Fiscal and monetary policy in the European Union

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FISCAL AND MONETARY POLICY IN THE EUROPEAN UNION

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Dissertation Abstract

by

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I develop a two-country dynamic stochastic general equilibrium model of the European Union (EU) and use this model throughout the chapters of my dissertation. The model incorporates some realistic features of the European Union members. I calibrate the model and it matches the dynamics of the data well.

In the first chapter I study the need for fiscal policy cooperation between the new EU members (a small country) and the European Economic and Monetary Union (EMU) (a large country). I find that both countries are better off when they do not cooperate their fiscal policies. This result depends on the assumption about the presence of foreign ownership in the smaller country. When there is no foreign ownership in the smaller country, the large economy is indifferent between cooperating and not cooperating

but the smaller country still prefers not to cooperate its fiscal policy with the EMU.

The new EU members are expected to join the monetary union. In the second chapter I analyze the welfare consequences of different monetary arrangements for the new EU members and investigate whether their participation in the EMU is welfare-improving. Based on households' utility the results show that a flexible exchange rate regime is preferred to a monetary union and a monetary union is preferred to a fixed exchange rate regime.

In the third chapter I investigate whether there are welfare gains from fiscal policy cooperation in the EMU. I assume that the EMU consists of countries that are currently its members as well as the countries that will join the EMU in the near future. I find that the incumbent EMU members are better off under fiscal policy cooperation and the new members are as well of under fiscal cooperation as they are in a non-cooperative equilibrium. Under fiscal policy cooperation in my model, all policymakers have the same objective by construction. Therefore, the results in my study differ from some previous findings in the literature.

Chapter 1

Fiscal and Monetary Policy in the Enlarged European Union

1.1 Introduction

In May 2004, the European Union (EU) enlarged once more and now includes two different groups of countries.[1] Most of the incumbent EU members renounced their sovereign monetary policies in favor of a single, supranational monetary policy and constitute the European Economic and Monetary Union (EMU). The second group are the new EU members who are expected to join the monetary union once they have met the exchange rate criterion and successfully participated in the Exchange Rate Mechanism (ERM2).[2] While the EMU countries do not have national monetary policies available, the new EU members are focusing on the exchange rate and cannot freely use monetary policies for stabilization purposes. Therefore, fiscal policies have become increasingly more important stabilization

[1] Without loss of generality I concentrate on two groups of countries within the EU: the EMU countries and the newly admitted Central and Eastern European countries (CEEC). I do not differentiate among countries within a group.

[2] They also have to satisfy other Maastricht criteria to be admitted to the monetary union.

tools in the EU.

At least two issues arise when considering how to conduct fiscal policies in the EU. First, it is important that the EU governments avoid large budget deficits to be able to facilitate stabilization policy and price stability. Second, national fiscal policies can cause international spillovers since the EU countries are highly interdependent.[3] The Maastricht Treaty and the Stability and Growth Pact in particular were introduced to ensure prudent fiscal policies of the EU member states. However, it remains an open question whether the Stability and Growth Pact needs to be changed since many of the EU members have not been adhering to its rules.[4]

In light of the above discussion, I ask the question whether it is desirable that the EU governments cooperate on their fiscal policies. More specifically, I take into account the environment of the enlarged EU and investigate whether fiscal cooperation between the new EU members and the EMU countries is welfare-improving. The contribution of my study is threefold. First, I develop a quantitative business cycle model which matches the dynamics of Central and Eastern European countries and the Euro Area. I use this model to analyze fiscal and monetary policy in the EU and provide an explanation about the desirability of fiscal cooperation. Second, I incorporate a realistic assumption about the presence of foreign ownership of the firms that has not yet been included in studies of Central and Eastern European countries. Conclusions about desirability of fiscal policy cooperation depend on this assumption.[5] Third, formal studies of the new EU countries

[3]See for example Giuliodori and Beetsma (forthcoming) who show some existence of fiscal spillovers and thus potential room for fiscal cooperation in the EU.

[4]For general discussion, see for example The Economist (2003, 2004). For a discussion tailored to the new EU members, see Gerald et al. (2004).

[5]CEE countries rely heavily on foreign (mainly European) capital to finance catching up with the incumbent EU members. As a consequence, the presence of foreign ownership in new EU countries is substantial.

have focused on their monetary issues during the transition period to the EU but have abstracted from fiscal policy.

In building the model, I follow Laxton and Pesenti (2003), Natalucci and Ravenna (2003), Devereux (2002), Devereux and Lane (2004), Ghironi and Rebucci (2001), and Galí and Monacelli (forthcoming). These are examples of two-country models where one country is large and the other one is much smaller.[6] In my model, the large (foreign) economy represents the 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 stabilization policy by use of policy rules and I assume that they can commit to the rules. Each government uses government consumption as a fiscal instrument and adjusts the instrument in response to its GDP movements. The foreign central bank follows a Taylor-type interest rate rule. When 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.

The foreign share in equity capitalization has ranged from 20% to 80% in many Central and Eastern European countries during the period 1997-2003, while the share of CEE countries in equity capitalization in incumbent EU members is negligible. See Table 1.2.

[6]The first three papers are tailored to Central and Eastern European countries. 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 EU.

To understand how foreign ownership affects results, I first analyze a benchmark model with no foreign ownership. When governments cooperate on their fiscal policies, they choose 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 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 in stabilizing the smaller economy when they cooperate and this makes government purchases in both countries more volatile. More aggressive fiscal policies have adverse effects on private non-tradable consumption in both countries.[7] There is also a shift towards stabilizing shocks that affect both countries when governments cooperate. Thus, 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 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 overall private consumption is slightly less volatile when governments cooperate. However, more volatility in labor supply and government purchases

[7]Government purchases non-tradable goods.

dominate and home welfare is also lower under fiscal cooperation. 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.

My work relates to the 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. My model is similar to Quadrini (2004) in the sense that capital market liberalization plays a role in the desirability of fiscal cooperation. In his model, 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 governments' inability to commit to future policies while I assume that policies can commit.

The inability of policymakers to commit is also the reason for counterproductive policy cooperation in Rogoff (1985), Kehoe (1989) and Canzoneri and Henderson (1991). If policymakers could commit in their models, cooperation would be beneficial. Beetsma and Bovenberg (1998), Beetsma et al. (2001) and Eichengreen and Ghironi (2002) show more examples of counterproductive cooperation which is limited to a subset of players. They 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.

Other contributions in the literature are Dixit and Lambertini (2001, 2003) and Eichengreen and Ghironi (2002) who 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 their bliss points. Jensen (1996) shows that fiscal cooperation may be disadvantageous if monetary cooperation lacks credibility with the private sector but is welfare-improving when central banks

adhere to a rule. Lombardo and Sutherland (2003) conclude that fiscal cooperation may be welfare-reducing if monetary policies are set non-cooperatively. Mendoza and Tesar (2003) find gains from fiscal cooperation but the gains are very small.

The rest of the Chapter is organized as follows. Section 2 outlines a two-country model of the European Union. In section 3 I describe the solution method and selection of parameters. In Section 4 I present the transmission mechanism and dynamic properties of the model. I explain the results about fiscal cooperation is Section 5. Section 6 concludes.

1.2 A general equilibrium model of the European Union

1.2.1 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 some of the key features of these countries.[8] One of them is the presence of foreign ownership of the firms. Central and Eastern European countries rely heavily on foreign (mainly European) capital to finance catching up with the rest of the EU. As a consequence, the presence of foreign ownership in the new EU countries is substantial. This feature is not present in other models on accession countries. Second, intermediate goods represent a substantial part of imports of these countries. 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.[9] Third,

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

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

domestic tradable goods are exported and consumed by domestic households. Fourth, non-tradable sector is important and most of the government purchases are on non-tradable goods. Taking all of the above into consideration provides more flexibility to match 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 the European Economic and Monetary Union and the home country represents an aggregate of the new members of the EU. In each country there are households, firms, fiscal authority (government) and monetary authority (central bank). Foreign variables are indexed by a star.

Households in both countries are infinitely lived and have preferences over consumption, real money balances, 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 the 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 the 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 foreign households who trade home and foreign equity shares and receive dividends from home and foreign intermediate sector firms.[10]

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. Final non-tradable goods 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 production of each intermediate good is domestic labor. The intermediate goods are used in production of the final tradable good. In the intermediate sector, there are nominal rigidities in the form of a quadratic cost of price adjustment.

Government conducts stabilization fiscal policy. Government spending falls on the final non-tradable good and is financed through tax revenues and seigniorage. The central bank in each country is instrument independent of the government. Foreign central bank conducts monetary policy by employing an interest rate rule and home central bank supports fixed exchange rate.

[10]The sector that is exclusively foreign-owned is only one out of three sectors. This assumption is thus not an extreme assumption about the extent of foreign presence.

1.2.2 Households and their trading opportunities

Utility function

Home consumer j's utility function has the following form:

$$U_t^j \equiv E_t \sum_{i=0}^{\infty} \beta^i \left[A_{C,t} \frac{\left(C_{t+i}^j\right)^{1-\sigma}}{1-\sigma} + \frac{\left(G_{t+i}^j\right)^{1-\sigma_g}}{1-\sigma_g} + \chi \frac{\left(\frac{M_{t+i}^j}{P_{t+i}}\right)^{1-\phi}}{1-\phi} - A_{L,t} \frac{\left(L_{t+i}^j\right)^{1+\psi}}{1+\psi} \right], \quad (1.1)$$

where labor supply equals $L_t = L_{N,t} + L_{X,t}$, and labor is homogenous and perfectly mobile between the sectors within the country, C_t is the consumption basket, P_t is 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 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 $j^* \in [a, 1]$.

Intra-temporal allocation of consumption

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

$$C_t^j \equiv \left[(1-\varphi_t)^{\frac{1}{\mu}} \left(C_{N,t}^j\right)^{\frac{\mu-1}{\mu}} + (\varphi_t)^{\frac{1}{\mu}} \left(C_{T,t}^j\right)^{\frac{\mu-1}{\mu}}\right]^{\frac{\mu}{\mu-1}}, \tag{1.2}$$

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, 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.

Consumption index of tradable goods is defined as:

$$C_{T,t}^j \equiv \left[\omega^{\frac{1}{\eta}} \left(C_{F,t}^j\right)^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} \left(C_{F^*,t}^j\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{1.3}$$

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 good consumption. C_F^j and $C_{F^*}^j$ are baskets of home and foreign final tradable goods also produced by perfectly competitive firms.

The definitions of 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, respec-

tively, and P_F and P_{F^*} are the prices of home and foreign baskets of final tradable goods, respectively.

The demands for baskets C_T^j and C_N^j are:

$$C_{T,t}^j = \varphi_t \left[\frac{P_{T,t}}{P_t}\right]^{-\mu} C_t^j, \tag{1.4}$$

$$C_{N,t}^j = (1-\varphi_t) \left[\frac{P_{N,t}}{P_t}\right]^{-\mu} C_t^j, \tag{1.5}$$

and the demands for home and foreign baskets of final tradable goods are:

$$C_{F,t}^j = \omega \left[\frac{P_{F,t}}{P_{T,t}}\right]^{-\eta} C_{T,t}^j, \tag{1.6}$$

$$C_{F^*,t}^j = (1-\omega) \left[\frac{P_{F^*,t}}{P_{T,t}}\right]^{-\eta} C_{T,t}^j. \tag{1.7}$$

Foreign households solve a similar problem.

Inter-temporal optimization

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

$$\begin{aligned} & M_t^j + B_{t+1}^j + \varepsilon_t B_{t+1}^{*,j} + P_t \frac{\xi_{B^*}}{2} \left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t} - \frac{\overline{\varepsilon}\overline{B}^{*,j}}{\overline{P}} \right)^2 + P_t C_t^j + P_t T_t^j \\ \leq \; & M_{t-1}^j + (1+i_t) B_t^j + \varepsilon_t (1+i_t^*) B_t^{*,j} + \left(1-\tau_t^L\right) \left(W_{N,t} L_{N,t}^j + W_{X,t} L_{X,t}^j \right) + P_t TCT_t^j. \end{aligned} \tag{1.8}$$

Home household j consumes, C_t^j, pays net lump-sum taxes, T_t^j, and receives wage income net of labor income tax, $\left(1-\tau_t^L\right)\left(W_{N,t}L_{N,t}^j + W_{X,t}L_{X,t}^j\right)$. Household j holds domestic money, M_t^j, and home and foreign bonds, B and B^*, denominated in 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 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 bond is traded internationally. There are intermediation costs for households entering the international bond market.[11] In particular, households face convex cost of holding foreign bonds in quantities different from the steady state level. The revenue from the intermediation is rebated to the home consumers as a lump-sum transaction cost transfer, TCT_t^j.[12] 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 labor supply, bond and money holdings, and consumption path to maximize expected utility (1.1) subject to the budget constraint (1.8). The first order conditions with respect to labor are:

$$\left(1-\tau_t^L\right)w_{N,t} = \left(1-\tau_t^L\right)w_{X,t} = \frac{A_{L,t}\left(L_t^j\right)^{\psi}}{A_{C,t}\left(C_t^j\right)^{-\sigma}}, \tag{1.9}$$

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

[11] The intermediation costs are introduced to guarantee that 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.

[12] I assume that intermediaries are perfectly competitive and owned by local households.

foreign bond holdings are:

$$A_{C,t}\left(C_t^j\right)^{-\sigma} = \beta\left(1+i_{t+1}\right)E_t\left[\frac{P_t}{P_{t+1}}A_{C,t+1}\left(C_{t+1}^j\right)^{-\sigma}\right], \tag{1.10}$$

$$A_{C,t}\left(C_t^j\right)^{-\sigma}\left[1+\xi_{B^*}\left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t}-\frac{\overline{\varepsilon}\overline{B}^{*,j}}{\overline{P}}\right)\right] = \beta\left(1+i_{t+1}^*\right)E_t\left[\frac{\varepsilon_{t+1}}{\varepsilon_t}\frac{P_t}{P_{t+1}}A_{C,t+1}\left(C_{t+1}^j\right)^{-\sigma}\right]. \tag{1.11}$$

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

Unlike home households, foreign households trade only foreign bonds and 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:

$$A_{C,t}^*\left(C_t^{j^*}\right)^{-\sigma} = \beta E_t\left[\frac{P_t^*}{P_{t+1}^*}\frac{\left(\left(1-\tau_{t+1}^{D^*}\right)D_{t+1}^{x^*}+V_{t+1}^{x^*}\right)}{V_t^{x^*}}A_{C,t+1}^*\left(C_{t+1}^{j^*}\right)^{-\sigma}\right], \tag{1.12}$$

$$A_{C,t}^*\left(C_t^{j^*}\right)^{-\sigma} = \beta E_t\left[\frac{\varepsilon_t}{\varepsilon_{t+1}}\frac{P_t^*}{P_{t+1}^*}\frac{\left(\left(1-\tau_{t+1}^{D}\right)D_{t+1}^{x}+V_{t+1}^{x}\right)}{V_t^{x}}A_{C,t+1}^*\left(C_{t+1}^{j^*}\right)^{-\sigma}\right], \tag{1.13}$$

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

by home and foreign firms x and x^*, respectively.

1.2.3 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 equity share holdings of foreign household j^* in home firm x and S^{x^*,j^*}_* are equity share holdings of foreign household j^* in foreign firm x^*. Market clearing conditions for the home and foreign bond are:

$$\int_0^a B_{t+1} dj = 0, \tag{1.14}$$

$$\int_0^a B^*_{t+1} dj + \int_a^1 B^*_{*,t+1} dj^* = 0. \tag{1.15}$$

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

$$\int_a^1 S_{*,t+1} dj^* = \int_0^a 1 dx, \tag{1.16}$$

$$\int_a^1 S^*_{*,t+1} dj^* = \int_a^1 1 dx^*. \tag{1.17}$$

1.2.4 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:

$$Y_{X,t}^x \equiv A_{X,t} L_{X,t}^x, \tag{1.18}$$

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

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

$$\max_{\{p_s(x), L_{X,s}^x\}} E_t \left(\sum_{s=t}^{\infty} \Omega_s^x d_s^x \right) \tag{1.19}$$

subject to

$$d_s^x = (1 - \tau_t) \frac{p_s(x)}{P_s} Y_{X,s}^x - \frac{W_{X,s}}{P_s} L_{X,s}^x - \frac{\kappa}{2} \left(\frac{p_s(x)}{p_{s-1}(x)} - 1 \right)^2 \frac{p_s(x)}{P_s} Y_{X,s}^x \tag{1.20}$$

and

$$Y_{X,s}^{S^x} = Y_{X,s}^{D^x} = Y_{X,s}^x. \tag{1.21}$$

Since foreign households own home intermediate sector firms, the discount factor for the home firm x is $\Omega_s^x = \beta^{s-t} \frac{A_{C,s}^*}{A_{C,t}^*} \left(\frac{C_s^*}{C_t^*} \right)^{-\sigma}$ 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:

$$\lambda_t^x = \frac{w_{X,t}}{A_{X,t}}, \tag{1.22}$$

which implies that the Lagrange multiplier on constraint (1.21), λ_t^x, 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 nominal marginal cost:

$$p_t(x) = \Psi_t^x P_t \lambda_t^x, \tag{1.23}$$

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 law of one price holds: $P_{X,t} = \varepsilon_t P_{X,t}^*$, $P_{X^*,t} = \varepsilon_t P_{X^*,t}^*$.

1.2.5 Production of final goods

Production of final non-tradable goods

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

$$Y_{N,t} \equiv A_{N,t} L_{N,t}, \tag{1.24}$$

where $A_{N,t}$ is a productivity shock common to producers of home non-tradable good and $L_{N,t}$ is homogenous labor used in the production of 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:

$$RP_{N,t} = \frac{w_{N,t}}{A_{N,t}}, \tag{1.25}$$

where $w_{N,t} \equiv \frac{W_{N,t}}{P_t}$ is 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 units of consumption basket. Foreign firms solve a similar problem.

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:

$$Y_{F,t} \equiv \left[\gamma^{\frac{1}{\epsilon}} (X_t)^{\frac{\epsilon-1}{\epsilon}} + (1-\gamma)^{\frac{1}{\epsilon}} (X_t^*)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{1.26}$$

where $Y_{F,t}$ is the amount of 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 good in the production of home final tradable good.

Baskets of home and foreign intermediate goods are defined as follows:

$$X_t \equiv \left[\left(\frac{1}{a}\right)^{\frac{1}{\theta}} \int_0^a (X_t(x))^{\frac{\theta-1}{\theta}} dx\right]^{\frac{\theta}{\theta-1}}, \tag{1.27}$$

$$X_t^* \equiv \left[\left(\frac{1}{1-a}\right)^{\frac{1}{\theta}} \int_a^1 (X_t^*(x^*))^{\frac{\theta-1}{\theta}} dx^*\right]^{\frac{\theta}{\theta-1}}, \tag{1.28}$$

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

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

and the definitions of the baskets of intermediate goods imply:

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

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

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

The representative firm's demands for baskets X and X^* are:

$$X_t = \gamma\left[\frac{P_{X,t}}{P_{F,t}}\right]^{-\epsilon} Y_{F,t}, \tag{1.29}$$

$$X_t^* = (1-\gamma)\left[\frac{P_{X^*,t}}{P_{F,t}}\right]^{-\epsilon} Y_{F,t} \tag{1.30}$$

and the demands for individual goods x and x^* by the representative firm are:

$$X_t(x) = \frac{1}{a}\left[\frac{p_t(x)}{P_{X,t}}\right]^{-\theta} X_t, \tag{1.31}$$

$$X_t^*(x^*) = \frac{1}{1-a}\left[\frac{p_t(x^*)}{P_{X^*,t}}\right]^{-\theta} X_t^*. \tag{1.32}$$

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

1.2.6 Goods and labor market clearing

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

$$\int_0^a Y_{N,t} dn = \int_0^a C_{N,t} dj + aG_t. \tag{1.33}$$

Final tradable goods are consumed by home and foreign households:

$$\int_0^a Y_{F,t} df = \int_0^a C_{F,t} dj + \int_a^1 C^*_{F,t} dj^* \tag{1.34}$$

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

$$Y^x_{X,t} = \int_0^a X_t(x) df + \int_a^1 X_{*,t}(x) df^*. \tag{1.35}$$

Labor market clearing requires:

$$\int_0^a L_{N,t} dj + \int_0^a L_{X,t} dj = \int_0^a L_{N,t} dn + \int_0^a L_{X,t} dx. \tag{1.36}$$

1.2.7 Fiscal and monetary policy

Government and fiscal policy

Government is not productive and public spending falls on final non-tradable good and is denoted by G, which is per capita government consumption. Government finances its consumption through lump-sum taxes imposed on consumers, taxes imposed on 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 stabilization policy. Fiscal policy is specified in terms of the following rule:[14]

$$g_t = \left(\frac{GDP_t}{\overline{GDP}}\right)^{f_{GDP}} \epsilon_t^{fp}, \tag{1.37}$$

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 empirical literature.[15] Foreign fiscal policy is specified in a similar way.

Central bank and monetary policy

Home central bank issues home nominal money. Monetary policy in the home economy is supports fixed exchange rate,[16] which is in line with the requirement of the membership in the Exchange Rate Mechanism prior to joining the monetary union.

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

[13]Government budget constraint is in the Appendix.

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

[15]Empirical fiscal rules also take into account 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 US and references therein.

Gali and Perotti (2003) find empirical evidence that fiscal policies had been more and more countercyclical in the EMU for the period 1980 until 2001 and that spending policies have had more important role as a countercyclical tool, as opposed to the revenue policies, while the Government of Slovenia, for example, announced it would be using fiscal policy for stabilization purposes after fixing the exchange rate to euro in summer 2004.

