0.5
Trade elasticity between home and foreign goods	η	1.5
Price adjustment costs	γ_p	50
Wage adjustment costs	γ_w	80
Capital adjustment costs	γ_k	30
Persistence of TFP shock	ρ_a	0.92
Persistence of risk premium shock	ρ_r	0.85
Standard deviation TFP innovation	σ_a	0.018
Standard deviation of risk innovation	σ_r	0.024

The Cobb-Douglass parameter α=0.40 is derived from the average labour income share and the marginal return to capital in the steady state. The quarterly capital depreciation rate compatible with the steady-state ratios of investment and capital is 1.7%, which together with the tax rate on capital income implies a quarterly equity premium of 2.2%, a quarterly interest rate on bonds of 0.6% and the quarterly discount factor β=0.994. The endogenous component of the country risk premium is set to ω=0.0025, i.e. one percentage-point deterioration in the

NFA-to-GDP position increases the annualised borrowing rate by one basis point. An external risk premium of this size has been estimated for Spain by Aspachs-Bracons and Rabanal (2010).

The steady-state TFP level of 0.47 equalises both sides of the production function for our metric of factor inputs and output. The values of $\varepsilon=6$ and $\theta=6$ for the elasticity of substitution between differentiated goods and labour services implies steady-state price and wage mark-ups of 20% that are in line with empirical estimates by Christopoulou and Vermeulen (2008). The elasticity of substitution between tradable and non-tradable goods is $\psi=0.5$. Home bias in the demand for domestically produced tradable goods $h=0.17$ in the small domestic economy to match the average export-to-GDP ratio of a group of eight smaller EA-12 countries during 1999-2009.[9]

The weights of public purchases ($\chi=1/3$) and employment ($\kappa=1.79$) in the utility function are chosen so that the euro area average levels of consumption, government purchases and employment for 1999-2009 satisfy the households' optimality conditions. The intertemporal elasticity of substitution is set to $1/\sigma=1.0$ in the benchmark model, i.e. standard logarithmic consumption utility. The value $1/\varphi=0.25$ for the elasticity of labour supply lies in the range of microeconomic estimates, even though DSGE models often use higher values (e.g., Evers et al., 2008; Fiorito and Zanella, 2008). The estimates for the share of liquidity-constrained households (slc) in the euro area cluster around 0.40 (e.g., Forni et al., 2009; Ratto et al., 2009).

The trade elasticity between domestic and foreign tradable goods is $\eta=1.5$ and corresponds to euro area estimates by Imbs and Méjean (2010), and the impact of higher value will be tested in the section on robustness checks. Price and wage adjustment costs are set to match the average price and wage durations of 4 and 5 quarters reported by Druant et al. (2009) and Knell (2010) and to generate demand and employment volatility in the range of empirical values for the group of smaller EA-12 members given the exogenous shocks. The parameter for capital adjustment costs is chosen to obtain empirically plausible values for the volatility of investment.

[9] The countries are AUT, BEL, ESP, FIN, GRC, IRL, NLD and PRT. The focus on this group of smaller countries among the early EA members is motivated by the fact that these countries have already more than one decade of EA history to quantify the role of asymmetric shocks.

The technology (TFP) shock is the estimated AR(1) process for the model-consistent Solow residual given the data on real output and factor inputs. The shock is estimated on the gap between the Solow residuals of the smaller EA-12 countries and the euro area average TFP level in 1999q1-2009q4. The use of TFP gaps relative to the euro area average rather than of absolute TFP levels derives from the focus on asymmetric shocks. In the same spirit, the risk-premium shock is the estimated AR(1) dynamics of the smaller EA-12 countries' interest rate spread over the German rate for 10-year government bonds in 1999q1-2009q4. The null hypothesis that the estimated innovations to the relative TFP level and the risk premium are uncorrelated is not rejected at conventional levels.

