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Abstract

We show in a dynamic stochastic general equilibrium framework that the introduction of a common currency by a group of countries with only partially integrated goods markets, incomplete financial markets and no labor migration across member states, significantly increases volatility of consumption and employment in the face of asymmetric shocks. We propose a simple transfer mechanism between member countries of the union that reduces this volatility. Furthermore, we show that this mechanism is more efficient than anticyclical policies at the national level in terms of a better stabilization for the same budgetary effects for households while in the long run deeper integration of goods markets could reduce volatility significantly. Regarding its implementation, we show that the centralized provision of public goods and services at the level of the monetary union implies cross-country transfers comparable to the scheme under study.

Keywords: Monetary Union, Asymmetric Shocks, Fiscal Policy, Fiscal Transfers

JEL classification: F41, F44, E2, E3, E52

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1 Introduction

Now in its teenager years, the euro area has reached a crucial phase. The sovereign debt crisis has brutally shown the limits to the economic governance of a monetary union of heterogenous member states that have not agreed upon a set of adequate policies that would deal with asymmetric shocks to individual member states. For the euro area to survive it crucially matters that new instruments are designed to address these structural flaws. In the public debate a lot has been said about the desirability of a deeper economic union as a complement to the monetary union. However, when the debate turns to what exactly would constitute necessary instruments and reforms, policy makers usually add little flesh to that claim. In this paper we want to contribute to this debate over suitable institutional reforms to make the euro area fit for the future. Based on simulations in a standard open economy dynamic stochastic general equilibrium model we propose a simple transfer mechanism that is suitable to address asymmetries across the monetary union.

Our starting point is the observation that national cyclical fluctuations can turn a lot more severe when countries form a currency area whose degree of economic integration, i.e. with respect to goods, labor and financial markets, is low[1]. With a common monetary policy, the volatility caused by asymmetric shocks can no longer be mitigated by a country specific monetary policy. The remaining options to deal with this volatility are labor migration from depressed to booming member states and an anti-cyclical fiscal policy. With insufficient labor mobility across countries within the euro area the only available option is fiscal policy.

All successful currency unions of heterogenous regions have common fiscal instruments to deal with asymmetric shocks.[2] These are common social security and tax systems, common debt issuance and expenditure programs and a creditor of last resort, the central bank[3]. Such a common set of instruments is missing in the euro area[4], so that the burden of national anti-cyclical stabilization policies rests entirely on national budget deficits and the willingness of private creditors to provide credit to national governments. Monacelli and Galí (2008) and Ferrero (2009) show that under complete financial mar-

[1]This theoretical insight goes back to the original theory on optimum currency areas of Mundell (1961), McKinnon (1963), Kenen (1969) and Mundell (1973).

[2]See, for example Bordo et al. (2011) for a recent account.

[3]See de Grauwe (2011a,b) for an account of central banks acting as creditors of last resort to governments when multiple equilibria are possible in sovereign debt markets.

[4]The European Union budget is currently only around 1% of GDP and expenditures are not desigend to reduce maroeconomic volatility (see Bernoth and Engler, 2013).

kets such policies are indeed optimal and Nakamura and Steinsson (2011) show that fiscal multipliers can be expected to be quite large in such an environment. However, the current crisis has clearly exposed the limits to debt financing and thereby to stabilization policies at the national level. It therefore appears straightforward to provide instruments for stabilization at the union level.

Within the framework of a dynamic stochastic general equilibrium model we propose a fiscal transfer mechanism as one such instrument that helps to reduce volatility and to synchronize business cycles across countries. If countries of a monetary union differ in their state of the business cycle, for example one country growing below trend while the rest of the union growing above trend, the poorly performing country would receive a transfer from the booming part of the union. Thereby aggregate demand could be increased in the first and reduced in the second. The advantages of such a transfer mechanism are straightforward: First, the cyclical fluctuations are mitigated in both regions. This could not be accomplished with the common monetary policy when cycles are asymmetric. Second, if the transfers are not paid out of national government budgets, they do not affect national governments' fiscal positions. Thus, national fiscal solvency issues do not arise in times of a severe downturn because of this mechanism. Risk premia related to sovereign default risk will not arise and, consequently, real interest rates will not be anticyclical as observed in the current crisis in many countries of the euro zone. Furthermore, Ricardian equivalence effects do not play any role in our transfer mechanism which render it a much more effective stabilization tool than national deficit financed fiscal stabilization.

We also show that in the long-run such a transfer system might not be needed as much as in the short-run as deeper integration reduces the asymmetry of business cycles in the presence of asymmetric shocks. To some extent a transfer system can thus be regarded as an instrument that is needed on the way to a deeper union that will be in place some time in the future. However, it is unclear that even strong policy measures fostering the further integration of goods, services and factor markets will result in such an optimum currency area without a need for strong central fiscal institutions as the example of the United States suggests. Deeper union in the form of a transfer mechanism may thus be desirable in any case.

In order to derive normative conclusions, we employ a standard welfare function and show that the transfer mechanism dominates domestic fiscal stabilization policies. However, both scenarios are dominated by a flexible exchange rate regime with independent monetary policies, a result that even a deeper degree of trade integration cannot overturn. This implies that optimality of the currency area in the sense of the original literature on optimum

currency areas of Mundell (1961), McKinnon (1963) and Kenen (1969) can only be established if other economic factors are taken into account that are beyond the scope of our model framework.[5]

We constructed the transfer mechanism in our model in a way that it looks very much like unemployment insurance schemes that have been up and running in many countries for ages: Workers in a booming region transfer resources to workers in a depressed region. As such insurance schemes work in a quasi-automatic fashion with little delay, the well-known drawbacks of decision and implementation lags of discretionary stabilization measures do not apply. If set up like an insurance scheme, this would imply that the central fiscal authority does not gain access to resources it can spend, it is just a measure to re-distribute resources across the union in a well-defined, state-contingent manner for a specific purpose that benefits members in the entire region. This may thus be a step towards political and fiscal union that is politically more feasible than setting up an agency with taxing and spending power (i.e. yielding more power to "Brussels").

However, we also analyze transfers which are implicit by the central provision of public goods on the union level. We assume that in the long-run, all member countries pay the same fraction of their GDP to finance a union-wide public good which is constant in its size. In the face of disturbances in one country's output, the resulting gap in revenues is distributed evenly over the rest of the union. This plausible financing scheme implies cross-country transfers which are very close to the transfer-scheme we are considering in this paper.

The idea of such a transfer mechanism is not new, of course. The first account of a fiscal transfer mechanism is, to the best of our knowledge, Kenen (1969)[6]. More recently, Evers (2012) and, in tandem with our work, Farhi and Werning (2012a, b) introduced transfer schemes into DSGE models. The first paper compares the effects of transfers related to different macroeconomic variables in a two country model similar to ours while the second is a small open economy model. The contribution of our analysis is to shed light on the absence of Ricardian equivalence effects under federal transfers schemes which make them the more effective tool in stabilizing economies that are member of a currency union, a point that is also made by Farhi and Werning (2012b). In addition, we endogenize feedback effects of the rest of the union which are mitigated by the transfer scheme and thereby provide a narrative for a mutually benefitial system of union wide transfers. Furthermore, we

[5] One such factor could be a boost by the euro to the welfare enhancing effects of the Common Market structure.

[6] See also Bean (1992).

introduce rule of thumb consumers and discuss the role of risk premia related to sovereign debt, two features that have not been addressed by these two papers.

The rest of the paper is structured as follows. Section 2 provides the set-up of the model and the transfer mechanism used for the positive analysis in section 3 and the welfare analysis in section 4. Section 5 concludes.

2 The Model

The model economy consists of two countries which first have independent monetary policies and a flexible exchange rate between them and then form a currency union with a common central bank. The two-country setting can be regarded as a short-cut to a multiple country setting as one country will be modelled as a small economy and the second country as a large one, which can be interpreted as an aggregate of all remaining countries. Each country is populated by two types of households, denoted as "Ricardian" and "rule-of-thumb" households as in Galí, López-Salido and Vallés (2007). The first type of households have access to a non-state contingent internationally traded bond allowing them to smooth consumption across time while the latter can consume only their current disposable income. This is motivated by the finding of Mankiw and Campbell (1989) that aggregate consumption is explained both by a random walk component and current income.[7] They consume domestically and foreign produced goods and supply labor in a competitive market to domestic firms. Firms are acting in a monopolistically competitive environment and set prices as a mark up over marginal costs. The only input factor to production is labor so for simplicity we abstract from investment decisions and the role of capital in production. Prices are set in a staggered fashion à la Calvo (1983). The central banks of the two countries before forming the monetary union implement monetary policies by setting the short-term interest rate following a Taylor-type rule (Taylor, 1993). The common central bank in the monetary union follows a Taylor rule with target values that are weighted averages of member countries' target realizations. Fiscal policy is modelled as a constant level of aggregate government spending while lump-sum country specific taxes and transfers across the union may or may not react endogenously to output fluctuations.

[7] See also Mankiw (2000) and Galí et al. (2007) and the literature surveyed therein.

2.1 Households

The fraction $(1-\lambda)$ of the continuum of domestic households is populated by 'Ricardian' consumers (or asset-holders), and the remaining fraction λ by 'rule of thumb' consumers or non-asset holders. We first describe their decisions with respect to consumption and then with respect to labor supply.

2.1.1 Consumption decisions

Ricardian households choose a plan $\left\{C_t^A, N_t^A, A_t, B_t\right\}_{t=0}^{\infty}$ (superscript A refers to asset holders) to maximize the following lifetime utility subject to a standard CES utility function

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left\{ \ln C_{t+k}^A - \frac{\left(N_{t+k}^A\right)^{1+\phi}}{1+\phi} \right\}$$

and to the nominal period budget constraint

$$A_{t+1} + B_{t+1}\mathcal{E}_t + P_t C_t^A = R_{t-1}A_t + R_{t-1}^* B_t \mathcal{E}_t + W_t N_t^A + \Pi_t^{pc} - T_t + Tr_t^H$$

where W_t denotes the economy-wide nominal wage, N_t^A the amount of hours worked, Π_t^{pc} nominal profits per capita (earned by Ricardian households only) and T_t nominal taxes which include payments for the union-wide public good in the respective scenario. Tr_t^H is an income transfer between home households, to which superscript H refers, and foreign households which will be discussed in detail below. A_t and B_t denote the (beginning of period) holdings of bonds issued by the government of the household's home country and by the households of the other country, respectively. $\mathcal{E}_t$ denotes the nominal exchange rate. There are thus three distinct borrower-lender relationships: Between domestic Ricardian households and the domestic government, between foreign Ricardian households and the foreign government and between domestic and foreign Ricardian households.

