Imbalances and Fiscal Policy in a Monetary Union[*]

Ida Hjortsø [†]

December 2011

Abstract

The Eurozone crisis has initiated a debate on the importance of international imbalances for policy making. In this paper, I study how international financial frictions lead to international imbalances and affect the optimal conduct of fiscal policy in a two-country, two-good DSGE model of a monetary union. I show that the presence of international imbalances affects the optimal conduct of cooperative fiscal policies when the internationally traded goods are complements: Government expenditures optimally play a cross-country risk sharing role. The cross-country insurance role of fiscal policy is in conflict with the domestic stabilization role. That is, domestic macroeconomic stabilization is not sufficient for achieving international macroeconomic stabilization. Optimal fiscal policy consists in setting government expenditures such as to reduce international imbalances at the expense of higher domestic inefficiencies.

1 Introduction

The international imbalances within the European Economic and Monetary Union (EMU), illustrated by large current account imbalances and debt differences across countries, are widely seen as one of the main reasons for the Eurozone crisis. This crisis has pointed out the tensions between national and international policy objectives, and has recast the debate over fiscal policy making within monetary unions. In the absence of alternative, potentially more suitable policy instruments, it could be desirable to use national fiscal policies to address international imbalances. In this paper, I investigate whether it is indeed optimal to use national government spending to contain the international demand imbalances which arise in the presence of international financial frictions in a monetary union. That is, I examine the potential cross-country insurance role of fiscal policies in a monetary union.

Within a two-country, two-good model of a monetary union, I show that the international transmission of productivity shocks and government spending and the resulting optimal fiscal policy is dependent on the structure of the international financial markets. Financial frictions are modelled in the spirit of P. Benigno (2001) who analyses the effects of international financial frictions for optimal monetary policy:[1] international financial markets are incomplete and bond yields are debt-elastic, replicating the recent situation within the EMU. Government spending, the fiscal policy instrument, yields utility to agents and shifts demand towards the domestically produced good, thereby affecting output, inflation and international imbalances. Under realistic assumptions, I show that fiscal policy optimally adjusts such as to reduce international demand imbalances illustrating deviations from full risk sharing. That is, fiscal policy acts as a cross-country insurance tool. Higher consumption risk sharing is achieved through relative price movements: changes in government spending affect international prices by shifting relative demand, and thus affect the real exchange rate and relative consumption demand.

The relative importance of the distortions arising due to internationally incomplete markets for the fiscal policy maker is shown to be very sensitive to the trade elasticity: the lower the trade elasticity, the more important is it for the policy maker to limit international demand imbalances. The trade elasticity determines the relative importance of the income and substitution effects of price changes. Hence, a change in prices in one country will either improve its current account or deteriorate it depending on the trade elasticity. As a result, the effects of fiscal policy on international imbalances, achieved through price changes, differ according to the trade elasticity.

For fiscal policy to effectively improve risk sharing across countries it must be able to affect consumption and the real exchange rate in opposite directions. Since these variables are affected in the same direction by fiscal policy under substitutability of the traded goods, decreasing the international demand imbalances requires large and costly changes in government spending. Hence, under high trade elasticities, the optimal response of government expenditures to a country-specific shock consists in stabilizing the national economies, not in redressing the cross-country demand imbalances arising due to international financial frictions. However, under low trade elasticities, the fiscal policy maker optimally acts such as to reduce them; since government spending leads to changes in consumption and the real exchange rate which go in opposite directions, it is possible for the fiscal policy maker to improve risk sharing without too large costs in terms of deviations from the optimal spending composition. That is, when the internationally traded goods are complements, the fiscal policy maker optimally sets policy such as to avoid large deviations from full consumption risk sharing across coun-

---

[1] Note that on the contrary to P. Benigno (2001), I assume that the financial frictions are symmetric across countries, and that home bias in consumption may be present, leading to deviations from PPP.

tries: government expenditures play the role of a cross-country insurance tool. Interestingly, within a monetary union where the traded goods are complements, it is optimal to reduce cross-country imbalances at the expense of larger national inefficiencies, indicating that the best outcome for the union as a whole consists in stabilizing union-wide imbalances at the expense of national imbalances.

To my knowledge, the consequences for fiscal policy of cross-country imbalances resulting from international financial frictions has not been addressed in the literature. The New Open Economy Macroeconomic (NOEM) literature, initiated by Obstfeld and Rogoff (1995), has investigated the relation between international financial frictions and the international transmission of government spending shocks. Sutherland (1996) is the first to consider the effects of international financial frictions on the transmission of fiscal policy within a NOEM framework. He investigates the effects of international portfolio adjustment costs for the transmission of government spending shocks in a two-country model with flexible exchange rates. Pierdzioch (2004) and Koenig and Zeyneloglu (2010) carry out similar exercises within a currency union. These analyses focus on the international transmission of fiscal policy. However, incomplete financial markets across countries do not only affect the transmission of shocks and policies but also create inefficiencies. These inefficiencies potentially affect welfare, and might thus have important implications for optimal policy - also fiscal policy. Some recent contributions to the international literature, such as Obstfeld and Rogoff (2002), P. Benigno (2009), or Corsetti et al. (2011) consider the effects of internationally incomplete markets for optimal monetary policy. However, these authors leave aside the analysis of the monetary and fiscal interaction, of the trade-off faced by the fiscal policy maker, and of the consequences for optimal fiscal policy, issues that I address here.

Within a monetary union where countries might be hit by asymmetric shocks, the implications of international financial frictions may be particularly important for the optimal conduct of fiscal policy because monetary policy is not available to address these shocks. Both Beetsma and Jensen (2005) and Gali and Monacelli (2008) point out the importance of the assumption of perfect risk-sharing within their analyses of optimal fiscal policy in a monetary union. However, they do not investigate the consequences of imperfect risk sharing in their research. I fill this gap in the literature and show that when national monetary policies cannot complement fiscal policies in redressing cross-country imbalances, the fiscal policy maker faces an important trade-off which cannot be characterized by domestic objectives: he must chose whether to stabilize output gaps, inflation, or limit the inefficiencies arising due to international financial frictions - thereby facing an additional objective, absent under complete markets. One implication of international financial frictions for the optimal conduct of fiscal policy within a monetary union is thus that optimal policies cannot be achieved by focusing on domestic objectives exclusively.

My analysis has important implications for the conduct of fiscal policy within the EMU. I show that, under realistic assumptions, the optimal cooperative fiscal policy in a monetary union consists in reducing international imbalances, at the expense of larger domestic inefficiencies. Since reducing the latter constitutes the main objective of national fiscal policy makers in the EMU, this research indicates that rethinking fiscal policy could result in welfare gains for the union as a whole.

In the following section, I present the monetary union framework within which I address the issue of international financial frictions for the conduct of fiscal policy. Then, in section 3, I describe the Ramsey policy problem and relate the Ramsey allocation to the efficient allocation. In section 4, I consider the implications of international financial frictions for optimal fiscal policy by investigating the optimal response of government expenditures to a country-specific technology shock. The

robustness of the results to different types of country-specific shocks and the sensitivity with respect to the chosen calibration are investigated in section 5. Finally, I conclude the paper.

2   The Model

2.1   Households

The world is composed of two countries, denoted H (Home) and F (Foreign). There are respectively n and $1-n$ households in each of these countries. In the following, I will focus on the agents in the home country.[2]

Households get utility from private consumption and government expenditures (respectively c and G), but disutility from work (l), and therefore a household's utility is given by

$$v = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \left[U^C(c_t) + U^G(G_t) - U^L(l_t) \right] \tag{1}$$

where β is the discount factor.

The functional forms are as follows:

$$U^C(c_t) = \frac{c_t^{1-\sigma} - 1}{1 - \sigma}$$

$$U^G(G_t) = \chi \frac{G_t^{1-\sigma} - 1}{1 - \sigma}$$

$$U^L(l_t) = \frac{l_t^{1+\eta}}{1 + \eta}$$

where $\sigma > 0$ is the inverse of the intertemporal elasticity of substitution and the relative risk aversion coefficient, $\eta > 0$ is the inverse of the Frisch labor-supply elasticity, and χ is the weight given to public consumption relative to private consumption

The differentiated goods produced by firms h and f in country H and F respectively, $c_t(h)$ and $c_t(f)$, are assembled by a Dixit-Stiglitz aggregator into the composite goods denoted respectively $C_{H,t}$ and $C_{F,t}$:

$$C_{H,t} = \left[\int_0^n c_t(h)^{\frac{\theta-1}{\theta}} dh \right]^{\frac{\theta}{\theta-1}}, \qquad C_{F,t} = \left[\int_n^1 c_t(f)^{\frac{\theta-1}{\theta}} df \right]^{\frac{\theta}{\theta-1}}$$

Consumption is a CES index of consumption of the goods produced at Home and the goods produced in the Foreign country

$$C_t = \left[a_H^{\frac{1}{\phi}} C_{H,t}^{\frac{\phi-1}{\phi}} + (1 - a_H)^{\frac{1}{\phi}} C_{F,t}^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}}, \qquad 0 < a_H < 1, \quad \phi > 0, \tag{2}$$

where the constant elasticity of substitution between the home and foreign goods, also called the trade elasticity, is denoted ϕ. The trade elasticity is an important determinant of the transmission of shocks and policies between countries. It therefore plays a crucial role in determining optimal fiscal policy. a_H is the weight given to consumption of the home goods, whereas $1 - a_H$ is the weight attached to consumption of the foreign goods. If $a_H > n$, then a home bias in consumption is present. The presence of home bias results in deviations from purchasing power parity, even when the law of one price holds.