Table 2: Comparing model and data moments

Variable	Baseline calibration		Actual data					
	Correlation with output	Standard deviation	Correlation with output			Standard deviation		
			Mean	Max	Min	Mean	Max	Min
Output	1.00	0.02	1.00	1.00	1.00	0.02	0.03	0.01
Consumption	0.67	1.61	0.78	0.94	0.42	0.74	1.21	0.26
Investment	0.66	3.18	0.82	0.94	0.68	2.77	3.59	1.70
Gov. purchases	1.00	1.00	0.17	0.48	-0.12	0.97	2.47	0.42
Trade balance	-0.42	1.03	-0.25	0.20	-0.66	1.13	1.42	0.80
Employment	0.39	1.18	0.63	0.96	0.29	0.70	1.40	0.47
Inflation	0.10	0.15	0.12	0.68	-0.40	0.57	1.05	0.37

Note: All moments are based on quarterly data. Except for inflation and the trade balance, the variables are in logarithms and model-generated and data series HP-filtered (λ=1600). The mean for actual data is the non-weighted average AUT, BEL, ESP, FIN, GRC, IRL, NLD and PRT during 1999q1-2009q4; maximum and minimum values refer to the highest and lowest ranking country in this group for a particular measure. The data are seasonally and working-day adjusted. The trade balance is relative to GDP, and inflation is the year-on-year percentage change in the core CPI. The standard deviation is the absolute standard deviation for output and the standard deviation relative to the standard deviation of output for all other variables.

Table 2 compares characteristic moments of the benchmark model under the combination of TFP and risk premium shocks and in the absence of fiscal stabilisation of business cycle fluctuations to data for the group of smaller EA12 countries in the period 1999q1-2009q4. Table 2 shows that that the model matches important aspects of the data. Namely, the model replicates the correlation of private demand, the trade balance, employment and inflation with output at business cycle frequencies in qualitative terms. Data patterns of the relative volatility are also replicated. Namely, the model replicates the observed high volatility of investment. The size of model-generated the trade balance and employment volatility lies within the range of values in the data. Compared to the data, private consumption is more volatile in the model, which is linked to fixing the share of government purchases to GDP in

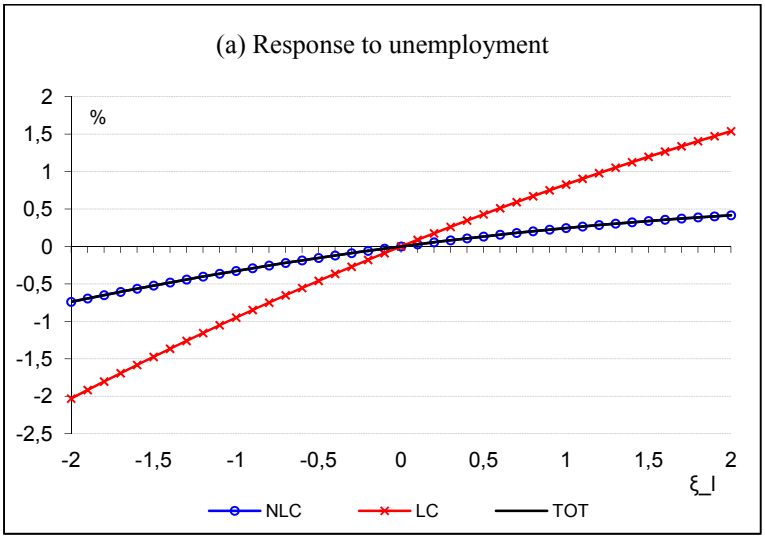
the baseline model, so that private demand absorbs additional fluctuations in aggregate demand. The low volatility of CPI inflation in the model relative to the data can be linked partly to the assumption of constant import prices in the model simulations, which derives from the exclusive focus on country-specific shocks.

3. Fiscal policy rules and current account rebalancing

In order to analyze the stabilizing effects of fiscal policy and to get some insights on the welfare effects of government spending shifting from the tradable to non-tradable sector we present simulations where fiscal policy (2.43) reacts to unemployment and trade balance to GDP ratio, respectively. We use budget stabilization by labour tax (2.45).

Figure 3 displays the welfare gains or costs from a fiscal reaction to unemployment expressed in percentage of steady-state consumption. We present simulations for an interval [-2;2] of values of ξ_L in steps of 0.1.

Figure 3: Welfare gains from response to unemployment.



Given rising unemployment it seems that a shift of government spending from tradable to non-tradable sector induces substantial welfare gains. This is plausible in the sense that in the case of high unemployment an increase in government spending in the non-tradable goods sector does only affect domestic demand for domestic production and does not fall upon foreign imported goods. Despite the shift in government spending the level of government

expenditure is kept constant. Fiscal policy is counter-cyclically, but budgetary neutral. Therefore, during a decrease in output and employment, an increase in domestic demand through government spending shifting could stabilize output and employment and lead to an increase in consumption for both types of households, without changing government's fiscal balance. The welfare gain is weaker for NLC households due to consumption smoothing effects, however. Even capital and employment adjustment costs do not outweigh the positive welfare effects. Furthermore, volatility plot shows that there is no trade-off between stabilising consumption and employment (see figure 4).

