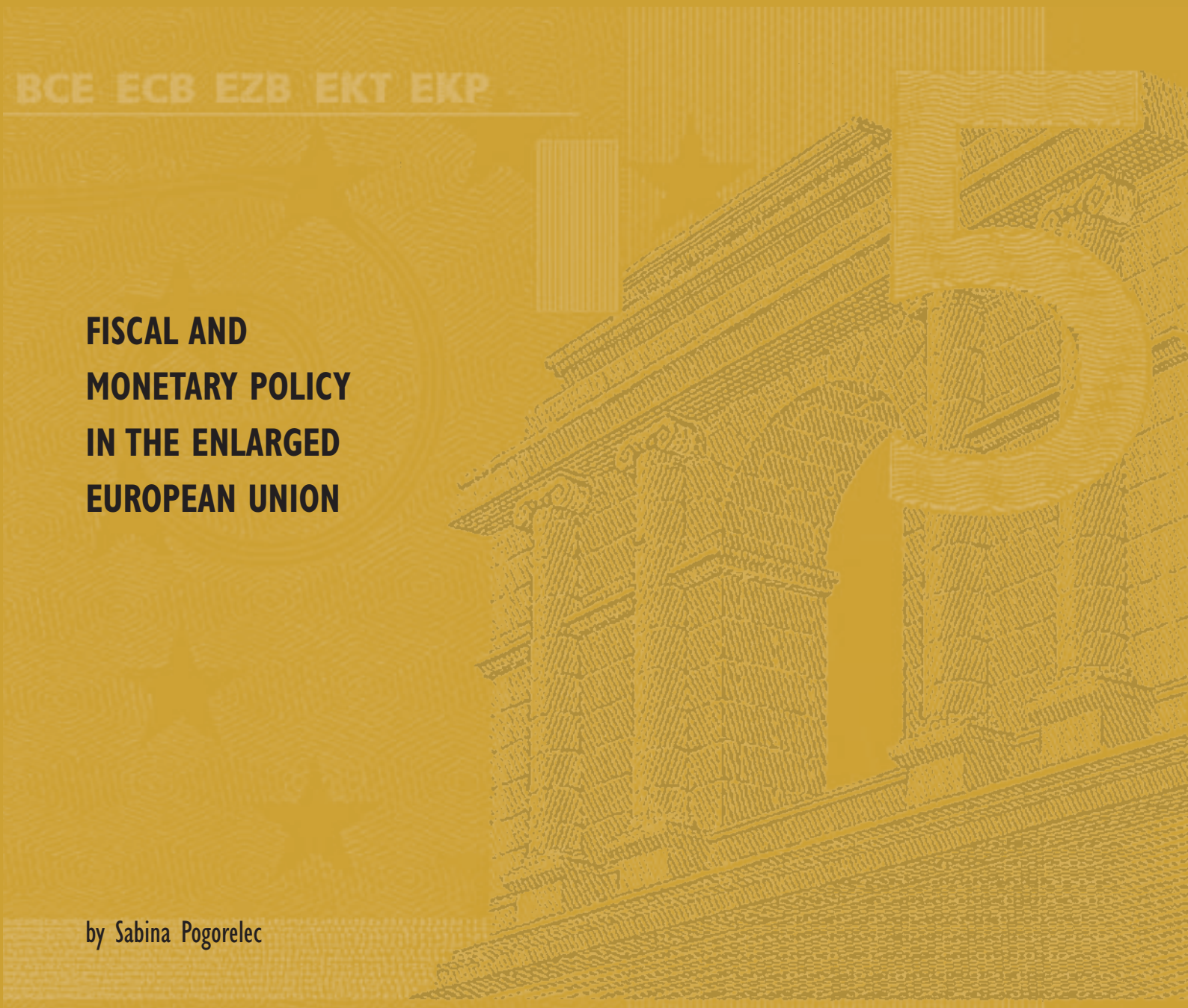
EUROPEAN CENTRAL BANK

WORKING PAPER SERIES
NO 655 / JULY 2006



FISCAL AND MONETARY POLICY IN THE ENLARGED EUROPEAN UNION

by Sabina Pogorelec

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES
NO 655 / JULY 2006

FISCAL AND MONETARY POLICY IN THE ENLARGED EUROPEAN UNION [1]

by Sabina Pogorelec [2]

In 2006 all ECB publications will feature a motif taken from the €5 banknote.

This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=913326

1 This is a revised chapter of my dissertation. I would like to thank Fabio Ghironi, Matteo Iacoviello, Peter Ireland and Luisa Lambertini. I thank Bank of Slovenia for a research grant. I am also grateful to the participants at the 7th INFER Workshop on Economic Policy, ZEW Summer Workshop on the EMU Enlargement and 2006 Applied Business Research Conference. While working on this paper I had useful conversations with Kolver Hernandez, Chuck Carlstrom, Matt Canzoneri and Federico Ravenna. All errors are mine. The views in this paper are my own and do not necessarily reflect those of the EIB.

2 European Investment Bank, 100 boulevard Konrad Adenauer, L-2950 Luxembourg; e-mail: s.pogorelec@eib.org. This paper was written when Sabina Pogorelec was working in the Monetary Policy Strategy Division of the European Central Bank.

© **European Central Bank, 2006**

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Internet
http://www.ecb.int

Fax
+49 69 1344 6000

Telex
411 144 ecb d

All rights reserved.

Any reproduction, publication and reprint in the form of a different publication, whether printed or produced electronically, in whole or in part, is permitted only with the explicit written authorisation of the ECB or the author(s).

The views expressed in this paper do not necessarily reflect those of the European Central Bank.

The statement of purpose for the ECB Working Paper Series is available from the ECB website, http://www.ecb.int.

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract 4
Non-technical summary 5
1 Introduction 8
2 Literature review 11
3 A general equilibrium model of the European Union 12
3.1 The overview of the economic environment 12
3.2 Households and their trading opportunities 15
3.3 The intermediate goods sector and its ownership structure 19
3.4 Production of final goods 21
3.5 Goods and labor market clearing 24
3.6 Fiscal and monetary policy 24
4 Solution and parameterization of the model 26
4.1 Solution of the model and the steady state 26
4.2 Parameterization 26
5 The effects and transmission of shocks and dynamic properties of the model 28
5.1 Foreign technology shock 28
5.2 Foreign fiscal shock 30
5.3 Estimates of macroeconomic variability 31
5.4 The role of foreign ownership 33
6 Design of fiscal and monetary policy 34
6.1 Optimal fiscal and monetary policies and the desirability of fiscal cooperation in the EU 36
6.2 Sensitivity analysis 41
7 Conclusions 42
References 43
Appendix 47
European Central Bank Working Paper Series 56

Abstract

I build a quantitative two-country DSGE model of the European Union (EU) and investigate whether there are welfare gains from fiscal policy cooperation between the new EU members and the euro area (EMU). Fiscal cooperation is defined in terms of joint maximization of the weighted average of households' welfare. I find that fiscal policy cooperation is welfare-reducing for both groups of countries. This result depends on a realistic assumption about the presence of foreign ownership of firms in the new EU countries. When there is no foreign ownership in the new EU countries, the euro area is indifferent between cooperating and not cooperating, but the new EU members still prefer not to cooperate with EMU in terms of fiscal policy.

Keywords: Fiscal policy cooperation; Foreign ownership of firms; Fiscal-monetary interactions; Enlarged European Union; Central and eastern European countries

JEL classification: E63; F42

Non-technical Summary

In 1999 most of the incumbent European Union (EU) countries renounced their sovereign monetary policy in favor of a single, supranational monetary policy and created the European Economic and Monetary Union (EMU). In May 2004, 10 central and eastern European countries (CEECs), plus Malta and Cyprus joined the EU and committed themselves to entering EMU. A precondition for this is that they have to meet various convergence criteria, one of which is successful participation for 2 years in the Exchange Rate Mechanism (ERM2). This means that for those CEECs which have already joined the ERM2, national monetary policy can no longer be freely used, particularly in terms of stabilizing the economy. As a result, the importance of fiscal policies as a means of stabilization could well have increased.

In light of the potentially higher importance of fiscal policy in CEECs with an exchange rate peg versus the euro, this paper examines the welfare implications of fiscal policy cooperation in a two-country model with a fixed exchange rate regime. The model incorporates several realistic assumptions about the structure of the two economies and performs well in terms of matching the dynamics of the macroeconomic variables. In particular, the assumption about the ownership structure of firms plays a vital role.

The large (foreign) economy in the model represents EMU and the smaller (home) country represents the new EU members. Each country has a fiscal and a monetary authority. The home central bank supports a fixed exchange rate. The other three policymakers conduct a stabilization policy by using policy rules which I assume that they can commit to. Each government uses government consumption as a fiscal instrument and adjusts the instrument in response to its GDP movements. I also assume that the government budgets are balanced in each period. The foreign central bank follows a Taylor-type interest rate rule. When the governments cooperate on fiscal policies, each government chooses the response parameter to its GDP to maximize the unconditional expectation of a weighted average of home and foreign households' utility (welfare), taking the behavior of the foreign central bank as given. The foreign central bank chooses its response parameters to inflation and GDP to maximize

the unconditional expectation of foreign households' welfare, taking the behavior of the governments as given. In a non-cooperative game, each player takes the actions of the other two players as given and chooses response parameter(s) in its rule to maximize the welfare of its own households. All players act simultaneously.

To understand how the foreign ownership of firms affects the results, I first analyze a benchmark model with no foreign ownership. When the governments cooperate on their fiscal policies, they choose the response parameters to GDP to maximize a weighted average of home and foreign welfare with the relative sizes of the economies as weights. The government of the large economy is indifferent between cooperating and not cooperating on fiscal policy with the government of the smaller economy. On the other hand, the government of the smaller country prefers not to cooperate because under fiscal cooperation, each government chooses the parameter in its fiscal rule to stabilize shocks mainly in the large country.

Fiscal cooperation is even less desirable in the empirically more realistic model where foreign households own some of the home firms. In this case, home households no longer receive the state-contingent dividend income, so their ability to insure themselves is reduced. Most of the variables in the smaller country become more volatile (e.g. private consumption, GDP). Therefore, both governments are more active than in the benchmark model in stabilizing the smaller economy when they cooperate, which makes government purchases in both countries more volatile. More aggressive fiscal policies have adverse effects on private non-tradable consumption in both countries. There is also a shift towards stabilizing the shocks that affect both countries when their governments cooperate. This means that the foreign non-tradable technology shock is not absorbed as efficiently and introduces more volatility into foreign tradable consumption. As a consequence, foreign overall private consumption is also more volatile, and welfare in the large economy is reduced. In the small country, less volatile prices translate into less volatile tradable private consumption, so that the overall private consumption is slightly less volatile when the governments cooperate. However, more volatility in the labor supply and government purchases dominate, and home welfare is also

lower under fiscal cooperation. The foreign central bank cushions the negative effect of fiscal policies on private consumption, but its actions are not sufficient to make fiscal policy cooperation desirable. These results reflect the fact that the monetary policy in the small country is taken as given (by supporting a fixed exchange rate), and that the monetary policy of the large economy is not set cooperatively with respect to fiscal policy.

1 Introduction

In 1999 most of the incumbent European Union (EU) countries renounced their sovereign monetary policy in favor of a single, supranational monetary policy and created the European Economic and Monetary Union (EMU). In May 2004, 10 central and eastern European countries (CEECs), plus Malta and Cyprus joined the EU and committed themselves to entering EMU.[1] A precondition for this is that they have to meet various convergence criteria, one of which is successful participation for 2 years in the Exchange Rate Mechanism (ERM2). This means that for those CEECs which have already joined the ERM2, national monetary policy can no longer be freely used, particularly in terms of stabilizing the economy. As a result, the importance of fiscal policies as a means of stabilization could well have increased.

In light of the potentially higher importance of fiscal policy in CEECs with an exchange rate peg versus the euro, this paper examines the welfare implications of fiscal policy cooperation in a two-country model with a fixed exchange rate regime.

The contribution of my paper is threefold. First, I provide an explanation about the desirability of fiscal cooperation by developing a quantitative business cycle model which matches the dynamics of CEECs and the euro area, and using this model to analyze fiscal and monetary policy in the EU. Second, I incorporate a realistic assumption about the presence of foreign ownership which is a central feature in CEECs. These countries rely heavily on foreign (mainly European) capital to finance the catching-up process with the incumbent EU members. As a consequence, the presence of foreign ownership in the new EU countries is substantial. For example, the foreign share in equity capitalization ranged from 20% to 80% in many CEECs during the period 1997-2003, while the share of CEECs in equity capitalization in the incumbent EU members is negligible.[2]The introduction of this characteristic is appealing, as conclusions about the desirability of fiscal policy cooperation depend on it. Previous studies of CEECs did not include this feature. Third, the importance

[1] In what follows, I concentrate on CEECs as the new EU members. For simplicity, I do not differentiate among EMU countries and among the new EU countries.

[2] See Table 2.

of fiscal policy has been neglected in formal studies of the new EU countries, which have focused on their monetary issues during the transition period to the EU, but not their fiscal policy.

In building the model, I follow Laxton and Pesenti (2003), Natalucci and Ravenna (2003), Devereux (2002), Devereux et al. (2004), Ghironi and Rebucci (2001), and Galí and Monacelli (2005), all of which are examples of two-country models where one country is large and the other one is much smaller. The structure of my model resembles these models, but includes some new elements that are necessary (fiscal policy) and appealing (foreign ownership) when studying the need for fiscal cooperation in the EU. In my model, the large (foreign) economy represents EMU and the smaller (home) country represents the new EU members. Each country has a fiscal and a monetary authority. The home central bank supports a fixed exchange rate.[3] The other three policymakers conduct a stabilization policy by using policy rules which I assume that they can commit to. Each government uses government consumption as a fiscal instrument and adjusts the instrument in response to its GDP movements. I also assume that the government budgets are balanced in each period.[4] The foreign central bank follows a Taylor-type interest rate rule. When the governments cooperate on fiscal policies, each government chooses the response parameter to its GDP to maximize the unconditional expectation of a weighted average of home and foreign households' utility (welfare), taking the behavior of the foreign central bank as given. The foreign central bank chooses its response parameters to inflation and GDP to maximize the unconditional expectation of foreign households' welfare, taking the behavior of the governments as given. In a non-cooperative game, each player takes the actions of the other two players as given and chooses response parameter(s) in its rule to maximize the welfare of its own households. All players act simultaneously.[5]

[3]Therefore, there are only three active players involved in the strategic games.