Given that households choose their relative consumption demand such as to maximize utility for

---

[2]Analogous relations hold for the agents in the foreign country, unless otherwise specified.

given expenditures, the domestic demand for respectively home and foreign goods are:

$$C_{H,t} = a_H \left(\frac{P_{H,t}}{P_t}\right)^{-\phi} C_t, \tag{3}$$

$$C_{F,t} = (1 - a_H) \left(\frac{P_{F,t}}{P_t}\right)^{-\phi} C_t. \tag{4}$$

where P_H and P_F respectively denote the price of the domestically produced generic good C_H and the foreign good C_F, whereas P and P^* denote the respective prices of the domestic and foreign consumption baskets C and C^*. The consumption-based price indices are defined analogously to the consumption bundles:

$$P_t = \left[a_H P_{H,t}^{1-\phi} + (1 - a_H) P_{F,t}^{1-\phi}\right]^{\frac{1}{1-\phi}}, \tag{5}$$

$$P_t^* = \left[(1 - a_H) P_{H,t}^{*\,1-\phi} + a_H P_{F,t}^{*\,1-\phi}\right]^{\frac{1}{1-\phi}}. \tag{6}$$

where

$$P_{H,t} = \left[\int_0^n p_t(h)^{1-\theta} dh\right]^{\frac{1}{1-\theta}}, \qquad P_{F,t} = \left[\int_n^1 p_t(f)^{1-\theta} df\right]^{\frac{1}{1-\theta}}$$

The terms of trade are defined as the ratio between the price of imports and exports: $TOT_t \equiv \frac{P_{F,t}}{P_{H,t}^*}$, whereas the real exchange rate is defined as the price of the foreign consumption bundle in terms of the home consumption good:

$$Q_t \equiv \frac{P_t^*}{P_t} \tag{7}$$

Households face complete financial markets at the domestic level, and firms' profits are equally distributed among domestic households (because they all hold an equal share of each domestic firm) such that a representative household exists within each country. However, households are subject to frictions at the international level: only a nominal risk-free one-period bond with debt-elastic yield is traded across countries. The yield of the bond is higher the higher is a country's debt relative to the steady state level, as in Schmitt-Grohe and Uribe (2003). Apart from implying stationarity of the steady state, modelling financial frictions through a debt-elastic yield on bonds allows for yield differences across countries which mimic those recently observed across countries in the EMU. Indeed, the model can replicate the recent situation in which inter alia Greek, Spanish, Irish, Portuguese and Italian bonds have experienced a wide yield spread relative to German bonds.

In order to model the debt-dependent interest rates, I assume that bonds can only be traded internationally through intermediaries. The intermediaries in countries with current account surpluses demand a higher yield on bonds which are issued by countries with higher debt levels, because of an underlying risk of default that is increasing in debt[3]. The additional rent thus extracted by the intermediaries by lending to indebted countries (i.e. countries with a current account deficit) is collected and distributed to households within the current account surplus country as lump-sum transfers.

To illustrate the mechanism of the debt-elastic yield, consider the situation in which Home bond holdings are above their steady state level i.e. $\frac{B_{H,t}}{P_t} > \frac{\bar{B}_H}{P}$, that is, the Foreign country has issued (excessive) debt. In that case, the Foreign yield is multiplied by a function $\Phi(B_{F,t}/P_t^*)$ (the premium) which depends positively on the deviation of Foreign debt ($\Phi'(B_{F,t}/P_t^*) < 0$) and satisfies $\Phi(\frac{\bar{B}_F}{P^*}) = 1$; the domestic interest rate is decreased, since it is multiplied by $\Phi(B_{H,t}/P_t) < 1$. Hence, a yield spread across the countries arise, and it is increasing in the difference between the countries' debt levels, or current accounts. The yield premium associated with holding bonds is assumed to be

---

[3]Note, however, that in equilibrium default never occurs.

linear in the excessive borrowing/lending (in deviations from the steady state value). An example of a function satisfying the requirements above is $\Phi(B_{F,t}/P_t^*) = 1 - \delta B_{F,t}/P_t^*$, with $\delta \geq 0$.

Labor is immobile between countries but perfectly mobile within countries such that wages are identical across households within a country. It follows that labor supply and consumption decisions are identical for all households within each country. Every period, the representative household uses its labor income, its wealth accumulated in bonds, profits of firms in the domestic economy, and the lump-sum transfers resulting from intermediation activities, to purchase consumption and bonds and pay lump-sum taxes. I assume that individual households do not internalize the effect of changes in their own bond holdings on the yield, i.e. they take the function $\Phi(.)$ as given.

In the home country, the household budget constraint thus amounts to:

$$c_t + \frac{b_t}{P_t(1+i_t)\Phi(B_{H,t}/P_t)} + T_t = \frac{w_t}{P_t}l_t + \frac{b_{t-1}}{P_t} + [\frac{1}{\Phi(B_{F,t}/P_t^*)} - 1]\frac{B_{F,t}}{(1+i_t)P_t} + profits_t \quad (8)$$

where P_t is the CPI, i_t denotes the nominal interest received in period $t+1$ on a bond purchased in period t, w_t is the wage rate, and l_t is the hours worked by the household, T_t denotes the lump-sum taxes paid by the household, and $B_{H,t} = \int_0^n b_t dh$ and $B_{F,t} = \int_n^1 b_t^* df$. The first-order conditions of the representative domestic household can be aggregated to yield:

$$\beta E_t[\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}}\frac{1+i_t}{\pi_{t+1}}] = \frac{1}{\Phi(B_{H,t}/P_t)} \quad (9)$$

$$\quad (10)$$

$$\frac{L_t^\eta}{C_t^{-\sigma}} = \frac{W_t}{P_t} \quad (11)$$

The first two equations are the Euler equations, determining the intertemporal allocation of consumption. The third equation is the labor supply equation stating that in equilibrium, the marginal utility of consumption obtained from an extra hour of work must equal the marginal disutility of working that extra hour.

2.2 Firms

Firms are monopolistically competitive, and set prices in a staggered fashion a la Calvo-Yun, that is reset their price at a time-independent random frequency. More specifically, each firm faces the probability $1 - \alpha$ of getting the possibility to reset their price every period.

Firms are owned by domestic households, and all firms within a country are identical in that their technology is such that output is linear in labor, and depends on an aggregate country-specific productivity shock denoted A: $Y_t(h) = A_t L_t(h)$.

The maximisation problem of the firm producing good h is:

$$\max_{p_t(h)} E_t \sum_{s=0}^{\infty} \alpha^s \mu_{t,t+s}[((1-\tau)p_t(h) - \frac{W_{t+s}}{A_{t+s}})y_{t,t+s}(h)]$$

$$\text{subject to demand: } y_{t,t+s}(h) = (\frac{p_t(h)}{P_{H,t+s}})^{-\theta}(C_{H,t+s} + G_{t+s}) + (\frac{p_t^*(h)}{P_{H,t+s}^*})^{-\theta}C_{H,t+s}^*$$

where $\mu_{t,t+s}$ is the stochastic discount factor of the firm, and τ is a tax on production. Given that the firms are owned by the households their discount factor is identical to the discount factor of the representative household: $\mu_{t,t+s} = \beta^s \frac{U_{C,t+s}}{P_{t+s}}\frac{P_t}{U_{C,t}}$.

The resulting first order conditions imply that prices are set according to expectations of future marginal costs and demand in the following way:

$$p_t(h) = \frac{\theta}{(\theta-1)(1-\tau)} \frac{\sum_{s=0}^{\infty}(\alpha\beta)^s \frac{C_{t+s}^{-\sigma}}{P_{t+s}} \frac{W_{t+s}}{A_{t+s}} y_{t,t+s}(h)}{\sum_{s=0}^{\infty}(\alpha\beta)^s \frac{C_{t+s}^{-\sigma}}{P_{t+s}} y_{t,t+s}(h)} \tag{12}$$

Because all firms that get to reset their price in a given period face the same expectations of marginal costs and demand, they all set the same price. Hence the following condition holds:

$$P_{H,t} = [\alpha P_{H,t-1}^{1-\theta} + (1-\alpha)p_t(h)^{1-\theta}]^{\frac{1}{1-\theta}} \Leftrightarrow (\frac{p_t(h)}{P_{H,t}})^{1-\theta} = \frac{1-\alpha\pi_{H,t}^{\theta-1}}{1-\alpha} \tag{13}$$

where $\pi_{H,t} \equiv \frac{P_{H,t}}{P_{H,t-1}}$.

Aggregating across firms, $Disp_t Y_{H,t} = A_t L_t$ where $Disp_t \equiv \int_0^n (\frac{p_t(h)}{P_{H,t}})^{-\theta} dh$ is a measure of the degree of price dispersion. This term is always larger or equal to unity[4]. The evolution of price dispersion is dependent on inflation in the following way:

$$Disp_t = (1-\alpha)[\frac{1-\alpha\pi_{H,t}^{\theta-1}}{1-\alpha}]^{\frac{-\theta}{(1-\theta)}} + \alpha\pi_{H,t}^{\theta}Disp_{t-1} \tag{14}$$

The price setting process of firms thus introduces dynamics into the framework, and is distortionary in that price dispersion among firms result.

Note that if firms operate in an environment with perfectly flexible prices, the representative domestic firm sets its price to equal a constant markup over marginal costs, that is the real wage rate adjusted for productivity:

$$\frac{P_{H,t}}{P_t} = \frac{\theta}{(\theta-1)(1-\tau)} \frac{1}{A_t} \frac{W_t}{P_t}$$

2.3 Monetary and fiscal policies

Monetary and fiscal policies are set simultaneously by a Ramsey planner. I abstract from monetary frictions and can thus consider a "cashless economy" as in Woodford (2003). Nevertheless, monetary policy affects the real economy because of the presence of nominal rigidities, and through its effect on the debt burden of countries.

2.3.1 Fiscal policy

Fiscal policy is defined as the path of government expenditures. These are assumed to be financed by lump-sum taxation and (non state-contingent) bond issuance.[6] That is, I focus on the effects of

---

[4]Proof: Let $v_t(h) = (\frac{p_{t,h}}{P_{H,t}})^{1-\theta}$, such that $Disp_t = \int_0^n (\frac{p_{t,h}}{P_{H,t}})^{-\theta} dh = \int_0^n v_t(h)^{\frac{\theta}{\theta-1}} dh$.