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

$$1 + i^*_{t+1} = (1 + i^*_t)^{m^*_i} (1 + \pi^*_t)^{m^*_{CPI}} \left(\frac{GDP^*_t}{\overline{GDP^*}} \right)^{m^*_{GDP}} \epsilon^{*mp}_t, \tag{1.38}$$

where m^*_i, m^*_{CPI}, and m^*_{GDP} are feedback parameters on previous period interest rate, CPI inflation and GDP gap, respectively, and ϵ^{*mp}_t is an exogenous shock to monetary policy.

1.3 Solution and parameterization of the model

1.3.1 Solution of the model and the steady state

Variables are expressed in real aggregate per capita terms. The model cannot be solved analytically. Thus I find the rational expectations equilibrium of the log-linearized approximation around the steady state.[17] 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 has analytical solution but I use numeric methods to solve for the steady state of the model with foreign ownership of home intermediate firms.

[17]Several authors, Schmitt-Grohé and Uribe (2003) among others, report that welfare reversals may occur in the case of a linear approximation of a model. However, their critique is not directly applicable here unless a higher order approximation of this model delivers different results.

1.3.2 Parameterization

The home economy in this model represents the new EU members and the foreign economy is designated to be the EMU.[18] Thus, the size of the home country relative to the foreign economy, a, is set to 5 percent.[19] 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 labor supply elasticity, ψ, is set to 2.5. I assume logarithmic utility of government consumption so that $\sigma_g = 1$.

The share of home tradable consumption in the tradable consumption basket, ω, and the share of home intermediate good in 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 good consumption, 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 intermediate goods. I set $\theta = 11$, which together with the revenue tax of 0.2 implies a markup of 1.375.[20] The price adjustment cost parameter, κ, is set to 77, as estimated by Ireland (2001) for the US economy. All parameters for financial transaction costs are set to

[18]The model is calibrated to the EMU and the Czech Republic's data.

[19]The new members' share of GDP in the EU total GDP is around 5 percent.

[20]Martins et al. (1996) estimate the average markup for 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).

0.01, which is standard in the literature.[21]

I treat tax rates as parameters and set them equal to the values as in Quadrini (2004) and Mendoza and Tesar (2003). Tax rate on revenue, τ, equals 20 percent. Tax rate on labor income is set to 37 percent and tax rate on dividends to 25 percent. The steady state share of government purchases in GDP is calibrated to 18 percent.

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 home central bank supports fixed exchange rate, which is in line with the ERM2, and keep this assumption across all model specifications.[22] Galí and Perotti (2003) 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 primary spending-to-potential output ratio reacts to output gap with the coefficient of 0.04 and that there is high persistence of fiscal instrument; persistence parameter is estimated to be 0.8. I approximate historic foreign fiscal policy by setting the reaction coefficient to the output gap to zero and incorporate high persistence coefficient on 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

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

[22] Some of the new EU members have already fixed their exchange rate to 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 regime of a fixed exchange rate but I assume the exchange rate to be fixed in order to be consistent across model specifications and for simplicity.

AR(1) processes with the persistence parameters 0.7 and 0.8, respectively.

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

To understand how the model's transmission mechanism works, I first analyze impulse responses of 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 the variables in the other economy.

1.4.1 Foreign technology shock

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

Figures 1.1 and 1.2 present impulse responses to a one-percent increase in foreign intermediate sector productivity. To understand the implications of the assumption about foreign ownership of home intermediate sector firms, I show impulse responses for a benchmark model without foreign ownership (solid line) and the model where home intermediate sector firms are exclusively foreign-owned (dashed line).

A positive productivity shock in foreign intermediate sector increases output of foreign intermediate goods, reduces 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. Markup increases to preserve profitability and the dividends are higher. This is reflected in an increase of foreign share price.

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

At the same time the original shock transmits to the home economy. Home final tradable sector expands for the same reason as foreign final tradable sector (foreign inputs have higher weight in production of final tradable goods) and home relative price of final tradable goods decreases. There is an initial boom in 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 home intermediate sector, demand for home inputs decreases (prices are higher at home). Labor dynamics at home follow output dynamics in the home intermediate sector. Higher demand for inputs initially results in higher demand for 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 intermediate sector is lower and output in non-tradable sector expands. Home relative price

of non-tradable goods increases.

As a consequence of a positive productivity shock in foreign intermediate sector home and foreign GDP and private consumptions expand. Foreign CPI inflation almost does not responds due to opposite dynamics of prices of tradable and non-tradable goods, while home CPI inflation increases because 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.

1.4.2 Foreign fiscal shock

Figures 1.3 and 1.4 present impulse responses to a one-percent increase in foreign fiscal shock. A demand shock in the form of an increase of foreign government purchases-to-GDP ratio increases demand for labor and output in foreign non-tradable sector. Government consumption crowds out private non-tradable consumption and this cushions foreign wage rate and relative price of 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, supply of foreign intermediate goods falls and demand adjusts. Because of the opposite dynamics of labor cost and markup in foreign intermediate sector the relative price of foreign inputs almost does not change. Intermediate goods are inputs in production of final tradable goods, which decreases in both countries. In the foreign economy, the relative price of 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 supply of foreign intermediate goods drops and so does the production of home inputs. This reduces 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 wages and relative prices in this sector. Overall home private consumption decreases because consumption of final tradable goods is lower and almost all of new non-tradable goods are consumed by the government which crowds out private non-tradable consumption. Home GDP decrease.

Home CPI inflation decreases because the main components of home CPI inflation (home prices of non-tradable goods and 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.

1.4.3 Estimates of macroeconomic variability

The previous section analyzed only the responses of variables in the two economies for 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 stochastic processes. Empirical evidence on productivity shocks shows high persistence and positive

correlation across countries.[23] In my model, productivity shocks follow AR(1) processes. I set 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. Persistence parameters of 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 baseline parameter values. The details on stochastic processes are in Table 1.3.

The second moments of the model (with foreign ownership) and the values from the data are presented in Table 1.4. The model generates almost twice as much variability in GDP in the new EU members compared to the Euro Area and the absolute values of the standard deviations of GDP are consistent with the variability in the 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 the GDP and since investment goods are not part of exports and imports in my model, the volatility of exports and imports may be understated. The government expenditure is more volatile in the model than in historic data.[24] There is a trade-off between matching the volatility

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

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

of government purchases and matching the rest of the variables in this exercise.

The CPI inflation rate is more volatile and 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 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, 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 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 volatility for each of them.

The dynamic properties of the model can be partially compared to the model of Laxton and Pesenti (2003) and Natalucci and Ravenna (2003). The model of Natalucci and Ravenna (2003) 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 a highly sophisticated model with 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

weight on government purchases in the welfare function.

match the CPI inflation rates and interest rates. As explained above, the lower volatilities of exports and imports in my model compared to the historic date 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).

1.4.4 The role of foreign ownership

Table 1.5 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 insure themselves against the risk of the firms only through 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, home labor effort and imports are slightly less volatile in this case.

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.[25] The model with foreign

[25]One should keep in mind that the standard deviations of the shocks are chosen to match the moments

ownership performs better in matching the volatilities of consumption, exports and the real exchange rate even though both models understate the volatilities of the three variables, while government expenditure, CPI inflation rate and imports are better matched in the model without foreign ownership. Government expenditure and the CPI inflation rate both overstate the data in both models while imports are understated. The real GDP may be better matched in the model with foreign ownership given the fact 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.

1.5 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 basis for empirical evaluation of the underlying model.

In this section I turn to the core question of my analysis: Are there gains from fiscal cooperation between new and incumbent members of the European Union? Before I answer this question, I specify the goals of fiscal and monetary authorities and the structure of the policymakers' strategic game.

I assume that policymakers choose stabilization policy, i.e. reaction parameters in their policy rules, to maximize unconditional expectation of households' welfare and that they

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.

can commit to the rules. Given the class of rules considered, such fiscal and monetary policies are optimal.[26] 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:[27]

$$W_t = -\frac{1}{2}\sigma\overline{C}^{1-\sigma}var(\widehat{C}_t) - \frac{1}{2}\psi\overline{L}^{1+\psi}var(\widehat{L}_t) - \frac{1}{2}\sigma_g\overline{G}^{1-\sigma_g}var(\widehat{G}_t), \tag{1.39}$$

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

The definitions of strategic games among 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. Foreign central bank chooses response parameters to inflation and GDP to maximize unconditional expectation of 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 foreign central bank as given. The weights in the joint welfare function are the relative sizes of the countries. The foreign central bank chooses parameters in its rule to maximize unconditional expectation of foreign households' welfare, taking the behavior of the governments as given. All policymakers act simultaneously.

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

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

Benchmark model without foreign ownership

To understand how foreign ownership of the firms affects fiscal and monetary policy and fiscal cooperation, I first analyze a benchmark case without foreign ownership. Table 1.1 presents optimal fiscal and monetary reaction coefficients to GDP and inflation and the associated welfare losses for the models with and without foreign ownership.

Table 1.1: 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 1.1 *Optimal policies are countercyclical and call for more aggressive stabilization of output gap than historic policies.*

It is optimal for foreign fiscal and monetary authority to respond strongly to 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 thus very exposed to anything that happens in the large economy. When foreign policymakers stabilize their 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]

Result 1.2 *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 internalize its (small) spillovers on the large economy.[29] 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.[30]

Model with foreign-owned home intermediate sector firms

I now turn to empirically more relevant case where I assume that foreign households are exclusive owners of home intermediate sector firms and investigate the differences in optimal policies and fiscal cooperation with respect to the benchmark model.[31]

[28]Foreign expansionary monetary policy increases home GDP.

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

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

[31]Home firms producing final goods remain locally-owned.

Result 1.3 *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.[32] 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 the same in the non-cooperative equilibrium.

Result 1.4 *Foreign fiscal policy is more aggressive in the cooperative equilibrium compared to the benchmark model.*

As in the benchmark model, when governments cooperate, they choose parameters in their rules to maximize a weighted average of home and foreign welfare. However, variables in the home economy are more volatile and foreign fiscal policy causes bigger spillovers on the small country in the model with foreign ownership.[33] This is the reason why foreign fiscal policy in more aggressive under fiscal cooperation and now contributes to the stabilization of shocks in the home economy.

Result 1.5 *Foreign monetary policy's reaction to inflation is smaller under fiscal cooperation.*

The importance of foreign central bank's inflation stabilization under fiscal cooperation is reduced. This can be explained by analyzing some impulse responses.[34] Contractionary

[32] See the explanation in the section on transmission mechanism.
[33] See impulse responses in the section on transmission mechanism.
[34] See Figure 1.5.

monetary policy triggers expansionary foreign fiscal policy and reduces foreign consumption. This consumption reduction is magnified by the expansionary fiscal policy. Under fiscal cooperation, foreign government reacts stronger to monetary actions and thus the indirect effect of foreign fiscal policy on foreign private consumption is larger. But because foreign monetary authority chooses its policy parameters to maximizes foreign households' utility and households dislike consumption variability, it is optimal for the foreign central bank not to respond as strongly to inflation as under non-cooperative fiscal game.

Result 1.6 *Both countries are better off in the non-cooperative equilibrium.*

In the model with foreign ownership 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 government purchases in both countries are more volatile.

Foreign fiscal rule is successful in stabilizing GDP in the large economy but it introduces excessive volatility in 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 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.[35] Foreign non-tradable technology shock increases volatility of foreign inputs and consequently the

[35]Foreign technology shock in the non-tradable sector does not affect quantities in the home economy.

volatility in the production of foreign final tradable goods. Thus, foreign tradable consumption is more volatile.[36] The foreign central bank cushions the effect of more volatile foreign government purchases on foreign private consumption. However, higher volatility of government purchases has the dominant effect on foreign private consumption. Private consumption is by far the most important component of welfare and foreign households are thus 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. On the contrary, 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 and less volatility in home prices translates into less volatility of quantities consumed. Another factor in determining the volatility of home private consumption is the foreign central bank which chooses its policy parameters to maximize foreign welfare. Nonetheless, 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 labor supply and government purchases and also home households are worse off under fiscal cooperation.

[36]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.

1.5.2 Some sensitivity analysis

Elasticity of intertemporal substitution of government purchases

The estimates of the inverse of the elasticity of intertemporal substitution of government consumption, σ_g, are not readily available. I assume logarithmic utility of government purchases in the benchmark calibration, which implies a weight of 0.5 on government purchases in the welfare function.[37] I reduce this weight to 0.3 which implies $\sigma_g = 0.81$ and 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.

Weights in the joint welfare function

The question of weights in the joint welfare function is of political nature 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 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.

[37] The weight on consumption is around 1.5.

All policymakers cooperate

The model I use incorporates some realistic assumption about the conduct of economic policies in the European Union. I assume that the new EU members participate in the ERM (by supporting a fixed exchange rate) and are not yet members of the monetary 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.[38] 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 governments cooperate. However, both countries are better off when all four policymakers cooperate. In this case, I assume that the home central bank conducts stabilization policy and follows an interest rate rule similar to the foreign central bank's rule.

1.6 Conclusions

In this Chapter I study how fiscal policies should be conducted in the enlarged European Union. I find that there is room for fiscal stabilization but there is no need for the national governments of the new EU members and the EMU members to cooperate on their fiscal

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

policies. In fact, fiscal cooperation is welfare-reducing for both groups of countries. An important factor which contributes to this result is the presence of foreign ownership of firms in the new EU members. When there is no foreign ownership, the EMU is indifferent between cooperating and not cooperating but the new EU members still prefer not to cooperate on fiscal policy with the EMU.

In this Chapter I assume that the two countries have national monetary policies. In the future, the new EU countries will have to join the monetary union (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 a different role and would interact differently with the national governments. I leave this extension for future research.

Appendix to Chapter 1

Foreign household j^*'s budget constraint is:

$$M_t^{j^*} + B_{*,t+1}^{*,j^*} + P_t^* \frac{\xi_{B^*}^*}{2}\left(\frac{B_{*,t+1}^{*,j^*}}{P_t^*} - \frac{\overline{B}_*^{*,j^*}}{\overline{P}^*}\right)^2 + \int_a^1 V_t^{x^*} S_{*,t+1}^{x^*,j^*} dx^* + \int_0^a \frac{V_t^x}{\varepsilon_t} S_{*,t+1}^{x,j^*} dx + P_t^* C_t^{j^*}$$

$$\leq M_{t-1}^{j^*} + (1+i_t^*) B_{*,t}^{*,j^*} + \int_a^1 \left(\left(1-\tau_t^{D^*}\right) D_t^{x^*} + V_t^{x^*}\right) S_{*,t}^{x^*,j^*} dx^* + \tag{A1-1}$$

$$\left(1-\tau_t^{L^*}\right)\left(W_{N,t}^* L_{N,t}^{j^*} + W_{X,t}^* L_{X,t}^{j^*}\right) - P_t^* T_t^{j^*} + P_t^* TCT_t^{j^*} + \int_0^a \frac{\left(\left(1-\tau_t^D\right) D_t^x + V_t^x\right)}{\varepsilon_t} S_{*,t}^{x,j^*} dx.$$

As opposed to home households, foreign consumers buy and trade 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 dividend tax at the rate of τ_t^D and $\tau_t^{D^*}$.

Home government budget constraint is:

$$\int_0^a P_{N,t} G_t dn = \int_0^a P_t T_t^j dj + \tau_t \int_0^a p_t(x) Y_{X,t}^x dx + \int_0^a \left(M_t^j - M_{t-1}^j\right) dj \tag{A1-2}$$

$$+ \tau_t^L \int_0^a \left(W_{N,t} L_{N,t}^j + W_{X,t} L_{X,t}^j\right) dj + \tau_t^D \int_a^1 \int_0^a D_t^x S_{*,t}^{x,j^*} dx dj^*.$$

Table 1.2: 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 1.3: 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 1.4: 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 HP filter. Estimates of historic standard deviations that are taken from Laxton and Pesenti (2003) are marked by a star. The rest of estimates for the Czech Republic are taken from Natalucci and Ravenna (2003) and for the Euro Area they are taken from Fagan et al. (2001). Data in Laxton and Pesenti (2003) are detrended with 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. Time span for the Czech Republic is 1994Q1 to 2003Q1. In Fagan et al. (forthcoming), variables are expressed in per capita terms and logged (except for inflation and interest rates). They are seasonally adjusted and HP filtered.

Table 1.5: 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 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 1.1: Impulse Responses of Foreign Variables to Foreign Intermediate Technology Shock