[4]Technically, this is done via lump-sum taxes. Given balanced budgets each period, fiscal sustainability is ensured, and I do not discuss fiscal cooperation in the form of common rules to ensure fiscal discipline.

[5]The model is solved numerically and calibrated to the euro area (large economy) and the Czech Republic (small economy). One must acknowledge that the new EU members are heterogenous in their structure. However, given limited time series for many of the new EU members, I follow several authors who have used

To understand how the foreign ownership of firms affects the results, I first analyze a benchmark model with no foreign ownership. When the governments cooperate on their fiscal policies, they choose the response parameters to GDP to maximize a weighted average of home and foreign welfare with the relative sizes of the economies as weights. The government of the large economy is indifferent between cooperating and not cooperating on fiscal policy with the government of the smaller economy. On the other hand, the government of the smaller country prefers not to cooperate because under fiscal cooperation, each government chooses the parameter in its fiscal rule to stabilize shocks mainly in the large country.

Fiscal cooperation is even less desirable in the empirically more realistic model where foreign households own home firms. In this case, home households no longer receive the state-contingent dividend income, so their ability to insure themselves is reduced. Most of the variables in the smaller country become more volatile (e.g. private consumption, GDP). Therefore, both governments are more active than in the benchmark model in stabilizing the smaller economy when they cooperate, which makes government purchases in both countries more volatile. More aggressive fiscal policies have adverse effects on private non-tradable consumption in both countries.[6] There is also a shift towards stabilizing the shocks that affect both countries when their governments cooperate. This means that the foreign non-tradable technology shock is not absorbed as efficiently and introduces more volatility into foreign tradable consumption. As a consequence, foreign overall private consumption is also more volatile, and welfare in the large economy is reduced. In the small country, less volatile prices translate into less volatile tradable private consumption, so that the overall private consumption is slightly less volatile when the governments cooperate. However, more volatility in the labor supply and government purchases dominate, and home welfare is also lower under fiscal cooperation. The foreign central bank cushions the negative effect of fiscal policies on private consumption, but its actions are not sufficient to make fiscal policy cooperation desirable. These results reflect the fact that the monetary policy in the small

the data for the Czech Republic to proxy for the new EU countries.

[6]The government purchases non-tradable goods.

country is taken as given (by supporting a fixed exchange rate), and that the monetary policy of the large economy is not set cooperatively with respect to fiscal policy.

It is worth mentioning that the fiscal side (and the monetary side) of the model is rather simple and therefore the fiscal experiment is a rather specific one. With such a complex model, it is impossible to solve a first-best problem. Instead, I use *ad hoc* fiscal and monetary policy rules motivated by the data and solve for this problem.

The rest of this paper is organized as follows. Section 2 briefly describes the related literature on monetary and fiscal policy interactions. Section 3 outlines a two-country model of the EU. In Section 4 I describe the solution method and the selection of parameters. In Section 5 I present the transmission mechanism and the dynamic properties of the model. I explain the results about fiscal cooperation is Section 6. Section 7 concludes.

2 Literature review

My work relates to a vast literature on monetary and fiscal policy interactions and the literature on optimal taxation, which provide insights on whether there are gains from policy cooperation or not. Within a more recent literature, there are several studies in which the gains from cooperation depend on the policymakers' inability to commit. Examples include Rogoff (1985), Kehoe (1989), Canzoneri, Henderson (1991), and Jensen (1996). If policymakers could commit in their models, cooperation would be beneficial. By contrast, if they could not commit, there would be no gains from cooperation.

Another branch of the literature shows that policy cooperation is counterproductive if it is limited to a subset of players. Beetsma and Bovenberg (1998), Beetsma et al. (2001) and Eichengreen and Ghironi (2002) consider a monetary union and decentralized fiscal policies, and show how the adverse reaction of a common central bank to fiscal cooperation can reduce welfare for some or all of the players. However, cooperation is the preferred outcome if it is extended to all players.

In Dixit and Lambertini (2001, 2003) and Eichengreen and Ghironi (2002) gains from fiscal cooperation depend on the policymakers' agreement on goals. They show that there is no need for fiscal cooperation in a monetary union when all players agree on their goals. In this case, they can reach the optimal outcome. However, this differs in Chari and Kehoe (2004), who show that the cooperative and the non-cooperative equilibria may not be the same under the same objectives.

Some contribution find that gains from fiscal policy cooperation depend on the monetary regime. For example, Lombardo and Sutherland (2004) conclude that fiscal cooperation may be welfare-reducing if monetary policies are set non-cooperatively. As regards the quantification of gains from fiscal cooperation, Mendoza and Tesar (2005) find that they are very small.

Finally, my model is similar to Quadrini (forthcoming) in the sense that capital market liberalization plays a role in the desirability of fiscal cooperation. In his model, the equilibrium with tax cooperation reproduces the outcome of the model without capital mobility, which is welfare-inferior to the case of capital market liberalization. His results crucially depend on the governments' inability to commit to future policies; by contrast, I assume that policymakers can commit.

3 A general equilibrium model of the European Union

3.1 The overview of the economic environment

To mimic the structure of the enlarged EU and in particular the nature of the newly admitted members, I take into account four key features of these countries.[7] The first is the high level of foreign ownership of firms, since central and eastern European countries rely heavily on foreign (mainly European) capital to finance the catching-up process with the rest of the EU.

[7] Many and even more of the countries' characteristics that I use in my model are incorporated into the models of accession countries mentioned in the Introduction.

This feature is not present in other accession country models. Second, intermediate goods represent a substantial part of these countries' imports. For example, intermediate goods account for 60% of all Slovene imports and above 50% of Czech and Hungarian imports, making them very exposed to external shocks.[8] Third, domestic tradable goods are exported and consumed by domestic households. Fourth, the non-tradable sector is important, and most government purchases are of non-tradable goods. Taking all of the above into consideration provides more flexibility in matching the data and more realistic interdependencies between the central and eastern European countries and the euro area.

The theoretical framework that I use for my analysis is a micro-founded dynamic stochastic general equilibrium model. The foreign country in the model is designated to fit EMU and the home country represents an aggregate of the new EU members. In each country, there are households, firms, a fiscal authority (government) and a monetary authority (central bank). Foreign variables are indexed by a star.

Households in both countries are infinitely lived and have preferences regarding consumption, real money balances, the labor supply, and government purchases. Each household consumes domestic final non-tradable goods, domestic final tradable goods and imported final tradable goods. Each household supplies homogenous labor to domestic firms producing final non-tradable goods and to domestic firms producing intermediate tradable goods. Labor is perfectly mobile between sectors within a country. The labor market is perfectly competitive, and labor is immobile internationally. Households trade short-term nominal bonds. There are two bonds, home and foreign, denominated in home and foreign currency, respectively. Only the foreign-denominated bond is traded internationally.

The ownership structure of the firms and the equity share trade is as follows: in all cases, all but intermediate sector firms are locally-owned, i.e. home households own home firms and foreign households own foreign firms. Since the presence of foreign ownership in the new EU countries is substantial, I assume that owners of home and foreign intermediate firms are

[8] McCallum and Nelson (2000) show that intermediate goods as imports improve model dynamics.

foreign households which trade home and foreign equity shares and receive dividends from home and foreign intermediate sector firms.[9]

Each country produces three types of goods: final non-tradable goods, final tradable goods and a continuum of differentiated intermediate tradable goods. The final non-tradable goods are produced by perfectly competitive firms using domestic labor as input and can be consumed by households and by the government. The firms which produce the final tradable goods operate in a perfectly competitive environment. Their goods are produced by combining domestic and imported intermediate goods and are used for private consumption. Each intermediate tradable good is produced by a single firm in a monopolistically competitive environment. The input used in the production of each intermediate good is domestic labor. The intermediate goods are used in the production of final tradable goods. In the intermediate sector, there are nominal rigidities in the form of a quadratic cost of price adjustment.

Finally, government conducts a fiscal policy of stabilization. The government spends its revenue on final non-tradable goods and this is financed through taxes and seigniorage. The central bank in each country is instrument-independent of the government. The foreign central bank conducts monetary policy by employing an interest rate rule, while the home central bank supports a fixed exchange rate.

[9]The sector that is exclusively foreign-owned is only one of three sectors. This assumption is thus not extreme with regard to the extent of foreign presence.

3.2 Households and their trading opportunities

3.2.1 Utility function

The home consumer j's utility function has the following form:

$$U_t^j \equiv E_t \sum_{i=0}^{\infty} \beta^i \left[A_{C,t} \frac{\left(C_{t+i}^j\right)^{1-\sigma}}{1-\sigma} + \frac{\left(G_{t+i}^j\right)^{1-\sigma_g}}{1-\sigma_g} + \chi \frac{\left(\frac{M_{t+i}^j}{P_{t+i}}\right)^{1-\phi}}{1-\phi} - A_{L,t} \frac{\left(L_{t+i}^j\right)^{1+\psi}}{1+\psi} \right], \quad (1)$$

where the labor supply equals $L_t = L_{N,t} + L_{X,t}$, and labor is homogenous and perfectly mobile between sectors within the country, C_t is the consumption basket, P_t is the consumption price index, M_t are nominal money balances, and G_t are government purchases. $\sigma > 0$, $\sigma_g > 0$, $\chi \geq 0$, $\phi > 0$, $\psi > 0$. β is the discount factor, $\frac{1}{\sigma}$ is the elasticity of intertemporal substitution of private consumption, $\frac{1}{\phi}$ is the elasticity of substitution of real money balances, and $\frac{1}{\psi}$ is the labor supply elasticity. $A_{C,t}$ is a preference shock and $A_{L,t}$ is a shock to labor disutility. Home consumers are indexed by $j \in [0, a)$ and a is the relative size of the home country. Foreign households' utility function is similar to the home one, and foreign households are indexed by $j^* \in [a, 1]$.

3.2.2 The intra-temporal allocation of consumption

Total consumption, C_t^j, is a composite index of the non-tradable and tradable consumption baskets, $C_{N,t}^j$ and $C_{T,t}^j$, respectively:

$$C_t^j \equiv \left[(1-\varphi_t)^{\frac{1}{\mu}} \left(C_{N,t}^j\right)^{\frac{\mu-1}{\mu}} + (\varphi_t)^{\frac{1}{\mu}} \left(C_{T,t}^j\right)^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}, \quad (2)$$

where $0 \leq \varphi_t \leq 1$ is the share of tradable consumption in the consumption basket and $\mu > 0$ is the elasticity of substitution between non-tradable and tradable consumption. The (log of) tradable goods' weight in consumption, φ_t, is subject to an autocorrelated disturbance term around the steady-state mean. This shock represents shifts in home residents' preferences from non-tradable to tradable goods. C_N^j is a basket of final non-tradable goods produced by perfectly competitive firms.

The consumption index of tradable goods is defined as:

$$C^j_{T,t} \equiv \left[\omega^{\frac{1}{\eta}} \left(C^j_{F,t}\right)^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} \left(C^j_{F^*,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{3}$$

where $0 \leq \omega \leq 1$ is the share of home tradable consumption and $\eta > 0$ is the elasticity of substitution between home and foreign tradable goods. C^j_F and $C^j_{F^*}$ are the baskets of home and foreign final tradable goods also produced by perfectly competitive firms.

The definitions of the consumption preferences imply:

$$P_t = \left[(1-\varphi_t)\left(P_{N,t}\right)^{1-\mu} + \varphi_t \left(P_{T,t}\right)^{1-\mu}\right]^{\frac{1}{1-\mu}},$$

$$P_{T,t} = \left[\omega \left(P_{F,t}\right)^{1-\eta} + (1-\omega)\left(P_{F^*,t}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}},$$

where P_N and P_T are the prices of non-tradable and tradable consumption baskets, respectively, and P_F and P_{F^*} are the prices of home and foreign baskets of final tradable goods, respectively.

The demand for baskets C^j_T and C^j_N is:

$$C^j_{T,t} = \varphi_t \left[\frac{P_{T,t}}{P_t}\right]^{-\mu} C^j_t, \tag{4}$$

$$C^j_{N,t} = (1-\varphi_t) \left[\frac{P_{N,t}}{P_t}\right]^{-\mu} C^j_t, \tag{5}$$

and the demand for the home and foreign baskets of final tradable goods is:

$$C^j_{F,t} = \omega \left[\frac{P_{F,t}}{P_{T,t}}\right]^{-\eta} C^j_{T,t}, \tag{6}$$

$$C^j_{F^*,t} = (1-\omega) \left[\frac{P_{F^*,t}}{P_{T,t}}\right]^{-\eta} C^j_{T,t}. \tag{7}$$

Foreign households solve a similar problem.