The intertemporally optimal allocation of consumption is governed by the following standard Euler equations, referring to the use of the domestic and foreign bond respectively:

$$R_t^{-1} = \beta \mathbb{E}_t \left\{ \frac{\left(C_{t+1}^A\right)^{-1}}{\left(C_t^A\right)^{-1}} \frac{P_t}{P_{t+1}} \right\}$$

$$\left(R_t^*\right)^{-1} = \beta \mathbb{E}_t \left\{ \frac{\left(C_{t+1}^A\right)^{-1}}{\left(C_t^A\right)^{-1}} \frac{P_t}{P_{t+1}} \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right\}$$

It follows that in the steady state, the returns on both bonds (i.e. R_t and R_t^*) are equal. Domestic and foreign interest rates are linked by an interest rate parity condition and a risk premium:

$$R_t = R_t^* \mathbb{E}_t \left\{ \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right\} - \psi \left(\exp(B_t) - 1 \right)$$

The risk premium, $-\psi \left(\exp(B_t) - 1 \right)$, is zero for a steady state with a zero net foreign asset position ($B = 0$)[8] and positive for a negative net foreign asset position ($B_t < 0$). As Schmidt-Grohé and Uribe (2003) have shown, this risk premium guarantees a unique steady state. But rather than using this risk premium just as a technical device to ensure stationarity, which is usually done by setting ψ very low, in a robustness analysis we will allow it to be "large" and we allow, in addition, the level of government debt to determine the risk premium to show that this crucially affects the relative effectiveness of national fiscal stabilization measures and the transfer mechanism we propose.

Rule-of-thumb consumers (superscript N denotes non asset holders) do not have access to capital marktes and respect the following one-period budget constraint:

$$P_t C_t^N = W_t N_t^N - T_t + Tr_t^H$$

Rule-of-thumb households' period t consumption thus simply equals their current disposable income which is determined by wage income, transfers and taxes[9].

Both types of households consume the same bundle of goods, denoted as C_t. This aggregate comprises two bundles C_t^H and C_t^F, which in turn contain the firm specific good-variations from the home- and foreign country respectively:

$$C_t = \left\{ \left[1 - \left(\omega^H + a_t \right) \right]^{\frac{1}{\sigma}} \left(C_t^H \right)^{\frac{\sigma-1}{\sigma}} + \left(\omega^H + a_t \right)^{\frac{1}{\sigma}} \left(C_t^F \right)^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{1-\sigma}}$$

where ω^H is the steady state import share of (private) households' consumption which is subject to an exogenous zero-expectation preference shock a_t which falls the AR(1)-process $a_t = \rho^a a_{t-1} + \varepsilon_t$ with the degree of autocorelation determined by ρ^a and white noise error term ε_t.[10]

To obtain symmetry of per ca-pita quantities in the steady state and at the same time allow for home bias in consumption, we use an import share of

[8] This could easily be generalized to a steady state where $B \neq 0$.

[9] We calibrate the model such that consumption does not turn negative.

[10] This shock enters the aggregator of the foreign household with a negative sign as described below.

$\omega^H = \Omega n$ for domestic households and $\omega^F = \Omega(1-n)$ for foreign households, where n is the relative size of the two countries. That is, the import share of either country equals the relative size of the other country scaled by the same factor $1 \leqslant \Omega \leqslant 0$. A value of $\Omega = 1$ implies the absence of home bias when households spread their consumption evenly over the entire union, while for $\Omega = 0$ households exclusively consume domestically produced goods.

Bundles C_t^H and C_t^F are defined as

$$C_t^H = \left[(1-n)^{-\frac{1}{\epsilon}} \int_n^1 \left(C_t^H(i)\right)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}, \qquad C_t^F = \left[n^{-\frac{1}{\epsilon}} \int_0^n \left(C_t^F(i)\right)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}$$

where $C_t^H(i)$ and $C_t^F(i)$ are home and foreign produced goods of the respective firm i with $i \in [0,n]$ denoting foreign firms and $i \in [n,1]$ denoting domestic firms. σ and ϵ are the price elasticities of substitution between home and foreign goods and between different goods produced in the same country, respectively. Cost minimization and aggregation across households results in the following standard demand functions:

$$C_t^H(i) = \frac{1-(\omega^H + a_t)}{1-n}\left(\frac{P_t^H(i)}{P_t^H}\right)^{-\epsilon}\left(\frac{P_t^H}{P_t}\right)^{-\sigma} C_t \tag{1}$$

$$C_t^F(i) = \frac{(\omega^H + a_t)}{n}\left(\frac{P_t^F(i)}{P_t^F}\right)^{-\epsilon}\left(\frac{P_t^F}{P_t}\right)^{-\sigma} C_t \tag{2}$$

where $C_t = \lambda C_t^N + (1-\lambda) C_t^A$ is aggregate consumption, $P_t^j(i)$ is the price of country j firm i's good in units of the domestic currency, with $j \in (H,F)$. P_t^H, P_t^F and P_t are the home and foreign producer price indexes and the domestic consumer price index defined as

$$P_t^H = \left((1-n)^{-1}\int_n^1 P_t^H(i)^{1-\epsilon}\,di\right)^{\frac{1}{1-\epsilon}}, \qquad P_t^F = \left(n^{-1}\int_0^n P_t^F(i)^{1-\epsilon}\,di\right)^{\frac{1}{1-\epsilon}}$$

$$P_t = \left(\left(1-(\omega^H + a_t)\right)\left(P_t^H\right)^{1-\sigma} + (\omega^H + a_t)\left(P_t^F\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$$

In the foreign country, households' consumption basket is defined by

$$C_t^* = \left\{\left[1-\left(\omega^F - a_t\right)\right]^{\frac{1}{\sigma}}\left(C_t^{*,F}\right)^{\frac{\sigma-1}{\sigma}} + \left(\omega^F - a_t\right)^{\frac{1}{\sigma}}\left(C_t^{*,H}\right)^{\frac{\sigma-1}{\sigma}}\right\}^{\frac{\sigma}{1-\sigma}}$$

where $C_t^{*,H}$ and $C_t^{*,F}$ denote the foreign households' demand for domestic and foreign goods respectively. According expressions for demand and price indices apply.

The terms of trade are defined as the price of one unit of the foreign goods aggregate measured in units of the domestic goods aggregate:

$$\mathcal{S}_t = \frac{P_t^F}{P_t^H} = \frac{\mathcal{E}_t P_t^{*,F}}{P_t^H}$$

where we made use of the assumption that the law of one price holds for individual goods.

2.1.2 Wages and labor supply

Wages are flexible so that households choose their labor supply such that their marginal rates of substitution between labor and consumption equal the real wage. We assume that rule-of-thumb consumers have the same functional form of intra-period utility as Ricardian households so that in equilibrium

$$C_t^A \left(N_t^A\right)^\phi = C_t^N \left(N_t^N\right)^\phi = \frac{W_t}{P_t}$$

holds.

2.2 Government

The two countries' governments have two anti-cyclical fiscal stabilization tools to deal with asymmetric shocks. The first one is a variation in taxes at the national level, the second one a transfer mechanism between households in both economies.

In order to allow for purely national stabilization policies, we introduce a taxation rule and a government budget constraint while aggregate government spending G is assumed to be constant. Per-capita lump sum taxes T_t are determined by the rule

$$T_t = G + \psi_y \left(Y_t^H - Y_t^{n,H}\right) + \psi_d A_t / P_t^H$$

where A_t is the level of period t government debt and G the constant steady state level of government spending. Y_t^H and $Y_t^{n,H}$ are the per capita levels of domestic output and domestic natural output, the later being the hypothetical output produced under flexible prices. The difference between the two is the output gap. The coefficients ψ_j with $j \in (y, d)$ determine the strength of the reaction of government revenues to changes in the level of debt and the output gap. For anti-cyclical fiscal policies, we have to set $\psi_y > 0$ so that taxes are increased when the output gap is positive and that taxes fall when it is negative. Forni and Momigliano (2004) have shown that such a rule is a

good description of government policies in OECD countries when using real time data[11] and similar rules have been empoyed by Colciago et al. (2008).

The evolution of government debt is determined by the budget constraint

$$(1-\lambda)A_t = (1+R_t)(1-\lambda)A_{t-1} + G - T_t$$

Governments consume just their respective country's consumption bundle, we thus assume complete home bias in government purchases. The aggregate government goods index is therefore

$$G = \left[(1-n)^{-\frac{1}{\epsilon}} \int_n^1 \left(G_t^H(i)\right)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}$$

where $G_t^H(i)$ is the domestic government's period t demand for domestic good i. The resulting demand equation is

$$G_t^H(i) = \frac{1}{1-n}\left(\frac{P_t^H(i)}{P_t^H}\right)^{-\epsilon} G \tag{3}$$

For the foreign government corresponding equations apply.

The transfer we employ in our model economy works as follows: Foreign consumers share foreign output deviations from the respective natural levels with domestic consumers and vice versa. The per capita transfer Tr_t^H home consumers receive from foreign consumers then is:

$$Tr_t^H = \phi_{tr}\left[\left(Y_t^F - Y_t^{n,F}\right) - \left(Y_t^H - Y_t^{n,H}\right)\right]$$

with ϕ_{tr} determining the degree to which output fluctuations are shared. Transfers are zero in the steady state and, of course, we have

$$(1-n)Tr_t^H + nTr_t^F = 0$$

When the home economy's output relative to its natural level falls below the foreign country's output relative to its natural level, it receives a transfer from the foreign country. This will boost aggregate demand in the home economy and depress it in the foreign economy and thereby reduce both the volatility of output and consumption and the asymmetry of the business cycles.

[11] The estimated rules indicate an asymmetry in that during recessions the budget deficit turns negative while there is no significant effect of a boom. In our analysis we abstract from this asymmetry. Furthermore, Forni and Momigliano (2004) find that with ex-post data the state of the business cycle is not significant any more. However, ex-post data are not the relevant measure for an analysis of what governments actually do due to the frequent data revisions ex-post.

Such a transfer mechanism has benefits both from a theoretical and a political perspective: First, as transfers are related to relative deviations from (constrained) efficient output, efficient deviations from a long run trend do not cause transfers. In our model this implies that output fluctuations driven by productivity shocks cause transfers only to the extent that the output gap is not closed. The transfer would thus simply correct the inefficiency related to the rigidity of prices and is therefore welfare enhancing.

Second, if constructed in this way, relative deviations from the countries' respective (possibly stochastic) trend growth are the point of reference. These transfers then would not offset per-capita income differences and differences in trend growth. They are thus purely cyclical instruments and countries with strong trend growth would not be "held back" by slow growth countries. This is certainly a strong argument relevant in a political debate as the transfer does not reduce a country's incentive to increase its productivity and to boost its growth trajectory.

Both the tax and the transfer rules are set up in a lump-sum fashion. The reason why we abstract from distortionary ways of raising revenues is that taxes and transfers would not differ in that respect: A euro raised would have a distortionary effect no matter whether it is used as a transfer or as a tax. We will show below that the difference between taxes and transfers is rather whether they imply Ricardian equivalence effects or not.