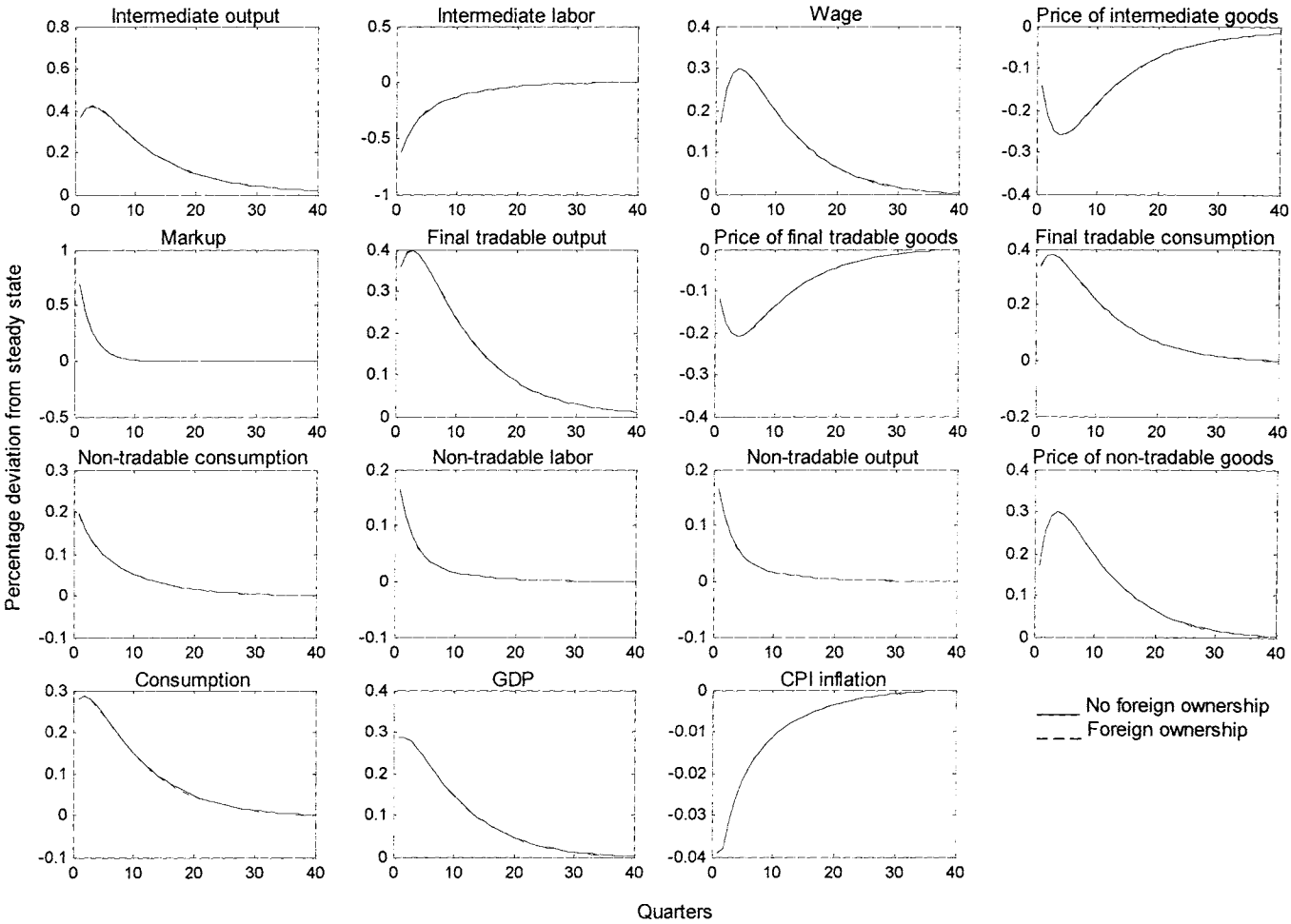


Figure 1.2: Impulse Responses of Home Variables to Foreign Technology Shock

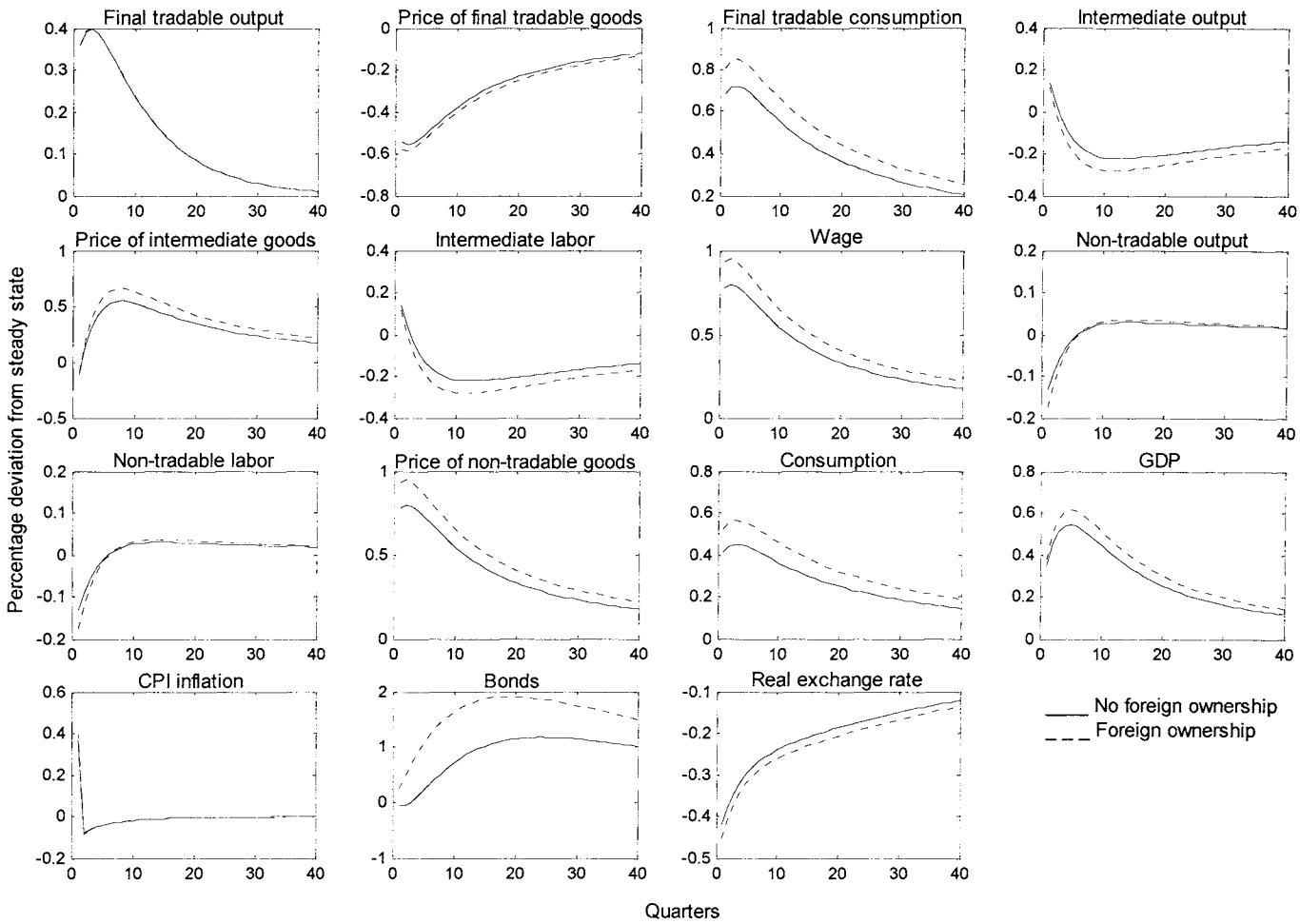


Figure 1.3: Impulse Responses of Foreign Variables to Foreign Fiscal Shock

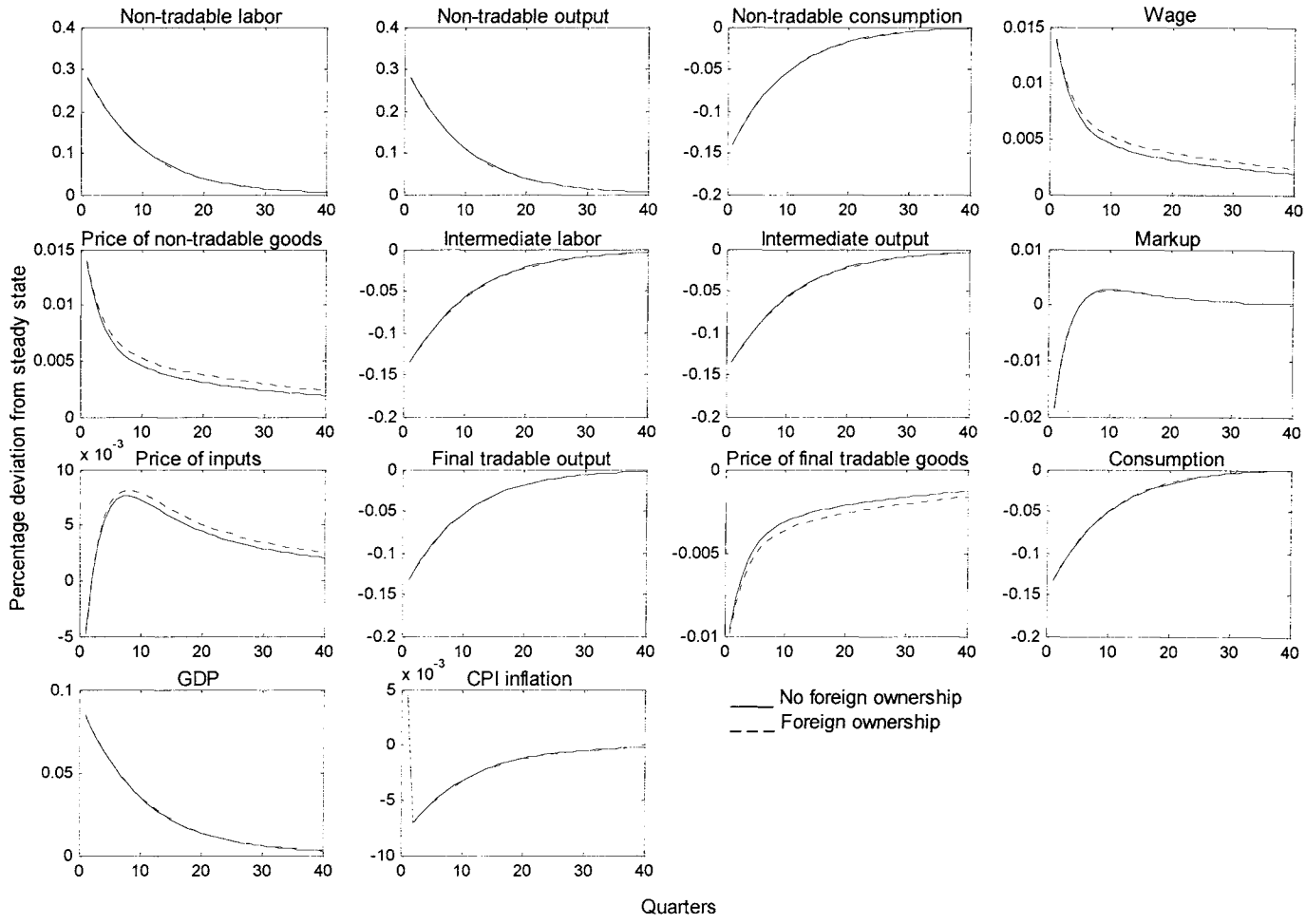


Figure 1.4: Impulse Responses of Home Variables to Foreign Fiscal Shock

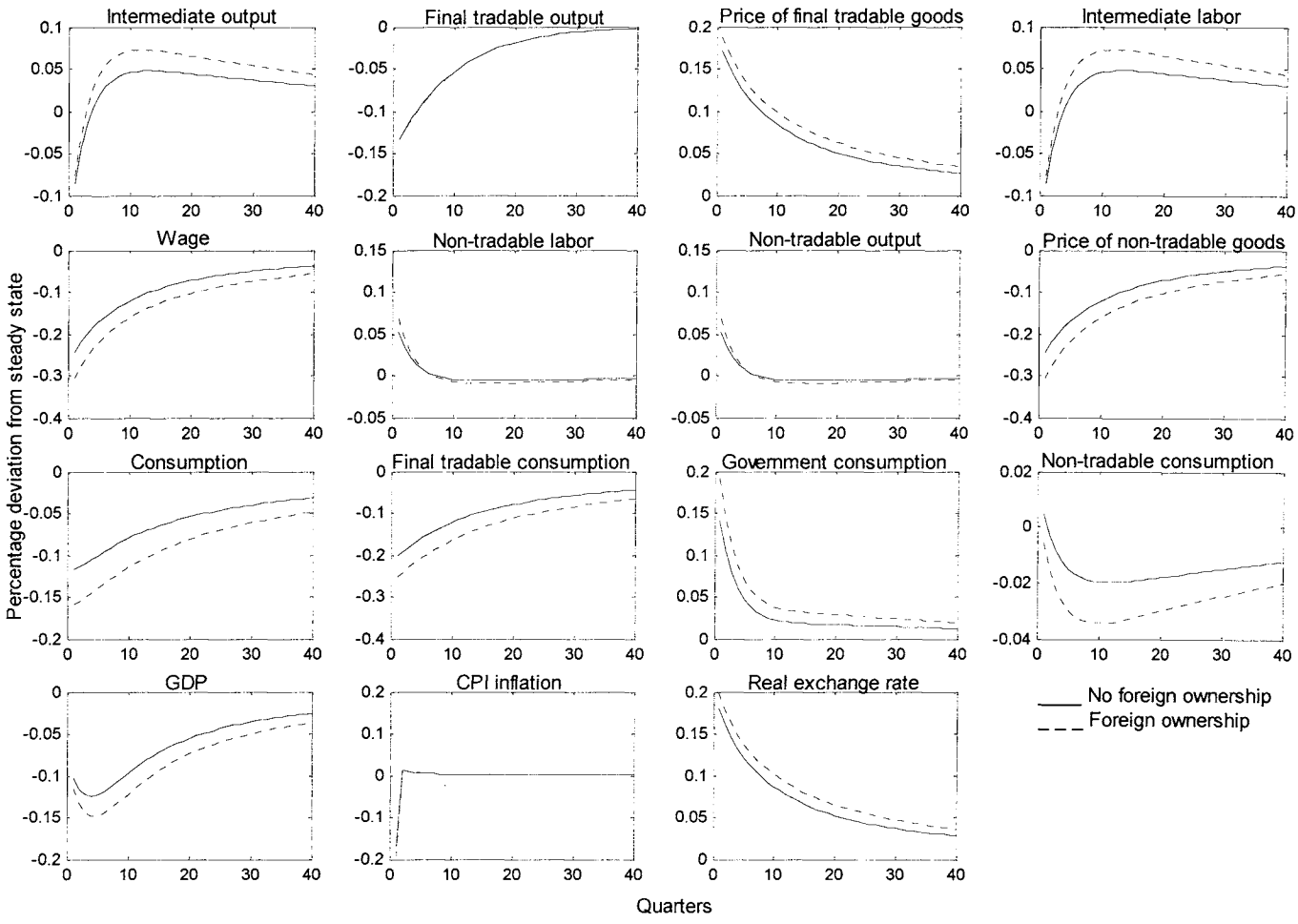
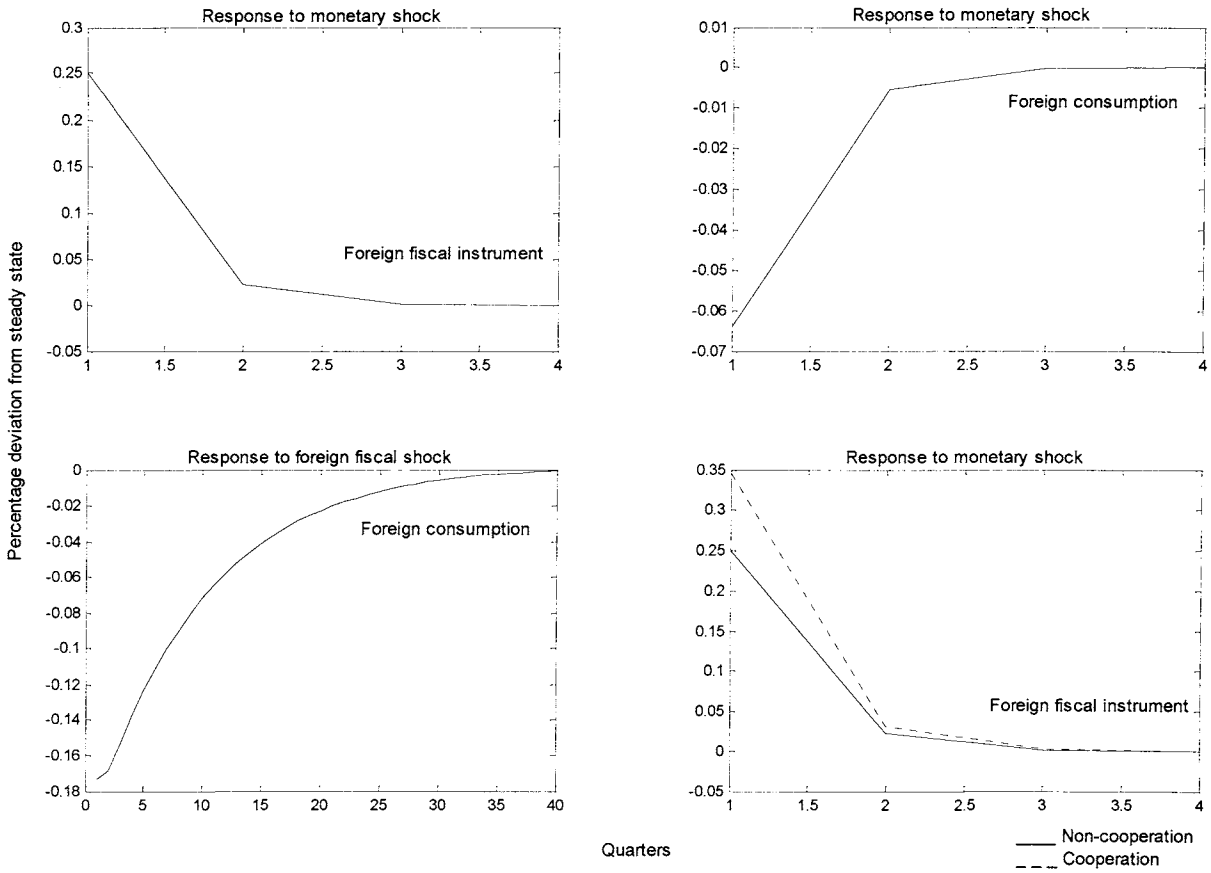


Figure 1.5: Explaining Why Monetary Policy is Looser Under Fiscal Cooperation



Chapter 2

The New EU Members and the Monetary Union

2.1 Introduction

Eight Central and Eastern European countries (CEEC) joined the European Union (EU) in 2004.[1] These countries will have to join the monetary union after they have met the entry conditions. Even though they cannot opt out from the monetary union, it is of interest to study how the membership in the euro currency area will affect them. In this paper I investigate whether it is beneficial for the CEEC to participate in the monetary union. In order to do so I analyze three monetary arrangements that are relevant for the CEEC. I choose to compare a monetary union to a flexible and a fixed exchange rate regime since these countries will have gone through a transition of floating exchange rate regimes and

[1] Without loss of generality I leave Cyprus and Malta out of my study.

a participation in the Exchange Rate Mechanism (ERM) by the time they join the euro currency area.

I build a two-country dynamic stochastic general equilibrium model which mimics the dynamics of the CEEC (home, small country) and the Euro Area (foreign, large country). I compare the outcome of a monetary union (CEEC's participation in the European Economic and Monetary Union (EMU)) to the outcomes of a flexible and a fixed exchange rate regime in the CEEC based on households' utility and optimal monetary and fiscal policies.[2] The main result can be summarized as follows. The households in the CEEC prefer a flexible exchange rate regime to a monetary union and a monetary union to a fixed exchange rate regime. Under a fixed exchange rate regime there is only fiscal policy available to directly stabilize the variables in the home country while there are benefits from monetary stabilization in the case of a flexible exchange rate regime and a monetary union. However, a flexible exchange rate regime is preferred to a monetary union. In a monetary union a single central bank stabilizes a weighted average of the two countries' inflation and output and thus shocks that affect the home country are better absorbed when there is a home central bank which pursues stabilization policy.

Surprisingly, not many theoretical studies, especially the studies within the framework of the new open economy macroeconomics, have addressed the issue of costs and benefits of joining a monetary union. There is only one paper which uses the latest techniques and analyzes the consequences of CEEC's participation in the monetary union. Bayoumi et al. (2004) focuses on assessing the benefits of the fall in transportation costs and a

[2]See the section on policy design for more details on optimal policies.

higher level of trade integration from entering the EMU.[3] They find that even a small fall in trade costs can significantly increase trade in the long-run and that lower trade costs due to the introduction of the euro generate welfare gains. My work on the other hand focuses on the loss of sovereign monetary policy in the CEEC and my results are based on optimal monetary (and fiscal) policies while monetary policy is not optimal in Bayoumi at al. (2004).

Other studies of the CEEC do not analyze the issue of these countries' participation in the monetary union. In Chapter 1 I study the need for fiscal cooperation between the new EU members and the EMU before the CEEC join the monetary union. Devereux (2002), Natalucci and Ravenna (2003) and Laxton and Pesenti (2003) evaluate different monetary arrangements, but not a monetary union, for the CEEC based on a volatility criterion. Similar to the latter studies are the analyses of monetary regimes for emerging/developing countries. Examples of these are Ghironi and Rebucci (2003) and Devereux et al. (2004).[4]

Except for Bayoumi et al. (2004) there are only few other recent studies of costs and benefits of joining a monetary union. One example is Carré and Collard (2003) which use a micro-founded model similar to Obstfeld and Rogoff (1995) and study the effects of a specific shock (either technology or fiscal shock) on welfare. They conclude that a monetary union is beneficial for households of the country in which a permanent technology or fiscal shock originates but disadvantageous to the households of the other country. As in most studies mentioned above, monetary and fiscal policies in Carré and Collard (2003) are not chosen optimally. Lane (2000) compares stabilization properties of a currency union to alternative

[3]Their paper is partially motivated by empirical literature on the impact of a currency union on trade. See Bayoumi et al. (2004) for references on this empirical literature.

[4]Results in these two studies are based on a welfare criterion.

exchange rate regimes (given a specific shock) in a Canzoneri-Henderson setup. One of his results resembles my result in that a currency union in his model dominates a fixed exchange rate regime in terms of stabilization properties and a flexible exchange rate generates lower losses than a currency union. Similarly, Ca'Zorzi and de Santis (2003) study the impact of accession to a monetary union on inflation and output in a Barro-Gordon setup. They conclude that the EMU is beneficial for the CEEC if the variance of the supply and the real exchange rate shock falls sufficiently after the EMU enlargement.

The rest of the Chapter is organized as follows. I present the model in Section 2. Parameterization of the model is explained in Section 3. In Section 4, I analyze the effects and transmission of monetary and technology shocks, dynamic properties of the model, and the volatility of some macroeconomic variables under different monetary regimes. I present the design of monetary and fiscal policies and results in Section 5. Section 6 concludes.

2.2 A general equilibrium model of the European Union

2.2.1 Overview of the economic environment

The model builds on the model from Chapter 1 and mimics the structure of the enlarged EU and in particular the nature of the newly admitted members. First, it incorporates the presence of foreign ownership of the firms in Central and Eastern Europe which has arisen as a consequence of foreign financing of caching up with the rest of the EU. This feature was first introduced into literature by myself in Chapter 1. Second, intermediate goods represent a substantial part of imports of these countries and contribute to the dynamics of

macroeconomic variables. Third, domestic tradable goods are exported and consumed by domestic households. Fourth, non-tradable sector is important and most of the government purchases are on non-tradable goods. Taking all of the above into consideration provides more flexibility to match 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 the European Economic and Monetary Union and the home country represents an aggregate of the new members of the EU. In each country there are households, firms, fiscal authority (government) and monetary authority (central bank). Foreign variables are indexed by a star.

Households in both countries are infinitely lived and have preferences over consumption, real money balances, 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 the 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.[5]

The ownership structure of the firms and the equity share trade is as follows: I assume

[5]In the case of a monetary union, there is only one bond which is denominated in the single currency and is traded internationally.

that owners of home and foreign intermediate sector firms are foreign households who trade home and foreign equity shares and receive dividends from home and foreign intermediate sector firms.[6] Firms in other sectors are owned by domestic households.

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 an input. Final non-tradable goods 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 production of each intermediate good is domestic labor. The intermediate goods are used in production of the final tradable good. In the intermediate sector, there are nominal rigidities in the form of a quadratic cost of price adjustment.

Government spending falls on the final non-tradable good and is financed through lump-sum tax revenues and seigniorage. Government conducts stabilization fiscal policy. I consider several monetary regimes. First, I analyze the case of a fixed exchange rate where the foreign central bank follows an interest rate rule and the home central bank supports a fixed exchange rate. Second, I investigate the case of a flexible exchange rate in both countries. In the third scenario the two countries constitute a monetary union.

[6]The sector that is exclusively foreign-owned is only one out of three sectors. This assumption is thus not an extreme assumption about the extent of foreign presence.

2.2.2 Households and their trading opportunities

Utility function

Home consumer j's utility function has the following form:

$$U_t^j \equiv E_t \sum_{i=0}^{\infty} \beta^i \left[A_{C,t} \frac{\left(C_{t+i}^j\right)^{1-\sigma}}{1-\sigma} + \frac{\left(G_{t+i}^j\right)^{1-\sigma_g}}{1-\sigma_g} + \chi \frac{\left(\frac{M_{t+i}^j}{P_{t+i}}\right)^{1-\phi}}{1-\phi} - A_{L,t} \frac{\left(L_{t+i}^j\right)^{1+\psi}}{1+\psi} \right], \quad (2.1)$$

where labor supply equals $L_t = L_{N,t} + L_{X,t}$, and labor is homogenous and perfectly mobile between the sectors within the country, C_t is the consumption basket, P_t is consumption price index, and M_t are nominal money balances, and G_t are government purchases. 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 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 $j^* \in [a, 1]$.

Intra-temporal allocation of consumption

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

$$C_t^j \equiv \left[(1-\varphi_t)^{\frac{1}{\mu}} \left(C_{N,t}^j\right)^{\frac{\mu-1}{\mu}} + (\varphi_t)^{\frac{1}{\mu}} \left(C_{T,t}^j\right)^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}, \quad (2.2)$$

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, 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.

Consumption index of tradable goods is defined as:

$$C_{T,t}^j \equiv \left[\omega^{\frac{1}{\eta}} \left(C_{F,t}^j\right)^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} \left(C_{F^*,t}^j\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{2.3}$$

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 good consumption. C_F^j and $C_{F^*}^j$ are baskets of home and foreign final tradable goods also produced by perfectly competitive firms.