Figure 4: Volatility of consumption and employment.

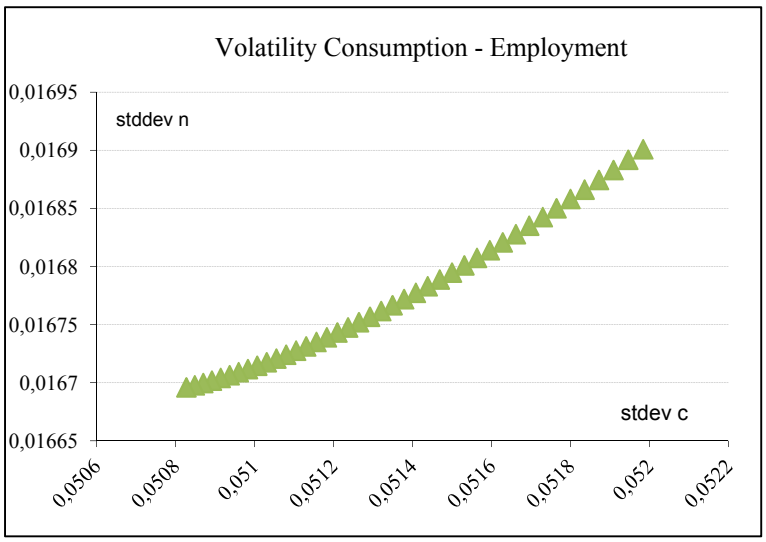
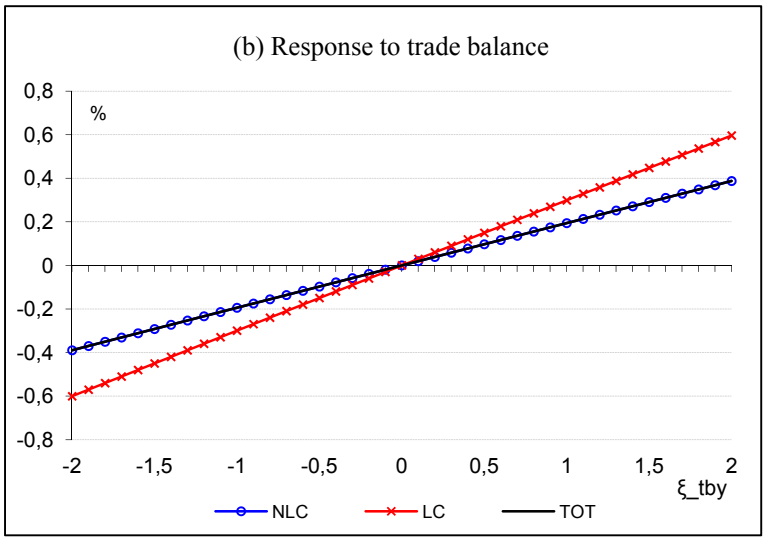


Figure 5 displays the welfare gains or costs from a fiscal response to the trade balance over an interval of values ranging from -2 to 2. The figure shows similar results to the fiscal response to unemployment. A pro-cyclical reaction to the trade balance in the sense that government spending is shifted from the tradable to non-tradable sector generates welfare gains for both LC and NLC households. This is plausible in the sense that shifting expenditure between tradable and non-tradable goods affects relative prices of tradable goods as well as relative domestic prices of tradable and non-tradable goods. That implies an improvement in the trade balance and thus an increase in consumption. Due to consumption smoothing the welfare gains of LC households exceed those of NLC households. Therefore, shifting government expenditure between tradable and non-tradable goods affects relative prices of tradable goods and can stabilise external accounts over the business cycle.

Figure 5: Welfare gains from response to trade balance.



Note: Welfare is measured relative to non-stabilization and expressed in % of steady state consumption.