2.3 Aggregate demand

Aggregate demand for good i, $Y_t^H(i)$, is the sum of domestic and foreign private and government demand:

$$Y_t^H(i) = \left(\frac{P_t^H(i)}{P_t^H}\right)^{-\epsilon} \left[\begin{array}{c} \left(1-\omega^H-a_t\right)\left(\frac{P_t^H}{P_t}\right)^{-\sigma} C_t + \left(\frac{P_t^H}{P_t^g}\right)^{-\sigma} G_t \\ +\frac{n}{1-n}\left(\omega^F+a_t\right)\left(\frac{P_t^H}{\mathcal{E}_t P_t^*}\right)^{-\sigma} C_t^* \end{array}\right]$$

Defining $Y_t^H \equiv \left[(1-n)^{-\frac{1}{\epsilon}} \int_n^1 \left(Y_t^H(i)\right)^{\frac{\epsilon-1}{\epsilon}} di\right]^{\frac{\epsilon}{\epsilon-1}}$, one can show that

$$Y_t^H(i) = (1-n)^{-1}\left(\frac{P_t^H(i)}{P_t^H}\right)^{-\epsilon} Y_t^H \tag{4}$$

2.4 Firms

Home firm i produces output $Y_t(i)$ with the production function

$$Y_t(i) = Z_t N_t(i)^{\alpha} \tag{5}$$

where $N_t(i)$ is firm i's employment and where Z_t is the total factor productivity that is assumed to be the same across firms and which in logs follows the autoregressive process $\ln Z_t = \rho^Z \ln Z_{t-1} + \varepsilon_t^Z$ where ε_t^Z is a white-noise shock term. The firm's period t profits are

$$\Pi_t(i) = P_t^H(i) Y_t(i) - W_t N_t(i),$$

which, when maximized, takes account of world demand (4) and the production function (5). Assuming price setting à la Calvo, with price stickiness parameter θ, the objective is $V_t(i)$,

$$\max_{P_t(i)} V_t(i) = \sum_{k=0}^{\infty} \theta^k E_t \{Q_{t,t+k} \Pi_{t+k}(i)\}$$

where $Q_{t,t+k} \equiv \beta E_t \left\{ \frac{C_t^A}{C_{t+1}^A} \frac{P_t}{P_{t+1}} \right\}$ is the Ricardian household's discount factor and the log-linearized optimality condition can be shown to be:

$$p_t^{Ho} = \mu + (1-\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k E_t \{\psi_{t+k}\} \tag{6}$$

with optimal price p_t^{Ho} and where $\psi_{t+k} = \log\left(W_{t+k}/\alpha Z_{t+k} N_{t+k}^{\alpha-1}\right)$ is the log marginal cost function in period $t+k$ of those firms that reset their price in period t and that have not reset the price between t and $t+k$. Finally, $\mu \equiv \log \frac{\epsilon}{\epsilon-1}$ is the optimal log price markup.

2.5 Aggregate prices and aggregate supply

As is standard in the literature, the New Keynesian Phillips curve,

$$\pi_t^H = \beta E_t \left\{\pi_{t+1}^H\right\} - \lambda(\mu_t - \mu)$$

which determines domestic inflation $\pi_t^H \equiv p_t^H - p_{t-1}^H$, is derived from equation (6) and the expression for the evolution of the aggregate domestic price index,

$$p_t^H = \theta p_{t-1}^H + (1-\theta) p_t^{Ho}$$

with average price markup $\mu_t \equiv p_t^H - \psi_t$ and $\lambda \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}$.

2.6 Monetary policy

Under a flexible exchange rate, the domestic central bank follows the following Taylor-type rule

$$R_t = \beta^{-1} \left(\frac{P_t^H}{P_{t-1}^H} \right)^{\phi_\pi}$$

An according rule applies for the foreign central bank. After having formed a currency union, the common central bank targets the weighted average of both countries' domestic inflation rates:

$$R_t^U = \beta^{-1} \left(\left(\frac{P_t^H}{P_{t-1}^H} \right)^{1-n} \left(\frac{P_t^F}{P_{t-1}^F} \right)^{n} \right)^{\phi_\pi}$$

3 Simulations

We now employ this model to illustrate the different stabilization properties of fiscal policy and transfers for various scenarios. In this section, we present simple impulse responses for asymmetric demand shocks to illustrate the mechanics of the model and briefly discuss results for a productivity shock. In section 4 we introduce a welfare metric that allows a normative comparison of different policies for different scenarios.

The demand shock is modelled as a shock to the relative preference of all households of the union for goods produced in the country subject to the shock. We model this by changing the share of this country's production in the consumption baskets of domestic as well as of foreign households. For example, the import share of a country subject to an adverse relative preference-shock increases because domestic households switch to foreign goods which they now perceive as relatively more attractive. The import share of the foreign country decreases at the same time as foreign households switch to products from their own country which they also perceive as relatively more attractive. We assume that the percentage change of import-shares is of the same magnitude in both countries but with opposed signs.

The goal is to analyse how the volatility of output and consumption and the co-movement of these variables differ across scenarios and what various stabilization policies can achieve. After presenting the calibration in section 3.1, we start with a benchmark scenario of a flexible exchange rate and independent central banks in both economies that we compare with a monetary union benchmark setting in section 3.2. We also increase the degree of trade integration to see whether asymmetric shocks will cause less volatility in this setting. Then we turn to national fiscal stabilization policies and a transfer system between the two countries under a lower degree of integration in section 3.3. Finally we briefly discuss these policies in a currency union for a productivity shock. In section 3.4 we construct a stabilization mechanism that allows us to prove that the transfer mechanism indeed implies a greater bang for the buck in terms of reducing macroeconomic volatility. Lastly, we present a version of the model with a union-wide public good the financing of

which allows for implicit transfers across countries when business cycles are asymmetric in section 3.5. The idea is to illustrate one way how a transfer mechanism could be implemented.

3.1 Calibration

The parameter values used in the simulation exercises below are summarized in Table 1. We assume time periods to be quarters so we use the standard value 0.99 for the discount factor β, for the consumption utility function we assume log utility, i.e. $\gamma = 1$. The inverse Frisch elasticity ϕ we set to one. We assume that 40% of all households do not optimize intertemporally, i.e. $\lambda = 0.4$, a value that is a bit below the one found by Campbell and Mankiw (1989). For ψ, the parameter determining the strength of the risk premium, we follow Bergin (2006) who estimated it to be 0.0038. We assume relatively short-lived shocks with $\rho^a = \rho^Z = 0.9$.

While we assume the home economy to make up 10 percent of the monetary union, i.e. $n = 0.1$, private consumption has a strong home bias with $\omega^H = 0.15$ in the baseline calibration which corresponds to the fraction of eurozone imports to GDP of several countries in the euro area. With deeper integration we increase ω^H to 0.3, which Nakamura and Steinsson (2011) found for US regions which we regard as a natural benchmark for a monetary union. Concerning the import share of the foreign country, we assume $\omega^F = \omega^H(1-n)/n$ which implies symmetry of per-capita quantities between both countries, as explained above.

We set the elasticity of substitution σ to 2, a value that was also used by Nakamura and Steinsson (2011) and Obstfeld and Rogoff (2005). For home and foreign government spending we assume a steady state governemnt spending to GDP ratio G/Y of 0.2. For the government revenue equation we set $\psi_y = 0.3$ in the specification with national fiscal policies and zero otherwise so that taxes inrease by 0.3 percent for an increase in GDP of one percent while taxes react to increaes in government debt with $\psi_d = 0.1$. In the specification with the transfer scheme we set $\phi_{tr} = 0.3$ and zero otherwise.

β	ϕ	σ	ω^H	ω^F	ϵ	$1-n$	λ	α
0.99	1	2	0.15 (0.3)	0.017 (0.033)	9	0.1	0.45	0.8

θ	ρ^Z	ρ^a	ψ	G/Y	ψ_d	ϕ_{tr}, ψ_y	ϕ_π
0.75	0.9	0.9	0.0038	0.2	0.1	0 (0.3)	1.5

Table 1: Parameters

The elasticity of substitution between goods produced in the same country, ϵ, is set to 9 which corresponds to a steady state price markup of 12.5 percent. Prices are re-set on average once a year, so that $\theta = 0.75$, and the central bank reacts to inflation with the standard Taylor cocefficient $\phi_\pi = 1.5$.

3.2 Relative Demand Shock: Flexible Exchange Rates and Monetary Union

Figures 1, 2 and 3 show the impulse responses to a shift away from domestic and towards foreign goods for a scenario where each country has its own monetary policy and where both countries are linked by a flexible nominal exchange rate (lines with a cross). Furthermore, Figures 1, 2 and 3 show results for a scenario of a fixed exchange rate and a common monetary policy (solid lines), which is the benchmark setting in our analysis. The lines marked by circles correspond to a monetary union setting with deeper integration of goods markets, i.e. a lower average home bias in consumption.

Under flexible exchange rates, output falls due to the shock and with it employment, real wages, marginal costs and domestic inflation (not shown). In reaction to their reduced income, rule-of-thumb consumers reduce spending, while in reaction to the reduced domestic inflation, the central bank reduces the nominal interest rate which depreciates the currency, and deteriorates the terms of trade. As a consequence of the decrease of the real interest rate, Ricardian consumers increase spending which works towards stabilizing output. The strong deterioration of the terms of trade further offsets the shock because the change in relative prices causes expenditure switching towards domestic goods. Thus, in equilibrium, rule-of-thumb-consumers' income is stabilized and consumption and employment move only little.

In the foreign economy two effects work in opposite directions: The relative shift in favor of its products increases aggregate demand and output and thereby employment, real wages and marginal costs. This in turn drives up inflation, the nominal and real interest rate which partially reduces aggregate demand through a reduced consumption of foreign Ricardian households and an improvement of the terms of trade that reduces net exports.

The net effects of these adjustments is that both employment and consumption in both economies is remarkably stable while aggregate output is stabilized by the central banks by affecting Ricardian households' consumption through real interest rates (up and down, respectively) and through net exports by quickly affecting the terms of trade through the nominal exchange rate. The reaction of the central banks and the depreciation of the currency thus provide an effective stabilization tool of aggregate consumption and

employment from the perspective of both economies.

Next we turn to a scenario where Home and Foreign form a monetary union by fixing the nominal exchange rate between them and setting up a common central bank that now sets the short term interest rate as a weighted average of the two countries' inflation rates. The central bank's response to the shifting in demand is now dominated by the inflationary effects of the foreign economy because of the small weight of the domestic economy in the central bank's objective function. The nominal interest rate thus increases. This implies that the real rate increases in the home economy where we have deflation (not shown) while it falls in the foreign economy (the rise in inflation dominates the increase of the nominal rate). The fact that the weak reaction of the central bank is dominated by changes in average inflation rates in both countries exacerbates the effect of the shock: In home, Ricardian consumers reduce their consumption while they increase consumption in foreign. At the same time, there is no change in the nominal exchange rate, the terms of trade deteriorate a lot less so the expenditure switching effect is muted as well compared to the flexible exchange rate scenario. Rule-of-thumb consumers' income thus falls which they try to offset by increasing their labor supply.

In the foreign economy, the lower real interest rate boosts Ricardian consumers' consumption (rather than reducing it as under flexible exchange rates). Consumption of rule-of-thumb households also increases due to the rise in income. They can now afford to supply less labor, as their marginal utility of working more falls with the strong increase in consumption.