3.2.3 Inter-temporal optimization

The budget constraint for household j in the home country is:

$$\begin{aligned} & M_t^j + B_{t+1}^j + \varepsilon_t B_{t+1}^{*,j} + P_t \frac{\xi_{B^*}}{2} \left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t} - \frac{\overline{\varepsilon}\overline{B}^{*,j}}{\overline{P}} \right)^2 + P_t C_t^j + P_t T_t^j \qquad (8) \\ \leq \; & M_{t-1}^j + (1+i_t) B_t^j + \varepsilon_t (1+i_t^*) B_t^{*,j} + \left(1-\tau_t^L\right) \left(W_{N,t} L_{N,t}^j + W_{X,t} L_{X,t}^j \right) + P_t TCT_t^j . \end{aligned}$$

The home household j consumes, C_t^j, pays net lump-sum taxes, T_t^j, and receives the wage income net of the labor income tax, $\left(1-\tau_t^L\right) \left(W_{N,t} L_{N,t}^j + W_{X,t} L_{X,t}^j \right)$. The home household j holds domestic money, M_t^j, and home and foreign bonds, B and B^*, denominated in the home and foreign currency, respectively, where B_{t+1}^j is the stock of home bonds held by household j entering period $t+1$ and $B_{t+1}^{*,j}$ is the stock of foreign bonds held by household j entering period $t+1$. ε_t is the nominal exchange rate in the units of home currency per one unit of foreign currency. The short-term nominal interest rates i_t and i_t^* are paid at the beginning of period t and are known at time $t-1$. Only the foreign bonds are traded internationally. There are intermediation costs for households entering the international bond market.[10] In particular, households face a convex cost of holding foreign bonds in quantities that differ from the steady-state level. The revenue from intermediation is rebated to households as a lump-sum transaction cost transfer, TCT_t^j.[11] In equilibrium, the rebate equals $TCT_t^j = \frac{\xi_{B^*}}{2} \left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t} - \frac{\overline{\varepsilon}\overline{B}^{*,j}}{\overline{P}} \right)^2$.

Each household chooses the labor supply, bond and money holdings, and consumption path to maximize the expected lifetime utility (1), subject to the budget constraint (8). The

[10] The intermediation costs are introduced to guarantee that the net bond positions follow a stationary process and economies converge asymptotically to a steady state. See Schmitt-Grohé and Uribe (2003) on this and other approaches on how to pin down the steday-state values of bonds.

[11] I assume that intermediaries are perfectly competitive and owned by domestic households.

first-order conditions with respect to labor are:

$$\left(1-\tau_t^L\right) w_{N,t} = \left(1-\tau_t^L\right) w_{X,t} = \frac{A_{L,t}\left(L_t^j\right)^{\psi}}{A_{C,t}\left(C_t^j\right)^{-\sigma}}, \tag{9}$$

where $w_{N,t} \equiv \frac{W_{N,t}}{P_t}$ and $w_{X,t} \equiv \frac{W_{X,t}}{P_t}$ are real wages in the final non-tradable sector and intermediate sector, respectively. The first order conditions with respect to home and foreign bond holdings are:

$$A_{C,t}\left(C_t^j\right)^{-\sigma} = \beta\left(1+i_{t+1}\right) E_t\left[\frac{P_t}{P_{t+1}} A_{C,t+1}\left(C_{t+1}^j\right)^{-\sigma}\right], \tag{10}$$

$$A_{C,t}\left(C_t^j\right)^{-\sigma}\left[1+\xi_{B^*}\left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t} - \frac{\overline{\varepsilon}\overline{B}^{*,j}}{\overline{P}}\right)\right] = \beta\left(1+i_{t+1}^*\right) E_t\left[\frac{\varepsilon_{t+1}}{\varepsilon_t}\frac{P_t}{P_{t+1}} A_{C,t+1}\left(C_{t+1}^j\right)^{-\sigma}\right]. \tag{11}$$

This first-order condition accounts for a reduced return on lending to foreigners and an increased cost of borrowing from foreigners due to intermediation costs.

Unlike home households, foreign households trade only foreign bonds; however, in addition to foreign bonds, they also trade equity shares in home and foreign intermediate sector firms. Their budget constraint is presented in the appendix. The first-order conditions with respect to home and foreign shares are:

$$A_{C,t}^*\left(C_t^{j^*}\right)^{-\sigma} = \beta E_t\left[\frac{P_t^*}{P_{t+1}^*}\frac{\left(\left(1-\tau_{t+1}^{D^*}\right) D_{t+1}^{x^*} + V_{t+1}^{x^*}\right)}{V_t^{x^*}} A_{C,t+1}^*\left(C_{t+1}^{j^*}\right)^{-\sigma}\right], \tag{12}$$

$$A_{C,t}^*\left(C_t^{j^*}\right)^{-\sigma} = \beta E_t\left[\frac{\varepsilon_t}{\varepsilon_{t+1}}\frac{P_t^*}{P_{t+1}^*}\frac{\left(\left(1-\tau_{t+1}^{D}\right) D_{t+1}^{x} + V_{t+1}^{x}\right)}{V_t^{x}} A_{C,t+1}^*\left(C_{t+1}^{j^*}\right)^{-\sigma}\right], \tag{13}$$

where V^x and V^{x^*} denote the price of the equity shares in the home intermediate firm x and the price of the equity shares in the foreign intermediate firm x^*, respectively. D^x and D^{x^*} are the dividends paid by the home and foreign firms x and x^*, respectively.

3.2.4 Asset market clearing

In equilibrium, households and firms are symmetric so that $B^{j}_{t+1} = B_{t+1}$, $B^{*,j}_{t+1} = B^{*}_{t+1}$, $B^{*,j^*}_{*,t+1} = B^{*}_{*,t+1}$ and $\int_0^a S^{x,j^*}_{*,t+1}dx = aS^{x,j^*}_{*,t+1} \equiv S_{*,t+1}$ and $\int_a^1 S^{x^*,j^*}_{*,t+1}dx^* = (1-a)S^{x^*,j^*}_{*,t+1} \equiv S^{*}_{*,t+1}$. S^{x,j^*}_{*} are the foreign household $j^{*\prime}s$ equity share holdings in home firm x and S^{x^*,j^*}_{*} are $j^{*\prime}s$ equity share holdings in foreign firm x^*.[12] The market clearing conditions for home and foreign bonds are:

$$\int_0^a B_{t+1}dj = 0, \tag{14}$$

$$\int_0^a B^{*}_{t+1}dj + \int_a^1 B^{*}_{*,t+1}dj^* = 0. \tag{15}$$

The market clearing conditions for home and foreign equity shares are:

$$\int_a^1 S_{*,t+1}dj^* = \int_0^a 1dx, \tag{16}$$

$$\int_a^1 S^{*}_{*,t+1}dj^* = \int_a^1 1dx^*. \tag{17}$$

3.3 The intermediate goods sector and its ownership structure

The home intermediate good $x \in [0, a)$ is produced by a monopolistically competitive firm that uses the following linear technology:

$$Y^{x}_{X,t} \equiv A_{X,t}L^{x}_{X,t}, \tag{18}$$

[12] See the appendix for the explanation of notation.

where $A_{X,t}$ is a productivity shock common to all producers and $L^x_{X,t}$ is homogenous labor used in the production of good x. Firms producing intermediate goods face nominal rigidities. Following Rotemberg (1982), these are expressed in the form of a quadratic cost of price adjustment.

The home firm x maximizes the present discounted value of the dividends, d^x_s,

$$\max_{\{p_s(x),L^x_{X,s}\}} E_t\left(\sum_{s=t}^{\infty}\Omega^x_s d^x_s\right) \tag{19}$$

subject to

$$d^x_s = (1-\tau_t)\frac{p_s(x)}{P_s}Y^x_{X,s} - \frac{W_{X,s}}{P_s}L^x_{X,s} - \frac{\kappa}{2}\left(\frac{p_s(x)}{p_{s-1}(x)}-1\right)^2\frac{p_s(x)}{P_s}Y^x_{X,s} \tag{20}$$

and

$$Y^{S^x}_{X,s} = Y^{D^x}_{X,s} = Y^x_{X,s}. \tag{21}$$

Since foreign households own home intermediate sector firms, the discount factor for the home firm x is $\Omega^x_s = \beta^{s-t}\frac{A^*_{C,s}}{A^*_{C,t}}\left(\frac{C^*_s}{C^*_t}\right)^{-\sigma}$ for $s = t, t+1, t+2...$ and τ is the tax rate on the firm's revenues.

The first-order condition with respect to labor is:

$$\lambda^x_t = \frac{w_{X,t}}{A_{X,t}}, \tag{22}$$

which implies that the Lagrange multiplier on constraint (21), λ^x_t, is equal to the real marginal cost. The first-order condition with respect to the price implies a price which is set as a markup over the nominal marginal cost:

$$p_t(x) = \Psi^x_t P_t \lambda^x_t, \tag{23}$$

where the markup equals

$$\Psi_t^x \equiv \frac{\theta Y_{X,t}^x}{(\theta-1)\, Y_{X,t}^x \left[(1-\tau_t) - \frac{\kappa}{2}\left(\frac{p_t(x)}{p_{t-1}(x)} - 1\right)^2\right] + \kappa \Theta_t},$$

with

$$\Theta_t \equiv Y_{X,t}^x \frac{p_t(x)}{p_{t-1}(x)}\left(\frac{p_t(x)}{p_{t-1}(x)} - 1\right) - E_t\left[\Omega_{t+1}^x Y_{X,t+1}^x \frac{P_t}{P_{t+1}}\left(\frac{p_{t+1}(x)}{p_t(x)}\right)^2\left(\frac{p_{t+1}(x)}{p_t(x)} - 1\right)\right].$$

In symmetric equilibrium, $p_t(x) = P_{X,t}$. Foreign firms solve a similar problem and the law of one price holds: $P_{X,t} = \varepsilon_t P_{X,t}^*$, $P_{X^*,t} = \varepsilon_t P_{X^*,t}^*$.

3.4 Production of final goods

3.4.1 Production of final non-tradable goods

There is a continuum of symmetric perfectly competitive home firms on the interval $n \in [0, a)$ producing the home final non-tradable good N. The output of a representative firm at time t is denoted by $Y_{N,t}$ and is generated using the following linear technology:

$$Y_{N,t} \equiv A_{N,t} L_{N,t}, \tag{24}$$

where $A_{N,t}$ is a productivity shock common to the producers of the home non-tradable good and $L_{N,t}$ is homogenous labor used in the production of the home non-tradable good. Taking the price of labor, W_N, as given, the firm chooses labor, $L_{N,t}$, to minimize its costs subject to the production function. The first order-condition for the firm is:

$$RP_{N,t} = \frac{w_{N,t}}{A_{N,t}}, \tag{25}$$

where $w_{N,t} \equiv \frac{W_{N,t}}{P_t}$ is the real wage in the non-tradable sector and $RP_{N,t} \equiv \frac{P_{N,t}}{P_t}$ is the price of good N in the units of the consumption basket. The same optimization problem applies to foreign firms.

3.4.2 Production of final tradable goods

There is a continuum of symmetric, perfectly competitive home firms on the interval $f \in [0, a)$ producing home final tradable good F with the following constant elasticity of substitution production function:

$$Y_{F,t} \equiv \left[\gamma^{\frac{1}{\epsilon}} (X_t)^{\frac{\epsilon-1}{\epsilon}} + (1-\gamma)^{\frac{1}{\epsilon}} (X_t^*)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{26}$$

where $Y_{F,t}$ is the amount of the home final tradable good produced by a representative firm at time t. The home final tradable good F is produced using two intermediate goods: a basket X of home tradable differentiated intermediate goods, and a basket X^* of foreign tradable differentiated intermediate goods. $\epsilon > 0$ is the elasticity of substitution between home and foreign intermediate goods, and $0 \leq \gamma \leq 1$ is the share of home intermediate goods in the production of the home final tradable good.

The baskets of home and foreign intermediate goods are defined as follows:

$$X_t \equiv \left[\left(\frac{1}{a}\right)^{\frac{1}{\theta}} \int_0^a (X_t(x))^{\frac{\theta-1}{\theta}} dx\right]^{\frac{\theta}{\theta-1}}, \tag{27}$$

$$X_t^* \equiv \left[\left(\frac{1}{1-a}\right)^{\frac{1}{\theta}} \int_a^1 (X_t^*(x^*))^{\frac{\theta-1}{\theta}} dx^*\right]^{\frac{\theta}{\theta-1}}, \tag{28}$$

where $\theta > 1$ denotes the elasticity of substitution among the intermediate goods and x and x^* denote the home and foreign varieties of intermediate goods. The definition of the production function implies:

$$P_{F,t} = \left[\gamma \left(P_{X,t}\right)^{1-\epsilon} + (1-\gamma)\left(P_{X^*,t}\right)^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}}$$

and the definitions of the baskets of intermediate goods imply:

$$P_{X,t} = \left[\left(\frac{1}{a}\right)\int_0^a \left(p_t(x)\right)^{1-\theta} dx\right]^{\frac{1}{1-\theta}},$$

$$P_{X^*,t} = \left[\left(\frac{1}{1-a}\right)\int_a^1 \left(p_t(x^*)\right)^{1-\theta} dx^*\right]^{\frac{1}{1-\theta}},$$

where P_X and P_{X^*} are the price indices of the home and foreign baskets of intermediate goods and $p_t(x)$ and $p_t(x^*)$ are the prices of the varieties x and x^*.

The representative firm's demand for baskets X and X^* is:

$$X_t = \gamma\left[\frac{P_{X,t}}{P_{F,t}}\right]^{-\epsilon} Y_{F,t}, \tag{29}$$

$$X_t^* = (1-\gamma)\left[\frac{P_{X^*,t}}{P_{F,t}}\right]^{-\epsilon} Y_{F,t} \tag{30}$$

and the demand for individual goods x and x^* by the representative firm is:

$$X_t(x) = \frac{1}{a}\left[\frac{p_t(x)}{P_{X,t}}\right]^{-\theta} X_t, \tag{31}$$

$$X_t^*(x^*) = \frac{1}{1-a}\left[\frac{p_t(x^*)}{P_{X^*,t}}\right]^{-\theta} X_t^*. \tag{32}$$

Foreign producers solve a similar problem. The law of one price holds in the final tradable sector: $P_{F,t} = \varepsilon_t P_{F,t}^*$, $P_{F^*,t} = \varepsilon_t P_{F^*,t}^*$.