The definitions of 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 demands for baskets C_T^j and C_N^j are:

$$C_{T,t}^j = \varphi_t \left[\frac{P_{T,t}}{P_t}\right]^{-\mu} C_t^j, \tag{2.4}$$

$$C_{N,t}^j = (1-\varphi_t) \left[\frac{P_{N,t}}{P_t}\right]^{-\mu} C_t^j, \tag{2.5}$$

and the demands for home and foreign baskets of final tradable goods are:

$$C_{F,t}^j = \omega \left[\frac{P_{F,t}}{P_{T,t}}\right]^{-\eta} C_{T,t}^j, \tag{2.6}$$

$$C_{F^*,t}^j = (1-\omega) \left[\frac{P_{F^*,t}}{P_{T,t}}\right]^{-\eta} C_{T,t}^j. \tag{2.7}$$

Foreign households solve a similar problem.

Inter-temporal optimization

The budget constraint for home household j is:

$$\begin{aligned} & M_t^j + B_{t+1}^j + \varepsilon_t B_{t+1}^{*,j} + P_t \frac{\xi_{B^*}}{2} \left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t}\right)^2 + P_t C_t^j + P_t T_t^j \\ \leq \; & M_{t-1}^j + (1+i_t) B_t^j + \varepsilon_t (1+i_t^*) B_t^{*,j} + W_{N,t} L_{N,t}^j + W_{X,t} L_{X,t}^j + P_t TCT_t^j. \end{aligned} \tag{2.8}$$

Home household j consumes, C_t^j, pays net lump-sum taxes, T_t^j, and receives wage income, $W_{N,t}L_{N,t}^j + W_{X,t}L_{X,t}^j$. Household j holds domestic money, M_t^j, and home and foreign bonds,

B and B^*, denominated in home and foreign currency, respectively. 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 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 bond is traded internationally. There are intermediation costs for households entering the international bond market.[7] The revenue from the intermediation is rebated to the home consumers as a lump-sum transaction cost transfer, TCT_t^j.[8] In equilibrium, the rebate equals $TCT_t^j = \frac{\xi_{B^*}}{2}\left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t}\right)^2$.

Each household chooses labor supply, bond and money holdings, and consumption path to maximize expected utility (2.1) subject to the budget constraint (2.8). The first order conditions with respect to labor are:

$$w_{N,t} = w_{X,t} = \frac{A_{L,t}\left(L_t^j\right)^{\psi}}{A_{C,t}\left(C_t^j\right)^{-\sigma}}, \tag{2.9}$$

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:

$$A_{C,t}\left(C_t^j\right)^{-\sigma} = \beta\left(1+i_{t+1}\right)E_t\left[\frac{P_t}{P_{t+1}}A_{C,t+1}\left(C_{t+1}^j\right)^{-\sigma}\right], \tag{2.10}$$

[7]The intermediation costs are introduced to guarantee that 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.

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

$$A_{C,t}\left(C_t^j\right)^{-\sigma}\left[1+\xi_{B^*}\left(\frac{\varepsilon_t B_{t+1}^{*,j}}{P_t}\right)\right]=\beta\left(1+i_{t+1}^*\right)E_t\left[\frac{\varepsilon_{t+1}}{\varepsilon_t}\frac{P_t}{P_{t+1}}A_{C,t+1}\left(C_{t+1}^j\right)^{-\sigma}\right]. \quad (2.11)$$

Unlike home households, foreign households trade only foreign bonds and 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:

$$A_{C,t}^*\left(C_t^{j^*}\right)^{-\sigma}=\beta E_t\left[\frac{P_t^*}{P_{t+1}^*}\frac{\left(D_{t+1}^{x^*}+V_{t+1}^{x^*}\right)}{V_t^{x^*}}A_{C,t+1}^*\left(C_{t+1}^{j^*}\right)^{-\sigma}\right], \quad (2.12)$$

$$A_{C,t}^*\left(C_t^{j^*}\right)^{-\sigma}=\beta E_t\left[\frac{\varepsilon_t}{\varepsilon_{t+1}}\frac{P_t^*}{P_{t+1}^*}\frac{\left(D_{t+1}^{x}+V_{t+1}^{x}\right)}{V_t^{x}}A_{C,t+1}^*\left(C_{t+1}^{j^*}\right)^{-\sigma}\right], \quad (2.13)$$

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

2.2.3 Asset market clearing

In equilibrium, households and firms are symmetric so that $B_{t+1}^j = B_{t+1}$, $B_{t+1}^{*,j} = B_{t+1}^*$, $B_{*,t+1}^{*,j^*} = B_{*,t+1}^*$ and $\int_0^a S_{*,t+1}^{x,j^*}dx = aS_{*,t+1}^{x,j^*} \equiv S_{*,t+1}$ and $\int_a^1 S_{*,t+1}^{x^*,j^*}dx^* = (1-a)S_{*,t+1}^{x^*,j^*} \equiv S_{*,t+1}^*$. S_*^{x,j^*} are equity share holdings of foreign household j^* in home firm x and $S_*^{x^*,j^*}$ are equity share holdings of foreign household j^* in foreign firm x^*. Market clearing conditions for the home and foreign bond are:

$$\int_0^a B_{t+1} dj = 0, \tag{2.14}$$

$$\int_0^a B^*_{t+1} dj + \int_a^1 B^*_{*,t+1} dj^* = 0. \tag{2.15}$$

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

$$\int_a^1 S_{*,t+1} dj^* = \int_0^a 1 dx, \tag{2.16}$$

$$\int_a^1 S^*_{*,t+1} dj^* = \int_a^1 1 dx^*. \tag{2.17}$$

2.2.4 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:

$$Y^x_{X,t} \equiv A_{X,t} L^x_{X,t}, \tag{2.18}$$

where $A_{X,t}$ is productivity shock common to all producers and $L^x_{X,t}$ is homogenous labor used in the production of good x. The firms producing intermediate goods face nominal rigidities. Following Rotemberg (1982), the nominal rigidities are 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,

$$\max_{\{p_s(x),L^x_{X,s}\}} E_t\left(\sum_{s=t}^{\infty}\Omega^x_s d^x_s\right) \tag{2.19}$$

subject to

$$d^x_s = \frac{p_s(x)}{P_s}Y^x_{X,s} - \frac{W_{X,s}}{P_s}L^x_{X,s} - \frac{\kappa}{2}\left(\frac{p_s(x)}{p_{s-1}(x)} - 1\right)^2 \frac{p_s(x)}{P_s}Y^x_{X,s} \tag{2.20}$$

and

$$Y^{S^x}_{X,s} = Y^{D^x}_{X,s} = Y^x_{X,s}. \tag{2.21}$$

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 $s = t, t+1, t+2....$

The first order condition with respect to labor is:

$$\lambda^x_t = \frac{w_{X,t}}{A_{X,t}}, \tag{2.22}$$

which implies that the Lagrange multiplier on constraint (2.21), 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 nominal marginal cost:

$$p_t(x) = \Psi^x_t P_t \lambda^x_t, \tag{2.23}$$

where the markup equals

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

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 law of one price holds: $P_{X,t} = \varepsilon_t P_{X,t}^*$, $P_{X^*,t} = \varepsilon_t P_{X^*,t}^*$.

2.2.5 Production of final goods

Production of final non-tradable goods

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

$$Y_{N,t} \equiv A_{N,t} L_{N,t}, \tag{2.24}$$

where $A_{N,t}$ is a productivity shock common to producers of home non-tradable good and $L_{N,t}$ is homogenous labor used in the production of 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:

$$RP_{N,t} = \frac{w_{N,t}}{A_{N,t}}, \tag{2.25}$$

where $w_{N,t} \equiv \frac{W_{N,t}}{P_t}$ is 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 units of consumption basket. Foreign firms solve a similar problem.

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:

$$Y_{F,t} \equiv \left[\gamma^{\frac{1}{\epsilon}} (X_t)^{\frac{\epsilon-1}{\epsilon}} + (1-\gamma)^{\frac{1}{\epsilon}} (X_t^*)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{2.26}$$

where $Y_{F,t}$ is the amount of 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 good in the production of home final tradable good.

Baskets of home and foreign intermediate goods are defined as follows:

$$X_t \equiv \left[\left(\frac{1}{a}\right)^{\frac{1}{\theta}} \int_0^a (X_t(x))^{\frac{\theta-1}{\theta}} dx\right]^{\frac{\theta}{\theta-1}}, \tag{2.27}$$

$$X_t^* \equiv \left[\left(\frac{1}{1-a} \right)^{\frac{1}{\theta}} \int_a^1 \left(X_t^*(x^*) \right)^{\frac{\theta-1}{\theta}} dx^* \right]^{\frac{\theta}{\theta-1}}, \tag{2.28}$$

where $\theta > 1$ denotes the elasticity of substitution among intermediate goods and x and x^* denote home and foreign varieties of the 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 home and foreign baskets of intermediate goods and $p_t(x)$ and $p_t(x^*)$ are the prices of varieties x and x^*.

The representative firm's demands for baskets X and X^* are:

$$X_t = \gamma \left[\frac{P_{X,t}}{P_{F,t}} \right]^{-\epsilon} Y_{F,t}, \tag{2.29}$$

$$X_t^* = (1-\gamma) \left[\frac{P_{X^*,t}}{P_{F,t}} \right]^{-\epsilon} Y_{F,t} \tag{2.30}$$

and the demands for individual goods x and x^* by the representative firm are:

$$X_t(x) = \frac{1}{a}\left[\frac{p_t(x)}{P_{X,t}}\right]^{-\theta} X_t, \tag{2.31}$$

$$X_t^*(x^*) = \frac{1}{1-a}\left[\frac{p_t(x^*)}{P_{X^*,t}}\right]^{-\theta} X_t^*. \tag{2.32}$$

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

2.2.6 Goods and labor market clearing

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

$$\int_0^a Y_{N,t} dn = \int_0^a C_{N,t} dj + aG_t, \tag{2.33}$$

where G_t denotes per capita government purchases. Final tradable goods are consumed by home and foreign households:

$$\int_0^a Y_{F,t} df = \int_0^a C_{F,t} dj + \int_a^1 C_{F,t}^* dj^* \tag{2.34}$$

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

$$Y_{X,t}^x = \int_0^a X_t(x) df + \int_a^1 X_{*,t}(x) df^*. \tag{2.35}$$

Labor market clearing requires:

$$\int_0^a L_{N,t}dj + \int_0^a L_{X,t}dj = \int_0^a L_{N,t}dn + \int_0^a L_{X,t}dx. \tag{2.36}$$

2.2.7 Government

The government is not productive and public spending falls on 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 and the seigniorage revenue and is required to balance its budget in every period:

$$\int_0^a P_{N,t}G_t dn = \int_0^a P_t T_t^j dj + \int_0^a \left(M_t^j - M_{t-1}^j\right) dj. \tag{2.37}$$

The government conducts stabilization policy which is specified (in log-linear terms) as:

$$\widehat{g}_t = f_{GDP}\widehat{GDP}_t + \xi_t^g, \tag{2.38}$$

where $g_t = \frac{RP_{N,t}G_t}{GDP_t}$, f_{GDP} is the feedback parameter on the GDP gap with respect to the steady state, and ξ_t^g is an exogenous shock to fiscal policy. Hats denote percentage deviations from the steady state. The foreign fiscal policy is specified in a similar way.

2.2.8 Central bank and monetary policy

The purpose of this study is to investigate whether the new EU members can benefit from joining the monetary union. In order to do so, I analyze three monetary regimes: a flexible exchange rate regime, a fixed exchange rate regime and a monetary union. I evaluate benefits or costs of joining the monetary union by comparing the monetary union to the other two regimes. Both of the two regimes are relevant when studying the new EU members since these countries have gone through several monetary arrangements. Prior to joining the Exchange Rate Mechanism most of the Central and Eastern European countries let their exchange rate float. Some of them have already fixed their exchange rate to the euro and participate in the ERM. Eventually, they will join the monetary union.

Fixed exchange rate

In the case of a fixed exchange rate regime, the home central bank issues home nominal money and supports a fixed exchange rate.[9] This is in line with the requirement of the membership in the Exchange Rate Mechanism 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 which in log-linear terms equals:

$$\widehat{i}^*_{t+1} = m^*_i \widehat{i}^*_t + m^*_{CPI} \widehat{\pi}^*_t + m^*_{GDP} \widehat{GDP}^*_t + \xi^{*m}_t, \tag{2.39}$$

where m^*_i, m^*_{CPI}, and m^*_{GDP} are feedback parameters on the previous period interest rate,

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

CPI inflation and GDP gap, respectively, and ξ_t^{*m} is an exogenous shock to monetary policy. Hats denote percentage deviations from the steady state and the interest rate and the inflation rate are gross rates.

Flexible exchange rate

In the second scenario, both countries have a flexible exchange rate. The home central bank follows the following interest rate rule:

$$\widehat{i}_{t+1} = m_i \widehat{i}_t + m_{CPI} \widehat{\pi}_t + m_{GDP} \widehat{GDP}_t + m_\varepsilon \widehat{\varepsilon}_t + \xi_t^m. \tag{2.40}$$

This interest rate rule allows the home central bank to respond to movements in the nominal exchange rate. The foreign central bank again follows the rule in equation (2.39).

Monetary union

When the two countries constitute a monetary union, there is only one central bank which issues a single currency and conducts a single monetary policy. Its monetary policy is specified in terms of an interest rate rule that takes into account inflation and output of both countries:[10]

$$\widehat{i}_{t+1} = m_i^u \widehat{i}_t + m_{CPI}^u \left[a\widehat{\pi}_t + (1-a)\widehat{\pi}_t^*\right] + m_{GDP}^u \left[a\widehat{GDP}_t + (1-a)\widehat{GDP}_t^*\right] + \xi_t^u, \tag{2.41}$$

[10]The EMU targets a weighted average of the harmonized index of consumer prices, where the weights are each country's share of total consumption. I assume that the weights are the relative sizes of the two countries.

where u refers to the monetary union. In the case of the monetary union, the model described above differs in that consumers in both countries trade one international bond denominated in the single currency and prices in both countries are denominated in the single currency as well.

2.3 Solution and parameterization of the model

The model cannot be solved analytically. Thus I find the rational expectations equilibrium of the log-linearized approximation around the steady state.[11]

2.3.1 Parameterization

The benchmark calibration and the choice of parameter values is a s follows. The home economy in this model represents the new EU members and the foreign economy is designated to be the EMU.[12] Thus, the size of the home country relative to the foreign economy, a, is set to 5 percent.[13] 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 labor supply elasticity, ψ, is set to 2.5. I assume a logarithmic utility of the government consumption so that $\sigma_g = 1$.

The share of the home tradable consumption in the tradable consumption basket, ω, and the share of the home intermediate good in production of final tradable goods, γ, are

[11] I employ the technique by Uhlig (1999).
[12] The model is calibrated to the EMU and the Czech Republic's data.
[13] The new members' share of GDP in the EU total GDP is around 5 percent.

equal to a. The share of the tradable consumption in the consumption basket, φ, equals 55 percent as in Natalucci and Ravenna (2003).

The elasticity of substitution between the non-tradable and the tradable consumption, μ, is set to 0.5 as in Stockman and Tesar (1995) and the elasticity of substitution between the home and the foreign tradable good consumption, η, is set to 1.5. ϵ is the elasticity of substitution between the home and the 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 intermediate goods. I set $\theta = 6$ which is standard in the literature and implies a markup of 1.2.[14] The price adjustment cost parameter, κ, is set to 77, as estimated by Ireland (2001) for the US economy. All parameters for financial transaction costs are set to 0.01, which is standard in the literature.

I first solve the model for historic fiscal and monetary policies. The steady state share of the government purchases in GDP is calibrated to 18 percent. According to the data, fiscal instruments follow an AR(1) process.[15] The foreign monetary policy parameters for the EMU 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 use the same parameters when I consider the case of a monetary union. There are no estimates of interest rate rules for the new EU members. In the case of a flexible exchange rate regime in the home economy I set m_i and m_{GDP} as in the foreign economy, m_{CPI} equals to 2 and m_ϵ is set to 0.5.

[14]Martins et al. (1996) estimate the average markup for manufacturing sector at 1.2 for the OECD countries. In the absence of an estimate for central and Eastern European countries I use their markup estimate.

[15]See Chapter 1 for details on historic fiscal policies.

2.4 The effects and transmission of shocks under different monetary regimes

To understand the model's transmission mechanism and the implications of different monetary regimes, I first present the impulse responses of macroeconomic variables to a monetary shock and a technology shock.[16] I choose to analyze the impulse responses of the variables in both economies to the foreign shocks because shocks originating the home economy almost do not affect the large country.

2.4.1 Foreign monetary shock

Figures 2.1 and 2.2 present impulse responses to a one-percent increase in the foreign monetary shock[17] which increases the foreign nominal interest rate. Solid lines represent the impulse responses under a flexible exchange rate and dashed lines correspond to a fixed exchange rate arrangement in the home economy. The foreign variables respond to the foreign monetary shock almost identically regardless of the monetary regime in the home economy. This happens because the foreign central bank implements a Taylor type interest rate rule regardless of the monetary policy in the home country and because the home economy is relatively small.

A positive foreign monetary shock increases the foreign nominal interest rate (not shown) and the foreign real interest rate (which is in units of foreign consumption basket). Con-

[16] In Chapter 1 I analyze fiscal shocks in a similar model.
[17] The monetary shock is an iid shock.

sequently, the foreign private consumption falls. The foreign country is relatively closed[18] so that dynamics of the foreign GDP follow the dynamics of the foreign consumption. The foreign CPI inflation decreases. The fall in the foreign consumption is due to a decrease in the foreign tradable consumption while the foreign non-tradable consumption increases. A lower demand for the foreign tradable goods reduces the production of the foreign final and intermediate tradable goods and a higher demand for the non-tradable goods increases the production of these goods.

In the case of a fixed exchange rate regime in the home economy, the real exchange rate appreciates in the foreign economy which looses competitiveness. Since the home economy has significant trade linkages with the foreign economy, the spillover effects are contractionary on the home consumption and GDP. The effects of the foreign monetary shock are qualitatively similar in the home economy as they are in the foreign country. The real interest rate (in units of home consumption basket) increases and the CPI inflation rate decreases. The home households borrow from abroad.

When the exchange rate is flexible in the home economy, the home real interest rate increases by less in response to the foreign monetary shock. Consequently, the fall in the home consumption is less pronounced. The home currency depreciates (not shown) and the home CPI inflation responds much less to the shock compared to the fixed exchange rate regime. The response of the real exchange rate is also smaller.

The third monetary regime that I consider is a monetary union between the two countries. I assume that a single central bank conducts its monetary policy by responding to a

[18]I only model trade linkages of the foreign economy with the small, home economy and abstract from the rest of the world.

weighted average of the CPI inflation and GDP where the weights are the relative sizes of the economies. In this case, the variables (not shown) in both countries respond similarly to the monetary shock as they do under a fixed exchange rate regime in the home economy.

2.4.2 Foreign technology shock

Figures 2.3 and 2.4 present impulse responses to a one-percent increase in the foreign intermediate sector productivity. Again, I show the impulse responses for a flexible exchange rate regime (solid line) and a fixed exchange rate regime in the home economy (dashed line).

A positive productivity shock in the foreign intermediate sector increases the output of the foreign intermediate goods, reduces the labor supply, and increases the wage rate in this sector. The increase in the productivity dominates the effect of higher wages so that the marginal costs decrease. As a consequence, the relative price of the foreign intermediate goods falls. The markup increases 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 and also to the home economy. The shock directly transmits to the foreign final tradable goods firms, which use intermediate goods in their production. They enjoy lower foreign input prices and therefore expand the production of the final tradable goods. The relative prices of the foreign final tradable goods decrease and the quantity demanded by home and foreign households increases. The foreign households also demand more non-tradable goods which increases the 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 to the home economy. Under a fixed exchange rate regime, the home final tradable sector expands for the same reason as the foreign final tradable sector (the foreign inputs have a higher weight in the production of the final tradable goods) and the home relative price of the final tradable goods decreases. There is an initial boom in the home intermediate sector coming from a higher home and foreign demand because both, the home and the foreign inputs are required in the production of the final tradable goods. After the initial positive effect on the home intermediate sector, the demand for the home inputs decreases (prices are higher at home). The labor dynamics at home follow the output dynamics in the home intermediate sector. A higher demand for inputs initially results in a 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, the home non-tradable output declines but once the positive effect in the intermediate sector is reversed, the 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 the home and the foreign GDP and private consumptions expand. The foreign CPI inflation almost does not responds due to the opposite dynamics of prices of tradable and non-tradable goods, while the 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). The home households accumulate foreign bonds because the shock results in a higher expansion in the home country.

As in the case of the foreign monetary shock, the home real interest rate (not shown)

responds much less to the shock under a flexible exchange rate regime. The home currency appreciates (not shown) and the home CPI inflation responds much less to the shock compared to the fixed exchange rate regime. The response of the real exchange rate is also smaller. When the two countries constitute a monetary union, both countries' variables (not shown) behave similarly as under a fixed exchange rate regime in the home economy.

2.4.3 Dynamic properties of the model and the volatility of macroeconomic variables under different monetary regimes

In this section I investigate how the model behaves when the two economies are hit by all shocks considered. In order to do so I make some assumption about the stochastic processes. Productivity, preference and fiscal shocks follow AR(1) processes. I set the persistence parameters of all productivity shocks to 0.9. The 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 persistence parameters of the preference shocks, the labor disutility shocks, the shocks to shifts in preferences between the non-tradable and the tradable goods, and the fiscal shocks are set to 0.7, 0.9, 0.9 and 0.9, respectively. The monetary shocks are iid processes. I choose the standard deviations of the shocks to match some of the moments of the macroeconomic variables given historic monetary and fiscal policies and the baseline parameter values.[19] The details on the stochastic processes are in Table 2.2.