Employment and consumption are thus a lot more volatile than under flexible exchange rates in both economies. Stabilization through monetary policy is thus a blunt tool in the presence of an asymmetric demand shock. The two countries' business cycles move a lot more in opposite directions in response to the relative demand shock than under flexible exchange rates. However, we will see that to some extent this can be mitigated by reducing the strong home-bias in consumption.

For that purpose, we increase the fraction of foreign produced goods in the domestic consumption index from 0.15 to 0.3 to increase it to the US benchmark (see Nakamura and Steinsson, 2011). We interpret this as an increase in trade integration that may be related to the fact that the monetary union boosts trade (the "Rose effect").

The lines denoted with a circle in figures 1-3 show the results for a currency union for the scenario of deeper integration. One can see that the impulse responses for aggregate output, consumption and employment are in between the responses under less integrated goods markets under flexible exchange rates and under the benchmark monetary union scenario. Integration thus leads to a reduction in employment and consumption volatility in

response to the shock in a monetary union, but it cannot fully replace the independent monetary policies and the flexible exchange rate.

The reason behind the more benign adjustment than under less integrated goods markets is, of course, the fact that a stronger integration implies that the impact of fluctuations in consumption on output is to a higher degree distributed over both countries. To provide comparability between both scenarios, the absolute change in the home bias of both countries is the same under higher integration as in the baseline scenario.[12]

Policies that increase the degree of integration can thus be regarded as important steps to build an optimum currency area.[13] However, as long as the degree of economic integration in a currency union like the euro area is not large enough to offset the asymmetric effects of asymmetric shocks and since such policies are unlikely to result in a quick change of market structures, other adjustment mechanisms are needed, at least for the time being. We now turn to two candidates, national fiscal policies and the union wide transfer mechanism.

3.3 Relative Demand Shock: National Fiscal Policies and Transfers

An obvious candidate for a stabilization tool is national fiscal policies, another is transfers between the two economies. We first turn to fiscal policies and then compare their effectiveness with that of the transfer mechanism introduced above. Figures 4 through 6 illustrate the impulse responses to the relative demand shock for the monetary union benchmark scenario (solid lines), which is the same as in figures 1-3, the scenario with national fiscal policy (lines with circles) and the scenario with the transfer scheme (lines with crosses).

As Ferrero (2009) demonstrated in his model, the optimal fiscal policy at the national level within a currency area is one that allows government budget deficits to offset asymmetric shocks and thereby government debt to fluctuate over the business cycle. However, this optimality result was based on the assumption of perfect capital markets. The run on government debt markets in the recent crisis shows that there are times when such an optimal policy stance is clearly infeasible. And even before the crisis the

[12] For the seminal work on the effect of the degree of trade integration on the optimality of a common currency see McKinnon (1963).

[13] Of course, until we haven't set up a welfare function we cannot infer normative results and thereby "optimal" policies or optimality of a currency union from this positive analysis. Below, however, we will show that a higher volatility of employment translates into lower welfare.

degree of financial market integration remained incomplete (see Lane, 2009). Furthermore, in normal times national fiscal stabilization can only work to the extent that Ricardian equivalence effects are not at play.

In our model, despite the existence of rule-of-thumb-consumers, the fact that the governments' creditors are intertemporally optimizing households, Ricardian equivalence effects do matter. The anticipation of the long-run consolidation of the public budged reduces the effectiveness of fiscal policy because the reduction of taxes is entirely financed by credit from Ricardian households. Because the tax reduction also applies for rule-of-thumb consumers, the amount of credit given out per Ricardian household exceeds the reduction of taxes per person. The resulting net decrease of the Ricardian's income during the time when taxes are below trend is reversed in the later period when the government consolidates its budget, financing the redemption of debt by above-trend taxes. This temporal fluctuation of income has a present value of zero, neglecting interest. The Ricardian household offsets the fluctuation by borrowing from the foreign country when taxes are lowered while repaying the debt when taxes are above trend level. As the present discounted value of the tax change is zero he does not change his consumption. This behavior of Ricardian households restricts the efficacy of fiscal policy to influence aggregate demand to credit-constrained households.

However, the presence of a risk-premium gives rise to an additional mechanism which further impedes the efficacy of this kind of fiscal policy. As borrowing by Ricardian households increases due to the policy intervention, this policy measure indirectly increases the interest rate which is a positive function of the stock of external debt. The resulting slight decrease of consumption is observed in figure 6. The increase in the perceived default risk thus decreases the effectiveness of the national anticyclical tax policy even further.[14]

Taking a look at the whole picture, we observe that despite these weakening mechanisms, the direct effect on the consumption of rule-of-thumb households (figure 6) leads to a reasonable amount of stabilization of aggre-

[14]Please notice that the reasoning of this passage does not depend on the fact that the government finances itself exclusively via credit from domestic Ricardian households. If governments were to sell bonds to foreign households, the fiscal policy's effect on the Ricardian household's budget would be zero in present-value terms as well. The reason to choose the specification at hand is that if governments sell bonds only to domestic Ricardian households, then the occurrence of the risk-premium related to private net foreign debt is conditional on the presence of Ricardian equivalence: Government debt is passed on to the foreign country (where it evokes the premium) just when equivalence holds. In the alternative specification in which the government sells its bonds to foreign households, a risk premium related to the government's net external debt would raise the interest rate independent of the behavior of the Ricardian households.

gate output and employment (figure 4).

A tool that is not subject to Ricardian equivalence effects and resulting risk premia is the transfer between countries introduced above. In order to make the national fiscal stabilization scenario quantitatively comparable with the fiscal transfer scenario, we set $\phi_{tr} = \psi_y = 0.3$.[15]

After the shock, domestic households receive a transfer and one can clearly see that both rule-of-thumb and Ricardian consumers' consumption increases relative to the benchmark scenario. The fact that the Ricardian households' consumption reacts strongly to the transfer (when compared with the scenario without transfers and compared to the scenario with taxes) is due to the fact that these households do not regard it as temporary. Conditioning on this specific shock it is a gift that does not have to be returned to the donor.

Another interpretation of the transfer mechanism is that it works like an insurance: The resources that the Ricardians regard as available are no longer determined by the present discounted value of current and future domestic output but rather by a weighted average of the present discounted values of domestic and foreign output. Any asymmetric changes in output therefore have a muted effect on Ricardian households' consumption response.

The muted consumption responses also imply that the deviations of employment from the steady state are lower after the shock, in particular of rule of thumb households. This result will turn out to be crucial for the increase in welfare that will be shown below. This is a remarkable finding, given that transfers between countries are zero in unconditional expectations if shocks are assumed to be evenly distributed over member countries. That is, the welfare improvement from this policy is a free lunch in the sense that in unconditional expectations every member country is better off.

As the transfer mechanism is constructed as a transfer between households across the monetary union rather than between governments, it very much mimics an unemployment insurance. An unemployment insurance has the advantage that it acts in a quasi-automatic and immediate fashion: When incomes fall due to temporary unemployment, households receive a transfer without delay, thereby quickly stabilizing aggregate demand. And as unemployment insurance schemes are only designed to support short-term or

[15] In the transfer-rule, parameter ϕ_{tr} multiplies the difference of output gaps in both countries, while in the two fiscal rules ψ_y multiplies the output gap of the respective country. Albeit the differences are of negligible order, we cannot claim with certainty that the policies employed in both scenario are perfectly comparable with respect to their budgetary effect on households. In chapter 3.5, we pick up on this issue and present a comparison which ensures that the budgetary effects of both policies are absolutely identical.

medium-term unemployment, any increase in long-term unemployment related to a decline in trend growth is not covered. And this is exactly what our model implies.

The alternative, a transfer between governments, would be much more difficult to implement. It would require the difficult task to determine the state of the business cycle in real time. This is difficult because it is almost impossible to differentiate efficient from inefficient fluctuations in real time. Furthermore, transfers between governments intended to affect aggregate demand are likely to suffer from the same time lags as discretionary spending programs.

One way of interpreting the transfer mechanism is to regard the effect of the shock on the foreign economy as an externality (in this case a positive one) that the foreign economy is exposed to. The transfer ensures the domestic economy internalizes this externality. Furthermore, the transfer is "self-financed" by the effect of the shock on the foreign economy in that it simply reverses the increase in output due to the shock.

3.4 Productivity shock

Figure 7-9 show the adjustment to an exogenous increase in total factor productivity in the scenario of no policy intervention (solid lines), fiscal policy as defined above (marked by circles) and the transfer scheme (marked by crosses). First, we focus on the scenario of no policy intervention. Here two effects work in opposite directions: The increase in total factor productivity causes a reduction of marginal costs and firms able to re-set their prices reduce them. In the monetary union setting, the central bank reduces its policy rate less than neccessary to reduce the short-term real rate when the shock occurs in a small member state. The real rate thus increases initially but falls later on as prices return to their initial levels so that the overall effect on the long-term real rate (i.e. the cumulative short-term rates) is negative. Ricardian households' consumption thus increases. However, as this increase in demand is muted in the currency union setting (because the central bank reduces its policy rate only slightly), the increase in Ricardians' consumption demand does not offset the fall in labor demand due to the increase in productivity. The real wage and employment thus fall and consequently rule-of thumbers' consumption which further depresses output, employment and wages. However, a second effect works against this contraction. The decrease in marginal costs causes a decrease in domestic inflation and thereby a depreciation of the terms of trade. This triggers expenditure switching away from foreign and towards domestic goods, increasing aggregate demand, output and employment.

Both effects jointly explain the adjustment of output observed in the figure: The adverse effect caused by the rule-of-thumb consumers dominates in the first two periods when the impact of the shock is still strong and the depreciation of the terms of trade has not yet accumulated to its maximum. As time elapses, the advancement of the shock's decay reduces the strength of the adverse effect stemming from the rule-of-thumb consumers, while the depreciation of the terms of trade further accumulates and thereby enforces expenditure switching. Hence, the second effect is dominating from period two on, and we observe a sustained increase in output subsequent to the initial slump.

Now we turn to the two policy measures under study, which both cause an increase in output and thereby a reduction of the loss in employment, the welfare-relevant variable. First notice that under flexible prices, there would be a stronger increase in output as all firms would be able to instantly lower prices in order to induce more expenditure switching and increase output. As both policies aim at reducing the gap to the natural allocation caused by the price rigidity, they boost output via the reduction of taxes or by the receipt of a transfer. From the same reasoning as in the previous section, the output-enhancing effect of fiscal policy is constrained by Ricardian equivalence and, further limiting the policy's efficacy, by resulting effects of the risk premium. As these impediments to not apply for transfer payments, we observe a stronger increment of output in the latter case, implying a better stabilization of employment.

3.5 Comparison

In this section, we make tax- and transfer policies directly comparable by constructing a transfer-scheme in which transfers substitute tax-policies to an extent such that the budgetary effects for households are identical for both policy measures. Thereby we show that the substitution of national fiscal policies by transfer payments offers more "bang for the same buck" in terms of stabilizing the macroeconomic environment in the monetary union.