3.5 Goods and labor market clearing

The market clearing conditions are as follows. Non-tradable goods can be consumed by households and the government:

$$\int_0^a Y_{N,t}dn = \int_0^a C_{N,t}dj + aG_t. \tag{33}$$

Final tradable goods are consumed by home and foreign households:

$$\int_0^a Y_{F,t}df = \int_0^a C_{F,t}dj + \int_a^1 C^*_{F,t}dj^* \tag{34}$$

and intermediate goods are used in the production of home and foreign final tradable goods. Markets clear for each variety x:

$$Y^x_{X,t} = \int_0^a X_t(x)df + \int_a^1 X_{*,t}(x)df^*. \tag{35}$$

The labor market clearing requires:

$$\int_0^a L_{N,t}dj + \int_0^a L_{X,t}dj = \int_0^a L_{N,t}dn + \int_0^a L_{X,t}dx. \tag{36}$$

Similar market clearing conditions hold for foreign goods and labor.

3.6 Fiscal and monetary policy

3.6.1 Government and fiscal policy

The government is assumed not to be productive and public spending is directed towards final non-tradable goods and is denoted by G, which is per capita government consumption. The government finances its consumption through lump-sum taxes imposed on consumers, taxes imposed on the intermediate sector firms, labor income taxes, dividend income taxes,

and seigniorage revenue. The government is required to balance its budget in every period.[13] Tax rates are taken as given and are calibrated to the EU data. The government uses the ratio of government consumption to GDP as its instrument and pursues a stabilization policy. Fiscal policy is specified in terms of the following rule:[14]

$$g_t = \left(\frac{GDP_t}{\overline{GDP}}\right)^{f_{GDP}} \epsilon_t^{fp}, \tag{37}$$

where $g_t = \frac{RP_{N,t}G_t}{GDP_t}$, f_{GDP} is the feedback parameter on GDP gap with respect to the steady state, and ϵ_t^{fp} is an exogenous shock to fiscal policy. This fiscal rule reflects an output gap stabilization motive and is motivated by the empirical literature.[15] Foreign fiscal policy is specified in a similar way.

3.6.2 Central bank and monetary policy

The home central bank issues home nominal money. The monetary policy in the home economy supports a fixed exchange rate,[16] which is in line with the requirements of membership in the ERM2 prior to joining the monetary union.

The foreign central bank issues foreign nominal money. The foreign monetary policy is endogenous and specified in terms of an interest rate rule:

$$1 + i_{t+1}^* = (1 + i_t^*)^{m_i^*} (1 + \pi_t^*)^{m_{CPI}^*} \left(\frac{GDP_t^*}{\overline{GDP^*}}\right)^{m_{GDP}^*} \epsilon_t^{*mp}, \tag{38}$$

[13] The government's budget constraint is in the appendix.

[14] Beetsma and Jensen (2002) show that this class of fiscal rules performs well relative to the optimal rules in their model.

[15] Empirical fiscal rules also take into account the public deficit stabilization motive. See for example Galí and Perotti (2003), who estimate fiscal rules for EMU/OECD countries, and Favero and Monacelli (2003) for the US and references therein.

Gali and Perotti (2003) find empirical evidence that fiscal policies became increasingly countercyclical in EMU in the period 1980-2001, and that spending policies played a more important role as a countercyclical tool than revenue policies, while the Government of Slovenia, for example, announced it would use its fiscal policy for stabilization purposes after fixing the exchange rate to the euro in summer 2004.

[16] See Benigno et al. (2002) for details on how to fix the exchange rate.

where m_i^*, m_{CPI}^*, and m_{GDP}^* are the feedback parameters on the previous period interest rate, CPI inflation and GDP gap, respectively, and ϵ_t^{*mp} is an exogenous shock to monetary policy.

4 Solution and parameterization of the model

4.1 Solution of the model and the steady state

The variables are expressed in real aggregate per capita terms. As the model cannot be solved analytically, I therefore calculate the rational expectations equilibrium of the log-linearized approximation around the steady state. I employ the solution method for solving nonlinear dynamic discrete-time stochastic models provided by Uhlig (1999), and find the recursive equilibrium law of motion using the method of undetermined coefficients. The steady state for the benchmark model with no foreign ownership can be solved analytically, but I use numeric methods to solve for the steady state of the model with the foreign ownership of home intermediate firms.

4.2 Parameterization

The home economy in this model represents the new EU members, and the foreign economy is designated to be EMU.[17] Thus, the size of the home country relative to the foreign economy, a, is set to 5 percent.[18] The discount factor, β, equals 0.99, which implies an annual real interest rate of around 4 percent. In line with the literature, the inverse of the elasticity of intertemporal substitution of consumption, σ, is equal to 2. Following Laxton and Pesenti (2003), the inverse of the labor supply elasticity, ψ, is set to 2.5. I assume the utility of government consumption is logarithmic so that $\sigma_g = 1$.

[17] The model is calibrated to the EMU and the Czech Republic's data.
[18] The new members' share of GDP in the EU's total GDP is around 5 percent.

The share of home tradable consumption in the tradable consumption basket, ω, and the share of home intermediate goods in the production of final tradable goods, γ, are equal to a. The share of tradable consumption in the consumption basket, φ, equals 55 percent as in Natalucci and Ravenna (2003).

The elasticity of substitution between non-tradable and tradable consumption, μ, is set to 0.5 as in Stockman and Tesar (1995) and the elasticity of substitution between home and foreign tradable goods, η, is set to 1.5. ϵ is the elasticity of substitution between home and foreign intermediate goods and is set to 0.5. The last two parameters are taken from Natalucci and Ravenna (2003). θ denotes the elasticity of substitution among the intermediate goods. I set $\theta = 11$ which, together with the revenue tax of 0.2, implies a markup of 1.375.[19] The price adjustment cost parameter, κ, is set to 77, as estimated by Ireland (2001) for the US economy. All financial transaction cost parameters are set to 0.01, which is standard in the literature.[20]

I treat tax rates as parameters and take their values from Quadrini (forthcoming) and Mendoza and Tesar (2005). The tax rate on revenue, τ, equals 20 percent. The tax rate on labor income is set to 37 percent, and the tax rate on dividends to 25 percent. The steady-state share of government purchases in GDP is calibrated to 18 percent.

The foreign monetary policy parameters are set as estimated by Smets and Wouters (2003). The degree of interest rate smoothing, m_i^*, is set to 0.95. The interest rate response to inflation, m_{CPI}^*, equals 1.65, and the interest rate response to GDP, m_{GDP}^*, is set to 0.14. I assume that the home central bank supports a fixed exchange rate, which is in line with ERM2, and keep this assumption across all model specifications.[21] Galí and Perotti (2003)

[19] Martins et al. (1996) estimate the average markup for the manufacturing sector at 1.2 for the OECD countries. Some authors suggest that the range between 1.2 and 1.7 is reasonable. See Morrison (1994) and Domowitz et al. (1988).

[20] Ghironi et al. (2003) set these parameters to 0.025 to match reasonable persistence of the net foreign assets.

[21] Some of the new EU members have already fixed their exchange rate to the euro in order to satisfy the exchange rate criterion to enter the monetary union. However, past policies in most of these countries did not have a fixed exchange rate regime, but I assume this in order to be consistent across model specifications and for simplicity.

estimate different specifications of fiscal rules for the Euro Area. Their spending rule for the period after the introduction of the Maastricht Treaty indicates that the primary spending-to-potential output ratio reacts to the output gap with the coefficient of 0.04 and that there is a high persistence of the fiscal instrument; the persistence parameter is estimated to be 0.8. I approximate the historic foreign fiscal policy by setting the reaction coefficient to the output gap to zero, and I incorporate a high persistence coefficient on the past instrument with an AR(1) fiscal shock. There are no empirical studies on fiscal policy rules for the new EU members. Without loss of generality, I assume that also the new EU members have not been using their fiscal policies as a stabilization tool until recently. Natalucci and Ravenna (2003) and Devereux (2002) estimate government spending for the Czech Republic and Estonia as AR(1) processes with the persistence parameters of 0.7 and 0.8, respectively.

5 The effects and transmission of shocks and dynamic properties of the model

To understand how the model's transmission mechanism works, I first analyze the impulse responses of the macroeconomic variables to a technology shock. I also investigate the effects of a fiscal shock in order to show how fiscal policy actions in one country affect variables in the other economy. This analysis is conducted for historic monetary and fiscal policies.

5.1 Foreign technology shock

I choose to analyze the impulse responses of variables in both economies to a foreign technology (and later fiscal) shock because the home country only marginally affects the large economy and most of the spillovers flow from the large to the small country.

Figures 1 and 2 present the impulse responses to a 1-percent increase in the foreign intermediate sector productivity. To understand the implications of the assumption about

the foreign ownership of the home intermediate sector firms, I show the impulse responses for a benchmark model without foreign ownership (solid line), as well as the model in which the home intermediate sector firms are exclusively foreign-owned (dashed line).

A positive productivity shock in the foreign intermediate sector increases the output of foreign intermediate goods, reduces the labor supply, and increases the wage rate in this sector. The increase in productivity dominates the effect of higher wages so that marginal costs decrease. As a consequence, the relative price of foreign intermediate goods falls. The markup increases in order to preserve profitability, and the dividends are higher. This is reflected in an increase of the foreign share price.

The productivity shock in the foreign intermediate sector transmits to other sectors in the foreign economy as well as to the home economy. The shock is directly transmitted to foreign firms which produce final tradable goods and use intermediate goods in their production. They enjoy lower foreign input prices and therefore expand the production of the final tradable goods. The relative price of the foreign final tradable goods decreases, while the quantity demanded by home and foreign households increases. Foreign households also demand more non-tradable goods, which increases labor demand and wages in the foreign non-tradable sector. The foreign relative price of the non-tradable goods is consequently higher.

At the same time, the original shock transmits into the home economy. The home final tradable sector expands for the same reason as the foreign final tradable sector (foreign inputs have a higher weight in the production of final tradable goods), while the home relative price of the final tradable goods decreases. There is an initial boom in the home intermediate sector coming from higher home and foreign demand because both, home and foreign inputs are required in the production of final tradable goods. After the initial positive effect on the home intermediate sector, the demand for home inputs decreases (prices are higher at home). The labor dynamics at home follow output dynamics in the home intermediate sector. Higher demand for inputs initially results in higher demand for the intermediate

labor and higher wages. Since labor is perfectly mobile between the two sectors, it flows to the intermediate sector. Initially, home non-tradable output declines but once the positive effect in the intermediate sector is reversed, labor in the intermediate sector is lower and the output in the non-tradable sector expands. The home relative price of the non-tradable goods increases.

As a consequence of a positive productivity shock in the foreign intermediate sector, home and foreign GDP and private consumption expand. Foreign CPI inflation almost does not responds due to the opposite dynamics of prices of tradable and non-tradable goods, while home CPI inflation increases because the prices of tradable and non-tradable goods both increase. As a result, the real exchange rate, which is defined as $RE_t = \frac{\varepsilon_t P_t^*}{P_t}$, declines (nominal exchange rate is fixed). Home households initially borrow from foreign households but they later accumulate foreign bonds because the shock results in higher expansion in the home country.

5.2 Foreign fiscal shock

Figures 3 and 4 present the impulse responses to a 1-percent increase in the foreign fiscal shock. A demand shock in the form of an increase of the foreign government purchases-to-GDP ratio increases demand for labor and output in the foreign non-tradable sector. Government consumption crowds out private non-tradable consumption, and this cushions the foreign wage rate and the relative price of the non-tradable goods from a large increase. Higher wages in the non-tradable sector attract labor from the intermediate sector and thus the wage in the intermediate sector increases as well. Consequently, the supply of foreign intermediate goods falls and demand adjusts. Because of the opposite labor cost and markup dynamics in the foreign intermediate sector, the relative price of the foreign inputs almost does not change. Intermediate goods are inputs in the production of final tradable goods, which decreases in both countries. In the foreign economy, the relative price of the final

tradable goods stays almost the same. Foreign private consumption falls mainly due to the crowding-out effect, which prevents foreign GDP from a significant expansion.

The shock transmits to the home economy because the supply of foreign intermediate goods drops and so does the production of home inputs. This reduces the supply of home and foreign final tradable goods. The relative price of home final tradable goods increases. Labor in the home country reallocates to the non-tradable sector because of lower labor demand and wages in the intermediate sector. Higher labor supply in the non-tradable sector increases production and reduces the wages and relative prices in this sector. Overall home private consumption decreases because the consumption of the final tradable goods is lower, and almost all of the additional non-tradable goods are consumed by the government, which crowds out private non-tradable consumption. Home GDP decreases.

Home CPI inflation decreases because the main components of home CPI inflation (the home prices of non-tradable goods and the foreign prices of tradable goods) are lower. On the other hand, foreign CPI does not change since all foreign prices stay almost constant. The real exchange rate is thus driven by home prices and increases.

5.3 Estimates of macroeconomic variability

The previous section analyzed only the responses of variables in the two economies to a given shock. Here I investigate how the model behaves when the two countries are hit by all shocks at once. In order to do so, I need to make some assumptions about the stochastic processes. The empirical evidence on the productivity shocks shows their high persistence and positive correlation across countries.[22] In my model, productivity shocks follow AR(1) processes. I set the persistence parameters of all productivity shocks to 0.9. Productivity shocks between different sectors within a country are perfectly correlated as in Natalucci and Ravenna (2003) and Laxton and Pesenti (2003). All other shocks are independent of each other. The monetary shock in the foreign interest rate rule is and *iid* process. The persistence

[22] See for example Backus et al. (1992).

parameters of the preference shocks, labor disutility shocks and shocks to shifts in preferences between non-tradable and tradable goods are set to 0.7, 0.9 and 0.9, respectively. I choose the standard deviations of the shocks to match some of the moments of macroeconomic variables given historic economic policies and the baseline parameter values. The details on stochastic processes are in Table 3.