The second moments of the model and the values from the data are presented in Table

[19]Moments are matched for a fixed exchange rate regime in the home country.

2.3. The model generates almost twice as much variability in GDP in the new EU members compared to the Euro Area and the absolute values of standard deviations are consistent with the variability in the 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, the government expenditure is more volatile in the model. The CPI inflation rate is more volatile and the nominal interest rate is 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 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, historic moments are based on a monetary regime that is not a fixed exchange rate regime.

For the Euro Area, the inflation and the interest rates are less variable in the model because of the assumption of an inflation-targeting regime, which is similar to the model properties of Laxton and Pesenti (2003). While data suggest less variability of the GDP components than that of the GDP for the Euro Area, the model generates about the same volatility for each of them.[20]

Before discussing the optimal policy rules I analyze the volatility of some variables given the calibrated model and historic policy rules for three different monetary regimes in the home economy. Table 2.4 presents the standard deviations of the GDP, the CPI inflation rate, the real interest rate, the real exchange rate, and the nominal interest rate. The numbers reflect some of the findings that were evident from the impulse responses. The

[20]A more detailed explanation of the model properties may be found in Chapter 1. However, keep in mind that the model in this Chapter and the model in Chapter 1 are not the same.

fixed exchange rate regime amplifies output and inflation volatility relative to the flexible exchange rate. This result is similar to Gali and Monacelli (forthcoming) while Devereux (2002) obtains a similar result for output volatility but not inflation volatility. The real exchange rate is more volatile under the fixed exchange rate regime, which is contrary to Gali and Monacelli (forthcoming) and Devereux (2002). When the two countries constitute a monetary union, home variables behave similarly as they do under a fixed exchange rate regime but are less volatile when compared to the fixed exchange rate regime.

I perform some sensitivity analysis with respect to the choice of the parameter values in the home interest rate rule under the flexible exchange rate regime in the home economy. The analysis confirms the findings from the benchmark calibration. The flexible exchange rate regime still produces the lowest volatility of the home variables. The same holds when I allow for endogenous fiscal policy and when I increase the relative size of the home economy. The volatility ranking is preserved for a value of 400 for κ, which measures price rigidity.[21]

2.5 Design of monetary and fiscal policies

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 basis for empirical evaluation of the underlying model.

In this section I turn to the optimal monetary and fiscal policies[22] and analyze how

[21] Laxton and Pesenti (2003) set the parameter which measures price stickiness to 400 for the Czech Republic.

[22] Due to the structure of the model, I cannot solve for fully optimal policies. In what follows, optimal policy

different monetary regimes in the new EU members perform in welfare terms. I assume that policymakers choose stabilization policy, i.e. 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. I use numeric optimization to solve for the optimal policies. The welfare function is derived as a second-order Taylor approximation to the utility function and can be expressed, after omitting irrelevant terms, in each period t as:[23]

$$W_t = -\frac{1}{2}\sigma\overline{C}^{1-\sigma}var(\widehat{C}_t) - \frac{1}{2}\psi\overline{L}^{1+\psi}var(\widehat{L}_t) - \frac{1}{2}\sigma_g\overline{G}^{1-\sigma_g}var(\widehat{G}_t), \tag{2.42}$$

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

The definitions of the strategic games among policymakers are as follows. Under a fixed exchange rate regime in the home country the home government, the foreign government and the foreign central bank choose their feedback parameters in a non-cooperative fashion. The home government chooses its feedback parameter to maximize home households' welfare and the foreign government and central bank choose (in a non-cooperative way) their feedback parameters to maximize foreign households' welfare. The home central bank supports the fixed exchange rate.

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refers to optimal policy within the class of rules specified in the model. Gali and Monacelli (forthcoming) show in a simpler model than mine that domestic inflation targeting is optimal for a small open economy but the welfare losses associated with the CPI inflation targeting and an exchange rate peg are small. Benigno (2003) shows that targeting a weighted average of the harmonized index of consumer prices is optimal in a currency union if the two regions have the same degree of nominal rigidities. I assume the same degree of nominal rigidities. Finally, Beetsma and Jensen (2002) show that a class of fiscal rules which I use perform well in their model. However, one should be cautious since my model differs significantly from the models mentioned above.

[23] I assume that real money balances do not matter for welfare as common in the literature.

Under a flexible exchange rate regime in the home country there are four players and they all choose their feedback parameters in a non-cooperative way. Again, the home policymakers maximize home households' welfare and the foreign policymakers maximize foreign households' welfare. When the two countries constitute a monetary union, there are two governments and only one single central bank. The three players again choose their feedback parameters in a non-cooperative fashion. The home government maximizes home and the foreign government maximizes foreign welfare. However, the single central bank chooses its policy parameters to maximize a joint welfare function. I assume that the joint welfare function is a weighted average of the home and the foreign welfare and that the weights correspond to the relative sizes of the countries. In each case all policymakers act simultaneously.

2.5.1 Optimal monetary and fiscal policies

Table 2.1 presents optimal monetary and fiscal reaction coefficients to GDP gap, CPI inflation, and the nominal exchange rate and the associated welfare losses for the three monetary arrangements in the home economy.

Result 2.1 *Optimal monetary and fiscal policies are countercyclical.*

Under a fixed and a flexible exchange rate regime in the home economy it is optimal for the foreign central bank and government to respond strongly to the output gap and this is consistent with a less aggressive home fiscal policy under a fixed exchange rate regime and less aggressive home monetary and fiscal policies under a flexible exchange rate regime. The

Table 2.1: Optimal Feedback Paramaters and the Associated Welfare Losses

Fixed Exchange Rate		Flexible Exchange Rate		Monetary Union	
f^*_{GDP}	-8.36	f^*_{GDP}	-8.06	f^*_{GDP}	-1.56
m^*_{CPI}	2.26	m^*_{CPI}	2.34	m^u_{CPI}	8.36
m^*_{GDP}	30.5	m^*_{GDP}	30.0	m^u_{GDP}	28.9
f_{GDP}	-4.11	f_{GDP}	-2.80	f_{GDP}	-2.10
		m_{CPI}	1.82		
		m_{GDP}	4.45		
		m_{ε}	0.03		
L	23.74	L	9.59	L	17.08
L^*	1.28	L^*	1.26	L^*	1.38

home country benefits from stabilization policy of the foreign country because it is a small open economy with strong trade links to the foreign country. When foreign policymakers stabilize their own economy they also reduce the volatility in the home country.

In the case of a monetary union, a single central bank responds strongly to the weighted average of the output gaps as well as the CPI inflation rates and the foreign government responds much less to foreign output gap compared to the cases with a sovereign foreign central bank. Even though it is optimal that the central bank takes on a larger stabilization role than the governments, there is a role for fiscal stabilization in the monetary union. This result and the magnitude of the fiscal parameters are in line with Beetsma and Jensen (2002) who augment the model of Benigno (2004) with fiscal policy.[24]

Result 2.2 *Comparing fixed and flexible exchange rate regimes.*

Foreign monetary and fiscal policies are almost the same regardless of the monetary regime in the home economy (either a fixed or a flexible exchange rate regime). This is true because I assume that foreign fiscal and monetary policy are specified in the same way in

[24]When considering simple policy rules based on output gaps as opposed to consumption gaps, Beetsma and Jensen (2002) take the monetary policy as constant.

both cases and because the home economy is too small to significantly affect the variables in the larger foreign economy.

The response of the home government under a fixed exchange rate regime is stronger compared to a flexible exchange rate arrangement since in this case the home government is the only policymaker who directly stabilizes the home economy. Under a flexible exchange rate regime the home central bank takes on a larger role in stabilizing home output gap. It is interesting to notice that there is almost no need for the home central bank to respond to the nominal exchange rate, i.e. the nominal exchange rate stabilization is not important in this setup. In welfare terms, a flexible exchange rate regime dominates a fixed exchange rate regime.

The results in this Chapter are consistent with the other studies in the literature which use a similar framework. Devereux (2002) and Natalucci and Ravenna (2002) find that based on a volatility criterion flexible exchange rates are preferable to a fixed exchange rate regime in the new EU members. Gali and Monacelli (forthcoming) and Devereux et al. (2004) conduct welfare analysis and conclude that a flexible exchange rate is always superior to a fixed exchange rate regime. The same can be inferred from Ghironi and Rebucci (2003) who find that a Taylor rule is preferred to a currency board (a policy rule that implements a fixed exchange rate is consistent with the currency board).

Result 2.3 *The welfare-based ranking of the monetary regimes in the home country is as follows: Home households prefer a flexible exchange rate regime to a monetary union and a monetary union to a fixed exchange rate regime.*

Flexible exchange rate vs. fixed exchange rate: A flexible exchange rate regime is

preferred to a fixed exchange rate regime because under a fixed exchange rate regime there is no home monetary policy available to stabilize the home country. Thus, home private consumption, home labor effort, and home government consumption are less volatile under a flexible exchange rate regime. Home welfare is thus higher when the home central bank has a stabilization role as opposed to supporting a fixed exchange rate.

Monetary union vs. fixed exchange rate: The single central bank pursues its monetary policy in a way that takes into account both countries. Therefore, the home country benefits from the single central bank's stabilization while there is no stabilization role for the home central bank when it supports a fixed exchange rate. As under a flexible exchange rate regime, home private consumption, labor effort, and government purchases are less volatile in a monetary union than under a fixed exchange rate regime. Home households' welfare is thus higher in a monetary union.

Flexible exchange rate vs. monetary union: Under a flexible exchange rate regime the home central bank directly stabilizes the home economy while in a monetary union a single central bank takes into account a weighted average of both counties' inflation rates and output. Thus, shocks that affect the home economy are best absorbed when the home country has a sovereign monetary policy. All variables that enter the utility function are less volatile under a flexible exchange rate regime compared to a monetary union and home welfare is higher under a flexible exchange rate regime.

Result 2.4 *Foreign households prefer a flexible exchange rate regime to a monetary union.*

I only consider two monetary regimes for the foreign economy, a flexible exchange rate

regime and a monetary union with the home economy. The choice of a fixed or a flexible exchange rate regime in the home country has a very limited effect on the larger foreign economy. However, foreign households prefer the case in which the home economy has a flexible exchange rate regime. In a flexible exchange rate regime, most of the home economy's variables are less volatile and even though the spillover effects on the foreign economy are very small, the larger foreign economy enjoys some benefits from a flexible exchange rate in the home country.

Foreign private consumption is less volatile under a flexible exchange rate regime in the foreign economy than in a monetary union. Foreign labor effort and government purchases are more volatile under a flexible exchange rate but the effect of foreign private consumption dominates and thus foreign welfare is higher under a flexible exchange rate regime.

Result 2.5 *Benefits from a monetary union.*

Even though the results show that a monetary union between the home and the foreign country is not desirable when compared to a flexible exchange rate regime, there are some benefits brought by a monetary union. The home as well as the foreign CPI inflation rates are least volatile in a monetary union. The single central bank is thus more successful in stabilizing inflation than national monetary policies. At the same time, the nominal interest rates and the fiscal instruments $\left(g_t = \frac{RP_{N,t}G_t}{GDP_t}\right)$ are also less volatile in the monetary union.

2.5.2 Sensitivity analysis

I conduct a sensitivity analysis with respect to the weights in the single central bank's joint welfare function in a monetary union. In the benchmark parameterization I assume

that the weights correspond to the relative sizes of the economies. Here instead, I set the weights to be equal to one half for both countries. The qualitative results stay the same and the ranking of the monetary regimes does not change. It is interesting to note, but not surprising, that the welfare of home households increases and welfare of the foreign households decreases compared to the case where the weights in the joint welfare function equal to the relative sizes of the countries.

2.6 Conclusions

In this Chapter I investigate whether Central and Eastern European countries (new EU members) can benefit from joining the EMU. I build a two-country model which is tailored to mimic the new EU members and the euro currency area and compare households' welfare under three different monetary regimes in the new EU countries: a fixed exchange rate regime, a flexible exchange rate regime and a monetary union. I find that welfare is highest under a flexible exchange rate regime followed by a monetary union and a fixed exchange rate regime.

The results I presented in this Chapter are conditional on the model specification I used. It should be noticed that there are several benefits that a monetary union can offer but I do not take into account or they are not reflected in the welfare function. One example are long-run benefits from greater trade integration which may dominate the costs of loosing monetary sovereignty. It would thus be of interest to take into account more dimensions of costs and benefits of joining a monetary union. I leave this issue open for future research.

Appendix to Chapter 2

Foreign household j^*'s budget constraint is:

$$
\begin{aligned}
&M_t^{j^*} + B_{*,t+1}^{*,j^*} + P_t^* \frac{\xi_{B^*}^*}{2} \left(\frac{B_{*,t+1}^{*,j^*}}{P_t^*} \right)^2 + \int_a^1 V_t^{x^*} S_{*,t+1}^{x^*,j^*} dx^* + \int_0^a \frac{V_t^x}{\varepsilon_t} S_{*,t+1}^{x,j^*} dx + P_t^* C_t^{j^*} \\
&\leq M_{t-1}^{j^*} + (1 + i_t^*) B_{*,t}^{*,j^*} + \int_a^1 \left(D_t^{x^*} + V_t^{x^*} \right) S_{*,t}^{x^*,j^*} dx^* + \qquad \text{(A2-1)} \\
&\left(W_{N,t}^* L_{N,t}^{j^*} + W_{X,t}^* L_{X,t}^{j^*} \right) - P_t^* T_t^{j^*} + P_t^* TCT_t^{j^*} + \int_0^a \frac{(D_t^x + V_t^x)}{\varepsilon_t} S_{*,t}^{x,j^*} dx.
\end{aligned}
$$

As opposed to home households, foreign consumers buy and trade 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.

Table 2.2: 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	0.0032	-	-

Table 2.3: Macroeconomic Variability of the Czech Republic and the Euro Area

	Czech Republic		Euro Area	
	Model	Historic	Model	Historic
Standard deviation (%)				
Real GDP	1.98	2.0*	1.01	1.0*
Consumption	2.72	2.29	1.02	0.8*
Government Expenditure	6.02	2.6*	1.09	0.6*
CPI Inflation	2.55	1.08	0.26	0.56
Short-Term Interest Rate	0.37	0.47	0.36	0.98
Employment	0.91	-	0.63	1.16
Real Exchange Rate	3.24	3.1	-	-

Note: The model's variables are detrended with HP filter. Estimates of historic standard deviations that are taken from Laxton and Pesenti (2003) are marked by a star. The rest of estimates for the Czech Republic are taken from Natalucci and Ravenna (2003) and for the Euro Area they are taken from Fagan et al. (2001). Data in Laxton and Pesenti (2003) are detrended with 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. Time span for the Czech Republic is 1994Q1 to 2003Q1. In Fagan et al. (forthcoming), variables are

expressed in per capita terms and logged (except for inflation and interest rates). They are seasonally adjusted and HP filtered.

Table 2.4: Volatility of Selected Home Variables under Different Monetary Regimes

	Fixed Ex. Rate	Flexible Ex. Rate	Monetary Union
Standard deviation (%)			
GDP	1.986	1.917	1.978
CPI Inflation	2.556	0.625	2.439
Real Interest Rate	2.604	0.385	2.472
Real Exchange Rate	3.246	2.948	3.222
Nominal Interest Rate	0.373	0.549	0.355

Figure 2.1: Impulse Responses of Foreign Variables to Foreign Monetary Shock

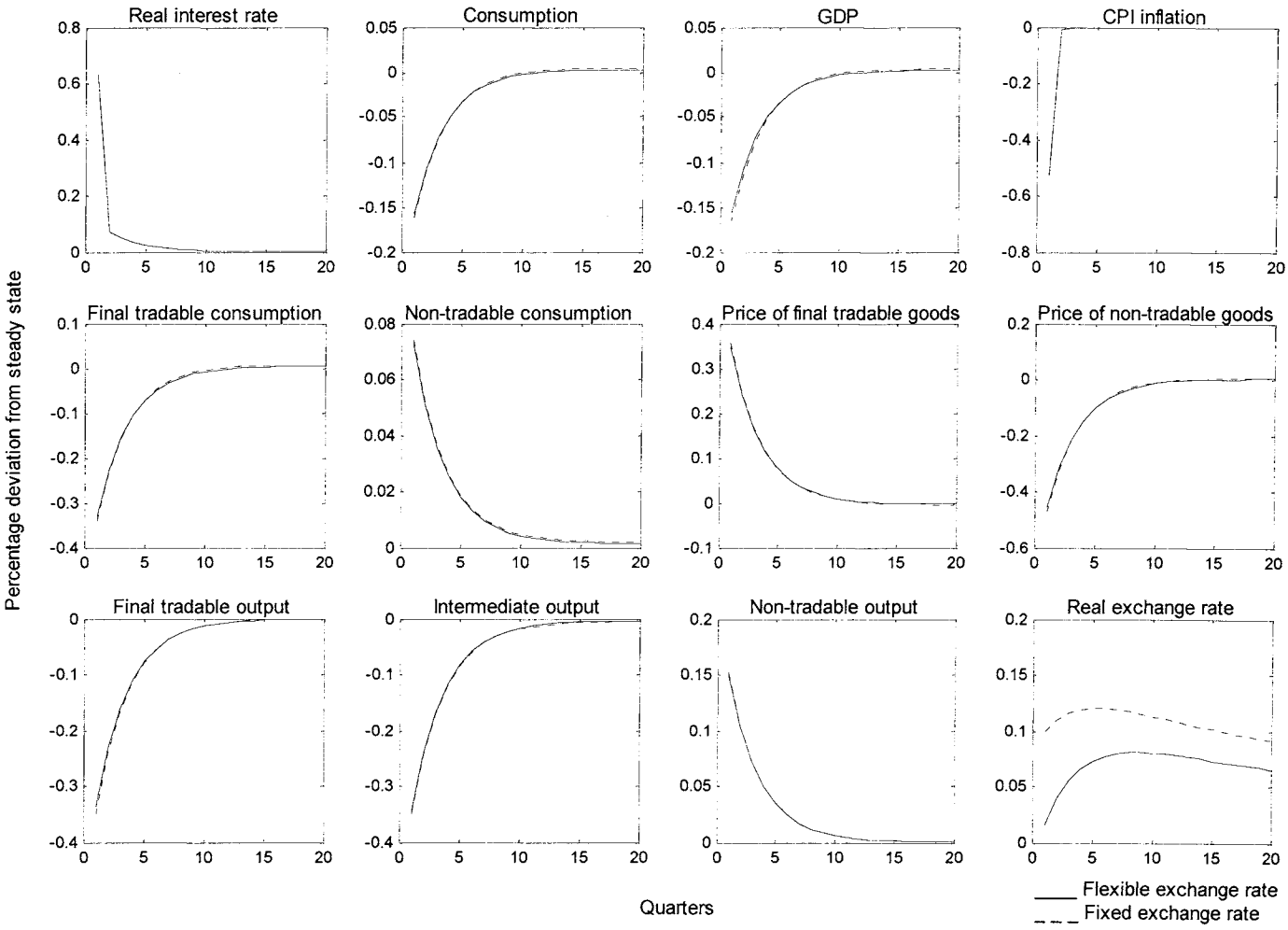


Figure 2.2: Impulse Responses of Home Variables to Foreign Monetary Shock

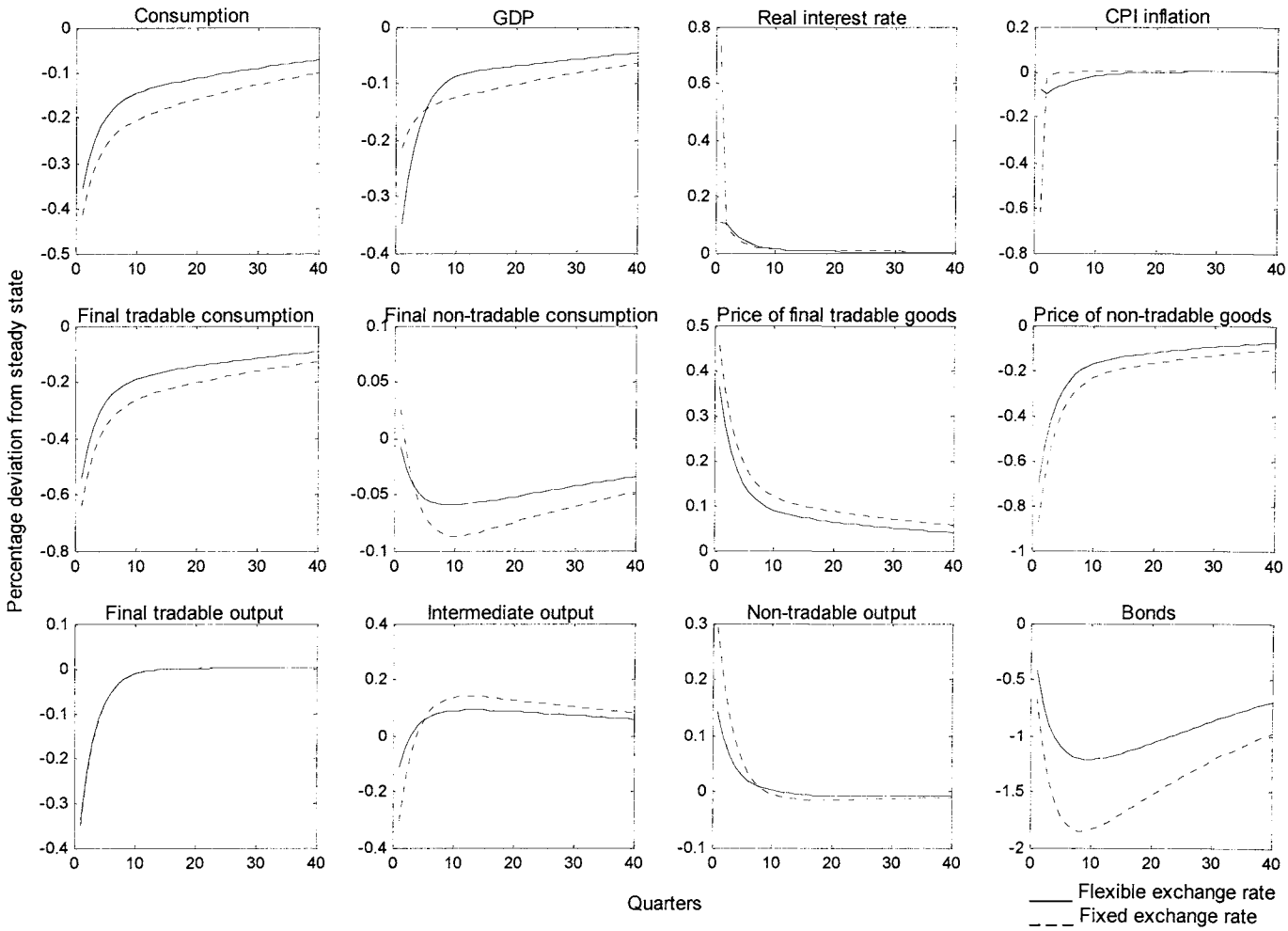


Figure 2.3: Impulse Responses of Foreign Variables to Foreign Intermediate Technology Shock