In building the setup for this experiment, we first slightly modify the taxation-rules of both countries by adding the respective transfer payment. Hence, for country H we have:

$$T_t = G + \psi_y \left(Y_t^H - Y_t^{n,H} \right) + \psi_d A_t / P_t^H + Tr_t^H$$

This specification implies that cross-country transfers substitute fiscal policy measures. Consider e.g. a situation in which fiscal policy schedules an

increase of taxes while at the same time the transfer scheme schedules the payment of a transfer. In the policy rule at hand, the rise in T_t is reduced by the amount of transfer-payments $Tr_t^H < 0$.

The aim of this experiment is to compare the exclusive use of national fiscal policies to a scenario in which national fiscal policies are partly substituted by cross-country transfers. The crucial step is to ensure that the budgetary effects for households are identical in both scenario. To understand how we achieve this aim, consider that a cross-country transfer means a loss for the households of the paying country and a gain for the households of the recipient country. This means for our purpose that we have to restrict the flow of cross-country transfers to situations in which the transfer's budgetary effects in both countries are backed by fiscal policy measures which have the same budgetary effect. Hence, the transfer only substitutes the tax measure which exist in the alternative scenario and we end up with the same budgetary positions in both countries under both scenarios. To give an example, consider a situation in which fiscal rules imply tax schedules moving in opposite direction in both countries. In such a situation, a tax increase in one country is substituted by a payment of a transfer to the other country, while in the other country the tax decrease is substituted by the receipt of the transfer.

The following transfer scheme fulfills the requirement of restricting transfers to the above mentioned situations:

$$Tr_t^H = \min\left\{\max\left[-\psi_Y\left(Y_t^H - Y^{n,H}\right), \frac{n}{1-n}\psi_Y\left(Y_t^F - Y^{n,F}\right)\right], 0\right\}$$

$$+\max\left\{\min\left[-\psi_Y\left(Y_t^H - Y^{n,H}\right), \frac{n}{1-n}\psi_Y\left(Y_t^F - Y^{n,F}\right)\right], 0\right\}$$

$$nTr_t^F = -\left(1-n\right)Tr_t^H$$

To see how this scheme works, first notice that the transfer is defined in per-capita units of the home country. The related transfer in the foreign country is governed by the second equation, taking into account different country sizes. If a transfer occurs, it substitutes changes in taxation from national fiscal policy via the last terms in the fiscal rules as explained above. Now consider the transfer scheme itself: The first term implies that a transfer is paid out by country H ($Tr_t^H < 0$) if taxes are increased in the home country ($\phi_Y\left(Y_t^H - Y^{n,H}\right) > 0$) and and the same time decreased in the foreign country ($\phi_Y\left(Y_t^F - Y^{n,F}\right) < 0$). In this case, the inner max-function selects the tax-variation which is smaller in absolute value (both of its arguments are

negative), while the outer min-function has no effect as the resulting value of the inner function is negative.

Hence, country H pays a transfer in the magnitude of the weaker of the two opposite tax-variations. This leads to a full substitution of the weaker tax-variation: While the total effect on the households' income remains unchanged, this income is now paid (received) as a transfer instead of being paid (received) as a tax variation to (from) the respective government. The stronger of the two opposite tax-variations is partially substituted by transfers, keeping the total effect on the household´s income constant as well.

The second term triggers transfers paid out by country F in situations in which national policies schedule a tax increase in country F and a tax reduction in country H. Then the inner min-function selects the magnitude of the smaller policy which determines the size of the transfer. It can easily be verified that for tax changes in the same direction in both countries no transfer occurs.

With this transfer scheme and the modified taxation-rules introduced above, we can compare the different policies knowing that both policies bear the very same effect on the households' income in both countries. This property of the comparison is crucial because it allows the following conclusion: As shown below in the simulation exercises, the policy regime in which national policies are partly substituted by transfers achieves a higher degree of macroeconomic stability than the scenario without transfers. *Since the policies prevailing in both scenarios have exactly the same effect on household income in either country, this gain in macroeconomic stability has to be due to a superior stabilizing effect of transfers, as all things except the partial substitution of anti-cyclical taxation are equal.* In other words, one unit of income has to have a stronger stabilizing effect if it is transferred between the countries than if it was deducted from the households' income via tax-increases in the paying country and given to the household in the recipient country via tax reductions.

We now turn to a simulation exercise for which we present the percent reduction in employment volatility due to the partial substitution, holding all households' budgetary positions constant. The simulation comprises 1000 periods and 1%-shocks to both countries' import shares (preference shocks) as well as 1%-shocks to both countries' total factor productivity.[16,17]

[16]The simulation is conducted using the extended-path method in Dynare. We do not show the means under both scenarios as they are identical because of the deterministic method.

[17]The reason we do not use the transfer scheme of this experiment in the welfare analysis below is a technical one: The use of max() and min() functions requires a global deter-

Shock	Variable	% Reduction of Variance
preferences	N^H	16
	N^F	16
technology	N^H	45
	N^F	19

Table 2: Comparison transfer and tax policy

The volatility of employment falls in both countries if national fiscal policies are substituted by transfers. Unsurprisingly the reduction is considerably larger for the small home economy. Hence, this experiment confirms the reduction in the volatility of employment.

3.6 Union wide public goods and implicit transfers

So far we have set up transfer schemes as explicit transfers between households. However, an important mechanism which in existing currency unions allows for implicit transfers across regions is the changing contributions to the provision of union-wide public goods. When a regional recession occurs, federal tax payments fall and other regions have to bear a bigger share of the tax burden (unless federal debt increases). In this section, we propose a mechanism with such implicit cross-country transfers arising from the centralized provision of union wide public goods, denoted G^{union}. We also sketch a normative argument in favor of such implicit transfer from a public finance perspective by referring to the Samuelson rule.

It is assumed that all citizens of the union consume the same constant amount of G^{union}. Concerning funding, we assume a simple taxation scheme in which the fraction of a country's output devoted to finance the union-wide public good is the same for all countries in the long run. Accordingly, with our assumption of equal per capita GDPs, the financing scheme does not imply long-run transfers between the regions. However, short-run fluctuations of per capita taxes give rise to transfers towards member states facing negative shocks. The financing scheme is governed by the following set of equations:

$$T_t^{union,j} = \tau Y_t^j + X_t \qquad j \in [H, F]$$

ministic solution method which does not allow for a technically flawless welfare analysis. Hence, we only report the simulated second moments of employment under both scenarios. Employment volatility will be shown to be the welfare relevant variable.

$$(1-n)\left(\tau Y_t^H + X_t\right) + n\left(\tau Y_t^F + X_t\right) = G^{union}$$

Taxes paid to the union level are split into cyclical components τY_t^j and a corrective term X_t which is the same for both countries. The corrective component X_t is determined by the second equation, which ensures a balanced budget in every period.

The tax rate τ equals the share of G^{union} in every country's long-run output, so that total tax revenues arising from cyclical payments of all member states cover G^{union} in the absence of shocks. Hence, we have $X_t = 0$ in the steady state.

To see why this scheme implies cross-country transfers in the face of asymmetric shocks, notice that a difference in output levels implies a difference in the cyclical components of taxes paid to the union. From the second equation, the symmetric correction term will adjust such that total revenues received by the union remain constant. This construction gives rise to cross-country transfers, as, for example, a positive deviation of output in one country increases the taxes this country pays from the cyclical component, so that the correction term turns negative for the union's budget to remain balanced. Hence, the country facing the positive shock pays a higher total amount of taxes for the same level of public goods, while the additional revenues are distributed as tax-refunds in the rest of the union. Also notice that no implicit transfers arise if both countries face the same level of output. In the case of $Y_t^H = Y_t^F = Y_t$, the second equation implies $X_t = G^{union} - \tau Y_t$ so the correction term simply offsets fluctuations in the cyclical components. Hence, taxes paid by both countries remain unchanged if the shock is symmetric.

Figure 10 illustrates the macroeconomic implications of a partial shift of the provision of public goods on the union level. In this figure we again compare two scenario: In the baseline scenario of a monetary union, national governments spend 20% of each country's GDP to finance the provision of national public goods (no markers). In the second scenario (marked by circles), 10% of each country's GDP is devoted to finance the provision of a union-wide public good, while 10% of each country's GDP remain used for national-wide public goods. We consider the preference shock introduced above, that is a 1% change in import shares.

Focusing on both countries' contributions to the financing of the union-wide public good, we observe that taxes paid to the union decrease in the home country and increase in the foreign country. This is of course driven by the cyclical components τY^H and τY^F, because the adjustment component is almost constant due to the symmetric effect of the shock.

The budgetary effects of this financing scheme closely mimics the transfer scheme studied in this paper: The country subject to a adverse shock enjoys a tax-reduction financed by the country which is in a more favorable position. Furthermore, fluctuations of each country's contribution is zero in expectations, so there is no transfer of resources in the long run. The stabilizing effect induced by this financing scheme is not limited to rule-of-thumb consumers, because there is not Ricardian equivalence as a transfer of resources does not bring about a reallocation in the reverse direction in the future.

Hence, the shift of the provision on public goods on the union level has the very same macroeconomic implications as the setup of the proposed transfer scheme. In the figure, we observe a considerable stabilization in output, consumption and employment in either country. Behind this effect is the same reasoning as the stabilization provided by the transfer scheme discussed in the previous chapter. Unsurprisingly, the gain in macroeconomic stability implies a gain in welfare, as shown in the next chapter.

It is easy to make the normative case for such implicit transfers by alluding to the Samuelson rule (Samuelson, 1954). The Samuelson rule states that the sum of marginal rates of substitution between the public good and the private good of all households in the union has to equal the relative price of the public good. The constant level of the public good implies a constant level of marginal utility of consuming it across the union. In a regional recession, the marginal rate of substitution falls in that region (because of a fall in consumption) and, given convex marginal utilities of consumption, an optimal tax scheme would imply a reduced taxation in that region and an increased taxation in the other regions in order to return to an optimum.

4 Welfare Analysis

In order to compare the different scenarios of sections 3.2-3.4 and 3.6 in their effect on the countries' welfare, we employ the following welfare function $\mathbb{W}_t^H$ that is a weighted average of the Ricardian household's intertemporal utility function and an intertemporal utility function of the rule-of-thumb consumers:

$$W_t^H \equiv \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left\{ \begin{array}{c} (1-\lambda) \ln C_{t+k}^A + \lambda \ln C_{t+k}^N \\ -(1-\lambda) \frac{\left(N_{t+k}^A\right)^{1+\phi}}{1+\phi} - \lambda \frac{\left(N_{t+k}^N\right)^{1+\phi}}{1+\phi} \end{array} \right\} \tag{7}$$

We thus assume that the rule-of-thumb consumers' consumption and employment can be evaluated from an intertemporal perspective even though

they do not use this perspective for their consumption choice. For the foreign economy an according welfare function applies.