Recall that $P_{H,t} = [\int_0^n p_t(h)^{1-\theta}]^{\frac{1}{1-\theta}} dh$[5]. It follows that $\int_0^n (\frac{p_t(h)}{P_{H,t}})^{1-\theta} dh = 1 \Leftrightarrow [\int_0^n (\frac{p_t(h)}{P_{H,t}})^{1-\theta} dh]^{\frac{\theta}{\theta-1}} = 1$, or, equivalently that $[\int_0^n v_t(h) dh]^{\frac{\theta}{\theta-1}} = 1$.

Noting that $f(v(h)) = v(h)^{\frac{\theta}{\theta-1}}$ is a convex function we can apply Jensen's inequality, and thereby conclude that $Disp_t = \int_0^n v_t(h)^{\frac{\theta}{\theta-1}} dh \geq [\int_0^n v_t(h) dh]^{\frac{\theta}{\theta-1}} = 1$.

[6]I abstract from any implications of fiscal policy that relates to distortionary taxation issues. This is reasonable if the path of government expenditures can be considered as independent of the financing of it.

government spending rather than on its financing in the present paper.[7]

Government demand is entirely directed towards domestically produced goods which are assembled by the government into a composite public good denoted G:

$$G_t = \left[\int_0^n c_t(h)^{\frac{\theta-1}{\theta}} dh \right]^{\frac{\theta}{\theta-1}}$$

The technology used by the government in order to assemble the goods is different from the technology available to the private agents, and therefore the good G and the good C_H yield different levels of utility to households.

The fiscal authorities impose a subsidy on production which eliminates monopolistic distortions in the steady state: $\tau = \frac{1}{1-\theta}$. Hence, under appropriately chosen government expenditure levels and zero inflation, the steady state will be efficient. Note that the subsidy is fixed: though it does constitute an expenditure for the government, it does not constitute a policy instrument that can be changed in the face of shocks.

Fiscal and monetary policy is set such as to maximize welfare from the view-point of the monetary union as a whole. More specifically, policies are set in a constrained Ramsey optimal way: A supranational policy maker sets a path for the common monetary policy instrument and for government expenditures in each country such as to maximize the population-weighted welfare of the monetary union, given the private sector's first order conditions and the national governments' budget constraints.

Imposing that in equilibrium, the bonds market must clear meaning that $B_{H,t} + B_{F,t} = 0 \ \forall t$, and using that $\int_0^n p_t(h)y_t(h)dh = P_{H,t}Y_{H,t}$ renders the government budget constraint:

$$\tau Y_{H,t} + T_t = G_t \tag{15}$$

A similar budget constraint holds for the Foreign government:

$$\tau^* Y_{F,t} + T_t^* = G_t^* \tag{16}$$

2.3.2 Monetary policy

Within the monetary union, the nominal exchange rate is normalized to unity and does therefore not constitute a policy instrument. The monetary policy instrument is the union-wide nominal interest rate paid on one-period bonds (more precisely on an internationally traded one-period bond).[8]

Whereas monetary policy is neutral under flexible prices within the described framework, it plays a role in the presence of nominal rigidities. Monetary policy (the common nominal interest rate) is set simultaneously with fiscal policy and such as to be Ramsey optimal from a "timeless perspective".

2.4 Market Clearing and Aggregation

Given the mentioned private and public demand, aggregate demand facing domestic producers amounts to:

$$Y_{H,t} = a_H \left(\frac{P_{H,t}}{P_t} \right)^{-\phi} C_t + \frac{1-n}{n} a_H^* \left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\phi} C_t^* + G_t \tag{17}$$

---

[7]See e.g. Ferrero (2009) for the role played by distortionary taxation and government debt

[8]As explained in Woodford (2003) (p. 239, footnote 4), "In a cashless economy the central bank achieves its operating target for i_t by adjusting the interest rate i_t^m paid on the monetary base; an arbitrage relation then requires that $i_t = i_t^m$ in any equilibrium, given a positive supply of base money at all times. Here I simplify by supposing that the central bank can directly control the short-term market rate i_t..."

and aggregate demand for the foreign good amounts to:

$$Y_{F,t} = \frac{n}{1-n}(1-a_H)\left(\frac{P_{F,t}}{P_t}\right)^{-\phi} C_t + a_H \left(\frac{P_{F,t}^*}{P_t^*}\right)^{-\phi} C_t^* + G_t \qquad (18)$$

Output is demand-determined in equilibrium, and, hence, the above equation can also be viewed as a goods market clearing condition.

Equilibrium on the financial markets requires that bonds and assets are in zero net supply:

$$B_{H,t} + B_{F,t} = 0 \qquad (19)$$

When there is not complete trade in assets across countries, then consumption risk is not fully shared across countries. It is therefore necessary to keep track of the evolution of the current account. Under a single internationally traded bond, the household's budget constraint and the government's budget constraint can be combined to yield an aggregate resource constraint, characterizing the evolution of the current account. The Home aggregate resource constraint is:

$$C_t + \frac{B_{H,t}}{P_t(1+i_t)\Phi(B_{H,t}/P_t)} = \frac{P_{H,t}}{P_t}(Y_{H,t} - G_t) + \frac{1}{\pi_t}\frac{B_{H,t-1}}{P_{t-1}} + [\frac{1}{\Phi(B_{F,t}/P_t^*)} - 1]\frac{B_{F,t}}{P_t^*(1+i_t)}Q_t \quad (20)$$

Within the model developed above, optimal monetary and fiscal policy will depend on the trade-off facing the Ramsey policy maker. In the following section, I will describe the Ramsey policy maker's problem, define the efficient allocation, and characterize the trade-off faced by the Ramsey policy maker when deviations from this efficient allocation occur.

3   Ramsey Optimal Policy

3.1   The Ramsey planner's problem

I analyse the effects of international financial frictions and the resulting international imbalances for Ramsey optimal policy from a "timeless perspective".[9] The policy instruments available to the Ramsey planner are the union-wide nominal interest rate and Home and Foreign government spending. The Ramsey planner chooses a sequence of policies which maximize union-wide welfare subject to private sector optimization, the government budget constraints and the resource constraints, given the initial conditions (I_{t-1}) and the contemporaneous shocks (Ω_t). The Ramsey problem thus is:

$$\max_{i_t(\Omega_t, I_{t-1}), G_t(\Omega_t, I_{t-1}), G_t^*(\Omega_t, I_{t-1})} E_t \sum_{s=0}^{\infty} \beta^{s-t}[nU(C_{t+s}, G_{t+s}, L_{t+s}) + (1-n)U^*(C_{t+s}^*, G_{t+s}^*, L_{t+s}^*)]$$

$$s.t. \quad (5),(6),(7),(9),(11),(15),(16),(12),(13),(14),(17),(18),(19) \text{ and Foreign counterparts}$$

Solving the above problem corresponds to taking derivatives of the Lagrangian figuring in appendix A with respect to all endogenous variables and lagrange multipliers.

The Ramsey allocation does generally not coincide with the first-best allocation. Only when no distortions are present and prices are flexible can the Ramsey planner set policies which sustain the

---

[9]This implies that the policy maker cannot deviate from commitments made previously, cf. Woodford (2003)

social planner's solution.[10] This efficient allocation constitutes a natural benchmark for evaluating different policies, and helps characterize the trade-off faced by the Ramsey policy maker.

3.2   The efficient allocation - a benchmark

In this section, I characterize the efficient allocation defined as the equilibrium which yields the highest possible union-wide welfare in the absence of any distortions. This allocation can be supported as a decentralized equilibrium under complete markets, flexible prices and appropriate subsidies eliminating monopolistic competition according to the second welfare theorem. The efficient allocation will serve as a benchmark in order to understand how the trade-off faced by the policy maker is affected by the international financial markets structure.

The efficient allocation derived from maximization of union-wide utility subject to private-sector optimization, government budget constraints, and firm technology, in the absence of distortions, is characterized by the following equations:

$$\chi G_t^{-\sigma} = \frac{P_{H,t}}{P_t} C_t^{-\sigma} \tag{21}$$

$$\chi G_t^{*-\sigma} = \frac{P_{F,t}^*}{P_t^*} C_t^{*-\sigma} \tag{22}$$

$$\frac{C_t^{-\sigma}}{C_t^{*-\sigma}} = \frac{P_t}{P_t^*} \tag{23}$$

That is, the policy maker aims at achieving the optimal composition of spending relating private and public consumption within each country (equations (21) and (22)) as well as full consumption risk sharing (equation (23)). Full risk sharing results from equalization of the marginal utility of consumption and its marginal cost, the latter being measured by the foreign marginal utility of consumption times the relative price.

It is useful to define deviations from the optimal spending composition and from full risk sharing by gaps. The spending composition gaps are defined as

$$Ggap_t \equiv \chi G_t^{-\sigma} - \frac{P_{H,t}}{P_t} C_t^{-\sigma} \qquad \text{and} \qquad Ggap_t^* \equiv \chi G_t^{*-\sigma} - \frac{P_{F,t}^*}{P_t^*} C_t^{*-\sigma} \tag{24}$$

The demand gap defining deviations from full risk sharing is described by the equation:

$$Dgap_t \equiv \frac{C_t^{-\sigma}}{C_t^{*-\sigma}} - \frac{P_t}{P_t^*} \tag{25}$$

When nominal frictions are present and markets are incomplete, the Ramsey policy maker faces a trade-off which can be characterized in terms of deviations from the efficient output level, from the optimal spending composition level, and from full risk sharing, i.e. in terms of output gaps, spending composition gaps and demand gap.