The second moments of the model (with foreign ownership) and the values from the data are presented in Table 4. The model generates almost twice as much variability in GDP in the new EU members compared to the euro area; the absolute values of the standard deviations of GDP are consistent with the variability in historic data. For the Czech Republic, the model performs well in the sense that all of the GDP components are more volatile than GDP itself. However, exports and imports in the model are less volatile than their historic counterparts. This may be explained by the fact that there is no capital/investment in my model. Investment is the most volatile component of GDP and since investment goods are not a part of exports and imports in my model, the volatility of exports and imports may accordingly be understated. Government expenditure is more volatile in the model than in the historic data.[23] There is a trade-off between matching the volatility of government purchases and matching the rest of the variables in this exercise.

The CPI inflation rate is more volatile and the interest rate is somewhat less volatile than in the data. This could be due to the monetary regime that I assume for the smaller economy in the model. In order to mimic the current arrangement of the institutions in the new EU member states and to keep the strategic games among policymakers as simple as possible, I assume that the smaller economy supports a fixed exchange rate regime. However, the historic moments are based on a monetary regime that is not a fixed exchange rate regime.

For the euro area, the CPI inflation and the interest rate are less variable in the model because of the assumption of an inflation-targeting regime, which is similar to the model

[23]The variability of government expenditure directly enters the welfare function used in the policy experiments. I thus correct for the fact that the variability of government purchases is too high by adjusting the weight on the government purchases in the welfare function.

properties of Laxton and Pesenti (2003). While data suggest less variability of GDP components than that of the GDP itself for the euro area, the model generates about the same degree of volatility for each of them.

The dynamic properties of the model can partially be compared to the model of Laxton and Pesenti (2003) and Natalucci and Ravenna (2003). The latter's performs better in terms of the CPI inflation rate and the interest rate. Given that I assume a fixed exchange rate regime (and they do not) this is not surprising. As for the other variables, the model performs at least as well as their model. I cannot compare the dynamics for the euro area to Natalucci and Ravenna (2003) since they assume that the rest of the world is exogenous and do not model the second country.

The model in Laxton and Pesenti (2003) is highly sophisticated and incorporates many realistic ingredients which I do not include in my model. Therefore, the overall performance of their model in matching the second moments is better. Nonetheless, both models fail to match the dynamics of the CPI inflation rates and the interest rates. As explained above, the lower volatilities of exports and imports in my model compared to the historic data may be a consequence of the lack of investment in the model. Finally, the real exchange rate is much better matched in my model compared to Laxton and Pesenti (2003).

5.4 The role of foreign ownership

Table 5 presents the standard deviations of selected variables for the model with foreign ownership of firms in the home economy (Foreign) and for the model without foreign ownership of home firms (Local). The volatility of most variables in the home economy is higher in the model where foreign households own home firms, compared to the model without foreign ownership (higher volatility can also be inferred from some impulse responses). When foreign households own home intermediate sector firms, home households no longer receive state-contingent dividend income and their ability to insure themselves and smooth consumption is thus reduced. Home households can only insure themselves against the risk of

firms through the labor supply. As a consequence, home private consumption, along with most other variables, is more volatile when foreign households own home intermediate sector firms. On the other hand, the home labor effort and imports are slightly less volatile in the model with foreign ownership of home firms.

The comparison of the second moments of selected variables between the model with and without foreign ownership of firms in the home economy reveals that the two models perform similarly in matching the second moments of the data.[24] The model with foreign ownership performs better in matching the volatilities of consumption, exports and the real exchange rate (even though both models understate the volatilities of these three variables), while the dynamics of government expenditure, the CPI inflation rate and imports are better matched in the model without foreign ownership. In both models, the volatility of government expenditure and the CPI inflation rate is overstated compared to the data, while the volatility of imports is understated. Real GDP may be better matched in the model with foreign ownership, given that Laxton and Pesenti (2003) estimate the standard deviation of the Czech GDP at 2 percent. The ownership structure in the home economy has negligible effects on the foreign economy.

6 Design of fiscal and monetary policy

So far I have assumed that fiscal and monetary policies are conducted by use of historic empirical rules. Such specification is useful because it helps us understand how shocks are transmitted to macroeconomic variables, and provides a basis for empirical evaluation of the underlying model.

In this section I turn to the question of fiscal policy cooperation, in particular whether there are gains from fiscal cooperation between the new and the incumbent members of the

[24] One should keep in mind that the standard deviations of the shocks are chosen to match the moments and are not estimates from the data. The estimated standard deviations of shocks may imply a different conclusion about the relative performance of the two models.

EU. Before I answer this question, I specify the goals of fiscal and monetary authorities and the structure of the policymakers' strategic games.

I assume that policymakers choose a stabilization policy, i.e. the reaction parameters in their policy rules, to maximize the unconditional expectation of households' welfare and that they can commit to the rules. Given the class of rules considered, such fiscal and monetary policies are optimal.[25] I use numeric optimization to solve for optimal policies. The welfare function is derived as a second-order Taylor approximation to the utility function, and can be expressed in each period t as:[26]

$$W_t = -\frac{1}{2}\sigma\overline{C}^{1-\sigma}var(\widehat{C}_t) - \frac{1}{2}\psi\overline{L}^{1+\psi}var(\widehat{L}_t) - \frac{1}{2}\sigma_g\overline{G}^{1-\sigma_g}var(\widehat{G}_t), \tag{39}$$

where $\overline{C}$, $\overline{L}$, and $\overline{G}$ are the steady state values of consumption, labor and government purchases, and the hats denote percentage deviations from the steady state.

The definitions of strategic games among the policymakers are as follows. Non-cooperative game: Each government chooses its reaction parameter to GDP to maximize the unconditional expectation of its households' welfare, taking the behavior of the other government and the foreign central bank as given. The foreign central bank chooses the response parameters to inflation and GDP to maximize the unconditional expectation of the foreign households' welfare, taking the behavior of the governments as given. All parameters are chosen simultaneously. Fiscal cooperation: The two governments act as a "single" policymaker and each choose its response parameter to GDP to jointly maximize the unconditional expectation of a weighted average of home and foreign welfare, taking the behavior of the foreign central bank as given. The weights in the joint welfare function are the relative sizes of the countries. The foreign central bank chooses the parameters in its rule to maximize the unconditional expectation of the foreign households' welfare, taking the behavior of the governments as given. All policymakers act simultaneously.

[25] In what follows, optimal policy refers to optimal policy within the class of rules specified in the model.
[26] I assume that real money balances do not matter for welfare, as is common in the literature.

6.1 Optimal fiscal and monetary policies and the desirability of fiscal cooperation in the EU

6.1.1 The benchmark model without foreign ownership

To understand how foreign ownership of firms affects fiscal and monetary policy and fiscal cooperation, I first analyze a benchmark case without foreign ownership. Table 1 presents the optimal fiscal and monetary reaction coefficients to GDP and inflation, plus the associated welfare losses for the models with and without foreign ownership.[27]

Table 1: Optimal Responses to Output and Inflation and the Associated Welfare Losses

	f_{GDP}	f^*_{GDP}	m^*_{CPI}	m^*_{GDP}	L	L^*
Foreign Ownership						
Non-cooperation	-0.925	-27.998	1.648	80.00	13.853	0.963
Cooperation	-1.137	-41.606	1.363	80.01	13.972	0.970
No Foreign Ownership						
Non-cooperation	-0.179	-28.098	1.723	80.44	8.574	0.946
Cooperation	-0.306	-28.017	1.720	80.00	8.578	0.945

Result 1 *The optimal policies are countercyclical and call for a more aggressive stabilization of the output gap than historic policies.*

It is optimal for the foreign fiscal and monetary authorities to respond strongly to the output gap, and this is consistent with a less aggressive home fiscal policy. The home country benefits from stabilization policy of the foreign country for two reasons. First, it is a small open economy with strong trade links to the foreign country, and is thus very exposed to anything that happens in the large economy. When foreign policymakers stabilize their

[27] A note on the magnitude of the optimized coefficients may be useful. The optimized coefficients may seem detached from reality. However, one should not compare them directly to the estimated ones and give any policy prescriptions regarding the size of the coefficients. A large coefficient purely reflects the fact that in this model it is optimal, for example, to close the output gap.

own economy they also reduce volatility in the home country. Second, the home economy supports a fixed exchange rate and therefore "imports" foreign monetary policy.[28]

It is interesting to notice that the optimal fiscal policy in this model is countercyclical. This is a typical feature of DSGE models and therefore not surprising. On the contrary, the empirical evidence suggests that the stance of fiscal policies has actually been procyclical or at best acyclical in many euro area countries. However, since the Maastricht criteria were set in place, fiscal policies in the euro area have become more and more countercyclical.[29]

Result 2 *The home country is better-off in the non-cooperative equilibrium, and the foreign economy prefers fiscal cooperation.*

In a world with a small and a large country, one would expect that policy cooperation may not matter for the large economy but could make sense for the small country. The results in the benchmark model support this intuition and the large economy is more or less indifferent between cooperating and not cooperating its fiscal policy with the smaller country. Moreover, the large economy almost does not change its policy when it cooperates with the small country. The small country, on the other hand, pursues a more aggressive fiscal policy when it internalizes its (small) spillovers on the large economy.[30] As a result, the home country is worse off in the cooperative equilibrium since in this equilibrium, the focus is on maximizing foreign welfare and stabilizing shocks in the large economy.[31]

6.1.2 The model with foreign-owned home intermediate sector firms

I now turn to an empirically more relevant case where I assume that foreign households are exclusive owners of the home intermediate sector firms, and I investigate the differences in

[28] Foreign expansionary monetary policy increases home GDP.

[29] See Galí and Perotti (2003).

[30] The change in the home fiscal policy's response is small because the externalities from home to foreign country are almost negligible.

[31] Both governments choose their policies mainly to maximize foreign welfare. The foreign central bank is maximizing foreign welfare, and there is no home central bank that would maximize its households' well-being.

optimal policies and fiscal cooperation with respect to the benchmark model with no foreign presence in the smaller country.[32]

Result 3 *Home fiscal policy is more aggressive compared to the benchmark model.*

Most of the variables in the home economy are more volatile in the model with exclusive foreign ownership in the home intermediate sector compared to the benchmark case.[33] Therefore, it is optimal for home fiscal policy to play a more active stabilization role. The difference in the volatility of the foreign economy's variables between the two models is negligible, so that foreign fiscal policy remains almost identical in the non-cooperative equilibrium.

Result 4 *Foreign fiscal policy is more aggressive in the cooperative equilibrium compared to the benchmark model.*

In the benchmark model, governments cooperate by choosing parameters in their rules to maximize a weighted average of home and foreign welfare. However, in the model with foreign ownership, the variables in the home economy are more volatile and foreign fiscal policy causes bigger spillovers on the small country.[34] This is why foreign fiscal policy is more aggressive under fiscal cooperation and now contributes to the stabilization of shocks in the home economy.

Result 5 *The reaction of foreign monetary policy to inflation is smaller under fiscal cooperation.*

[32] Home firms producing final goods remain locally-owned.
[33] See the explanation in the section on the transmission mechanism.
[34] See the impulse responses in the section on the transmission mechanism.

The importance of the foreign central bank's inflation stabilization under fiscal cooperation is reduced. This can be explained by analyzing some impulse responses.[35] Contractionary monetary policy triggers an expansionary foreign fiscal policy and reduces foreign consumption. This consumption reduction is magnified by the expansionary fiscal policy. Under fiscal cooperation, the foreign government reacts stronger to monetary actions, thus making the indirect effect of foreign fiscal policy on foreign private consumption larger. However, the foreign monetary authority chooses its policy parameters to maximize the foreign households' utility; and households dislike consumption variability. Therefore, it is optimal for the foreign central bank not to respond as strongly to inflation as under the non-cooperative fiscal game.

Result 6 *Both countries are better-off in the non-cooperative equilibrium.*

In the foreign ownership model, home households do not receive state-contingent dividend income, and their ability to insure themselves is reduced. Most of the variables in the smaller country become more volatile (private consumption, GDP). Therefore, both governments are more active in stabilizing the smaller economy when they cooperate and the government purchases in both countries are more volatile.

The foreign fiscal rule is successful in stabilizing GDP in the large economy, but introduces excessive volatility into foreign private consumption when governments cooperate fiscal policies. The non-tradable private consumption becomes more volatile because government consumption, which is on non-tradable goods, is more volatile. Foreign tradable private consumption is also more volatile under fiscal cooperation. More volatility comes from the foreign technology shock in the non-tradable sector. This is not surprising since under fiscal cooperation, the weight shifts to stabilizing shocks which affect both countries.[36] The foreign non-tradable technology shock increases volatility of foreign inputs and consequently

[35] See Figure 5.

[36] The foreign technology shock in the non-tradable sector does not affect quantities in the home economy.

the volatility in the production of the foreign final tradable goods. Thus, foreign tradable consumption is more volatile.[37] The foreign central bank cushions the effect of more volatile foreign government purchases on foreign private consumption. However, higher volatility of government purchases has a dominant effect on foreign private consumption. Private consumption is by far the most important component of welfare, and therefore foreign households are worse off under fiscal cooperation.

The interaction between fiscal policy and private consumption in the home economy is qualitatively the same as in the foreign country. More volatile government purchases translate into more volatile non-tradable private consumption. By contrast, home tradable private consumption is less volatile under fiscal cooperation. Most of home tradable private consumption is on foreign goods and the production of those goods is more volatile. However, there is a key difference between foreign and home prices. Less volatility in home prices translates into less volatility of quantities consumed. Another factor which determines the volatility of home private consumption is the foreign central bank, which chooses its policy parameters to maximize foreign welfare. Nonetheless, the foreign central bank has a positive effect on home private consumption (for the same reason as in the foreign economy). The overall effect of fiscal cooperation on home private consumption is positive but the reduction in volatility is very small. This small welfare-improving effect is not enough to counterbalance more volatility in the labor supply and government purchases, therefore, home households are worse-off under fiscal cooperation.