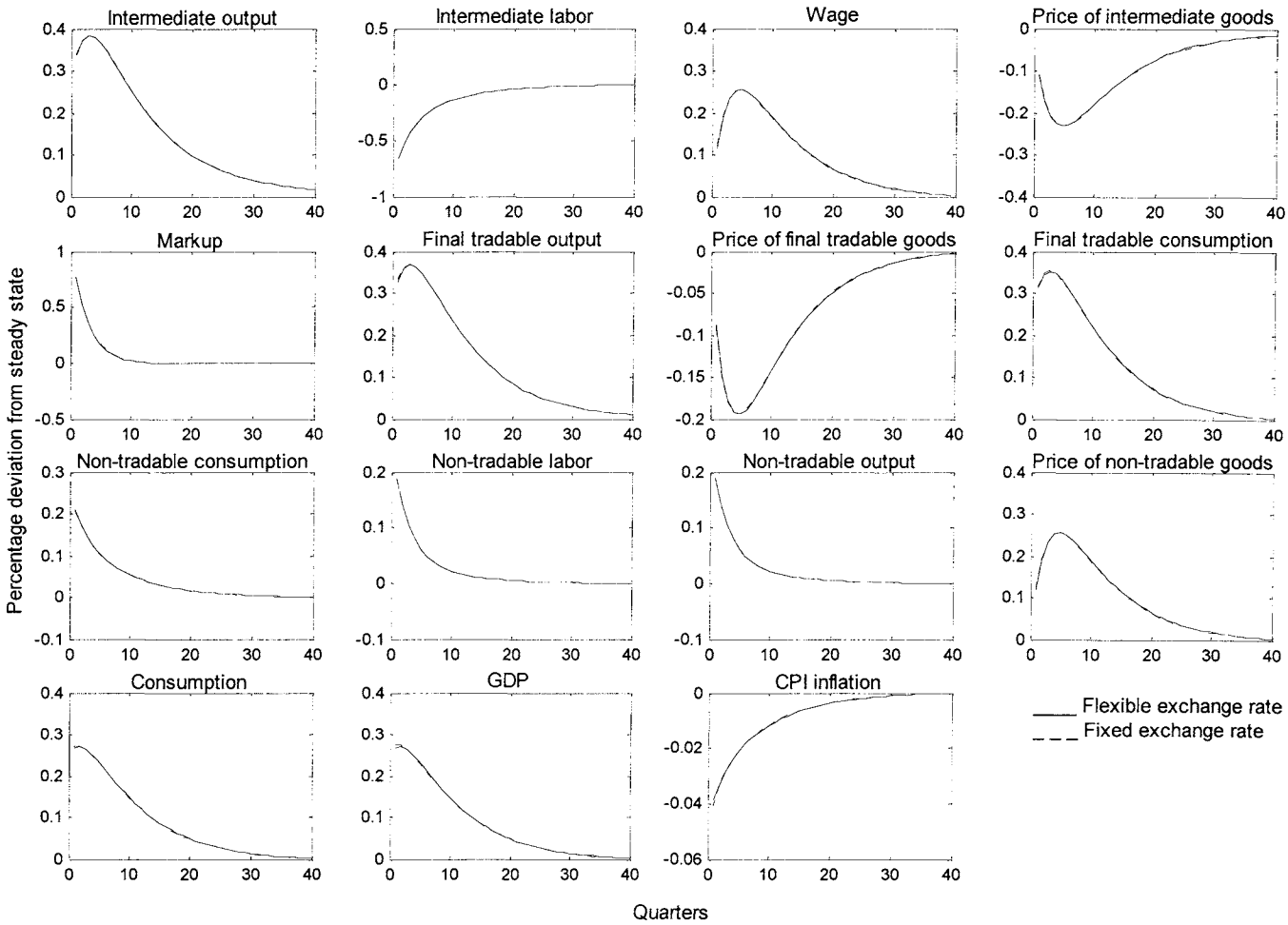
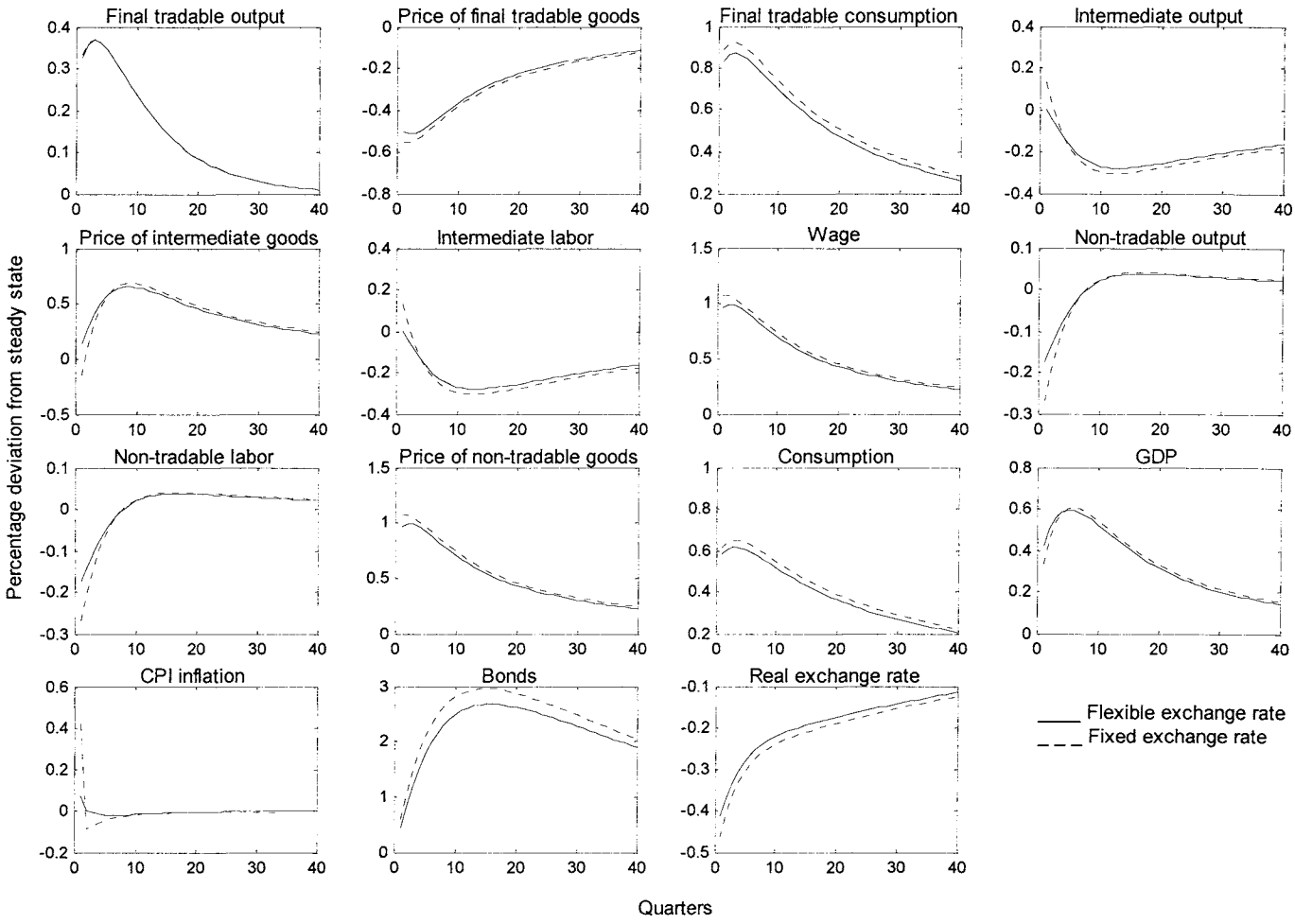


Figure 2.4: Impulse Responses of Home Variables to Foreign Intermediate Technology Shock



Chapter 3

Fiscal Policy Cooperation in the EMU

3.1 Introduction

Many studies have analyzed the need for fiscal policy cooperation in a monetary union. This literature has been inspired by the idea and later the launch of a single currency shared by some European Union (EU) members. However, the literature usually addresses the issue of fiscal policy cooperation given a simple model in which countries are arbitrary. In this Chapter I investigate whether there are welfare gains from fiscal policy cooperation in the European Economic and Monetary Union (EMU) given a model that better incorporates the features of current as well as future EMU members.

Even though the new EU members do not yet participate in the monetary union they will have to join it once they have met the entry criteria. I thus choose to analyze the need

for fiscal policy cooperation between the following two groups of countries in the EMU, the current euro area and the new EU members which will join the EMU in the near future.

I build a two-country model where the larger (foreign) country represents current EMU members (incumbents) and the smaller (home) economy represents the countries that will join the EMU in the near future. I assume that the two countries constitute a monetary union. Each country has a government but they share a single central bank. The three policymakers conduct stabilization policy by use of policy rules. When governments cooperate on fiscal policies, each government chooses the response parameter in its policy rule to maximize the unconditional expectation of a weighted average of home and foreign households' utility (joint welfare), taking the behavior of the central bank as given. The central bank chooses its response parameters to maximize the unconditional expectation of the joint welfare, taking the behavior of the governments as given. In a non-cooperative game, the central bank still maximizes the joint welfare (since the two countries constitute a monetary union) and the governments maximize its own households' welfare. Each player takes the actions of the other two players as given and all players act simultaneously.

The results show that the foreign economy is better off when the governments cooperate their fiscal policies while the home country is indifferent between the two equilibria. This result differs from Dixit and Lambertini (2001, 2003) and Eichengreen and Ghironi (2002) who show that there is no need for fiscal cooperation in a monetary union when all policymakers agree on their goals.[1] The result also differs from the results in Chapter 1. There I assume that the two countries each have a national central bank and both countries

[1] In my model all policymakers maximize the same objective function (joint welfare) when the governments cooperate. This follows by construction of the model.

are better off when the governments do not cooperate. However, my conclusions in this paper resemble Lombardo and Sutherland (2003) who show that fiscal policy cooperation is beneficial if also monetary policies are set cooperatively.[2]

The rest of the Chapter is organized as follows. Section 2 outlines a two-country model of the EMU. In section 3 I describe the solution method and the selection of parameters. In Section 4 I present the transmission mechanism and the dynamic properties of the model. I explain the results about fiscal policy cooperation is Section 5. Section 6 concludes.

3.2 A general equilibrium model of the European Union

3.2.1 Overview of the economic environment

The model builds on the model from Chapter 1. However, in this paper I assume that the new EU members from Central and Eastern Europe participate in the monetary union. While this is currently not the case, the new EU members will have to join the EMU. The model mimics in particular the structure of the new EU members. First, it incorporates the presence of foreign ownership of the firms in Central and Eastern Europe which has arisen as a consequence of foreign financing of caching up with the rest of the EU. This feature was first introduced in Chapter 1. Second, intermediate goods represent a substantial part of imports of these countries and contribute to the dynamics of macroeconomic variables. Third, domestic tradable goods are exported and consumed by domestic households. Fourth, non-tradable sector is important and most of the government purchases are

[2]More related studies can be found in Chapter 1.

on non-tradable goods. Taking all of the above into consideration provides more flexibility to match the data and more realistic interdependencies between Central and Eastern European countries and the incumbent EU members.

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 the incumbent EU members and the home country represents an aggregate of the new members of the EU. In each country there are households, firms, and a fiscal authority (government). The two countries constitute a monetary union and have a single central bank. Foreign variables are indexed by a star.

Households in both countries are infinitely lived and have preferences over consumption, real money balances, 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 the sectors within a country. Labor market is perfectly competitive and labor is immobile internationally. Households trade a short-term nominal bond which is denominated in the single currency.

The ownership structure of the firms and the equity share trade is as follows: in all the 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 foreign households who trade home and foreign equity shares and receive dividends

from home and foreign intermediate sector firms.[3]

Each country produces three types of goods: final non-tradable goods, final tradable goods and a continuum of differentiated intermediate tradable goods. Final non-tradable goods are produced by perfectly competitive firms using domestic labor as input. Final non-tradable goods 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 production of each intermediate good is domestic labor. The intermediate goods are used in the production of the final tradable good. In the intermediate sector, there are nominal rigidities in the form of a quadratic cost of price adjustment.

Government conducts stabilization fiscal policy. Government spending falls on the final non-tradable good and is financed through lump-sum tax revenues and seigniorage. The single central bank conducts monetary policy by employing an interest rate rule.

3.2.2 Households and their trading opportunities

Utility function

Home consumer j's utility function has the following form:

[3]The sector that is exclusively foreign-owned is only one out of three sectors. This assumption is thus not an extreme assumption about the extent of foreign presence.

$$U_t^j \equiv E_t \sum_{i=0}^{\infty} \beta^i \left[A_{C,t} \frac{\left(C_{t+i}^j\right)^{1-\sigma}}{1-\sigma} + \frac{\left(G_{t+i}^j\right)^{1-\sigma_g}}{1-\sigma_g} + \chi \frac{\left(\frac{M_{t+i}^j}{P_{t+i}}\right)^{1-\phi}}{1-\phi} - A_{L,t} \frac{\left(L_{t+i}^j\right)^{1+\psi}}{1+\psi} \right], \quad (3.1)$$

where labor supply equals $L_t = L_{N,t} + L_{X,t}$, and labor is homogenous and perfectly mobile between the sectors within the country, C_t is the consumption basket, P_t is 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 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 $j^* \in [a, 1]$.

Intra-temporal allocation of consumption

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

$$C_t^j \equiv \left[(1-\varphi_t)^{\frac{1}{\mu}} \left(C_{N,t}^j\right)^{\frac{\mu-1}{\mu}} + (\varphi_t)^{\frac{1}{\mu}} \left(C_{T,t}^j\right)^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}, \quad (3.2)$$

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, 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.

Consumption index of tradable goods is defined as:

$$C_{T,t}^j \equiv \left[\omega^{\frac{1}{\eta}} \left(C_{F,t}^j\right)^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} \left(C_{F^*,t}^j\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{3.3}$$

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 good consumption. C_F^j and $C_{F^*}^j$ are baskets of home and foreign final tradable goods also produced by perfectly competitive firms.

The definitions of 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 demands for baskets C_T^j and C_N^j are:

$$C_{T,t}^j = \varphi_t \left[\frac{P_{T,t}}{P_t}\right]^{-\mu} C_t^j, \tag{3.4}$$

$$C^j_{N,t} = (1-\varphi_t)\left[\frac{P_{N,t}}{P_t}\right]^{-\mu} C^j_t, \tag{3.5}$$

and the demands for home and foreign baskets of final tradable goods are:

$$C^j_{F,t} = \omega\left[\frac{P_{F,t}}{P_{T,t}}\right]^{-\eta} C^j_{T,t}, \tag{3.6}$$

$$C^j_{F^*,t} = (1-\omega)\left[\frac{P_{F^*,t}}{P_{T,t}}\right]^{-\eta} C^j_{T,t}. \tag{3.7}$$

Foreign households solve a similar problem.

Inter-temporal optimization

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

$$\begin{aligned} & M^j_t + B^j_{t+1} + P_t\frac{\xi_B}{2}\left(\frac{B^j_{t+1}}{P_t}\right)^2 + P_t C^j_t + P_t T^j_t \\ \leq\ & M^j_{t-1} + (1+i_t)B^j_t + W_{N,t}L^j_{N,t} + W_{X,t}L^j_{X,t} + P_t TCT^j_t. \end{aligned} \tag{3.8}$$

Home household j consumes, C^j_t, pays net lump-sum taxes, T^j_t, and receives wage income. Household j holds money, M^j_t, and a bond, B, denominated in the single currency, where B^j_{t+1} is the stock of bonds held by household j entering period $t+1$. The short-term nominal interest rates i_t is paid at the beginning of period t and is known at time $t-1$. There are

intermediation costs for households entering the international bond market.[4]. The revenue from the intermediation is rebated to the home consumers as a lump-sum transaction cost transfer, TCT_t^j.[5] In equilibrium, the rebate equals $TCT_t^j = \frac{\xi_B}{2}\left(\frac{B_{t+1}^j}{P_t}\right)^2$.

Each household chooses labor supply, bond and money holdings, and consumption path to maximize expected utility (3.1) subject to the budget constraint (3.8). The first order conditions with respect to labor are:

$$w_{N,t} = w_{X,t} = \frac{A_{L,t}\left(L_t^j\right)^{\psi}}{A_{C,t}\left(C_t^j\right)^{-\sigma}}, \tag{3.9}$$

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 bond holdings are:

$$A_{C,t}\left(C_t^j\right)^{-\sigma}\left[1+\xi_B\left(\frac{B_{t+1}^j}{P_t}\right)\right] = \beta\left(1+i_{t+1}\right)E_t\left[\frac{P_t}{P_{t+1}}A_{C,t+1}\left(C_{t+1}^j\right)^{-\sigma}\right]. \tag{3.10}$$

Unlike home households, foreign households 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:

$$A_{C,t}^*\left(C_t^{j^*}\right)^{-\sigma} = \beta E_t\left[\frac{P_t^*}{P_{t+1}^*}\frac{\left(D_{t+1}^{x^*}+V_{t+1}^{x^*}\right)}{V_t^{x^*}}A_{C,t+1}^*\left(C_{t+1}^{j^*}\right)^{-\sigma}\right], \tag{3.11}$$

[4]The intermediation costs are introduced to guarantee that 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.

[5]I assume that intermediaries are perfectly competitive and owned by local households.

$$A^*_{C,t}\left(C^{j^*}_t\right)^{-\sigma} = \beta E_t\left[\frac{P^*_t}{P^*_{t+1}}\frac{\left(D^x_{t+1}+V^x_{t+1}\right)}{V^x_t}A^*_{C,t+1}\left(C^{j^*}_{t+1}\right)^{-\sigma}\right], \tag{3.12}$$

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

3.2.3 Asset market clearing

In equilibrium, households and firms are symmetric so that $B^j_{t+1} = B_{t+1}$, $B^{*,j^*}_{t+1} = B^*_{t+1}$ 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 equity share holdings of foreign household j^* in home firm x and S^{x^*,j^*}_* are equity share holdings of foreign household j^* in foreign firm x^*. Market clearing conditions for the home and foreign bond are:

$$\int_0^a B_{t+1}dj + \int_a^1 B^*_{t+1}dj^* = 0. \tag{3.13}$$

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

$$\int_a^1 S_{*,t+1}dj^* = \int_0^a 1dx, \tag{3.14}$$

$$\int_a^1 S^*_{*,t+1}dj^* = \int_a^1 1dx^*. \tag{3.15}$$

3.2.4 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:

$$Y_{X,t}^x \equiv A_{X,t} L_{X,t}^x, \tag{3.16}$$

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

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

$$\max_{\{p_s(x), L_{X,s}^x\}} E_t \left(\sum_{s=t}^{\infty} \Omega_s^x d_s^x \right) \tag{3.17}$$

subject to

$$d_s^x = \frac{p_s(x)}{P_s} Y_{X,s}^x - \frac{W_{X,s}}{P_s} L_{X,s}^x - \frac{\kappa}{2} \left(\frac{p_s(x)}{p_{s-1}(x)} - 1 \right)^2 \frac{p_s(x)}{P_s} Y_{X,s}^x \tag{3.18}$$

and

$$Y_{X,s}^{S^x} = Y_{X,s}^{D^x} = Y_{X,s}^x. \tag{3.19}$$

Since foreign households own home intermediate sector firms, the discount factor for the home firm x is $\Omega_s^x = \beta^{s-t} \frac{A_{C,s}^*}{A_{C,t}^*} \left(\frac{C_s^*}{C_t^*} \right)^{-\sigma}$ 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:

$$\lambda_t^x = \frac{w_{X,t}}{A_{X,t}}, \tag{3.20}$$

which implies that the Lagrange multiplier on constraint (3.19), λ_t^x, 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 nominal marginal cost:

$$p_t(x) = \Psi_t^x P_t \lambda_t^x, \tag{3.21}$$

where the markup equals

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

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.

3.2.5 Production of final goods

Production of final non-tradable goods

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

$$Y_{N,t} \equiv A_{N,t} L_{N,t}, \tag{3.22}$$

where $A_{N,t}$ is a productivity shock common to producers of home non-tradable good and $L_{N,t}$ is homogenous labor used in the production of 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:

$$RP_{N,t} = \frac{w_{N,t}}{A_{N,t}}, \tag{3.23}$$

where $w_{N,t} \equiv \frac{W_{N,t}}{P_t}$ is 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 units of consumption basket. Foreign firms solve a similar problem.