3.3   Targeting rules - an analytical characterization of optimal policy

The trade-off faced by the policy maker can be illustrated by his loss function. The loss function can be transformed into a quadratic targeting rule in which the relative weights attached to minimizing the different inefficiencies illustrate the relative importance of each objective. In the case where the

---

[10]The Ramsey planner sets the policy instruments such as to increase common welfare - constrained by private agents' behavior and national government budget constraints. That is, he cannot transfer funds from one country to the other directly. Could he do so, then the first-best allocation could be obtained at all points in time, whatever shocks hit. However, given that this is not possible, the first-best allocation can generally not be obtained when a country-specific shock hits.

countries are symmetric and $\chi \to 0$, the targeting rule can be written as:

$$\mathcal{L}_0 = E_0 \sum_{t=0}^{\infty} \lambda_C((\hat{C}_t - \tilde{C}_t)^2 + (\hat{C}_t^* - \tilde{C}_t^*)^2) + \lambda_T(\hat{T}_t - \tilde{T}_t)^2 + \lambda_D Dgap_t^2$$
$$+ \lambda_{CT}(\hat{T}_t - \tilde{T}_t)((\hat{C}_t - \tilde{C}_t) - (\hat{C}_t^* - \tilde{C}_t^*)) + \lambda_\pi(\pi_{H,t}^2 + \pi_{F,t}^{*2}) + t.i.p. + (||\mathcal{O}||)^3$$

where

$$\lambda_C = \eta + \sigma$$
$$\lambda_T = \frac{a_H(1 - a_H)(\eta + \sigma)[4a_H(1 - a_H)\eta(1 + 2\phi^2\sigma^2) + 2\phi\sigma^2 - \eta]}{\sigma^2[\sigma + \eta - 3a_H(1 - a_H)\eta]}$$
$$\lambda_D = \frac{1}{2}(\eta + \sigma) - \eta a_H(1 - a_H)$$
$$\lambda_{CT} = \frac{8a_H(1 - a_H)\eta(\eta + \sigma)(\frac{1}{2} + \sigma\phi)(a_H - 1/2)}{\sigma[\sigma + \eta - 3a_H(1 - a_H)\eta]}$$
$$\lambda_\pi = \frac{2(\eta + \sigma)\alpha\theta(\eta\theta + 1)}{(3a_H^2\eta + \sigma + \eta - 3a_H\eta)(1 - \alpha\beta)(1 - \alpha)}$$

and $t.i.p.$ denotes terms independent of policy, and $(||\mathcal{O}||)^3$ denote terms of order 3 or higher. A tilted variable denotes the efficient deviation of that variable from steady state.[11]

The demand gap ($Dgap$) enters the targeting rule showing that deviations from full risk sharing across countries are distortionary and reduce welfare. The coefficient in front of the demand gap, assigning the relative weight of this policy objective relative to the other objectives, is dependent on the degree of home bias, as well as on the intertemporal elasticities of labor and consumption, and on the trade elasticity,[12] confirming the findings in Corsetti et al (2011): openness and elasticities play a key role in shaping the policy trade-offs in open economies with incomplete markets. The relative weight of the demand gap is increasing in the degree of home bias a_H and decreasing in the trade elasticty ϕ. The reason for this relates to the fact that redirecting demand from one country to the other requires larger price deviations the higher the degree of home bias and the lower the trade elasticity. Hence, it is optimal, in order to avoid large deviations from full risk sharing, to allow relative price changes to a larger degree the higher the degree of home bias and the lower the trade elasticity. As a result the weight on the demand imbalances relative to the weight on the terms of trade rises with the degree of home bias and falls with the trade elasticity.

As illustrated by the targeting rule, the relative importance of the gaps and the resulting trade-off faced by the policy maker differ according to the international financial markets structure and to the international goods market structure. In order to understand the implications for optimal policy, I engage in numerical analysis in the following sections. More specifically, I investigate the trade-off facing the fiscal policy maker within the specified framework by studying the impulse responses following a country-specific technology shock.

---

[11] If government spending was present the G-gaps would also enter the rule. For simplicity, they do not figure in the targeting rule. For details on the derivation of the targeting rule, please refer to the technical appendix on the author's homepage.

[12] Even though the trade elasticity does not figure in the coefficient on the D-gap, it enters the coefficient on the terms of trade and thus affects the relative weight assigned to either of those objectives.

4 A Numerical Investigation of Optimal Policy in a Monetary Union

4.1 Solution method and Parameterization

The recursive solution to the Ramsey problem consists in policy functions describing the response of the nominal interest rate and the government spending levels to initial conditions and current disturbances. However, the form of the policy functions are undetermined and therefore a closed-form solution does not exist. We can nevertheless approximate the policy functions around some specified steady state. By using the method of undetermined coefficients (perturbation methods), based on the knowledge of the derivatives of the equilibrium equations at the steady state, the model above can be solved by approximating the solution to the policy functions. The steady state around which the policy functions are approximated is the symmetric zero-inflation steady state in which monopolistic distortions are eliminated through appropriate subsidies. The approximated policy functions thus found are used for the numerical analysis carried out in this section.[13]

The parameter values used throughout this section figure in the Table 1. Most of them are quite standard in the business cycle literature, and realistic for the EMU.[14]

The population of each of the countries are assumed to be identical. The discount factor is set such that the steady state annual real interest rate is 4 percent. The Frisch elasticity of labor is set equal to 0.5. The inverse of the intertemporal elasticity of substitution, the risk aversion coefficient, is set to 1.5 in the benchmark calibration following Smets and Wouters (2003). χ is equal to 1/3 such that in steady state private consumption is three times larger than government consumption.

The degree of home bias is set to 0.9, implying that the steady state import ratio is 10 percent. The elasticity of substitution between goods produced within a country is set equal to 7.66 such as to ensure a mark-up of 15 percent. On average prices are sticky for a year: $\alpha = 0.75$. This value is in line with the GMM-estimates found by both Gali et al. (2001) and the Bayesian DSGE estimations carried out by Smets and Wouters (2003).[15]

Since the international trade elasticity is an important determinant of the equilibrium dynamics of the model presented in section 2, and thus of the trade-off faced by the policy maker, and since the empirical literature has not reached a consensus as to plausible values for that parameter, I consider different possible values for this elasticity. Whereas large values have been predicted by the international trade literature and by microeconomic studies, a relatively low trade elasticity, close to 1/2, corresponds to the estimates found in the international macroeconomic literature, see e.g. Hooper et al. (2000) or Corsetti et al. (2008). I thus consider values in the [0.5; 4] range for the trade elasticity. In the incomplete markets model, δ, the sensitivity of the bond yield to debt is set such as to roughly mimic the observed yield differences across the EMU before the debt crisis.[16]

As compared to the former literature on the fiscal and monetary policy interaction in a monetary union, the calibration here departs on several points: Both Gali and Monacelli (2008) as well as Beetsma and Jensen (2005) assume no home bias in consumption, and a unitary trade elasticity. The assumption of no home bias rules out deviations from PPP (and thus changes in the real exchange

---

[13]I use code developed by Levin et al (2004) to compute the Ramsey optimal policies.

[14]The parameter values used are within the range of estimates found by Smets and Wouters (2003) by engaging in Bayesian estimation of a DSGE model of the euro area, or follow Benigno (2004) who calibrates his model to the EMU. See also Gali and Monacelli (2008).

[15]The degree of price stickiness is assumed to be identical across countries in the benchmark calibration, but I also carry out an experiment in which price stickiness differs across countries, mimicking potential differences in price rigidities across regions within the EMU as noted inter alia by Benigno (2004). See the appendix available on the author's homepage.

[16]The estimates vary quite a lot from country to country and from year to year. The benchmark parameterization of δ is a rather conservative value when comparing to recent years.

rate), whereas a unitary trade elasticity simplifies their models considerably. Furthermore, Gali and Monacelli (2008) consider the knife-edge case of log-utility in consumption, which together with a unitary trade elasticity implies that there are no spillovers across countries. The calibration chosen here can be considered as being somewhat better suited for considering realistic equilibrium dynamics within the EMU.

Table 1: Parameter values in benchmark case		
Population in country H	n	0.5
Discount factor	β	$1.04^{-1/4}$
Inverse of the elasticity of labor supply	η	2
Risk aversion coefficient	σ	1.5
Degree of home bias	a_H	0.9
Price stickiness coefficient	α	0.75
Weight on government expenditures	χ	1/3
Intratemporal elasticity of substitution	θ	7.66
Trade elasticity	ϕ	[0.5; 4]
Yield sensitivity to debt	δ	0.05

The following process is assumed for the technology shocks:

$$\begin{bmatrix} \log A_t \\ \log A_t^* \end{bmatrix} = \begin{bmatrix} 0.95 & 0 \\ 0 & 0.95 \end{bmatrix} \begin{bmatrix} \log A_{t-1} \\ \log A_{t-1}^* \end{bmatrix} + \begin{bmatrix} v_t \\ v_t^* \end{bmatrix} \tag{26}$$

where v_t and v_t^* are white noise processes with standard deviations 0.01.

In the following, the parameter values listed above are used in order to investigate the effects of international financial frictions for the trade-off faced by the policy maker, and the resulting optimal monetary-fiscal policy mix. First, I analyze the optimal policy response to country-specific shocks when prices are flexible. Then, I show how the trade-off changes when nominal rigidities are present.

4.2 Optimal policy under flexible prices

When prices are flexible and markets complete, then the efficient allocation can be implemented. In that case, fiscal policy does not play a stabilization role: government spending is set such as to satisfy the optimal spending composition. If, instead, international financial markets are incomplete, it might be optimal to use the fiscal policy instruments such as to reduce the distortions associated with international financial frictions. The derived targeting rule indeed showed the $Dgap$ to be an objective for the cooperative policy maker. The optimality of using fiscal policies for this objective, that is, to reduce international imbalances, depends on the fiscal transmission mechanism which is shaped by the trade elasticity.

To understand the mechanism, consider the effect of government spending. A change in government spending affects marginal costs through its effect on aggregate demand and thus labor demand. Under flexible prices, producer prices are set at a constant mark-up over marginal costs, and thus the change in government spending affects prices. The induced change in the terms of trade affects relative income and thus relative consumption demand differently depending on whether the internationally traded goods are substitutes or complements in utility. Indeed, the trade elasticity determines the movements in income following a change in the terms of trade induced by fiscal policy.

Under a high trade elasticity the effects of government spending on relative consumption and price movements are such that large deviations of government spending from its optimal spending composition level are required in order to achieve a given reduction in international demand imbalances.