[37] Recall that most of final tradable consumption is on foreign goods.
Also, increased volatility in foreign non-tradable consumption does not come from the foreign non-tradable technology shock. The non-tradable private consumption is more volatile because of more aggressive fiscal policy.

6.2 Sensitivity analysis

6.2.1 The elasticity of the intertemporal substitution of government purchases

The estimates of the inverse of the elasticity of the intertemporal substitution of government consumption, σ_g, are not readily available. I assume the logarithmic utility of government purchases in the benchmark calibration, which implies a weight of 0.5 on government purchases in the welfare function.[38] I reduce this weight to 0.3, which implies the relative weight of 0.2 on government purchases compared to private consumption. As a consequence, the stabilization role of home government is increased but foreign policies are very similar to the case of logarithmic preferences over government consumption. Both countries are still better-off in the non-cooperative equilibrium.

6.2.2 The weights in the joint welfare function

The question of weights in the joint welfare function is a political one, and one could object to almost any selection of the weights. The literature on fiscal cooperation usually assumes that the weights in the joint welfare function are equal to the relative sizes of the countries. The results reported above follow such a specification. However, I conduct a sensitivity analysis with respect to the weights, and find that qualitative results do not change if the two countries have equal weight in the joint welfare function.

6.2.3 All policymakers cooperate

The model I use incorporates some realistic assumption about the conduct of economic policy in the European Union. I assume that the new EU members already participate in the ERM (by supporting a fixed exchange rate) and are not yet members of the monetary

[38] The weight on consumption is around 1.5.

union. Thus, there is no explicit policy cooperation between the monetary authorities of the new EU members and the EMU. I also assume that fiscal and monetary policies are set in a non-cooperative fashion which is the case in the EU. Therefore, the results presented above should not be surprising and are consistent with the literature.

For completeness, I also solve the model in which all policymakers cooperate on their policies.[39] It is interesting that a cooperation among the three "active" players, namely the two governments and the foreign central bank, is not enough to make both countries better off compared to the non-cooperative solution and the solution where only the governments cooperate. However, both countries are better off when all four policymakers cooperate. In this case, I assume that the home central bank conducts a stabilization policy and follows an interest rate rule similar to that of the foreign central bank.

7 Conclusions

In this paper I study how fiscal policies should be conducted in the enlarged EU. I find that there is room for fiscal stabilization, but no need for the national governments of the new EU members and the EMU members to cooperate on their fiscal policies. In fact, fiscal cooperation is welfare-reducing for both groups of countries. An important factor which contributes to this result is the high degree of foreign ownership in the new EU members. When there is no foreign ownership in the new EU members, EMU is indifferent between cooperating and not cooperating, but the new EU members still prefer not to cooperate on fiscal policy with EMU.

In this paper I assume that the two countries have national monetary policies. In the future, the new EU countries will have to join EMU. It would thus be of interest to analyze the need for fiscal cooperation between the two groups of countries considered in this paper when they constitute a monetary union. In this case, a single central bank would have

[39] Such a specification is not close to the current arrangement in the EU/EMU.

a different role and would interact differently with the national governments. I leave this extension for future research.

References

[1] Backus, D.K., Kehoe, P.J., Kydland, F.E., 1992. International real business cycles. Journal of Political Economy 100, 745–775.

[2] Beetsma, R., Bovenberg, A.L., 1998. Monetary union without fiscal coordination may discipline policymakers. Journal of International Economics 45, 239–258.

[3] Beetsma, R., Debrun, X., Klaassen, F., 2001. Is Fiscal policy coordination in EMU desirable? Swedish Economic Policy Review 8, 57–98.

[4] Beetsma, R., Jensen, H., 2002. Monetary and fiscal policy interactions in a micro-founded model of a monetary union. European Central Bank Working Paper 166.

[5] Benigno, G., Benigno, P., Ghironi, F., 2002. Interest rate rules for fixed exchange rate regimes. Boston College Economics Department Working Paper 468.

[6] Canzoneri, M.B., Henderson, D.W., 1991. Monetary Policy in Interdependent Economies: A Game-Theoretic Approach. The MIT Press, Cambridge, Massachusetts.

[7] Chari, V.V., Kehoe, P.J., 2004. On the desirability of fiscal constraints in a monetary union. NBER Working Paper 10232.

[8] Devereux, M.B., 2002. Monetary policy strategies for emerging market countries: The case of East European accession countries, in: Sepp, U., Randveer, M. (Eds.), Alternative Monetary Regimes in Entry to EMU. Bank of Estonia, Tallinn, pp. 29–66.

[9] Devereux, M.B., Lane, P.R., Xu, J., 2004. Exchange rates and monetary policy in emerging market economies. IIIS Discussion Paper 36.

[10] Dixit, A., Lambertini, L., 2001. Monetary-fiscal policy interactions and commitment versus discretion in a monetary union. European Economic Review 45, 977–987.

[11] Dixit, A., Lambertini, L., 2003. Symbiosis of monetary and fiscal policies in a monetary union. Journal of International Economics 60, 235–247.

[12] Domowitz, I., Hubbard, G., Petersen, B., 1988. Market structure and cyclical fluctuations in U.S. manufacturing. Review of Economics and Statistics 80, 55–66.

[13] Eichengreen, B., Ghironi, F., 2002. Transatlantic trade-offs in the age of balanced budgets and European Monetary Union. Open Economies Review 13, 381–411.

[14] Fagan, G., Henry, J., Mestre, J.R., (2005). An area wide model (AWM) for the euro area. Economic Modelling 22, 39–59.

[15] Favero, C., Monacelli, T., 2003. Monetary-fiscal mix and inflation performance: Evidence from the U.S. CEPR Discussion Paper 3887.

[16] Galí, J., Monacelli, T., 2005. Monetary policy and exchange rate volatility in a small open economy. Review of Economic Studies 72, 707–734.

[17] Galí, J., Perotti, R., 2003. Fiscal policy and monetary integration in Europe. Economic Policy 37, 533–572.

[18] Ghironi, F., Lee, J., Rebucci, A., 2003. International equity trading and macroeconomic dynamics. Unpublished manuscript.

[19] Ghironi, F., Rebucci, A., 2001. Monetary rules for emerging market economies. Boston College Economics Department Working Paper 476.

[20] Ireland, P., 2001. Sticky-price models of the business cycle: Specification and stability. Journal of Monetary Economics 47, 3–18.

[21] Jensen, H., 1996. The advantage of international fiscal cooperation under alternative monetary regimes. European Journal of Political Economy 12, 485–504.

[22] Kehoe, P.J., 1989. Policy coordination among benevolent governments may be undesirable. Review of Economic Studies 56, 289–296.

[23] Laxton, D., Pesenti, P., 2003. Monetary rules for small, open, emerging economies. Journal of Monetary Economics 50, 1109–1146.

[24] Lombardo, G., Sutherland, A., 2004. Monetary and fiscal interactions in open economies. Journal of Macroeconomics 26, 319–348.

[25] Martins, J., Scarpetta, S., Pilat, D., 1996. Mark-up pricing, market structure and the business cycle. OECD Economic Studies 27 (II), 71–106.

[26] McCallum, B.T., Nelson, E., 2000. Monetary policy for an open economy: An alternative framework with optimizing agents and sticky prices. Oxford Review of Economic Policy 16, 74–91.

[27] Mendoza, E.G., Tesar, L.L., 2005. Why hasn't tax competition triggered a race to the bottom? Some quantitative lessons from the EU. Journal of Monetary Economics 52, 163–204.

[28] Morrison, C., 1994. The cyclical nature of markups in Canadian manufacturing: A production theory approach. Journal of Applied Econometrics 9, 269–282.

[29] Natalucci, F.M., Ravenna, F., 2003. The road to adopting the euro: Monetary policy and exchange rate regimes in EU candidate countries. International Finance Discussion Papers 741, Board of Governors of the Federal Reserve System.

[30] Quadrini, V., forthcoming. Policy commitment and the welfare gains from capital market liberalization. European Economic Review.

[31] Reininger, T., Schardax, F., Summer, M., 2001. The financial system in the Czech Republic, Hungary and Poland after a decade of transition. Discussion Paper 16/01, Economic Research Center of the Deutsche Bundesbank.

[32] Rogoff, K., 1985. Can international monetary policy coordination be counterproductive? Journal of International Economics 18, 390–407.

[33] Rotemberg, J.J., 1982. Monopolistic price adjustment and aggregate output. Review of Economic Studies 49, 517–531.

[34] Schmitt-Grohé, S., Uribe, M., 2003. Closing small open economy models. Journal of International Economics 61, 163–185.

[35] Smets, F., Wouters, R., 2003. An estimated stochastic dynamic general equilibrium model of the euro area. Journal of European Economic Association 1, 1123–1175.

[36] Stockman, A.C., Tesar, L.L., 1995. Tastes and technology in a two-country model of the business cycle: Explaining international comovements. The American Economic Review 85, 168–185.

[37] Uhlig, H., 1999. A Toolkit for analyzing nonlinear dynamic stochastic models easily, in: Marimon, R., Scott, A. (Eds.), Computational Methods for the Study of Dynamic Economics. Oxford University Press, Oxford, pp. 30–61.

Appendix

The foreign household j^*'s budget constraint is:

$$M_t^{j^*} + B_{*,t+1}^{*,j^*} + P_t^* \frac{\xi_{B^*}^*}{2}\left(\frac{B_{*,t+1}^{*,j^*}}{P_t^*} - \frac{\overline{B}_*^{*,j^*}}{\overline{P}^*}\right)^2 + \int_a^1 V_t^{x^*} S_{*,t+1}^{x^*,j^*} dx^* + \int_0^a \frac{V_t^x}{\varepsilon_t} S_{*,t+1}^{x,j^*} dx + P_t^* C_t^{j^*}$$
$$\leq M_{t-1}^{j^*} + (1+i_t^*) B_{*,t}^{*,j^*} + \int_a^1 \left(\left(1-\tau_t^{D^*}\right) D_t^{x^*} + V_t^{x^*}\right) S_{*,t}^{x^*,j^*} dx^* + \tag{A-1}$$
$$\left(1-\tau_t^{L^*}\right)\left(W_{N,t}^* L_{N,t}^{j^*} + W_{X,t}^* L_{X,t}^{j^*}\right) - P_t^* T_t^{j^*} + P_t^* TCT_t^{j^*} + \int_0^a \frac{\left(\left(1-\tau_t^D\right) D_t^x + V_t^x\right)}{\varepsilon_t} S_{*,t}^{x,j^*} dx.$$

As opposed to home households, foreign consumers buy and trade equity shares in home and foreign intermediate sector firms and do not hold home bonds. B_*^* denotes foreign bonds held by foreign consumers, $S_{*,t}^{x^*}$ are shares in foreign firm x^* held by a foreign consumer entering period t and $S_{*,t}^{x}$ are shares in home firm x held by a foreign consumer entering period t. The price of shares of foreign firm x^* is denoted by $V_t^{x^*}$ and the price of shares of home firm x is denoted by V_t^x. Foreign households receive dividends on foreign and home shares, $D_t^{x^*}$ and D_t^x, respectively. They pay the dividend tax at the rate of τ_t^D and $\tau_t^{D^*}$.

Home government's budget constraint is:

$$\int_0^a P_{N,t} G_t dn = \int_0^a P_t T_t^j dj + \tau_t \int_0^a p_t(x) Y_{X,t}^x dx + \int_0^a \left(M_t^j - M_{t-1}^j\right) dj \tag{A-2}$$
$$+ \tau_t^L \int_0^a \left(W_{N,t} L_{N,t}^j + W_{X,t} L_{X,t}^j\right) dj + \tau_t^D \int_a^1 \int_0^a D_t^x S_{*,t}^{x,j^*} dx dj^*.$$

Table 2: Foreign Share of Equity Market Capitalization in CEEC

	1997	1998	1999	2000	2001	2002	2003
Share in percent							
Slovenia	-	8.86	7.98	7.77	10.51	19.68	6.01
Estonia	31.50	64.00	72.30	76.70	75.80	79.30	80.88
Hungary	68.30	-	79.20	70.70	-	-	-
Latvia	-	-	-	-	-	-	54.00

Sources: Ljubljana Stock Exchange, Tallinn Stock Exchange, Riga Stock Exchange, Latvian Central Depository, Reininger et al. (2001).

Table 3: Assumptions About Stochastic Processes

	Standard Deviation		Persistence Parameter	
	Home	Foreign	Home	Foreign
Productivity	0.0200	0.0087	0.9	0.9
Marginal Utility of Consumption	0.0387	0.0224	0.7	0.7
Marginal Disutility of Labor	0.0100	0.0032	0.9	0.9
Preference Shifter	0.0089	0.0032	0.9	0.9
Government/GDP	0.0032	0.0010	0.9	0.9
Interest Rate	-	0.0032	-	-

Table 4: Macroeconomic Variability of the Czech Republic and the euro area

	Czech Republic		Euro Area	
	Model	Historic	Model	Historic
Standard deviation (in %)				
Real GDP	1.87	1.74	1.01	1.0*
Consumption	2.23	2.29	1.02	0.8*
Government Expenditure	4.66	2.6*	1.08	0.6*
CPI Inflation	2.39	1.08	0.25	0.56
Short-Term Interest Rate	0.36	0.47	0.36	0.98
Employment	0.91	-	0.63	1.16
Exports	2.33	3.9*	-	2.4*
Imports	2.14	4.1*	-	3.1*
Real Exchange Rate	3.05	3.1	-	-

Note: The model's variables are detrended with the HP filter. The estimates of historic standard deviations that are taken from Laxton and Pesenti (2003) are marked by a star. The rest of the estimates for the Czech Republic are taken from Natalucci and Ravenna (2003) and for the euro area they are taken from Fagan et al. (2005). Data in Laxton and Pesenti (2003) are detrended with the HP filter using the smoothness parameter of 1600. The time period for the euro area data is from 1970Q1 to 2002Q4 and for the Czech Republic from 1973Q1 to 2002Q4. In Natalucci and Ravenna (2003) all series are logged (except for interest and inflation rates) and HP filtered. Data are per capita and seasonally adjusted. The time span for the Czech Republic is 1994Q1 to 2003Q1. In Fagan et al. (2005), variables are expressed in per capita terms and logged (except for inflation and interest rates). They are seasonally adjusted and HP filtered.