In the appendix we show that when employing a second order approximation to $\mathbb{W}_t^H$, one can express the welfare loss of business cycle fluctuations, expressed as a fraction of steady state consumption, as a function of the weighted unconditional variances of employment[18]:

$$\mathbb{W}_t^H - \mathbb{W}^H = -\left[(1-\lambda)Var\left(N_t^A\right) + \lambda Var\left(N_t^N\right)\right]$$

for $\phi = 1$. The relative welfare gain (in percent) of moving from the benchmark scenario to a scenario $i \in (1,2,3,4)$, denoted as $\Delta_t^i \equiv 100 * \frac{\left(\mathbb{W}_t^H - \mathbb{W}^H\right)_i - \left(\mathbb{W}_t^H - \mathbb{W}^H\right)_j}{\left(\mathbb{W}_t^H - \mathbb{W}^H\right)_j}$, is therefore

$$\Delta_t^i = 100 * \frac{(1-\lambda)Var_i\left(N_t^A\right) + \lambda Var_i\left(N_t^N\right)}{(1-\lambda)Var_j\left(N_t^A\right) + \lambda Var_j\left(N_t^N\right)} - 1$$

where $\mathrm{Var}_i\left(N_t\right)$ with $i \in (1,2,3,4)$ is the variance of employment under scenario i and index j stands for the benchmark scenario. Table 3 presents these gains relative to the benchmark currency union scenario for the scenarios shown in section 3 (note that a negative sign indicates a welfare gain compared to the benchmark because volatility falls for higher welfare levels):

		Δ_t^i					
		Scenario					
Type of shock	Country	(1) Fl. Ex. Rate	(2) Deeper Integr.	(3) Fisc. Policy	(4) Transfer	(2),(3), (4)	(5) Publ. Goods
De-mand	H	-97	-61	-31	-45	-79	-18
	F	-100	-60	-40	-40	-80	-20
Produc-tivity	H	-91	-52	-36	-51	-64	-4
	F	-48	-20	-21	-19	-46	-1

Table 3: Welfare gains compared to currency union benchmark (in %)

[18] The variance of consumption drops out of this expression for the special case of log utility.

The welfare effects were computed for both the domestic and the foreign economy by running simulations over 100000 periods for the two shocks separately but for both countries affected by country specific shocks. Table 3 tells the same story as the impulse response functions presented above: The benchmark currency union incurs significant welfare costs in terms of employment volatility both when compared to a flexible exchange rate scenario and when compared to a currency union with a high degree of goods market integration, fiscal stabilization and fiscal transfers. The biggest welfare gains within the currency union arrangement are to be expected from a deepened integration of goods markets while a system of transfers allows much larger gains compared to fiscal stabilization at the national level. Lastly, when deeper integration is combined with national fiscal stabilization and the transfer mechanism, welfare in the monetary union increases further but never reaches welfare under flexible exchange rates.

Turning to the differences between the shocks, one can clearly see that for the demand shock, the transfer mechanism clearly dominates the tax policy when the goal is to maximize welfare, i.e. minimize employment volatility. Welfare is clearly higher for the small domestic economy while it is at the same level in the foreign economy. In contrast, for the productivity shock the transfer dominates only for the small domestic economy, the large foreign economy is worse off. However, as is well-known from the empirical New Keynesian literature (see e.g. Smets and Wouters, 2003), the demand shock is of much bigger importance for overall volatility in the euro area so that a transfer is likely to be a necessary instrument to reduce overall volatility and increase overall welfare.

In light of these results one can certainly ask why one should not simply abandon the monetary union and return to a world of flexible exchange rates which obviously delivers the highest levels of welfare. But one should not forget that we focused on only one aspect of monetary integration, volatility, which has to be assessed jointly with other aspects. One such aspect could be a boost to growth that we cannot adress in our framework.

5 Conclusion

We show that a currency union formed by economies that are not perfectly integrated may experience large volatility and asymmetric business cycles when these economies are hit by asymmetric shocks. We propose a transfer mechanism between the members of the union that can offset these asym-

metric effects and argue that this might be a policy option until deeper trade (and possibly financial and labor market) integration is accomplished. Furthermore, we show that such a transfer mechanism is more effective than fiscal stabilization measures at the national level as Ricardian equivalence effects and risk premia do not arise. Lastly, we show that such transfers increase welfare more than fiscal stabilization.

The mechanism looks very much like an insurance scheme that offsets the effects on consumption caused by deviations of output from trend relative to other member economies' output deviations from trend. When one country booms while another country contracts, a transfer from the booming to the depressed country sets in. Under the assumption of these asymmetric shocks being equally and identically distributed across countries, the net-payments over time will be zero. There is thus no permanent transfer between countries.

The euro area, which is clearly in need for new business cycle stabilization tools but which lacks strong support for deeper political union with a European authority equipped with spending and taxing powers that might be used as a stabilization tools at the national level, this last aspect might make it politically implementable: When the mechanism implies no net transfers on average over time, but a reduced volatility of employment and consumption, everyone is better off. On average, no money is transferred to "Brussels" by richer economies.

One obvious candidate for a real world equivalent of such a mechanism is an unemployment scheme that re-distributes resources across the monetary union. Another, politically more ambitious, candidate is the provision of union wide public goods. We present a variant of the model with taxation rules related to the relative state of the business cycle for financing union wide public goods that allow for implicit transfers across countries and which also have very beneficial welfare effects.

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A Appendix

A.1 Welfare Function

A utility function $U(C_t, N_t)$, when aproximated up to second order around the deterministic steady state, can be written as

$$U(C_t,N_t)-U(C,N)=U_CC\frac{C_t-C}{C}+\frac{U_{CC}CC}{2}\left(\frac{C_t-C}{C}\right)^2 + U_NN\frac{N_t-N}{N}+\frac{U_{NN}NN}{2}\left(\frac{N_t-N}{N}\right)^2$$

Making use of the second order Taylor approximation $\frac{X_t-X}{X}=\widehat{x}_t+\frac{1}{2}\widehat{x}_t^2$ and re-arranging, we get

$$U(C_t,N_t)-U(C,N)=U_CC\left(\begin{array}{c}\left(\widehat{c}_t+\frac{1}{2}\left(1+\frac{U_{CC}C}{U_C}\right)\widehat{c}_t^2\right)\\ +\frac{U_NN}{U_CC}\left(\widehat{n}_t+\frac{1}{2}\left(1+\frac{U_{NN}N}{U_N}\right)\widehat{n}_t^2\right)\end{array}\right)$$

where we neglected terms of an order higher than two. For log utility in consumption and $U(N)=-\frac{N^{1+\phi}}{1+\phi}$ this reduces to

$$U(C_t,N_t)-U(C,N)=\left(\widehat{c}_t-N^{1+\phi}\left(\widehat{n}_t+\frac{1}{2}\left(1+\phi\right)\widehat{n}_t^2\right)\right)$$

Plugging this into equation (7) we get

$$W_t^H-W^H=\mathbb{E}_t\sum_{k=0}^{\infty}\beta^k\left\{\begin{array}{c}(1-\lambda)\widehat{c}_t-(1-\lambda)\left(N^A\right)^{1+\phi}\left(\widehat{n}_t^A+\frac{1}{2}\left(1+\phi\right)\left(\widehat{n}_t^A\right)^2\right)\\ -\lambda\left(N^N\right)^{1+\phi}\left(\widehat{n}_t^N+\frac{1}{2}\left(1+\phi\right)\left(\widehat{n}_t^N\right)^2\right)\end{array}\right\}$$

Taking the limit $\beta\to 1$, we can express the welfare measure in terms of employment variances,

$$W_t^H-W^H=-\frac{1}{2}\left(1+\phi\right)\left[(1-\lambda)\left(N^A\right)^{1+\phi}Var\left(\widehat{n}_t^A\right)+\lambda\left(N^N\right)^{1+\phi}Var\left(\widehat{n}_t^N\right)\right]$$

which, when noting that $Var\left(\widehat{n}_t^A\right)=\frac{Var(N_t)}{N^2}$, can be re-written in terms the employment volatility in levels,

$$W_t^H-W^H=-\frac{1}{2}\left(1+\phi\right)\left[(1-\lambda)\left(N^A\right)^{\phi-1}Var\left(N_t^A\right)+\lambda\left(N^N\right)^{\phi-1}Var\left(N_t^N\right)\right]$$

which reduces to

$$W_t^H-W^H=-\left[(1-\lambda)Var\left(N_t^A\right)+\lambda Var\left(N_t^N\right)\right]$$

for $\phi=1$.

A.2 Impulse Responses

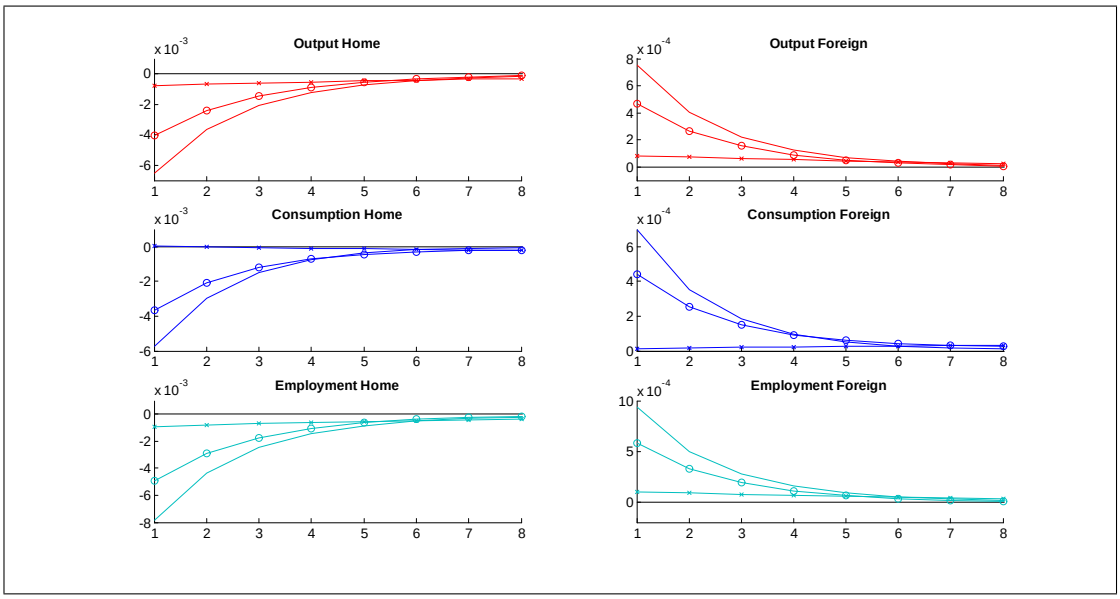

Figure 1: Demand shock, aggregate variables I. *Solid line: MU benchmark; Circles: MU with deeper integration; Crosses: Flexible exchange rate*