Consider the effect of an increase in Home government spending, shifting demand towards the Home good, and thus increasing inflationary pressure at Home. The latter implies a fall in the real exchange rate and a fall in relative Home income. Since the demand gap is defined as $Dgap_t \equiv \left(\frac{C_t}{C_t^*}\right)^{-\sigma} - \frac{1}{Q_t}$, the fact that fiscal policy affects both of the terms defining the $Dgap$ in similar directions implies that it is rather difficult to narrow the demand gap using the fiscal policy instrument - at least without large costs in terms of government spending gaps. And, hence, it is not optimal to reduce the demand gap using fiscal policy when the trade elasticity is large, as Figure 1 shows.

Figure 1 depicts the optimal policy response to a one standard deviation shock to productivity in country H. Due to the resulting fall in marginal costs, producer prices fall in the Home country. Since the substitution effect of the price change dominates the income effect, Home agents become temporarily richer and the current account turns positive. Prices move less than under complete markets in order to contain the rise in the current account at the expense of output gaps. This illustrates the fact that the efficient allocation, characterized by a zero demand gap and zero output gaps, cannot be achieved in the face of country-specific shocks. As already pointed out, optimal fiscal policy does not consist in reducing the demand gap since the costs associated with doing so, in terms of deviations from the optimal spending composition, are too large.

Figure 1: Optimal policy under substitutability ($\phi = 4$).
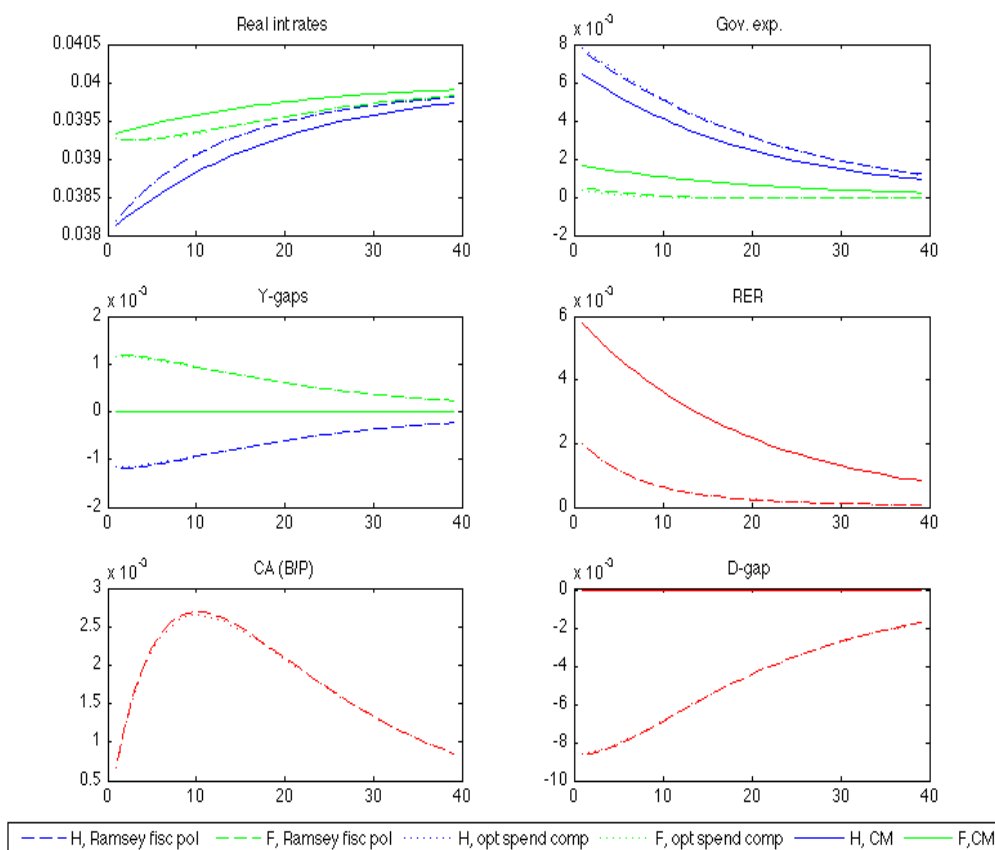
The impulse responses are those following a one-standard deviation shock to productivity in country H. "H, Ramsey fisc pol" refers to the response of Home variables under Ramsey fiscal and monetary policy. "H, opt spend comp" refers to the response of Home variables in the case where monetary policy is Ramsey optimal whereas government expenditures are set at their optimal spending composition level, i.e. such as to close the spending composition gap. "CM" refers to the case of complete markets. For all variables, except for the annualized real interest rates, deviations are shown relative to their steady state level. The real interest rates depicted are not identical to the bond yields which depend on debt levels.

The optimal fiscal policy response to a productivity shock to country H is in line with the predictions from the targeting rule derived in section 3.3. Indeed, the targeting rule indicates that the cross-country insurance role of fiscal policy might be rather small when the traded goods are substitutes. In combination with the limited effectiveness of fiscal policy in reducing international imbalances, this refrains fiscal policy from acting as a cross-country insurance tool. However, the derived targeting rule implies a larger risk-sharing role for fiscal policy when the traded goods are complements. The numerical exercise confirms this: The international imbalances affect the trade-off to a larger extent under a low trade elasticity, cf. Figure 2.

Figure 2 depicts the optimal policy response to a Home TFP shock under complementarity of the traded goods. Whereas the Home agents were made relatively richer by the TFP shock under a high trade elasticity, the TFP shock makes them temporarily poorer under a low trade elasticity: the domination of the income effect implies that the fall in prices triggered by the TFP shock results in lower income. Hence, the current account is negative. Prices react more aggressively to a Home technology shock such as to retain international imbalances: The Home real interest rate falls further than under complete markets, thereby increasing demand for the Home good, and the Foreign real

interest rate rises such as to decrease demand in country F. Price adjustments thus limit the current account imbalances by also increase Home output above the complete markets level and reduce Foreign output below its efficient level. The imbalances are thus curbed at the expense of output gaps which are of the opposite sign of those appearing under substitutability of the goods.

In a monetary union the fiscal policy maker faces a trade-off between using government spending such as to reduce the output gaps at the expense of higher international imbalances and using it in order to decrease international imbalances at the expense of higher output gaps. The trade-off faced by the policy maker is illustrated by the presence of domestic inefficiencies (the output gaps) and international imbalances (the D-gap) in Figure 2.[17] On the one hand, closing the positive output gap in H and the negative output gap in F requires a decrease in relative Home government expenditures; on the other hand, closing the positive relative demand gap requires an increase in relative domestic government expenditures. As the impulse responses below show, the trade-off facing the policy maker is optimally tilted towards correcting the relative demand imbalances arising due to international financial frictions: Government expenditures are optimally increased at Home (relative to the case where they are passively set to satisfy the optimal spending composition) and decreased in F such as to reduce the demand gap at the expense of larger output gaps and spending composition gaps. Hence, under a low trade elasticity, fiscal policy plays a risk-sharing role which clearly overshadows its stabilization role. Government expenditures thus optimally follow a very different path than they would were markets complete, or were they simply set at the optimal spending composition level.

The reason why it is optimal to use fiscal policy to reduce international imbalances rather than national inefficiencies is simple. Whereas the fiscal instruments, namely government spending, are rather ineffective in reducing inefficiencies associated with internationally incomplete markets under substitutable goods, they can improve risk sharing without high costs in terms of deviations from the optimal spending composition level under complementary goods. Indeed, a rise in government spending leads to a rise in relative prices and a rise in relative consumption (rather than a fall in relative consumption under substitutability). Hence, an improvement in risk sharing across countries can be obtained at the expense of rather small deviations from the optimal spending composition under complementarity of the internationally traded goods: fiscal policy is more effective in reducing international demand imbalances. Combined with a relatively large weight on the $Dgap$ in the targeting rule of the policy maker, the incentive to use fiscal policy for this purpose, rather than in order to stabilize domestic objectives, is thus high under complementarity of the internationally traded goods. And, indeed, optimal fiscal policy consists in reducing international imbalances at the expense of larger domestic inefficiencies as illustrated in Figure 2.

---

[17]In the case where the countries do not form a monetary union, optimal fiscal policy leads to a reduction in all inefficiencies. Fiscal policy cannot achieve the same within a monetary union because the output gaps are of different signs than under flexible exchange rates, cf. appendix on the author's homepage.

Figure 2: Optimal policy under complementarity ($\phi = 0.5$).
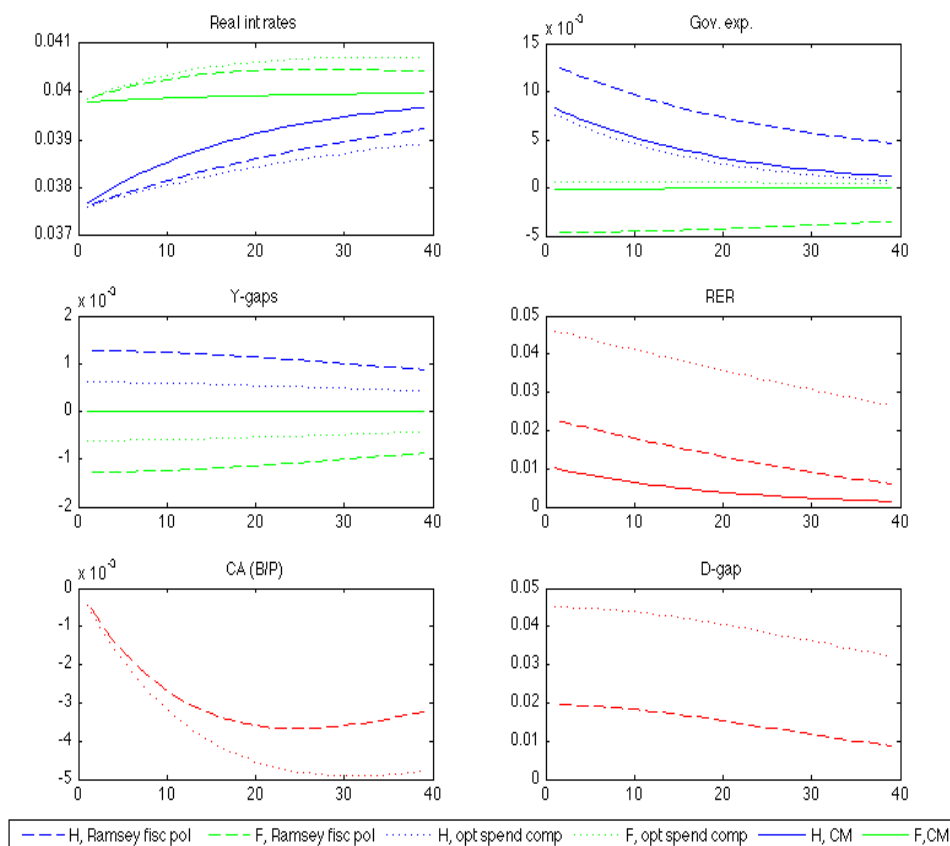
See notes for Figure 1.