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:

$$Y_{F,t} \equiv \left[\gamma^{\frac{1}{\epsilon}} (X_t)^{\frac{\epsilon-1}{\epsilon}} + (1-\gamma)^{\frac{1}{\epsilon}} (X_t^*)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{3.24}$$

where $Y_{F,t}$ is the amount of 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 good in the production of home final tradable good.

Baskets of home and foreign intermediate goods are defined as follows:

$$X_t \equiv \left[\left(\frac{1}{a}\right)^{\frac{1}{\theta}} \int_0^a (X_t(x))^{\frac{\theta-1}{\theta}} dx\right]^{\frac{\theta}{\theta-1}}, \tag{3.25}$$

$$X_t^* \equiv \left[\left(\frac{1}{1-a}\right)^{\frac{1}{\theta}} \int_a^1 (X_t^*(x^*))^{\frac{\theta-1}{\theta}} dx^*\right]^{\frac{\theta}{\theta-1}}, \tag{3.26}$$

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

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

and the definitions of the baskets of intermediate goods imply:

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

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

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

The representative firm's demands for baskets X and X^* are:

$$X_t = \gamma\left[\frac{P_{X,t}}{P_{F,t}}\right]^{-\epsilon} Y_{F,t}, \tag{3.27}$$

$$X_t^* = (1-\gamma)\left[\frac{P_{X^*,t}}{P_{F,t}}\right]^{-\epsilon} Y_{F,t} \tag{3.28}$$

and the demands for individual goods x and x^* by the representative firm are:

$$X_t(x) = \frac{1}{a}\left[\frac{p_t(x)}{P_{X,t}}\right]^{-\theta} X_t, \tag{3.29}$$

$$X_t^*(x^*) = \frac{1}{1-a}\left[\frac{p_t(x^*)}{P_{X^*,t}}\right]^{-\theta} X_t^*. \tag{3.30}$$

Foreign producers solve a similar problem.

3.2.6 Goods and labor market clearing

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

$$\int_0^a Y_{N,t} dn = \int_0^a C_{N,t} dj + aG_t. \tag{3.31}$$

Final tradable goods are consumed by home and foreign households:

$$\int_0^a Y_{F,t} df = \int_0^a C_{F,t} dj + \int_a^1 C^*_{F,t} dj^* \tag{3.32}$$

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

$$Y^x_{X,t} = \int_0^a X_t(x) df + \int_a^1 X_{*,t}(x) df^*. \tag{3.33}$$

Labor market clearing requires:

$$\int_0^a L_{N,t} dj + \int_0^a L_{X,t} dj = \int_0^a L_{N,t} dn + \int_0^a L_{X,t} dx. \tag{3.34}$$

3.2.7 Fiscal and monetary policy

Government and fiscal policy

The government is not productive and public spending falls on 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 and the seigniorage revenue and is required to balance its budget in every period:

$$\int_0^a P_{N,t}G_t dn = \int_0^a P_t T_t^j dj + \int_0^a \left(M_t^j - M_{t-1}^j\right) dj. \tag{3.35}$$

The government conducts stabilization policy which is specified (in log-linear terms) as:

$$\widehat{g}_t = f_{GDP}\widehat{GDP}_t + \xi_t^g, \tag{3.36}$$

where $g_t = \frac{RP_{N,t}G_t}{GDP_t}$, f_{GDP} is the feedback parameter on the GDP gap with respect to the steady state, and ξ_t^g is an exogenous shock to fiscal policy. Hats denote percentage deviations from the steady state. The foreign fiscal policy is specified in a similar way.

Central bank and monetary policy

The two countries constitute a monetary union and there is only one central bank which issues a single currency and conducts a single monetary policy. Its monetary policy is specified in terms of an interest rate rule that takes into account inflation and output of both countries:[6]

$$\widehat{i}_{t+1} = m_i\widehat{i}_t + m_{CPI}\left[a\widehat{\pi}_t + (1-a)\widehat{\pi}_t^*\right] + m_{GDP}\left[a\widehat{GDP}_t + (1-a)\widehat{GDP}_t^*\right] + \xi_t^m. \tag{3.37}$$

[6]The EMU targets a weighted average of the harmonized index of consumer prices, where the weights are each country's share of total consumption. I assume that the weights are the relative sizes of the two countries.

3.3 Solution and parameterization of the model

3.3.1 Solution of the model and the steady state

Variables are expressed in real aggregate per capita terms. The model cannot be solved analytically. Thus I find 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.

3.3.2 Parameterization

The home economy in this model represents the new EU members and the foreign economy represents the incumbent EU members.[7] Thus, the size of the home country relative to the foreign economy, a, is set to 5 percent.[8] 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 labor supply elasticity, ψ, is set to 2.5. I assume logarithmic utility of government consumption so that $\sigma_g = 1$.

The share of home tradable consumption in the tradable consumption basket, ω, and the share of home intermediate good in 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).

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

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 good consumption, 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 intermediate goods. I set $\theta = 6$ which is standard in the literature and implies a markup of 1.2.[9] The price adjustment cost parameter, κ, is set to 77, as estimated by Ireland (2001) for the US economy. All parameters for financial transaction costs are set to 0.01, which is standard in the literature.

I first solve the model for historic fiscal and monetary policies. The steady state share of the government purchases in GDP is calibrated to 18 percent. According to the data, fiscal instruments follow an AR(1) process.[10] The monetary policy parameters for the EMU 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.

[9]Martins et al. (1996) estimate the average markup for manufacturing sector at 1.2 for the OECD countries. In the absence of an estimate for central and Eastern European countries I use their markup estimate.

[10]See Chapter 1 for details on historic fiscal policies.

3.4 Transmission of shocks and dynamic properties of the model

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

3.4.1 Impulse responses to the monetary shock

Figures 3.1 and 3.2 present impulse responses to a one-percent increase in the monetary shock[11] which increases the nominal interest rate and the foreign real interest rate (which is in units of foreign consumption basket). Consequently, the foreign private consumption falls. The foreign country is relatively closed[12] so that dynamics of the foreign GDP follow the dynamics of the foreign consumption. The foreign CPI inflation decreases. The fall in the foreign consumption is due to a decrease in the foreign tradable consumption while the foreign non-tradable consumption increases. A lower demand for the foreign tradable goods reduces the production of the foreign final and intermediate tradable goods and a higher demand for the non-tradable goods increases the production of these goods.

The real exchange rate appreciates in the foreign economy which looses competitiveness. Since the home economy has significant trade linkages with the foreign economy, the spillover

[11]The monetary shock is an iid shock.

[12]I only model trade linkages of the foreign economy with the small, home economy and abstract from the rest of the world.

effects are contractionary on home consumption and GDP. The effects of the monetary shock are qualitatively similar in the home economy as they are in the foreign country. The real interest rate (in units of home consumption basket) increases and the CPI inflation rate decreases. The home households borrow from abroad.

3.4.2 Impulse responses to the foreign fiscal shock

Figures 3.3 and 3.4 present impulse responses to a one-percent increase in foreign fiscal shock. A demand shock in the form of an increase of foreign government purchases-to-GDP ratio increases demand for labor and output in foreign non-tradable sector. Government consumption crowds out private non-tradable consumption and this cushions foreign wage rate and relative price of 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, supply of foreign intermediate goods falls and demand adjusts. Because of the opposite dynamics of labor cost and markup in foreign intermediate sector the relative price of foreign inputs almost does not change. Intermediate goods are inputs in production of final tradable goods, which decreases in both countries. In the foreign economy, the relative price of 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 supply of foreign intermediate goods drops and so does the production of home inputs. This reduces 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 wages and relative prices in this sector. Overall home private consumption decreases because consumption of final tradable goods is lower and almost all of new non-tradable goods are consumed by the government which crowds out private non-tradable consumption. Home GDP decrease.

Home CPI inflation decreases because the main components of home CPI inflation (home prices of non-tradable goods and 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.

3.4.3 Estimates of macroeconomic variability

Previous section only analyzed the responses of variables in the two economies for a given shock. When I analyze the optimal policies and the need for fiscal cooperation, I simulate the model in the presence of all shock. In order to do so, I need to make some assumptions about stochastic processes. Empirical evidence on productivity shocks shows high persistence and positive correlation across countries.[13] In my model, productivity shocks follow AR(1) processes. I set 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 is and iid process. Persistence parameters of preference

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

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 baseline parameter values. The details on stochastic processes are in Table 3.2.

Table 3.3 presents the second moments of selected macroeconomic variables. The model generates almost twice as much variability in GDP in the new EU members compared to the Euro Area and the absolute values of standard deviations are consistent with the variability in the 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, the government expenditure is more volatile in the model. The CPI inflation rate is more volatile and the nominal interest rate is 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 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, historic moments are based on a monetary regime that is not a fixed exchange rate regime.

For the Euro Area, the inflation and the interest rates are less variable in the model because of the assumption of an inflation-targeting regime, which is similar to the model properties of Laxton and Pesenti (2003). While data suggest less variability of the GDP components than that of the GDP for the Euro Area, the model generates about the same volatility for each of them.[14]

[14]A more detailed explanation of the model properties may be found in Chapter 1. However, keep in mind

3.5 Design of fiscal and monetary policy

So far I have assumed that fiscal and monetary policies are conducted by use of historic empirical rules. In this section I turn to the core question of my analysis: Are there gains from fiscal cooperation in the EMU? Even though the new EU members do not yet participate in the monetary union, they are expected to join it. Therefore, I assume that the monetary union in my model consists of two different groups of countries; countries such as the new EU members (Central and Eastern European countries) and countries that currently constitute the EMU.

I assume that policymakers choose stabilization policy, i.e. 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.[15] 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:[16]

$$W_t = -\frac{1}{2}\sigma\overline{C}^{1-\sigma}var(\widehat{C}_t) - \frac{1}{2}\psi\overline{L}^{1+\psi}var(\widehat{L}_t) - \frac{1}{2}\sigma_g\overline{G}^{1-\sigma_g}var(\widehat{G}_t), \tag{3.38}$$

where $\overline{C}$, $\overline{L}$, and $\overline{G}$ denote the steady state values of consumption, labor and government purchases and 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 uncondi-

that the model in this Chapter and the model in Chapter 1 are not the same.

[15] In what follows, optimal policy refers to optimal policy within the class of rules specified in the model.

[16] I assume that real money balances do not matter for welfare as common in the literature.

tional expectation of its households' welfare, taking the behavior of the other government and the central bank as given. Taking the actions of the governments as given, the central bank chooses the response parameters to inflation and GDP to maximize the unconditional expectation of the joint welfare function which is defined as a weighted average of home and foreign welfare and the weights correspond to the relative sizes of the two countries. 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 the joint welfare function, taking the behavior of the central bank as given. The central bank again chooses parameters in its rule to maximize the unconditional expectation of the joint welfare function. All policymakers act simultaneously.

3.5.1 Optimal fiscal and monetary policies and the desirability of fiscal cooperation in the EMU

Table 3.1 shows the optimal feedback parameters and the associated welfare losses for the cases of fiscal cooperation and the non-cooperative solution. In both cases, optimal policies are countercyclical.

Table 3.1: Optimal Responses to Output and Inflation and the Associated Welfare Losses

	f_{GDP}	f^*_{GDP}	m_{CPI}	m_{GDP}	L	L^*
No cooperation	-2.10	-1.58	8.36	28.9	17.083	1.382
Cooperation	-2.13	-2.45	2.67	9.20	17.083	1.364

Result 3.1 *Fiscal policies are more aggressive under fiscal cooperation compared to the non-cooperative equilibrium.*

Under fiscal cooperation the foreign government takes into account foreign as well as home households' welfare. It is thus optimal that the foreign government pursues a more active stabilization role and contributes to absorbing shocks that affect the home economy. While there is a clear difference in foreign fiscal policy between the cooperative and the non-cooperative solution, the home government does not change its policy by much. Since the home economy is much smaller than the foreign economy, home fiscal policy almost does not effect the foreign country's variables.

Result 3.2 *The central bank's reaction to inflation and output is smaller under fiscal cooperation.*

The importance of the central bank's inflation and output stabilization under fiscal cooperation is reduced. This can be explained by analyzing some impulse responses.[17] Contractionary monetary policy triggers expansionary foreign fiscal policy and reduces foreign consumption. This consumption reduction is magnified by the expansionary foreign fiscal policy. Under fiscal cooperation, the foreign government reacts stronger to the monetary actions and thus the indirect effect of foreign fiscal policy on foreign private consumption is larger. But because the central bank chooses its policy parameters to maximizes the joint welfare function (and the weight on foreign welfare in the joint welfare function is much bigger that the weight on home welfare) and households dislike consumption variability, it is optimal for the central bank not to respond as strongly to inflation and output as under the non-cooperative fiscal game.[18]

[17] See Figure 3.5.

[18] Similar conclusion can be made based on the home fiscal policy and the home private consumption.

Result 3.3 *Foreign households are better off in the cooperative equilibrium and home households are as well off under fiscal cooperation as they are in the non-cooperative equilibrium.*

In welfare terms home households are indifferent between fiscal cooperation and no fiscal cooperation. Even though fiscal cooperation implies different fiscal and monetary policies and different values of individual components of the utility function, home welfare is the same under both cases. On the other hand, foreign households are better off when the governments cooperate their fiscal policies. Foreign private and government consumption are both less volatile under fiscal cooperation and dominate the effect of the more volatile foreign labor effort.[19]

This result differs from Pogorelec (2004) who shows in a similar model that fiscal cooperation is not desirable. There I assume that each country has a central bank and the two monetary policies are set in a non-cooperative way. In this paper however, there is only one monetary policy and when the two governments cooperate all the policymakers maximize a weighted average of home and foreign welfare. In other words, they have the same objective. Nonetheless, foreign household prefer fiscal cooperation and home households are indifferent between the two equilibria. This result differs from Dixit and Lambertini (2001, 2003) and Eichengreen and Ghironi (2002) who show that there is no need for fiscal cooperation in a monetary union when all the players agree on their goals. However, the result is similar to Lombardo and Sutherland (2003) who conclude that fiscal cooperation is beneficial in a monetary union (or when monetary policies are set cooperatively).

[19]Recall that government consumption is endogenous, $G_t = \frac{g_t GDP_t}{RP_{N,t}}$.

3.6 Conclusions

The new EU members will have to join the monetary union in the near future. I thus analyze whether there are welfare gains from fiscal cooperation in a monetary union which consists of the new (future) members and the incumbent EMU countries. I find that there are welfare gains from fiscal cooperation for the incumbent members and the new members are as well off under fiscal cooperation as in the non-cooperative solution. However, I do not quantify the gains and I also do not model the costs associated with implementing and supporting fiscal cooperation. I leave these issues for future research.

Appendix to Chapter 3

Foreign household j^*'s budget constraint is:

$$
\begin{aligned}
& M_t^{j^*} + B_{t+1}^{*,j^*} + P_t^* \frac{\xi_B^*}{2} \left(\frac{B_{t+1}^{*,j^*}}{P_t^*} \right)^2 + \int_a^1 V_t^{x^*} S_{*,t+1}^{x^*,j^*} dx^* + \int_0^a V_t^x S_{*,t+1}^{x,j^*} dx + P_t^* C_t^{j^*} \\
& \leq M_{t-1}^{j^*} + (1+i_t) B_t^{*,j^*} + \int_a^1 \left(D_t^{x^*} + V_t^{x^*} \right) S_{*,t}^{x^*,j^*} dx^* + \qquad \text{(A3-1)} \\
& W_{N,t}^* L_{N,t}^{j^*} + W_{X,t}^* L_{X,t}^{j^*} - P_t^* T_t^{j^*} + P_t^* TCT_t^{j^*} + \int_0^a \left(D_t^x + V_t^x \right) S_{*,t}^{x,j^*} dx.
\end{aligned}
$$

As opposed to home households, foreign consumers buy and trade shares in home and foreign intermediate sector firms. B^* denotes 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.

Table 3.2: 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 3.3: Macroeconomic Variability of the Czech Republic and the Euro Area

	Czech Republic		Euro Area	
	Model	Historic	Model	Historic
Standard deviation (in %)				
Real GDP	1.98	2.0*	1.00	1.0*
Consumption	2.68	2.29	1.01	0.8*
Government Expenditure	5.89	2.6*	1.12	0.6*
CPI Inflation	2.44	1.08	0.30	0.56
Short-Term Interest Rate	0.36	0.47	0.36	0.98
Employment	0.91	-	0.64	1.16
Real Exchange Rate	3.22	3.1	-	-

Note: The model's variables are detrended with HP filter. Estimates of historic standard deviations that are taken from Laxton and Pesenti (2003) are marked by a star. The rest of estimates for the Czech Republic are taken from Natalucci and Ravenna (2003) and for the Euro Area they are taken from Fagan et al. (2001). Data in Laxton and Pesenti (2003) are detrended with 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. Time span for the Czech Republic is 1994Q1 to 2003Q1. In Fagan et al. (forthcoming), variables are expressed in per capita terms and logged (except for inflation and interest rates). They are seasonally adjusted and HP filtered.