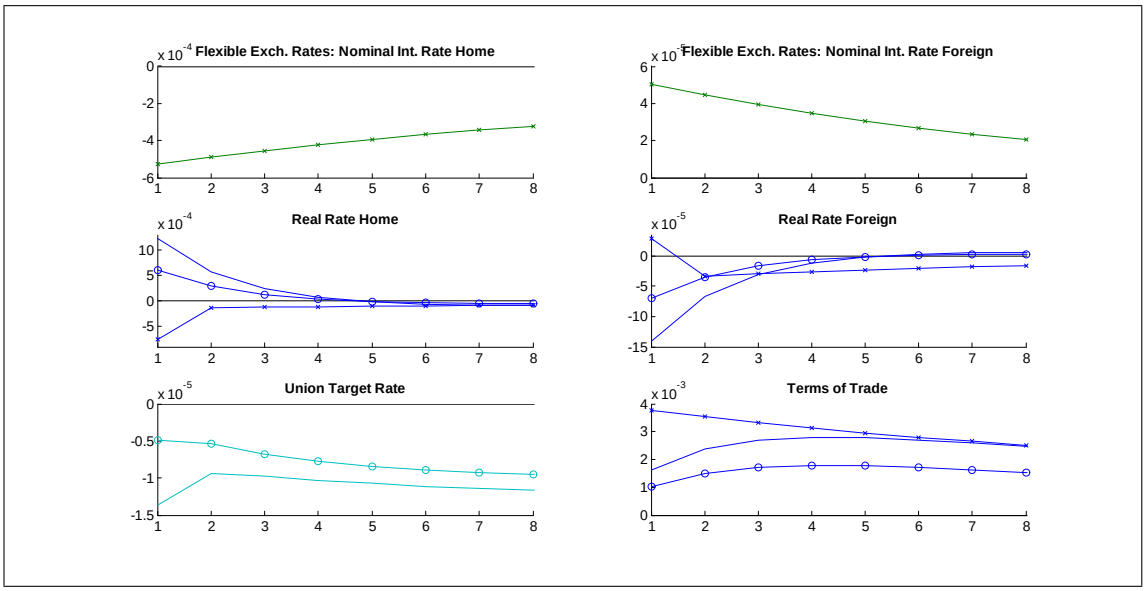

Figure 2: Demand shock, aggregate variables II. *Solid line: MU benchmark; Circles: MU with deeper integration; Crosses: Flexible exchange rate*

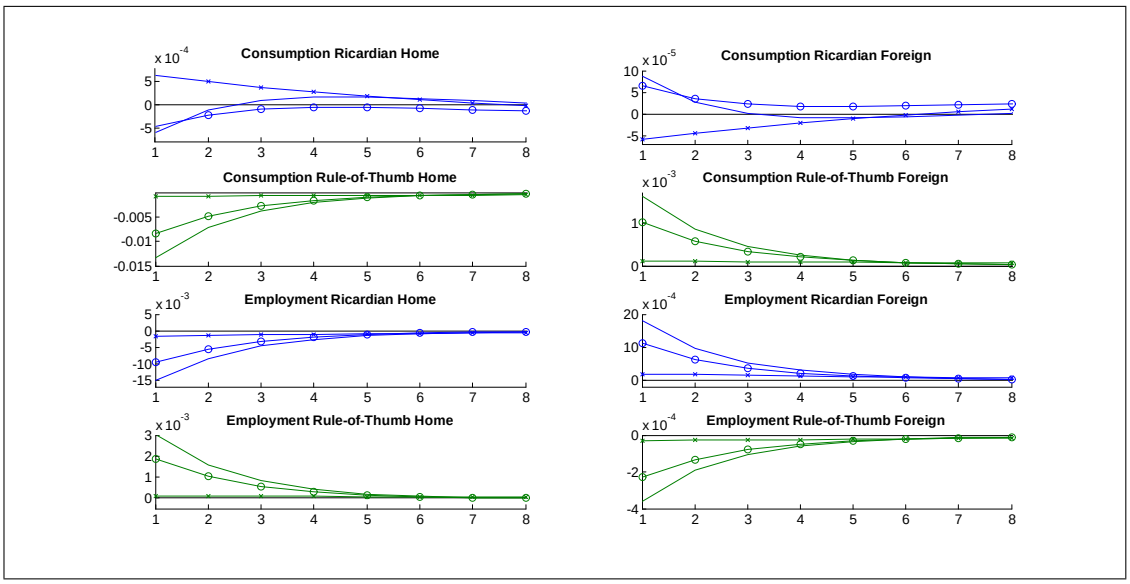

Figure 3: Demand shock, disaggregated variables. *Solid line: MU benchmark; Circles: MU with deeper integration; Crosses: Flexible exchange rate*

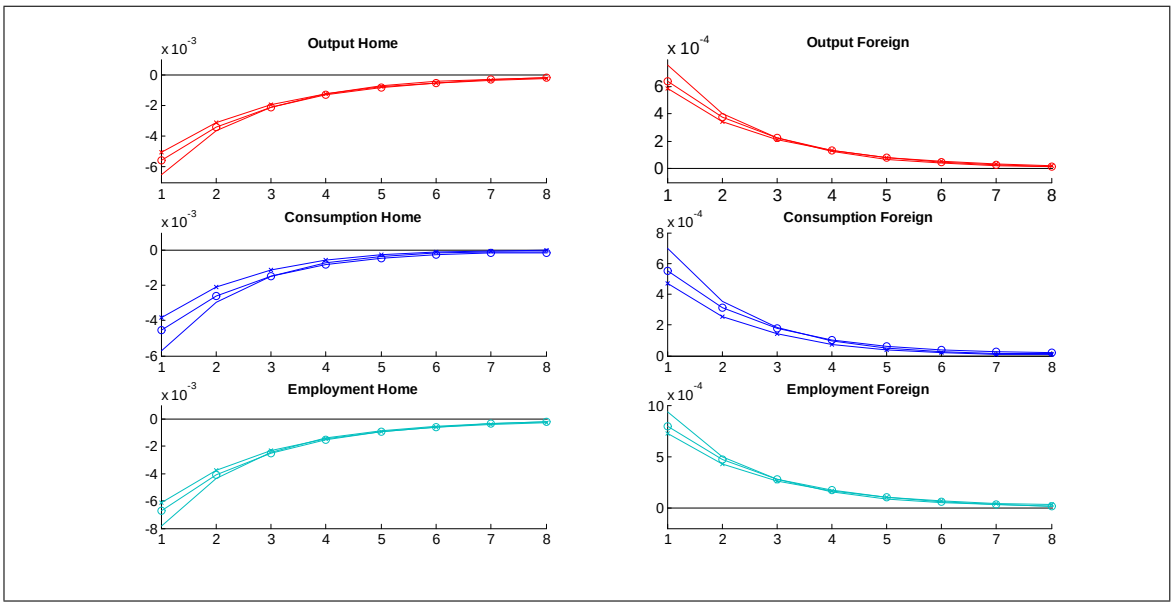

Figure 4: Demand shock, aggregate variables I. *Solid line: MU benchmark; Circles: Tax policy; Crosses: Transfers*

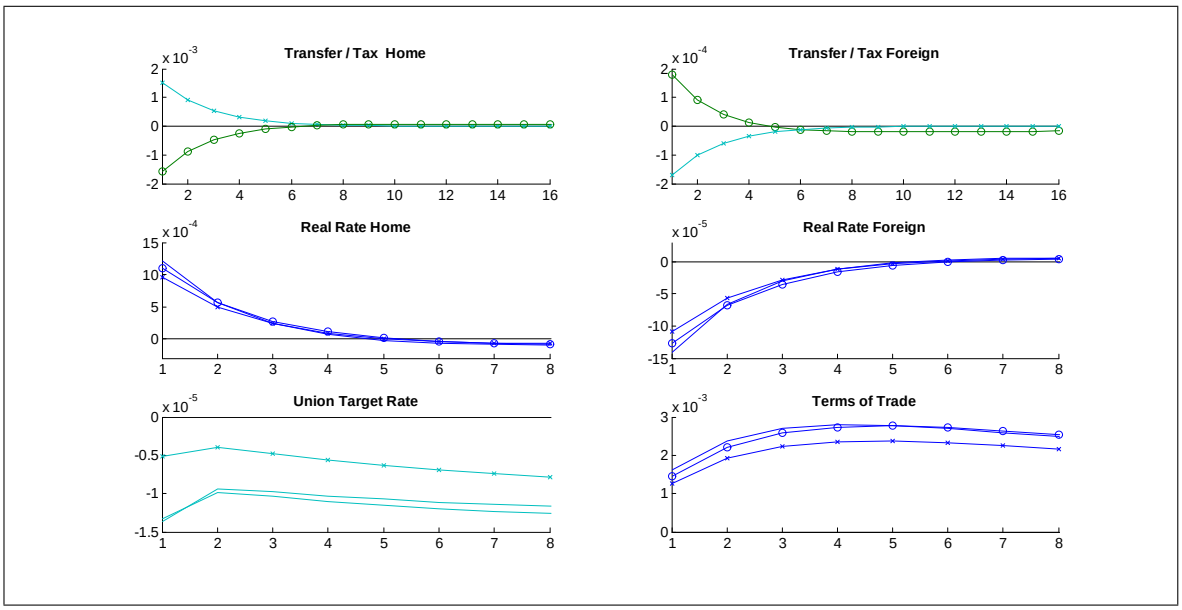

Figure 5: Demand shock, aggregate variables II. *Solid line: MU benchmark; Circles: Tax policy; Crosses: Transfers*

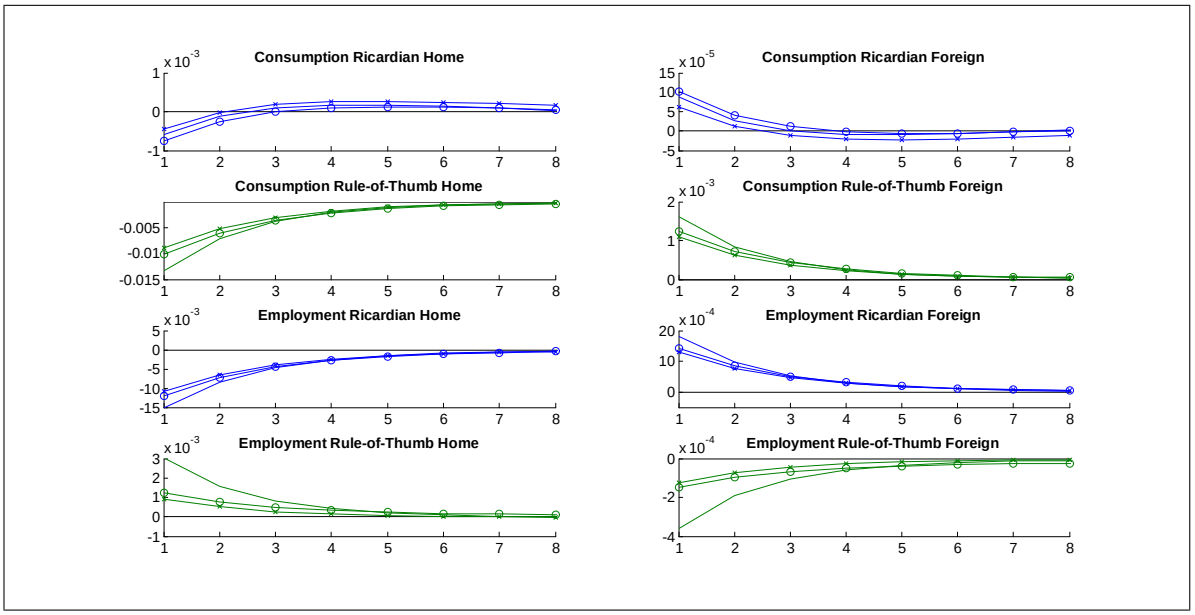

Figure 6: Demand shock, disaggregated variables. *Solid line: MU benchmark; Circles: Tax policy; Crosses: Transfers*