The strand of the NOEM literature which considers the presence of international financial markets incompleteness has mostly come to the conclusion that the gains from taking into account the structure of international financial markets are rather small, cf. e.g. P. Benigno (2001).[18] As a result the policy maker need not care much about the international financial markets structure when setting policies, but should simply focus on domestic targets. Above, I have shown that this is not so under a low trade elasticity, in a monetary union with flexible prices: optimal policy consists in reducing the demand imbalances due to internationally incomplete markets at the expense of larger domestic inefficiencies (output gaps).

Since inflation per se does not result in distortions which are relevant for the policy maker under flexible prices, it is optimal to let prices and government expenditures adjust such as to narrow a welfare-weighted combination of the output gaps, the relative demand gap and the optimal spending composition gaps. When prices are set in a staggered way as described in section 2, however, inflation leads to inefficient price dispersion across firms within a country. The New-Keynesian literature has emphasized the importance of stabilizing output gaps and inflation in this environment. More

---

[18]The gains from taking into account financial markets have been shown to be non-existent in some special cases as pointed out by Cole and Obstfeld (1991) and Corsetti and Pesenti (2001). Recently, Corsetti et al (2011) is one among a few exceptions to point out that the international financial markets structure might have important consequences for optimal policy.

specifically, Beetsma and Jensen (2005) as well as Gali and Monacelli (2008) point out the output and inflation stabilization role of government expenditures within a monetary union with complete markets.

When prices are sticky and international financial frictions are present, there might be conflicts between achieving output stabilization, inflation stabilization, and cross-country insurance. In the following I study which policy objectives are conflicting, and which goal is the most important for a benevolent policy maker.

4.3 Optimal fiscal policy under sticky prices

The results found in the previous section go through when nominal rigidities are present. The trade-off faced by the fiscal policy maker is not very much affected by the structure of international financial markets under a high trade elasticity, and government spending continues to be inefficient as a cross-country insurance tool. However, when the trade elasticity is low, government expenditures can play a risk-sharing role.

Substitutability. In order to understand the trade-off faced by the Ramsey policy maker, consider the effects of a positive Home TFP shock. The nominal interest rate is optimally decreased such as to ensure a union-wide increase in demand to counter-act the fall in prices due to the increased output supply. Since the real exchange rate is fixed and prices are sticky, relative prices will not adjust sufficiently to ensure the efficient level of output. Output gaps and inflation are thus non-zero. Under complete markets, fiscal policy faces a trade-off between closing output gaps and reducing inflation, as emphasized in Beetsma and Jensen (2005). For example, by increasing Home government spending, the fiscal policy maker can reduce the deflationary pressure on Home prices resulting from the increase in TFP, but only at the expense of a higher output gap: the reduced fall in Home prices reduces the substitution towards the Home good, and since the substitution effect dominates the income effect of the price change, Home output falls further below its efficient level. A similar trade-off applies to the Foreign country's fiscal policy. Hence, the optimal monetary-fiscal policy mix cannot achieve the first-best allocation under sticky prices.

In the presence of international financial frictions, the conduct of optimal policy is altered, showing the importance of the distortions stemming from incomplete markets. The main difference pertains to the fact that price changes are optimally much lower under incomplete markets implying higher output gaps, see Figure 3. The fact that prices fall less in country H following the TFP shock not only decreases distortions arising due to price changes, but also implies a lower substitution towards the Home good, thus lower income in country H. Since country H agents have become relatively rich following the positive Home TFP shock under a high trade elasticity, the current account has turned positive: Home agents lend to Foreign agents. The lower price changes, achieved at the expense of higher output gaps, ensure that current account imbalances leading to distortionary demand gaps do not become too large.

An active use of government spending only leads to minor changes, cf. Figure 3. This is so because government spending is a rather inefficient risk-sharing tool, as already noted in the case of flexible prices.[19]

---

[19]Indeed, domestic government expenditures are set to be above their optimal spending composition level in the first periods such as to decrease deflationary pressures at home, and vice-versa in country F. When inflation becomes positive, government expenditures fall below their optimal spending composition level such as to dampen inflationary pressures. Whereas the initial increase in home government spending and decrease in foreign government spending reduce the output gaps and the demand gap, the subsequent reversal has the opposite effect. This indicates that government expenditures are first and foremost set such as to stabilize inflation, under a high trade elasticity.

Figure 3: Optimal policy under sticky prices and high trade elasticity ($\phi = 4$).
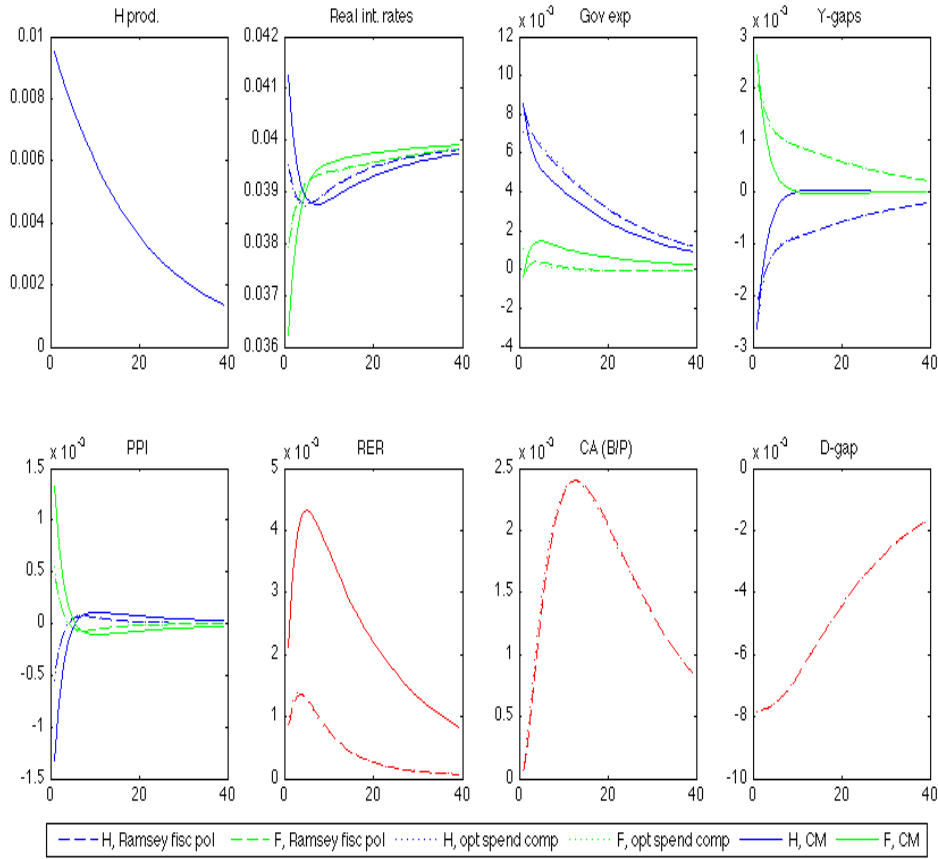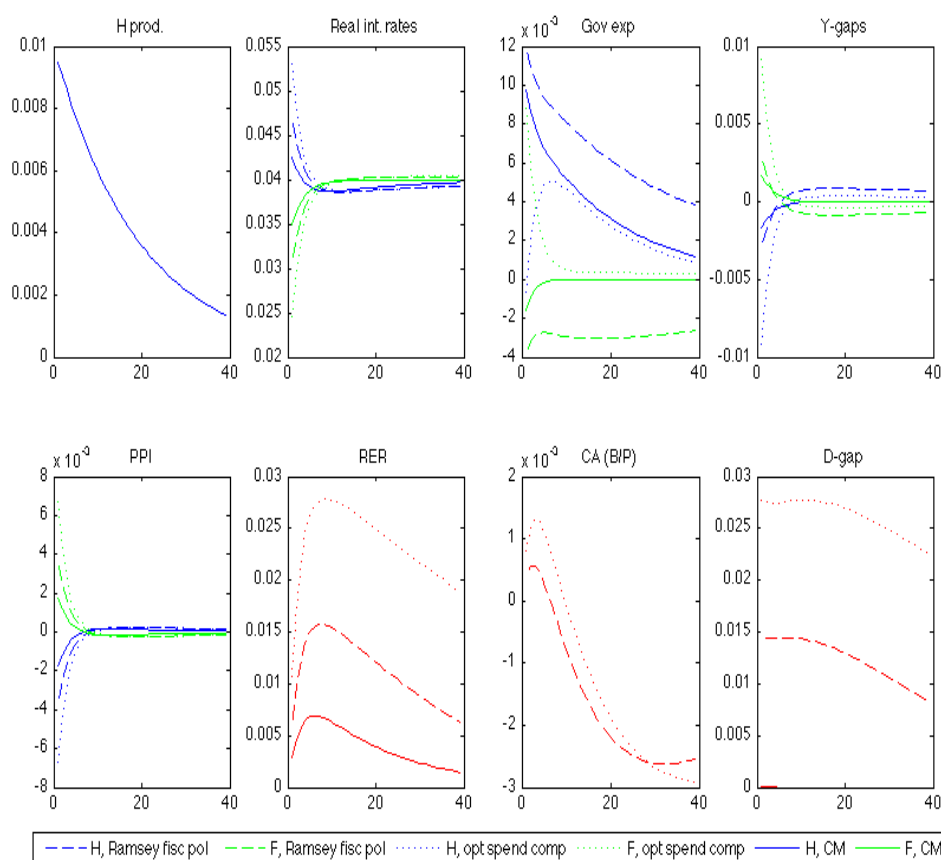

See notes for Figure 1.