4. Conclusions

The paper analyses in a two-region two-sector DSGE model with nominal and real rigidities the stabilising properties of simple fiscal policy rules in a small open economy in monetary union. The model is calibrated to match data moments of small euro area countries over the period 1999-2009. The focus is on rules that adjust the composition of government spending on tradable and non-tradable goods in response to business cycle indicators. In order to achieve stabilisation even when the government's fiscal space is very limited the policy is budgetary neutral in the sense that the level of government expenditure is kept constant. The paper finds that shifting government spending between tradable and non-tradable goods in response to fluctuations in unemployment or the trade balance can substantially increases household welfare. The potential welfare gain increases with the strength of adjustment frictions in the private sector. Shifting expenditure between tradable and non-tradable goods also affects relative prices of tradable goods and can stabilise external accounts over the business cycle.

Revisions of the paper will include an analysis of potential trade-offs between consumption, unemployment and trade balance stabilization as well as robustness checks for our results. Furthermore, an extended framework of our model should include the theory of unemployment proposed by Gali (2011) and Gali et al. (2011).

References:

Abiad, A., J. Bluedorn, J. Guajardo, M. Kumhof and D. Leigh (2011): Separated at Birth? The Twin Budget and Trade Balances, in *World Economic Outlook: Slowing Growth, Rising Risks*, Chapter 4, pp. 135 – 160.

Ali Abbas, S.M. et al. (2010): *Fiscal Policy and the Current Account*, IMF Working Paper 10/121.

Arghyrou, M and G. Chortareas (2008): Current Account Imbalances and Real Exchange Rates in the Euro Area, *Review of International Economics,* Vol. 16 (4), pp. 747 – 764.

Aspachs-Bracons, O. and P. Rabanal (2009): *The drivers of housing cycles in Spain*. IMF Working Paper No. 09/203.

Beetsma, R. and H. Jensen (2004): Mark-up fluctuations and fiscal policy stabilization in a monetary union, *Journal of Macroeconomics* Vol. 26(2): 357-376.

Beetsma, R., M. Giuliodori and F. Klaassen (2008): The Effects of Public Spending Shocks on Trade Balances and Budget Deficits in the European Union, *Journal of the European Economic Association*, April–May 2008, Vol. 6, No. 2-3, pp. 414 – 23.

Belke, A. and Ch. Dreger (2011): *Current Account Imbalances in the Euro Area: Catching Up or Competitiveness?* DIW Discussion Papers No. 1106.

Benetrix, A. and P. R. Lane (2009): *Fiscal Shocks and the Real Exchange Rate*, IIIS Discussion Paper No. 286.

Benetrix, A. and P. R. Lane (2010): Fiscal Shocks and the Sectoral Composition of Output, *Open Economies Review* 21(3), 335-350.

Blanchard, O. and F. Giavazzi (2002): Current Account Deficits in the Euro Area: The End of the Feldstein Horioka Puzzle? *Brookings Papers on Economic Activity 33*, No. 2, 147-186.

Bouakez, H., F. Chihi and M. Normandin (2011): *Fiscal Policy and External Adjustment: New Evidence*, CIRPÉE Working Paper 11-23.

Casares, M. and B. McCallum (2006): An optimizing IS-LM framework with endogenous investment, *Journal of Macroeconomics*, Vol. 28(4): 621-644.

Catalán, M. and R. Lama (2006): *Fiscal Policy and the External Balance in Spain*, Selected Issues, IMF Country Report No. 06/213.

Chen, R., G.M. Milesi-Ferretti and T. Tressel (2012): *External Imbalances in the Euro Area*, IMF Working Paper 12/236.

Christopoulou, R. and P. Vermeulen (2008): *Markups in the euro area and the US over the period 1981-2004: a comparison of 50 sectors*, ECB Working Paper No. 856.

Corsetti, G. and G. Müller (2006): Budget Deficits and Current Accounts: Openness and Fiscal Persistence, *Economic Policy*, Vol. 21, No. 48, pp. 597 – 638.

Cournède, B. and D. Moccero (2009): *Is there a case for price-level targeting?* OECD Econ. Depart, Working Paper No. 721.

Druant, M., S. Fabiani, G. Kezdi, A. Lamo, F. Martins and R. Sabbatici (2009): *How are firms' wages and prices linked: survey evidence in Europe*, ECB Working Paper 1048.

ECB (2012): *Competitiveness and External Imbalances within the Euro Area*, ECB Occasional Paper No. 139.

European Commission (2012): Scoreboard for the surveillance of macroeconomic imbalances, European Economy, Occasional Papers 92, February 2012.

Evers, M., R. de Mooij, D. van Vuuren (2008): The wage elasticity of labour supply: a synthesis of empirical estimates. *De Economist* Vol. 156(1): 25-43.