Table 5: Macroeconomic Variability in the Model with and without Foreign Ownership

	Czech Republic		Euro Area	
	Foreign	Local	Foreign	Local
Standard deviation (in %)				
Real GDP	1.87	1.64	1.01	1.01
Consumption	2.23	1.95	1.02	1.02
Government Expenditure	4.66	3.96	1.08	1.08
CPI Inflation	2.39	2.23	0.25	0.25
Short-Term Interest Rate	0.36	0.36	0.36	0.36
Employment	0.91	0.97	0.63	0.63
Exports	2.33	2.21	-	-
Imports	2.14	2.27	-	-
Real Exchange Rate	3.05	2.88	-	-

Note: "Foreign" refers to the model with the foreign ownership of intermediate sector firms in the home economy. "Local" refers to the model in which all firms are locally-owned, i.e. there is no foreign ownership of firms in the home economy.

Figure 1: Impulse Responses of Foreign Variables to Foreign Intermediate Technology Shock

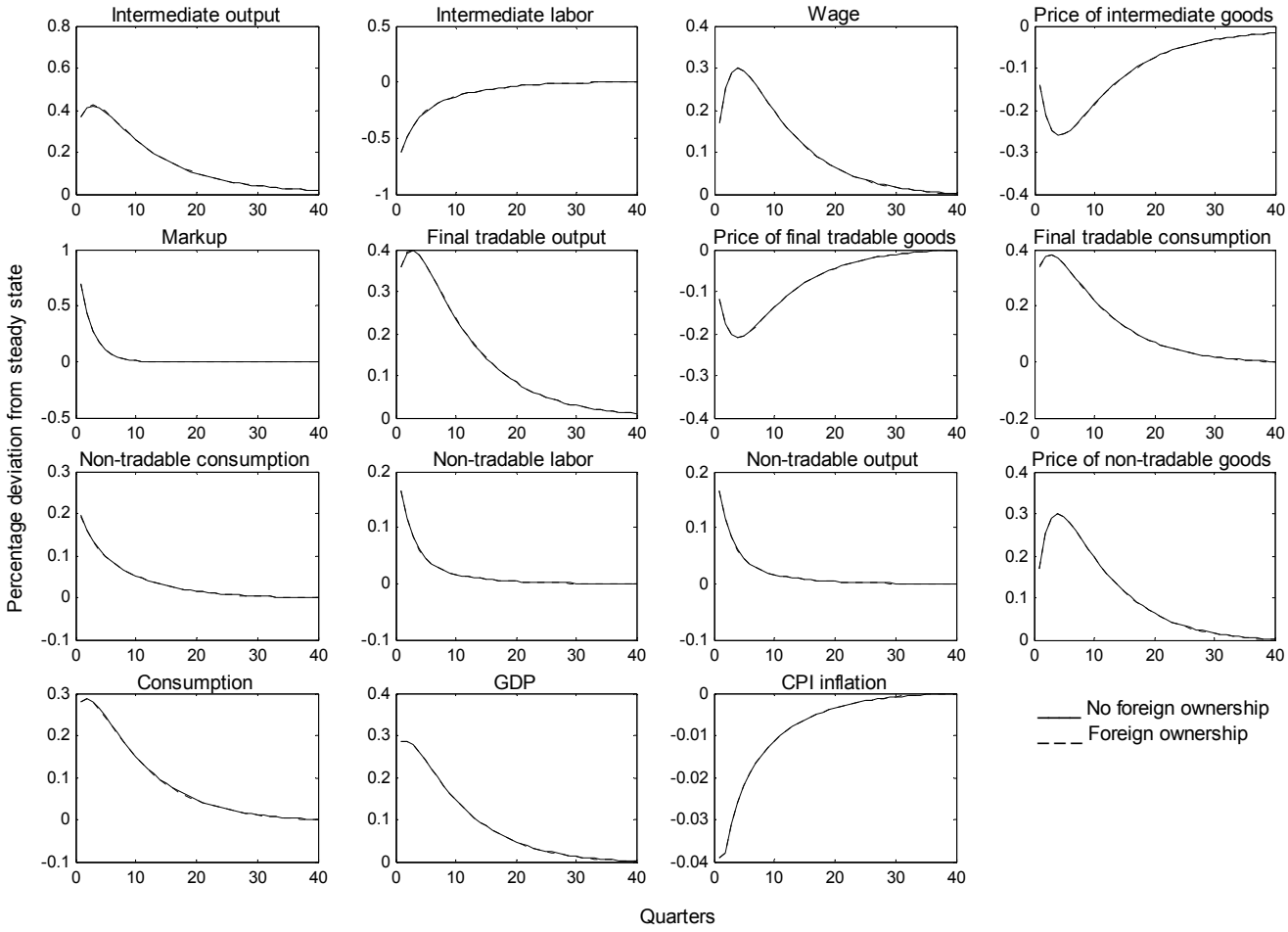


Figure 2: Impulse Responses of Home Variables to Foreign Technology Shock

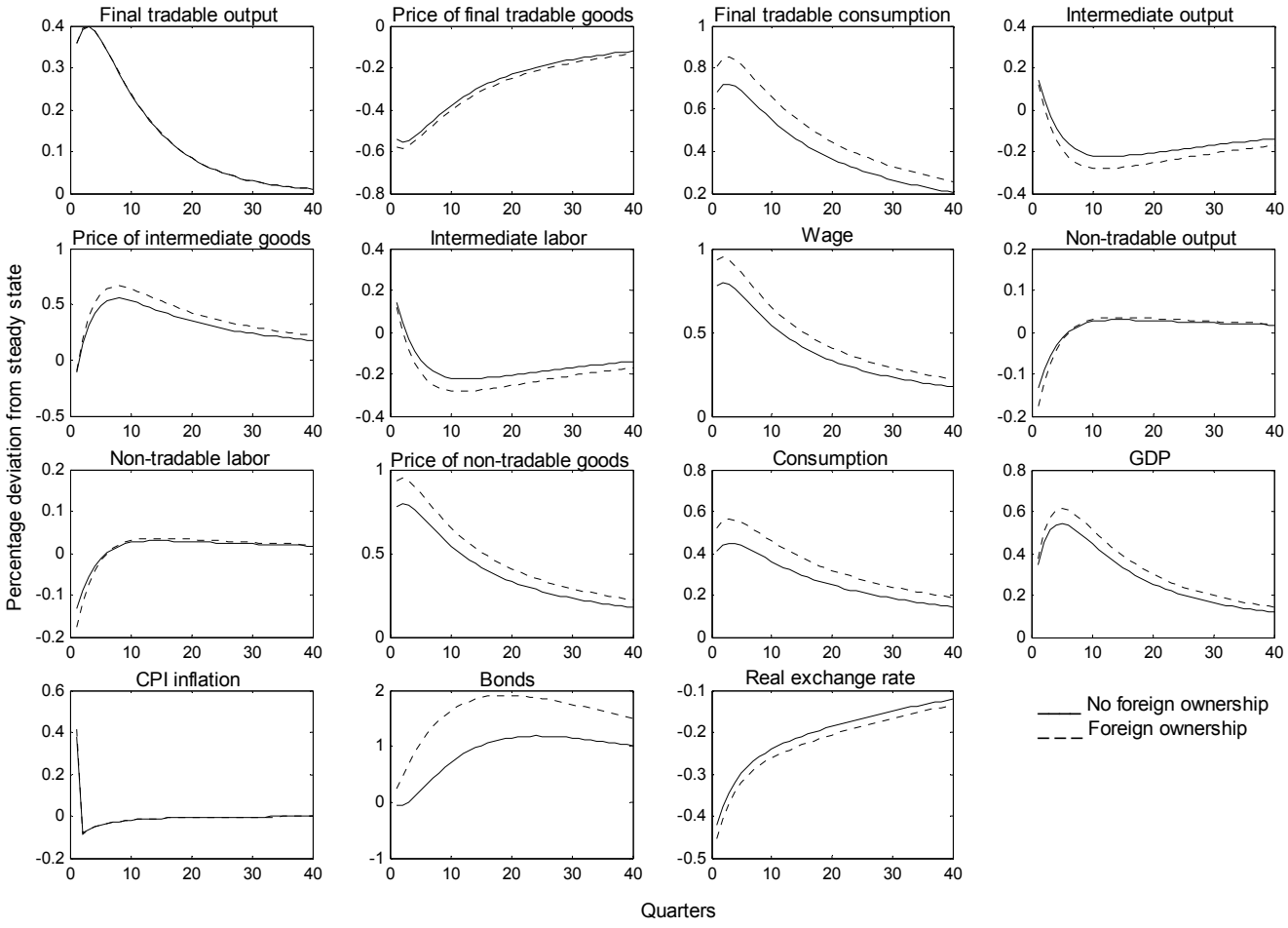


Figure 3: Impulse Responses of Foreign Variables to Foreign Fiscal Shock

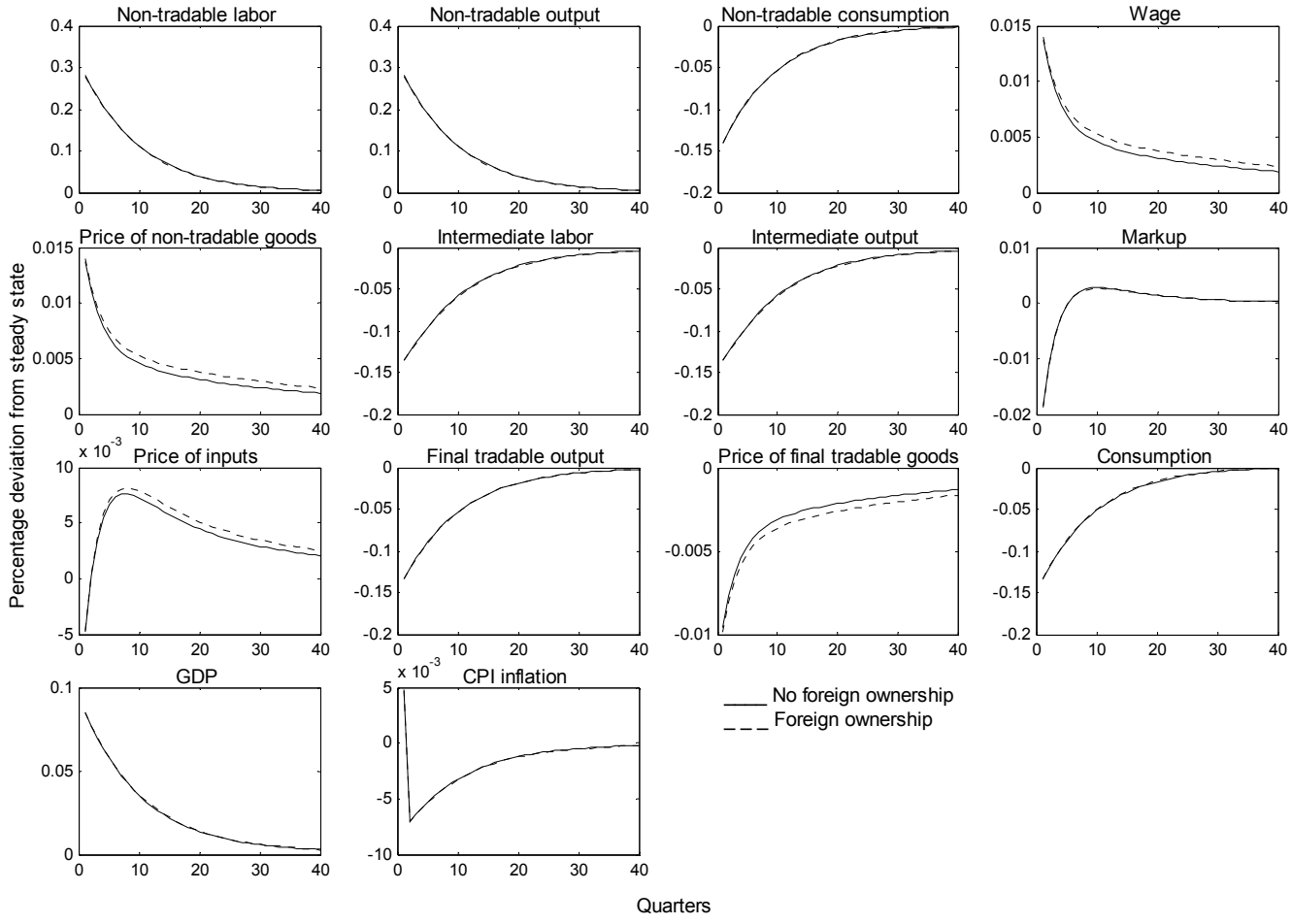


Figure 4: Impulse Responses of Home Variables to Foreign Fiscal Shock

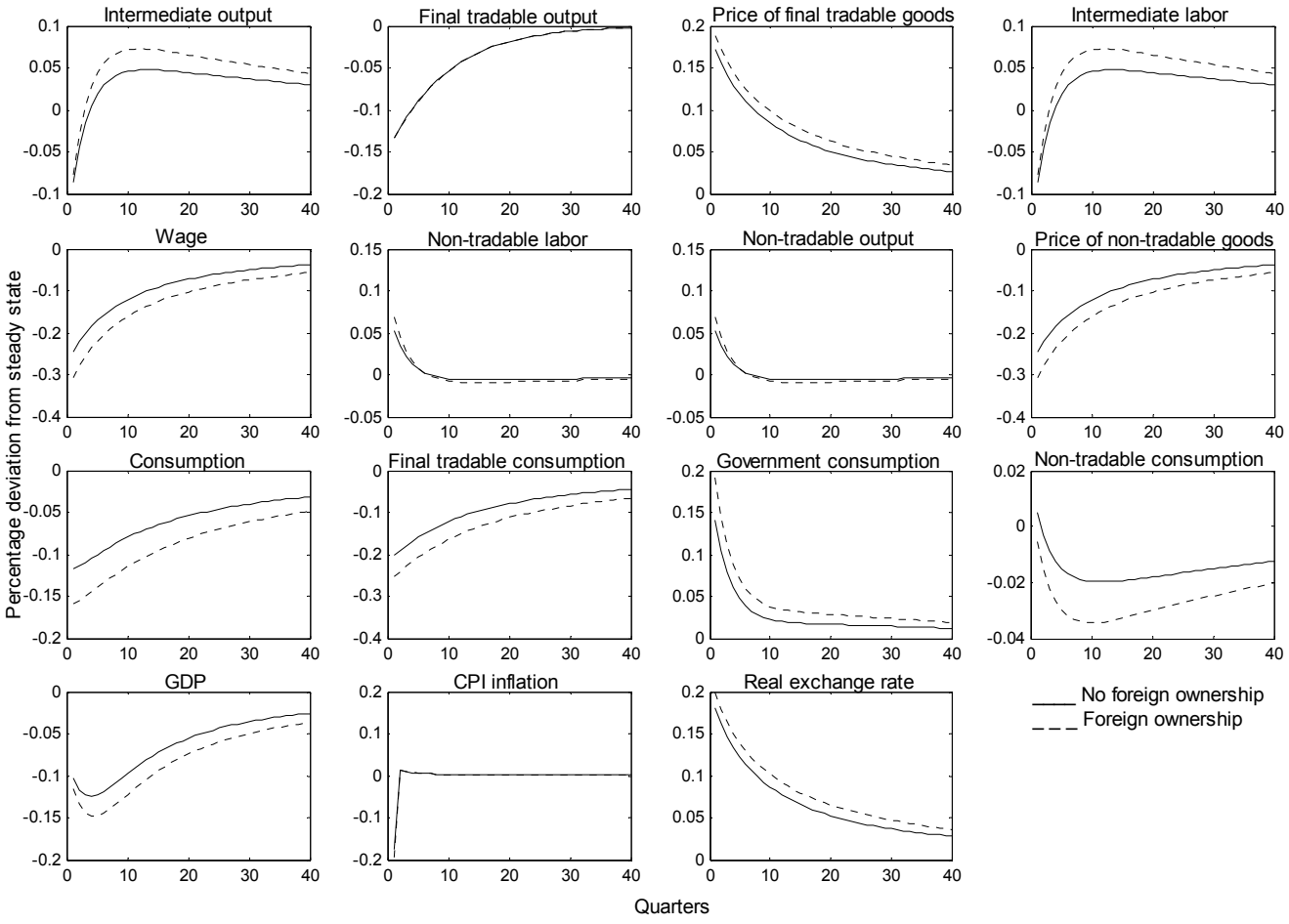
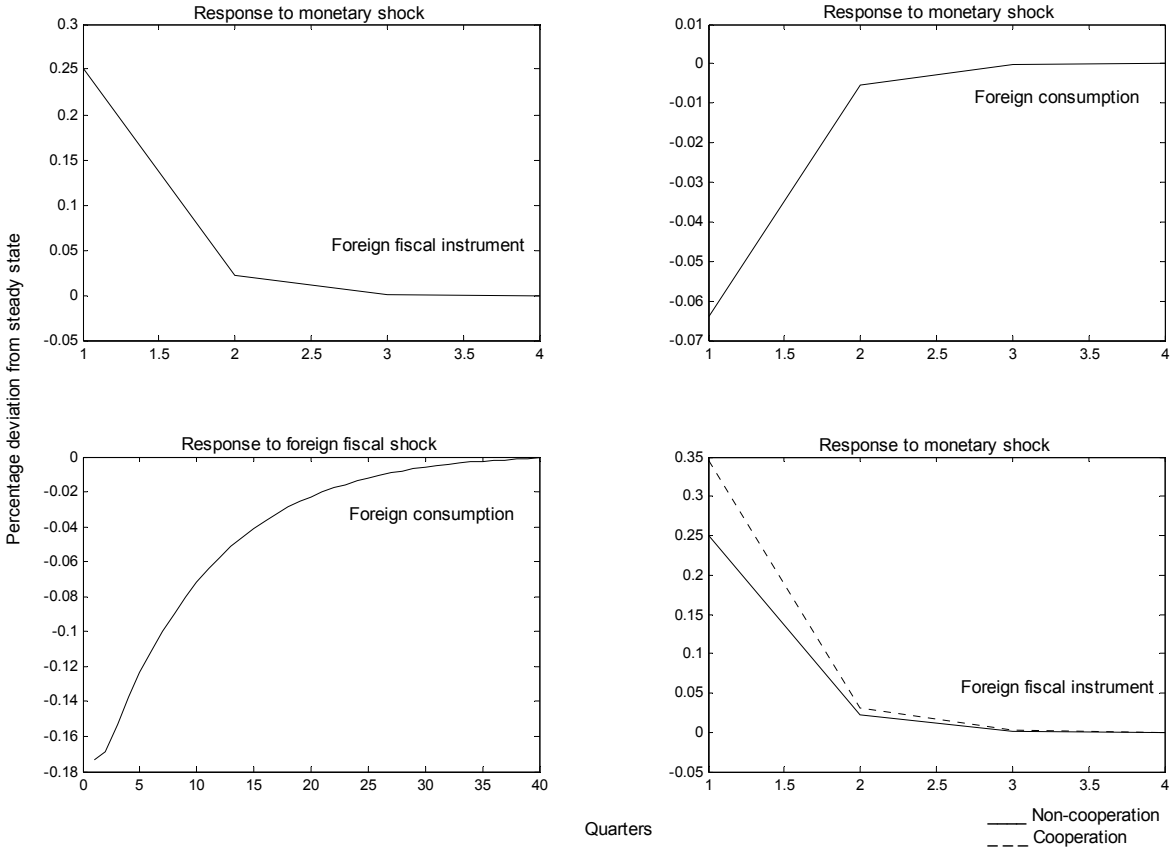


Figure 5: Explaining Why Monetary Policy is Looser Under Fiscal Cooperation



European Central Bank Working Paper Series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.int)

600 "A speed limit monetary policy rule for the euro area" by L. Stracca, April 2006.

601 "Excess burden and the cost of inefficiency in public services provision" by A. Afonso and V. Gaspar, April 2006.

602 "Job flow dynamics and firing restrictions: evidence from Europe" by J. Messina and G. Vallanti, April 2006.

603 "Estimating multi-country VAR models" by F. Canova and M. Ciccarelli, April 2006.

604 "A dynamic model of settlement" by T. Koeppl, C. Monnet and T. Temzelides, April 2006.

605 "(Un)Predictability and macroeconomic stability" by A. D'Agostino, D. Giannone and P. Surico, April 2006.

606 "Measuring the importance of the uniform nonsynchronization hypothesis" by D. A. Dias, C. Robalo Marques and J. M. C. Santos Silva, April 2006.

607 "Price setting behaviour in the Netherlands: results of a survey" by M. Hoeberichts and A. Stokman, April 2006.

608 "How does information affect the comovement between interest rates and exchange rates?" by M. Sánchez, April 2006.

609 "The elusive welfare economics of price stability as a monetary policy objective: why New Keynesian central bankers should validate core inflation" by W. H. Buiter, April 2006.

610 "Real-time model uncertainty in the United States: the Fed from 1996-2003" by R. J. Tetlow and B. Ironside, April 2006.

611 "Monetary policy, determinacy, and learnability in the open economy" by J. Bullard and E. Schaling, April 2006.

612 "Optimal fiscal and monetary policy in a medium-scale macroeconomic model" by S. Schmitt-Grohé and M. Uribe, April 2006.

613 "Welfare-based monetary policy rules in an estimated DSGE model of the US economy" by M. Juillard, P. Karam, D. Laxton and P. Pesenti, April 2006.

614 "Expenditure switching vs. real exchange rate stabilization: competing objectives for exchange rate policy" by M. B. Devereux and C. Engel, April 2006.

615 "Quantitative goals for monetary policy" by A. Fatás, I. Mihov and A. K. Rose, April 2006.

616 "Global financial transmission of monetary policy shocks" by M. Ehrmann and M. Fratzscher, April 2006.

617 "New survey evidence on the pricing behaviour of Luxembourg firms" by P. Lünnemann and T. Y. Mathä, May 2006.

618 "The patterns and determinants of price setting in the Belgian industry" by D. Cornille and M. Dossche, May 2006.

619 "Cyclical inflation divergence and different labor market institutions in the EMU" by A. Campolmi and E. Faia, May 2006.

620 "Does fiscal policy matter for the trade account? A panel cointegration study" by K. Funke and C. Nickel, May 2006.

621 "Assessing predetermined expectations in the standard sticky-price model: a Bayesian approach" by P. Welz, May 2006.

622 "Short-term forecasts of euro area real GDP growth: an assessment of real-time performance based on vintage data" by M. Diron, May 2006.