The impulse responses above show that financial market incompleteness only plays a minor role for optimal fiscal policy when the trade elasticity is high. However, this is not a general result. Indeed, as under the flexible prices, the above result changes dramatically when the trade elasticity is low.

Complementarity. In the face of a temporary positive Home TFP shock, aggregate Home producer prices do not fall sufficiently under sticky prices in the first periods. Home firms thus make large profits on aggregate during these first periods where firms readjust their prices. As a result, Home agents become relatively richer in the short term following a productivity shock. Only after prices have adjusted do their income fall and will they thus wish to borrow. The current account then turns negative. When the internationally traded goods are complements, the presence of international financial frictions leads to larger - but contained - price movements and thus more aggressive responses of the real interest rates. Prices vary more such as to contain international imbalances: the resulting short term increase in the Home real interest rate retains Home lending in the first periods. Following, the H real interest rate falls implying higher income in country H and thus less borrowing. Both in the short term and in the long term, monetary policy thus acts such as to retain current account imbalances, at the expense of higher distortions associated with price changes and higher output gaps.

When fiscal policy is allowed to adjust optimally, it is increased in Home and decreased in the Foreign

country, cf. Figure 4. This has the effect of increasing inflationary pressure in the Home country while reducing it in the foreign country. As a result the real exchange rate is largely reduced - reducing the welfare losses associated with international imbalances and illustrated by the reduction in the demand gap. That is, whereas optimal monetary policy retains international imbalances by limiting current account imbalances, optimal fiscal policy acts such as to reduce the demand imbalances through lower price changes. This is done at the expense of higher output gaps after the price adjustment has taken place. Fiscal policy thus simultaneously reduces distortionary inflation and the demand gap, at the expense of output stabilization, cf. Figure 4.

Figure 4: Optimal policy under sticky prices and complementarity ($\phi = 0.5$).

See notes for Figure 1.

On the contrary to the case where the traded goods are substitutes, fiscal policy plays an important role in reducing cross-country demand imbalances when the traded goods are complements - whether nominal rigidities are present or not.

The impulse responses figuring above show that optimal fiscal policy leads to a halvening of the relative demand imbalances. Indeed, setting government expenditures optimally decreases the welfare losses from incomplete markets arising within this model by 66 percent in the benchmark case, see Table 2. Hence, ignoring the financial markets structure can lead to policies that are very far from being optimal! This result contrasts with a large part of the earlier literature on the risk sharing role of optimal policies. P. Benigno (2001) e.g. concludes that "even if the costs of incomplete markets are non-negligible, the gains by using monetary policy optimally are always negligible." He finds that

only when there are asymmetries across countries in initial net foreign asset positions do sizeable gains from optimal monetary policy arise as compared to policies of price stability.

In the following section, I assess the robustness of the results found above. First, I investigate whether the results found hinge on the specific kind of shocks hitting the economy. More specifically, I will consider whether the results go through in the face of news shocks, preference shocks, and mark-up shocks in order to exploit the generality of the results found for technology shocks. Following, I consider the sensitivity of the results to specific parameter values chosen in the numerical analysis above.

5   Robustness

5.1   News, preference and mark-up shocks

In order to check whether the cross-country insurance role of government expenditures hinges on the shocks affecting only technology, I consider the results' robustness to news shocks, preference shocks, and mark-up shocks. News shocks differ from productivity shocks in that they are anticipated, thus affecting forward-looking exchange rates and thereby the deviations from risk sharing before the actual technology change occurs. Preference shocks have the particularity of affecting the risk sharing condition directly. Mark-up shocks differ from the two other types of shocks in that they are "inefficient", that is, imply inefficient movements in variables. Hence, by considering those three types of shocks, I make sure to consider a wide range of shocks. Details are available in the online appendix.

The response of government expenditures to news shocks is of interest because news shocks emphasize the forward-looking features of the model: because prices are forward-looking, the exchange rate reacts to news about technology changes before they eventually take place. This affects the international demand imbalances directly. The optimality of fiscal policy as a cross-country insurance tool goes through in the face of news shocks, under complementarity of the traded goods: optimal fiscal policy consists in correcting the international imbalances at the expense of larger output gaps in the medium run.

The results found in the previous sections also go through to a large extent in the presence of preference shocks: Under a low trade elasticity the international imbalances are corrected, at the expense of wider national output gaps in the medium term.

As a last check, I consider the presence of mark-up shocks e.g. induced by a change in the tax rate on production. In the face of mark-up shocks which are inefficient in their nature, the relevance of the cross-country demand imbalances for the fiscal policy maker is once again apparent in the case where the trade elasticity is low.

That is, the results for technology shocks go through for other kind of shocks as well, making clear that the concerns of the fiscal policy maker should depend on the international financial markets structure whenever the traded goods are complements.

5.2   Sensitivity analysis

I now consider the sensitivity of the risk-sharing role of fiscal policies in a monetary union to some important parameters, namely the trade elasticity, which plays a crucial role within this analysis, the debt-sensitivity of the yield which governs the international financial frictions, and the correlation of

shocks and their spillover across countries.[20]

5.2.1 The trade elasticity

The elasticity of substitution between the domestically produced goods and the Foreign goods is a crucial determinant of the way in which fiscal policy should optimally be set. As noted previously a trade elasticity of 0.5 appears to be a reasonable value according to several studies such as Hooper et al. (2000) and Corsetti et al (2008). While 0.5 remains in the confidence band of estimates found by Heathcote and Perri (2002) for the US, their point estimate is 0.9 - a little larger than the previous sources indicate, but still much lower than the trade literature indicates. In the following, I show that the results found for an elasticity of 0.5 go through qualitatively for an elasticity of 0.9. However, the optimal deviations of government expenditures from its optimal spending composition in order to reduce demand imbalances are dampened.

Figure 5 shows the impulse responses following a domestic technology shock, for the case of flexible prices. The important point is that - also for an elasticity of 0.9 - the trade-off between reducing demand imbalances or output gaps goes in the favor of reducing the demand imbalances at the expense of larger output gaps. That is, the qualitative result that welfare is maximized by reducing international demand imbalances rather than national output gaps goes through.

Figure 5: Optimal policies under flexible prices and $\phi = 0.9$.
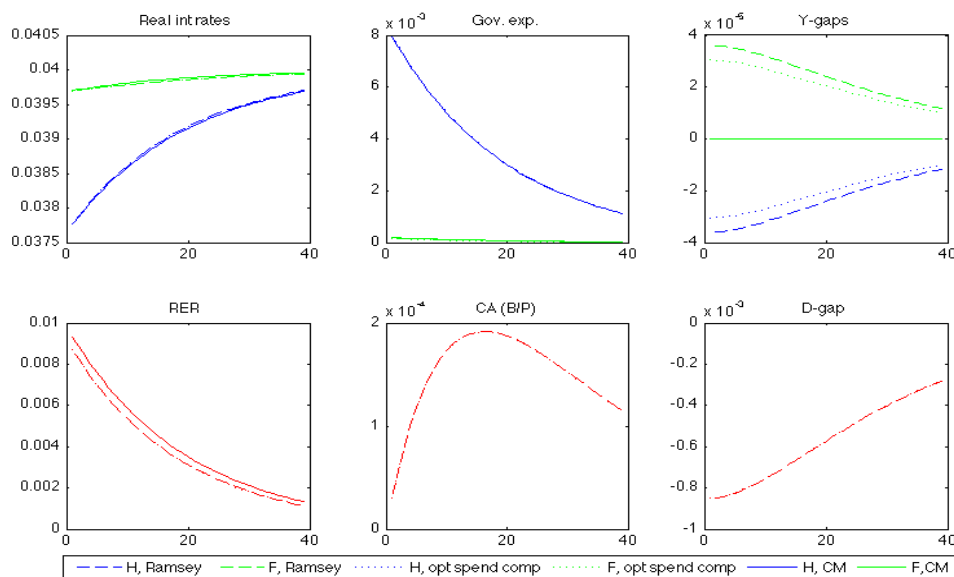
See notes for Figure 1.

5.2.2 Debt-sensitivity of yield

The yield on bonds is a function of debt: the higher is a country's external debt, the higher will be the yield to be paid on this debt. This debt-sensitivity is modelled through the parameter δ. The benchmark value of δ is such that for every ten percentage points increase in debt,[21] the annual interest increases by 0.5 percentage points. The estimates obtained by regressing interest differentials between EMU-countries and Germany on deviations of debt-to-gdp ratios for the period 2001-2010

---

[20]In the online appendix figure sensitivity analyses to the coefficient of relative risk aversion as well as to asymmetric degrees of price rigidities.

[21]this corresponds approximately to a similar increase in debt-to-steady state gdp.

gives varying results depending on the country and the time period.[22] The benchmark value chosen is close to the average for all EMU-countries during the entire period considered, and the effects of deviations from this benchmark value have no effect on the main results of this paper. However, changes in δ do affect the magnitude of current account changes following shocks and have implications for the speed of transition to steady state following shocks.

The main effect of δ is to restrict the optimal magnitude of current account imbalances, and, hence, the higher is the debt-sensitivity of the yield, the lower are the current account imbalances occurring. However, this does not imply that the resulting international demand imbalances are lower: indeed, in order to achieve the optimal real yield differences across countries in response to a country-specific shock, inflation differences are higher the higher is the debt-sensitivity of the yield. This ensures relative demand across countries to be closer to their efficient level, but also creates demand imbalances resulting from the higher real exchange rate movements.