Fiorito, R. and G. Zanella (2008): *Labor supply elasticities: Can micro be misleading for macro?* University of Siena, Department Economics, Working Paper 547.

Ferrero, A. (2009): Fiscal and monetary rules for a currency union, *Journal of International Economics*, Vol. 77(1): 1-10.

Forni, L., L. Monteforte and L. Sessa (2009): The general equilibrium effects of fiscal policy: estimates for the euro area, *Journal of Public Economics* Vol. 93(3-4): 559-585.

Galí, J. (2011): *Unemployment Fluctuations and Stabilization Policies: A New Keynesian Perspective*. Cambridge, MA: MIT Press.

Galí, J. and T. Monacelli (2008): Optimal monetary and fiscal policy in a currency union, *Journal of International Economics* Vol. 76: 116-132.

Galí, J., D. López-Salido and J. Vallés (2007): Understanding the effects of government spending on consumption, *Journal of European Economic Association*, Vol. 5(1): 227-270.

Galí, J., F. Smets and R. Wouters (2011): Unemployment in an Estimated New Keynesian Model, *NBER Macroeconomics Annual 2011*, University of Chicago Press, pp. 329-360.

Herz, B. and S. Hohberger (2013): Fiscal Policy, Monetary Regimes and Current Account Dynamics, *Review of International Economics*, Vol. 21(1), pp. 118-136.

Imbs, J. and I. Méjean (2010): *Trade elasticities: a final report for the European Commission*, European Economy EP 432.

Jaumotte, F. and P. Sodsriwiboon (2010): *Current Account Imbalances in the Southern Euro Area*, IMF Working Paper 10/139.

Kim, S. and N. Roubini (2008): Twin Deficits or Twin Divergence? Fiscal Policy, Current Account and Real Exchange Rate in the U.S., *Journal of International Economics, Vol. 74 (2)*, pp. 362 – 383.

Kirsanova, T., M. Satchi, D. Vines and S. Wren-Lewis (2007): Optimal fiscal policy rules in a monetary union, *Journal of Money, Credit, and Banking*, Vol. 39(7): 1759-1784.

Knell, M. (2010): *Nominal and real wage rigidities: in theory and in Europe*. ECB Working Paper 1180.

Kollmann, R. (1996): Incomplete asset markets and the cross-country consumption correlation puzzle, *Journal of Economic Dynamics and Control*, Vol. 20(5): 945-961.

Kumhof, M. and D. Laxton (2009a): *Simple, implementable fiscal policy rules*, IMF Working Paper 09/76.

Kumhof, M. and D. Laxton (2009b): *Fiscal Deficits and Current Account Deficits*, IMF Working Paper No. 09/237.

Lane, P. R. (2010a): External Imbalances and Fiscal Policy, in: *External Imbalances and Public Finances in the EU* (edited by Salvador Barrios, Servaas Deroose, Sven Langedijk and Lucio Pench) , European Economy Occasional Paper No. 66.

Lane, P. R. (2010b): Some Lessons for Fiscal Policy from the Financial Crisis, Nordic *Economic Policy Review* Vol. 1(1), pp. 13-34.

Lane, P. R. and G. M. Milesi-Ferretti (2012): External Adjustment and the Global Crisis, *Journal of International Economics*, Vol. 88(2), pp. 252-265.

Lane, P. R. and B. Pels (2012): Current Account Imbalances in Europe, IIIS Discussion Paper No. 397.

Lombardo, G. and F. Ravenna (2012): The size of the tradable and non-tradable sectors: Evidence from input-output tables for 25 countries, *Economic Letters*, Vol. 116, pp. 558-561.

Ratto, M., W. Roeger and J. in't Veld (2009): QUEST III: an estimated open-economy DSGE model of the euro area with fiscal and monetary policy, *Economic Modelling*, Vol. 26(1): 222-233.

Schmitt-Grohé, S. and M. Uribe (2003): Closing small open economy models, *Journal of International Economics*, Vol. 61(1): 163-185.

Vogel, L., Werner R. and B. Herz (2012): *The performance of simple fiscal policy rules in monetary union*, European Economy, Economic Papers No. 470.

Woodford, M. (2003): *Interest and prices: foundations of a theory of monetary policy*, Princeton University Press, Princeton.

Zemanek, H., A. Belke and G. Schnabl (2010): Current Account Balances and Structural Adjustment in the Euro Area, *International Economics and Economic Policy* 7, 83-127.