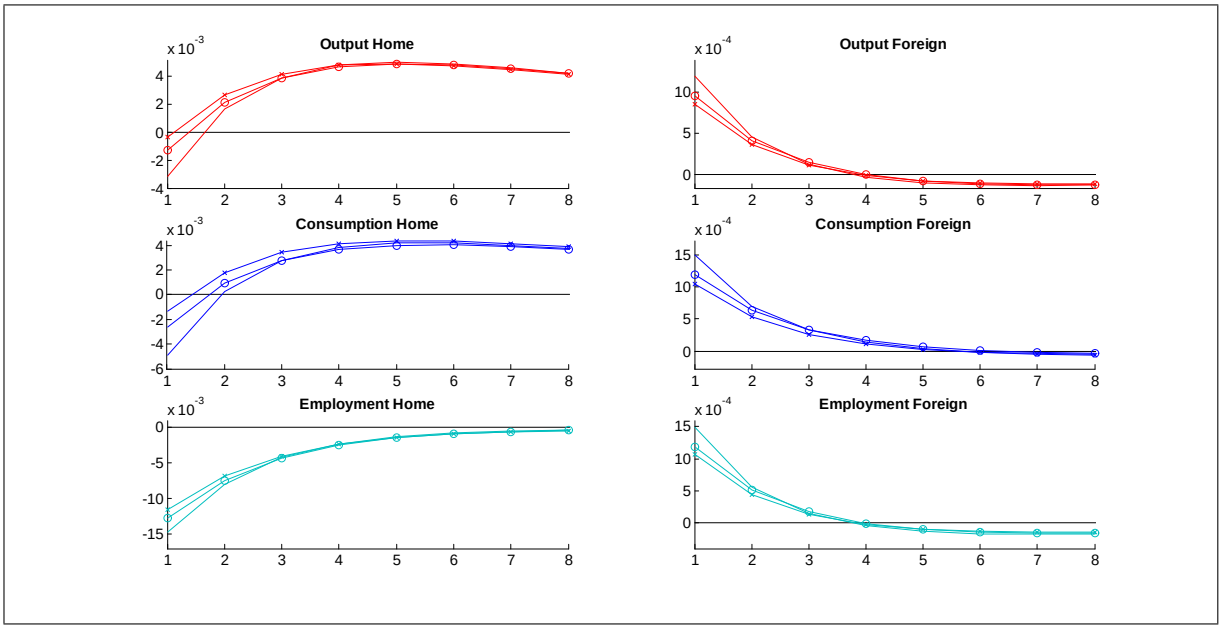

Figure 7: TFP shock, aggregate variables I. *Solid line: MU benchmark; Circles: Tax policy; Crosses: Transfers*

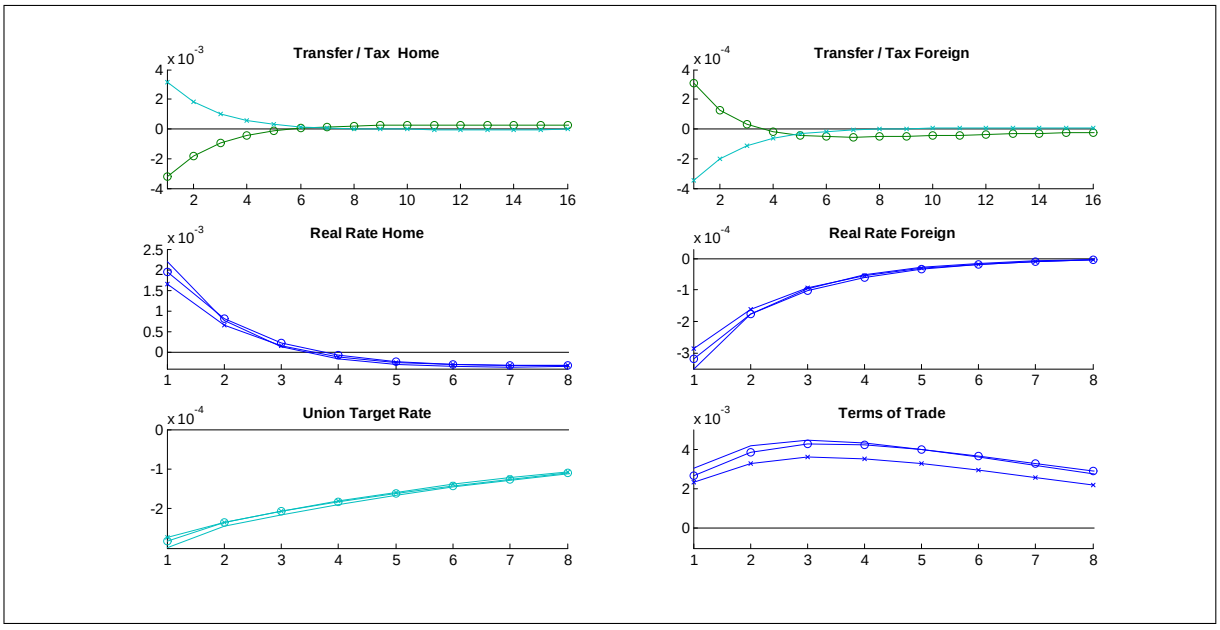

Figure 8: TFP shock, aggregate variables II. *Solid line: MU benchmark; Circles: Tax policy; Crosses: Transfers*

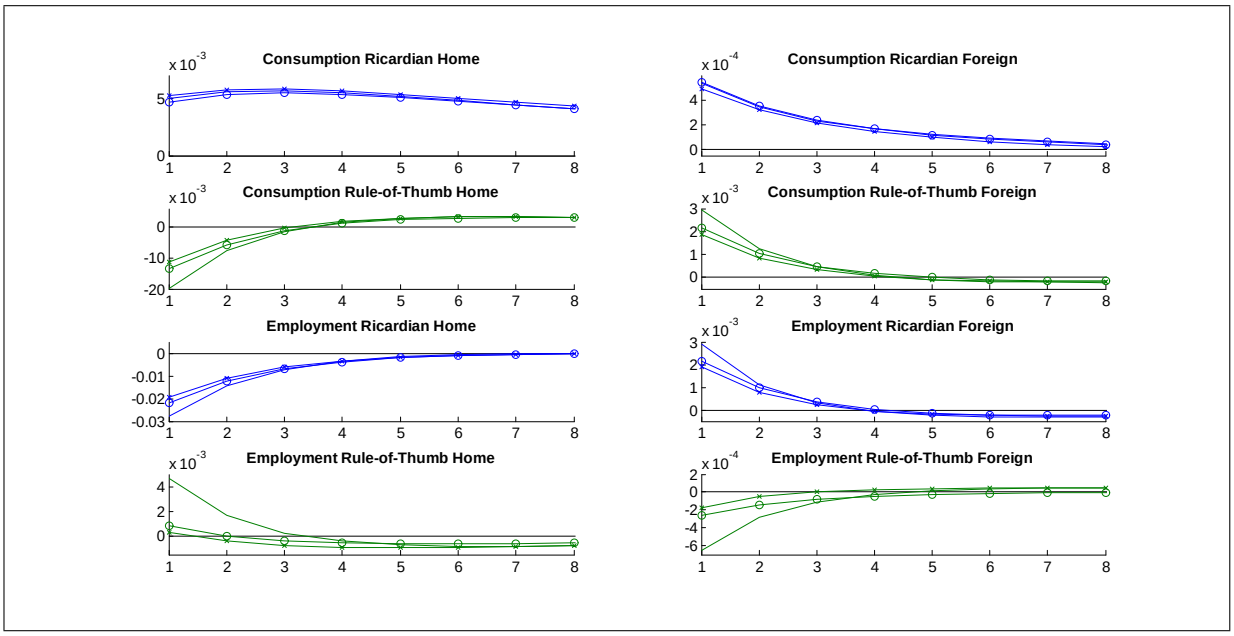

Figure 9: TFP shock, disaggregated variables. *Solid line: MU benchmark; Circles: Tax policy; Crosses: Transfers*

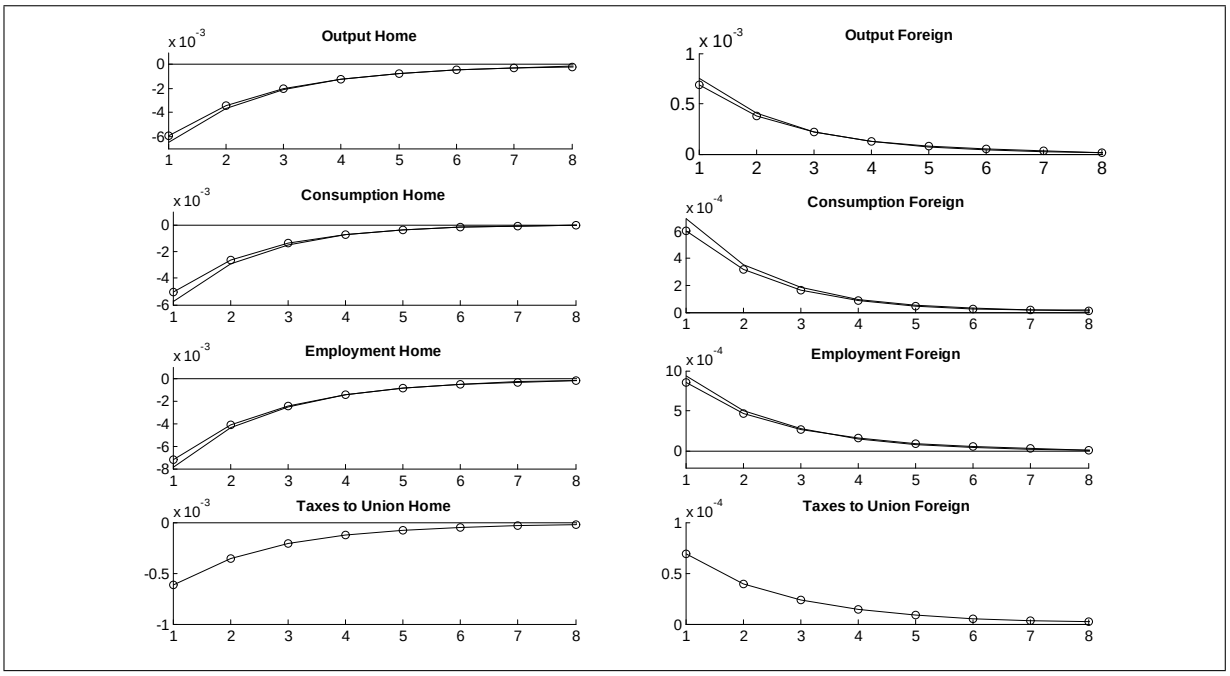

Figure 10: Union-wide public goods versus national public goods. *Solid lines: National public goods; Circles: Union-wide public goods.*

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