Figure 3.1: Impulse Responses of Foreign Variables to Monetary Shock

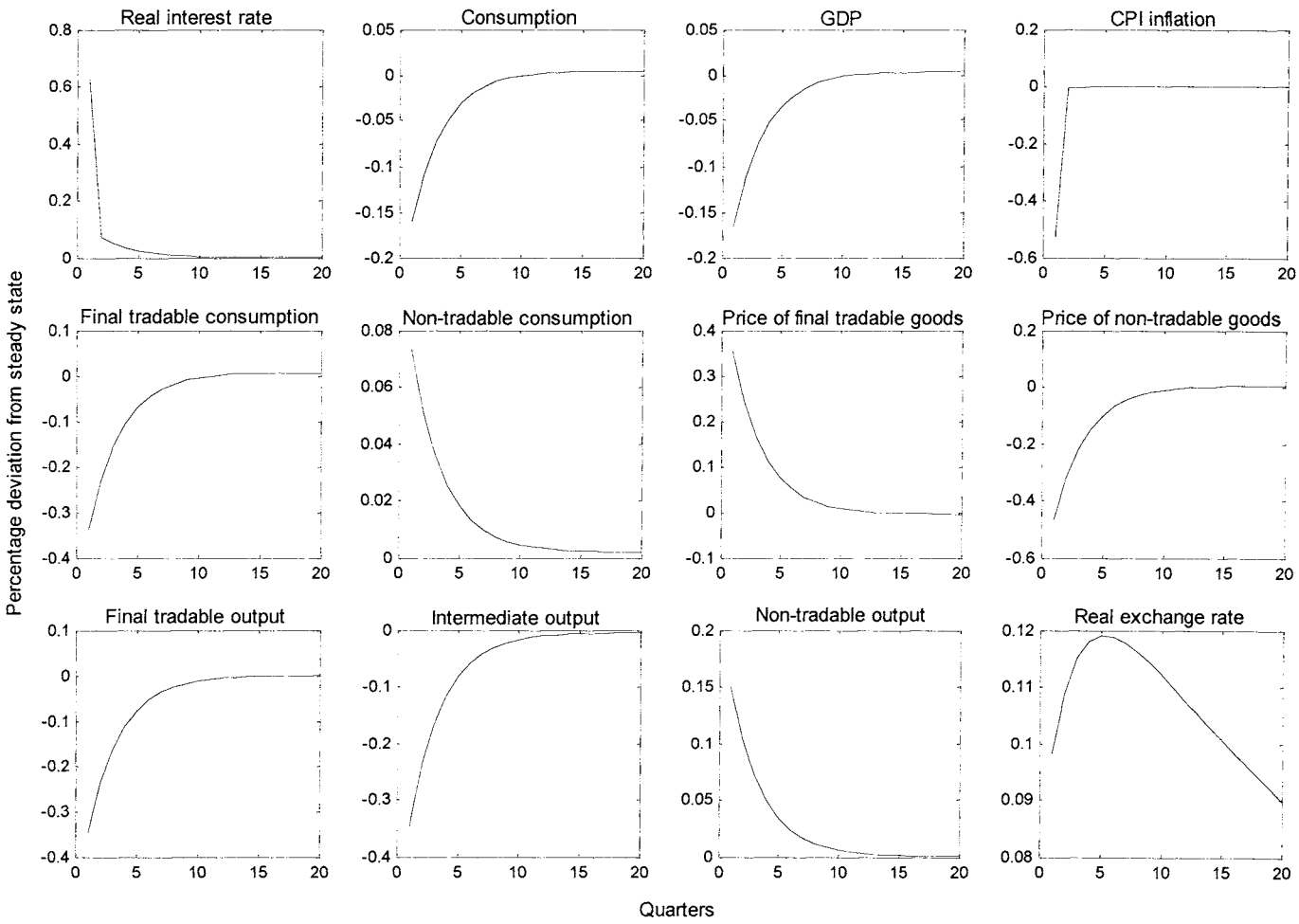


Figure 3.2: Impulse Responses of Home Variables to Monetary Shock

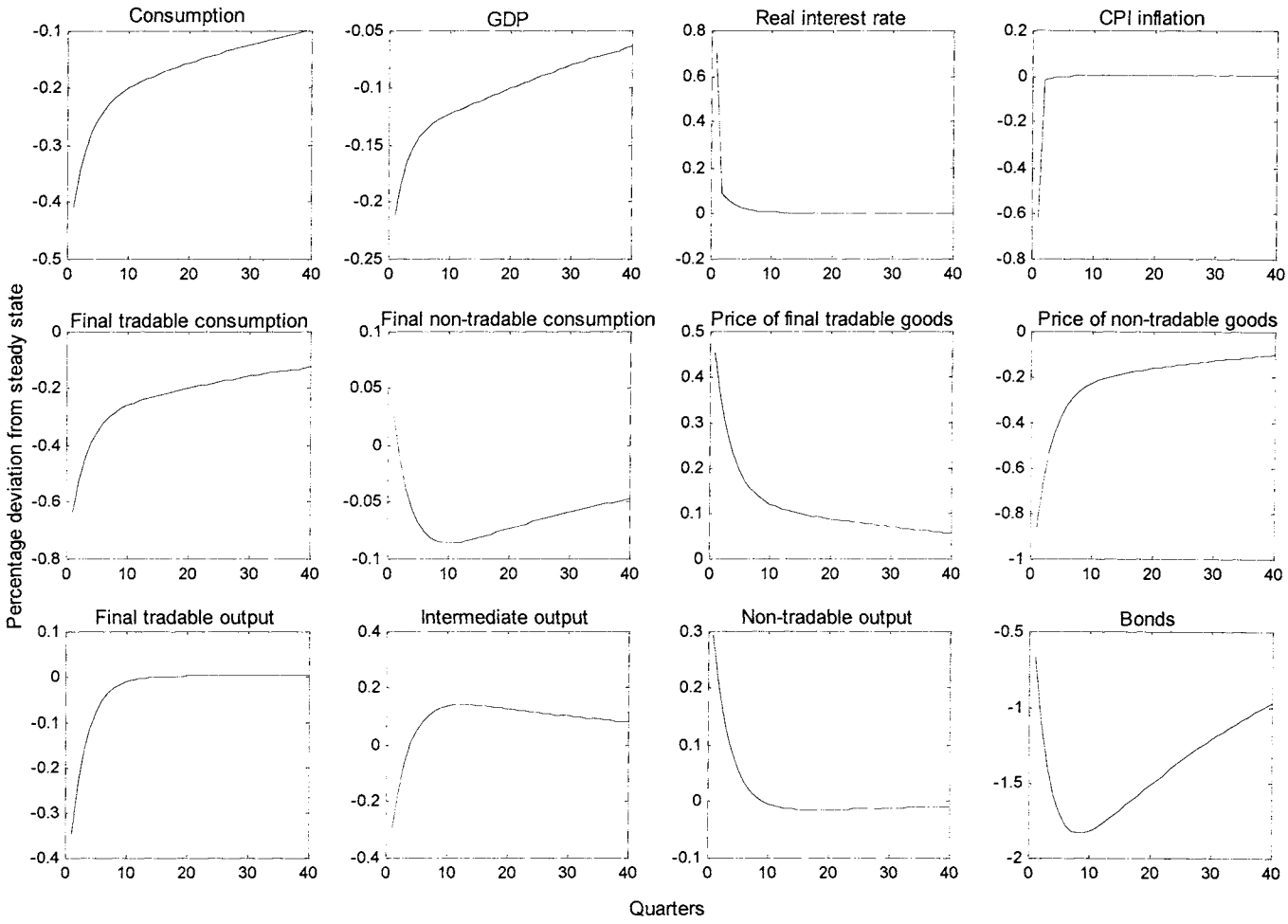


Figure 3.3: Impulse Responses of Foreign Variables to Foreign Fiscal Shock

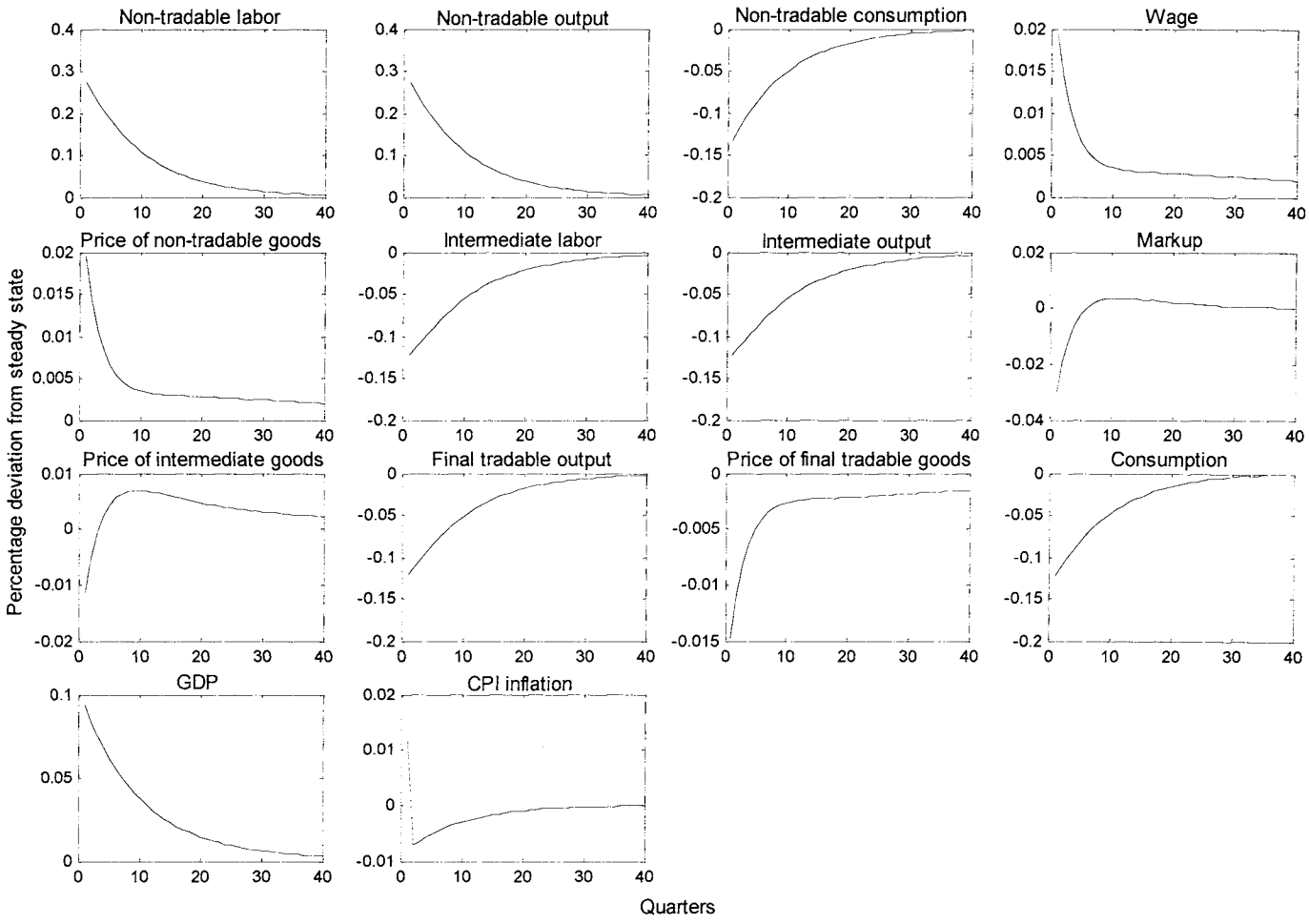


Figure 3.4: Impulse Responses of Home Variables to Foreign Fiscal Shock

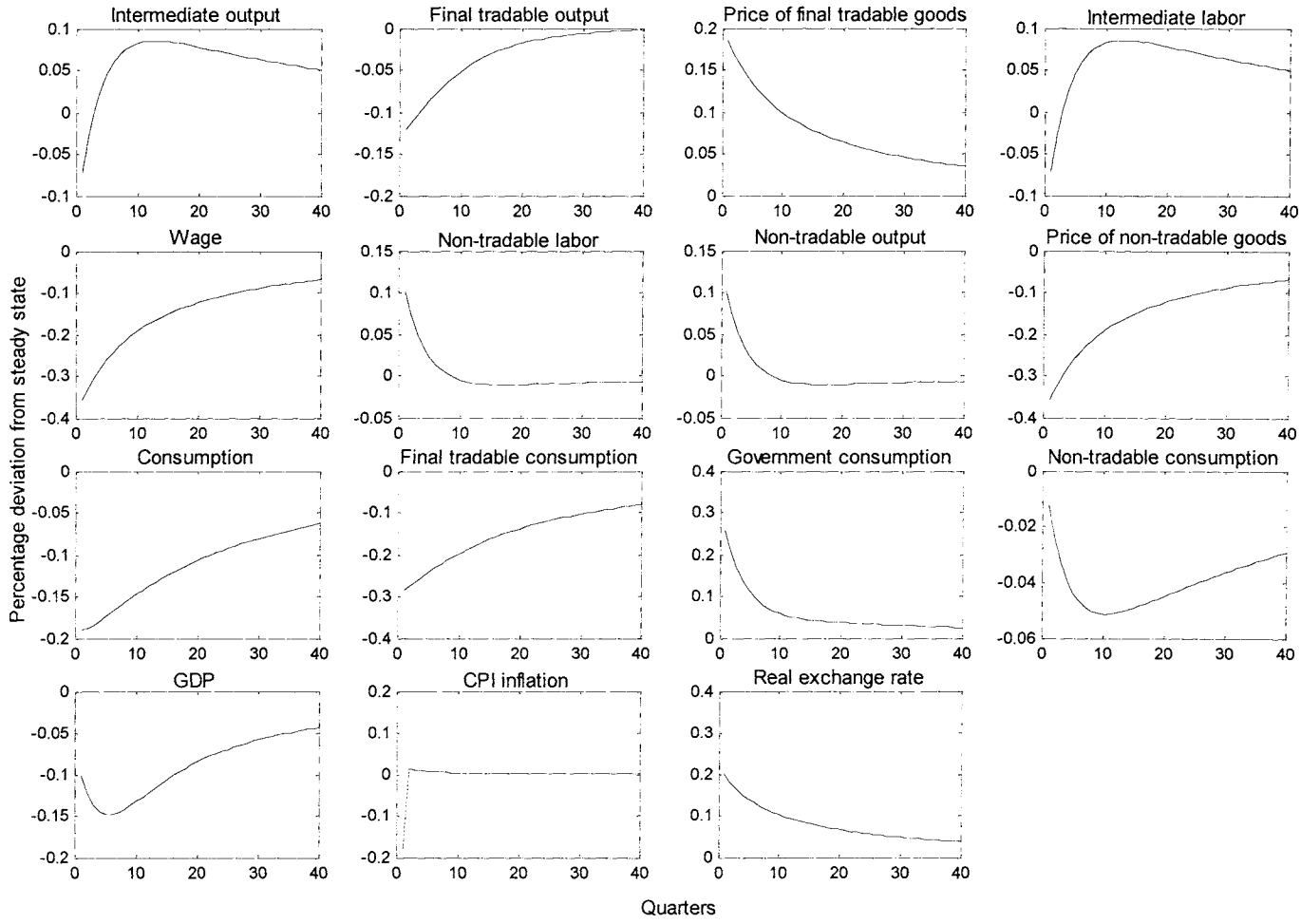
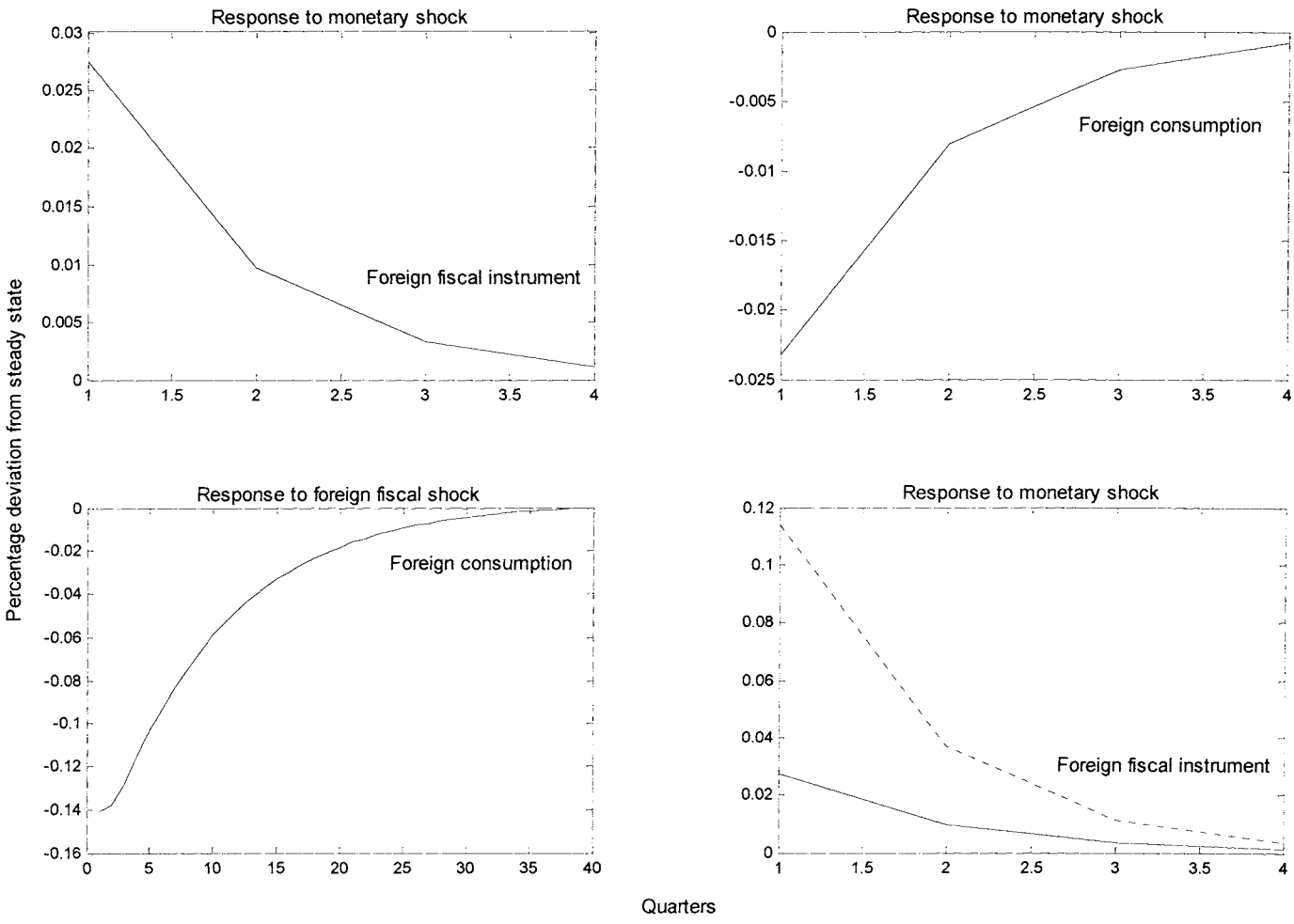


Figure 3.5: Explaining Why Monetary Policy is Looser Under Fiscal Cooperation



Bibliography

[1] Backus, D. K., Kehoe, P. J. and F. E. Kydland (1992): "International Real Business Cycles," *Journal of Political Economy* 100: 745-775.

[2] Bayoumi, T., Kumhof, M., Laxton, D. and K. Naknoi (2003): "Exchange Rate Regimes, International Linkages, and the Macroeconomic Performance of the New Member States," unpublished manuscript.

[3] Beetsma, R. and A. L. Bovenberg (1998): "Monetary Union without Fiscal Coordination May Discipline Policymakers," *Journal of International Economics* 45: 239-258.

[4] Beetsma, R., Debrun, X. and F. Klaassen (2001): "Is Fiscal Policy Coordination in EMU Desirable?" *Swedish Economic Policy Review* 8: 57-98.

[5] Beetsma, R. and H. Jensen (2002): "Monetary and Fiscal Policy Interactions in a Micro-founded Model of a Monetary Union," European Central Bank Working Paper No. 166.

[6] Benigno, P. (2004): "Optimal Monetary Policy in a Currency Area," *Journal of International Economics* 63 (2): 293-320.

[7] Benigno, G., Benigno, P. and F. Ghironi (2002): "Interest Rate Rules for Fixed Exchange Rate Regimes," Boston College Economics Department Working Paper No. 468.

[8] Carré, M. and F. Collard (2003): "Monetary Union: A Welfare Based Approach," *European Economic Review* 47: 521-552.

[9] Ca'Zorzi, M. and A. de Santis (2003): "The Admission of Accession Countries to and Enlarged Monetary Union: A tentative Assessment," European Central Bank Working Paper No. 216.

[10] 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: 29-66.

[11] Devereux, M. B., P. R. Lane and J. Xu (2004): "Exchange Rates and Monetary Policy in Emerging Market Economies," IIIS Discussion Paper No. 36.

[12] Dixit, A. and L. Lambertini (2001): "Monetary-Fiscal Policy Interactions and Commitment versus Discretion in a Monetary Union," *European Economic Review* 45: 977-987.

[13] Dixit, A. and L. Lambertini (2003): "Symbiosis of Monetary and Fiscal Policies in a Monetary Union," *Journal of International Economics* 60 (2): 235-247.

[14] Domowitz, I., Hubbard, G. and B. Petersen (1988): "Market Structure and Cyclical Fluctuations in U.S. Manufacturing," *Review of Economics and Statistics* 80: 55-66.

[15] Economist, The (2004): "Europe's Single Currency: The Instability and Fudge Pact," September 11.

[16] Economist, The (2003): "The German and French Economies: Co-ordinated Kick-Start?", "The Euro, Trade and Growth", "Europe's Stability and Growth Pact: Loosening Those Bonds," July 5, July 12, and July 19, respectively.

[17] Eichengreen, B. and F. Ghironi (2002): "Transatlantic Trade-Offs in the Age of Balanced Budgets and European Monetary Union," *Open Economies Review* 13: 381-411.

[18] Fagan, G., Henry, J. and R. Mestre (forthcoming): "An Area Wide Model (AWM) for the Euro Area," *Economic Modelling.*

[19] Favero, C. and T. Monacelli (2003): "Monetary-Fiscal Mix and Inflation Performance: Evidence from the U.S.," CEPR Discussion Paper No. 3887.

[20] Galí, J. and T. Monacelli (forthcoming): "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *Review of Economic Studies.*

[21] Galí, J. and R. Perotti (2003): "Fiscal Policy and Monetary Integration in Europe," *Economic Policy* 37: 533-572.

[22] Ghironi, F., Lee, J. and A. Rebucci (2003): "International Equity Trading and Macroeconomic Dynamics," unpublished manuscript.

[23] Ghironi, F. and A. Rebucci (2001): "Monetary Rules for Emerging Market Economies," Boston College Economics Department Working Paper No. 476.

[24] Giuliodori, M. and R. Beetsma (forthcoming): "What are the Spill-overs from Fiscal Shocks in Europe? An Empirical Analysis," *De Economist.*

[25] Ireland, P. (2001): "Sticky-Price Models of the Business Cycle: Specification and Stability," *Journal of Monetary Economics* 47: 3-18.

[26] Jensen, H. (1996): "The Advantage of International Fiscal Cooperation under Alternative Monetary Regimes," *European Journal of Political Economy* 12: 485-504.

[27] Kehoe, P. J. (1989): "Policy Coordination among Benevolent Governments May Be Undesirable," *Review of Economic Studies* 56: 289-296.

[28] Lane, P. (2000): "Asymmetric Shocks and Monetary Policy in a Currency Union," *Scandinavian Journal of Economics* 102: 585-604.

[29] Laxton, D. and P. Pesenti (2003): "Monetary Rules for Small, Open, Emerging Economies," *Journal of Monetary Economics* 50 (5): 1109-1146.

[30] Lombardo, G. and A. Sutherland (2004): "Monetary and Fiscal Interactions in Open Economies," *Journal of Macroeconomics* 26: 319-348.

[31] Martins, J., Scarpetta, S. and D. Pilat (1996): "Mark-up Pricing, Market Structure and the Business Cycle," OECD Economic Studies 27 (II): 71-106.

[32] McCallum, B. T. and E. Nelson (2000): "Monetary Policy for an Open Economy: An Alternative Framework with Optimizing Agents and Sticky Prices," *Oxford Review of Economic Policy* 16 (4): 74-91.

[33] Mendoza, E. G. and L. L. Tesar (2003): "A Quantitative Analysis of Tax Competition v. Tax Coordination under Perfect Capital Mobility," NBER Working Paper No. 9746.

[34] Morrison, C. (1994): "The Cyclical Nature of Markups in Canadian Manufacturing: A Production Theory Approach," *Journal of Applied Econometrics* 9 (3): 269-282.

[35] Natalucci, F. M. and F. Ravenna (2003): "The Road to Adopting the Euro: Monetary Policy and Exchange Rate Regimes in EU Candidate Countries," International Finance Discussion Papers Number 741, Board of Governors of the Federal Reserve System.

[36] Obstfeld, M. and K. Rogoff (1995): "Exchange Rate Dynamics Redux," *Journal of Political Economy* 103 (3): 624-660.

[37] Quadrini, Vincenzo (2004): "Policy Commitment and the Welfare Gains from Capital Market Liberalization," unpublished manuscript.

[38] Reininger, T., Schardax, F. and M. Summer (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.

[39] Rogoff, K. (1985): "Can International Monetary Policy Coordination be Counterproductive?" *Journal of International Economics* 18: 390-407.

[40] Rotemberg, J. J. (1982): "Monopolistic Price Adjustment and Aggregate Output," *Review of Economic Studies* 49: 517-531.

[41] Schmitt-Grohé, S. and M. Uribe (2004): "Solving Dynamic General Equilibrium Models using a Second-order Approximation to the Policy Function," *Journal of Economic Dynamics and Control* 28: 755-775.

[42] Schmitt-Grohé, S. and M. Uribe (2003): "Closing Small Open Economy Models," *Journal of International Economics* 61: 163-185.

[43] Smets, F. and R. Wouters (2003): "An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area," Journal of European Economic Association 1 (5): 1123-1175.

[44] Stockman, A. C. and L. L. Tesar (1995): "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," *The American Economic Review* 85 (1): 168-185.

[45] Uhlig, Harald (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: 30-61.