623 "Human capital, the structure of production, and growth" by A. Ciccone and E. Papaioannou, May 2006.

624 "Foreign reserves management subject to a policy objective" by J. Coche, M. Koivu, K. Nyholm and V. Poikonen, May 2006.

625 "Sectoral explanations of employment in Europe: the role of services" by A. D'Agostino, R. Serafini and M. Ward-Warmedinger, May 2006.

626 "Financial integration, international portfolio choice and the European Monetary Union" by R. A. De Santis and B. Gérard, May 2006.

627 "Euro area banking sector integration: using hierarchical cluster analysis techniques" by C. Kok Sørensen, J. M. Puigvert Gutiérrez, May 2006.

628 "Long-run money demand in the new EU Member States with exchange rate effects" by C. Dreger, H.-E. Reimers and B. Roffia, May 2006.

629 "A market microstructure analysis of foreign exchange intervention" by P. Vitale, May 2006.

630 "Implications of monetary union for catching-up member states" by M. Sánchez, May 2006.

631 "Which news moves the euro area bond market?" by M. Andersson, L. J. Hansen and S. Sebestyén, May 2006.

632 "Does information help recovering structural shocks from past observations?" by D. Giannone and L. Reichlin, May 2006.

633 "Nowcasting GDP and inflation: the real-time informational content of macroeconomic data releases" by D. Giannone, L. Reichlin and D. H. Small, May 2006.

634 "Expenditure reform in industrialised countries: a case study approach" by S. Hauptmeier, M. Heipertz and L. Schuknecht, May 2006.

635 "Identifying the role of labor markets for monetary policy in an estimated DSGE model" by K. Christoffel, K. Kuester and T. Linzert, June 2006.

636 "Exchange rate stabilization in developed and underdeveloped capital markets" by V. Chmelarova and G. Schnabl, June 2006.

637 "Transparency, expectations, and forecasts" by A. Bauer, R. Eisenbeis, D. Waggoner and T. Zha, June 2006.

638 "Detecting and predicting forecast breakdowns" by R. Giacomini and B. Rossi, June 2006.

639 "Optimal monetary policy with uncertainty about financial frictions" by R. Moessner, June 2006.

640 "Employment stickiness in small manufacturing firms" by P. Vermeulen, June 2006.

641 "A factor risk model with reference returns for the US dollar and Japanese yen bond markets" by C. Bernadell, J. Coche and K. Nyholm, June 2006.

642 "Financing constraints and firms' cash policy in the euro area" by R. Pál and A. Ferrando, June 2006.

643 "Inflation forecast-based-rules and indeterminacy: a puzzle and a resolution" by P. Levine, P. McAdam and J. Pearlman, June 2006.

644 "Adaptive learning, persistence, and optimal monetary policy" by V. Gaspar, F. Smets and D. Vestin, June 2006.

645 "Are internet prices sticky?" by P. Lünnemann and L. Wintr, June 2006.

646 "The Dutch block of the ESCB multi-country model" by E. Angelini, F. Boissay and M. Ciccarelli, June 2006.

647 "The economic effects of exogenous fiscal shocks in Spain: a SVAR approach" by F. de Castro Fernández and P. Hernández de Cos, June 2006.

648 "Firm-specific production factors in a DSGE model with Taylor price setting" by G. de Walque, F. Smets and R. Wouters, June 2006.

649 "Monetary and fiscal policy interactions in a New Keynesian model with capital accumulation and non-Ricardian consumers" by C. Leith and L. von Thadden, June 2006.

650 "A structural break in the effects of Japanese foreign exchange intervention on yen/dollar exchange rate volatility" by E. Hillebrand and G. Schnabl, June 2006.

651 "On the determinants of external imbalances and net international portfolio flows: a global perspective" by R. A. De Santis and M. Lührmann, July 2006.

652 "Consumer price adjustment under the microscope: Germany in a period of low inflation" by J. Hoffmann and J.-R. Kurz-Kim, July 2006.

653 "Acquisition versus greenfield: the impact of the mode of foreign bank entry on information and bank lending rates" by S. Claeys and C. Hainz, July 2006.

654 "The German block of the ESCB multi-country model" by I. Vetlov and T. Warmedinger, July 2006.

655 "Fiscal and monetary policy in the enlarged European Union" by I. Vetlov and T. Warmedinger, July 2006.

ISSN 1561081-0