5.2.3 Technology spillovers and correlation of shocks

The importance of the demand imbalances arising as a consequence of international financial frictions under a low trade elasticity depends on the cross-country correlation of shocks as well as on potential technology spillovers across countries. The higher is the correlation between the shocks and the technological spillovers across countries, the lower are the resulting international imbalances arising in the face of country-specific shocks. One might therefore suspect that the tradeoff faced by the policy maker may tilt away from correcting the international imbalances towards correcting national inefficiencies as shocks become more correlated and technology is transferred across countries.

Allowing shocks to be correlated and technology to be shared across countries do not alter the qualitative conclusions reached for uncorrelated technology shocks and productivity processes. Even though the correlation between shocks is set to 0.3 and the productivity spillover across countries is 0.025 (replacing the zeros in the productivity transition matrix), as in Heathcote and Perri (2002), the optimal fiscal policy still consists in correcting the international demand imbalances at the expense of national inefficiencies under complementarity of the goods. Hence, even though the international imbalances are of a lower magnitude when shocks are correlated and technology spills over from one country to the other, they remain important for union-wide welfare, and the policy maker optimally corrects them.

Note however that given the smaller imbalances arising under correlation of technology shocks and productivity processes, the welfare gains from setting fiscal policy at its Ramsey optimal level rather than at its optimal spending composition level are smaller than in the benchmark case. Indeed, the welfare gains from Ramsey fiscal policy under incomplete markets are only $7.125 \ 10^{-4}$ percent of permanent consumption under the Heathcote and Perri (2002) calibration for productivity processes and shocks, corresponding to 36 percent of the welfare costs of market incompleteness. This is considerably smaller than the 66 percent obtained in the benchmark case.

6 Conclusion

The analysis carried out in this paper shows the importance of international imbalances for the tradeoff faced by the policy maker in a monetary union, in the case where the internationally traded goods are complements. The optimal path for government spending is dependent on the financial markets structure. In the monetary union framework with complementary traded goods, the optimal fiscal

---

[22]The estimation relies on the steady state debt-to-gdp ratio being 60 percent, and the German interest rate being the interest rate set by the ECB.

policy consists in setting government spending such as to decrease the international demand imbalances arising due to imperfect financial markets, even as this results in higher domestic inefficiencies. That is, fiscal policy optimally acts as a cross-country insurance tool rather than as a domestic stabilization tool.

National and international objectives are shown to require conflicting fiscal policy movements within the monetary union framework. That is, it is not possible to set fiscal policies optimally by focusing solely on domestic targets such as output gaps. This is a particularity associated with the absence of national monetary policy instruments. This implication of the analysis is in line with a growing recognition that policy making needs to be rethought. The Committee on International Economic Policy and Reform note that monetary policy has been conducted following the "own house in order" doctrine, meaning that "national macroeconomic stability was seen as sufficient for international macroeconomic stability. The domestic and international aspects were essentially regarded as two sides of the same coin."[23] The Committee concludes that central banks should go beyond their traditional emphasis on domestic objectives. Though these statements regard central banking, they are in line with the implications for fiscal policy making drawn from this paper.

The results of this paper have important implications for policy making within the EMU: since they indicate that it is optimal from the perspective of the monetary union to use fiscal policies such as to reduce deviations from full risk sharing rather than to address country-specific output gaps, the implications must be a rethinking of the way fiscal policy is to be conducted within the EMU. In particular, macro-prudential policies aiming at reducing current account imbalances might prove welfare-increasing.

Furthermore, the results naturally raise the issue of potential welfare gains from fiscal policy cooperation in monetary unions. Indeed, the results show that optimal fiscal policy cannot be attained by focusing on national objectives, but instead requires international objectives to enter into the targeting rule of the policy maker. Further research on the extent to which independent strategically competitive fiscal policy authorities deviate from the cooperative allocation is needed in order to address this question.

Another interesting question - also related to recent debates about fiscal policies in the EMU - is whether fiscal rules might prove beneficial within a monetary union. This paper indicates that if the internationally traded goods are complements, then debt-dependent fiscal rules may lead to higher international imbalances and deteriorate risk sharing across countries.

---

[23]"Rethinking Central Banking", September 2011.

Appendix A. The Ramsey problem

The Lagrangian of the Ramsey planner's problem is:

$$
\begin{aligned}
\mathcal{L} =E_t\sum_{s=0}^{\infty}\beta^{t+s}\Bigg(& [nU(C_{t+s},G_{t+s},L_{t+s})+(1-n)U^*(C_{t+s}^*,G_{t+s}^*,L_{t+s}^*)] \\
&+\lambda_{1,t+s}\left[Y_{H,t+s}-a_H\left(\frac{P_{H,t+s}}{P_{t+s}}\right)^{-\phi}C_{t+s}-\frac{1-n}{n}(1-a_H)\left(\frac{P_{H,t+s}}{P_{t+s}}\right)^{-\phi}Q_{t+s}^{\phi}C_{t+s}^*\right] \\
&+\lambda_{2,t+s}\left[Y_{F,t+s}-a_H\left(\frac{P_{F,t+s}^*}{P_{t+s}^*}\right)^{-\phi}C_{t+s}^*-\frac{n}{1-n}(1-a_H)\left(\frac{P_{F,t+s}^*}{P_{t+s}^*}\right)^{-\phi}Q_{t+s}^{-\phi}C_{t+s}\right] \\
&+\lambda_{3,t+s}\left[[\frac{1-\alpha\pi_{H,t+s}^{\theta-1}}{1-\alpha}]^{\frac{1}{1-\theta}}-\frac{\theta}{(\theta-1)(1-\tau)}\frac{x_{t+s}^1}{x_{t+s}^2}\right] \\
&+\lambda_{4,t+s}\left[x_{t+s}^1-D_{t+s}^{\eta}A_{t+s}^{-(1+\eta)}Y_{H,t+s}^{1+\eta}-\alpha\beta\pi_{H,t+s+1}^{\theta}x_{t+s+1}^1\right] \\
&+\lambda_{5,t+s}\left[x_{t+s}^2-C_{t+s}^{-\sigma}p_{H,t+s}Y_{H,t+s}-\alpha\beta\pi_{H,t+s+1}^{\theta-1}x_{t+s+1}^2\right] \\
&+\lambda_{6,t+s}\left[D_{t+s}-(1-\alpha)[\frac{1-\alpha\pi_{H,t+s}^{\theta-1}}{1-\alpha}]^{\frac{-\theta}{1-\theta}}-\alpha\pi_{H,t+s}^{\theta}D_{t+s-1}\right] \\
&+\lambda_{7,t+s}\left[[\frac{1-\alpha\pi_{F,t+s}^{\theta-1}}{1-\alpha}]^{\frac{1}{1-\theta}}-\frac{\theta}{(\theta-1)(1-\tau)}\frac{x_{t+s}^{1*}}{x_{t+s}^{2*}}\right] \\
&+\lambda_{8,t+s}\left[x_{t+s}^{1*}-D_{t+s}^{*\eta}A_{t+s}^{*-(1+\eta)}Y_{F,t+s}^{*1+\eta}-\alpha\beta\pi_{F,t+s+1}^{\theta}x_{t+s+1}^{1*}\right] \\
&+\lambda_{9,t+s}\left[x_{t+s}^{2*}-C_{t+s}^{*-\sigma}p_{F,t+s}^*Y_{F,t+s}^*-\alpha\beta\pi_{F,t+s+1}^{\theta-1}x_{t+s+1}^{2*}\right] \\
&+\lambda_{10,t+s}\left[D_{t+s}^*-(1-\alpha)[\frac{1-\alpha\pi_{F,t+s}^{*\theta-1}}{1-\alpha}]^{\frac{-\theta}{1-\theta}}-\alpha\pi_{F,t+s}^{*\theta}D_{t+s-1}^*\right] \\
&+\lambda_{11,t+s}\left[C_{H,t+s}-a_H\left(\frac{P_{H,t+s}}{P_{t+s}}\right)^{-\phi}C_{t+s}\right]+\lambda_{12,t+s}\left[C_{F,t+s}-(1-a_H)\left(\frac{P_{F,t+s}^*}{P_{t+s}^*}\right)^{-\phi}Q_{t+s}^{-\phi}C_{t+s}\right] \\
&+\lambda_{13,t+s}\left[C_{H,t+s}^*-(1-a_H)\left(\frac{P_{H,t+s}}{P_{t+s}}\right)^{-\phi}Q_{t+s}^{\phi}C_{t+s}^*\right]+\lambda_{14,t+s}\left[C_{F,t+s}^*-a_H\left(\frac{P_{F,t+s}^*}{P_{t+s}^*}\right)^{-\phi}C_{t+s}^*\right] \\
&+\lambda_{15,t+s}\left[a_H(\frac{P_{H,t+s}}{P_t})^{1-\phi}+(1-a_H)(\frac{P_{F,t+s}^*}{P_{t+s}^*})^{1-\phi}Q_{t+s}^{1-\phi}-1\right] \\
&+\lambda_{16,t+s}\left[\frac{a_H(\frac{P_{F,t+s}^*}{P_{t+s}^*})^{1-\phi}Q_{t+s}^{1-\phi}+(1-a_H)(\frac{P_{H,t+s}}{P_{t+s}})^{1-\phi}}{a_H(\frac{P_{H,t+s}}{P_{t+s}})^{1-\phi}+(1-a_H)(\frac{P_{F,t+s}^*}{P_{t+s}^*})^{1-\phi}Q_{t+s}^{1-\phi}}-Q_{t+s}^{1-\phi}\right] \\
&+\lambda_{17,t+s}\left[\frac{p_{F,t+s}^*}{p_{H,t+s}}\frac{p_{H,t+s-1}}{p_{F,t+s-1}^*}\frac{Q_{t+s}}{Q_{t+s-1}}-\frac{\pi_{F,t+s}^*}{\pi_{H,t+s}}\right] \\
&+\lambda_{18,t+s}\left[\beta E_{t+s}[\frac{C_{t+s+1}^{-\sigma}}{C_{t+s}^{-\sigma}}\frac{1+i_{t+s}}{\pi_{t+s+1}}]-\frac{1}{\Phi(\frac{B_{H,t+s}}{P_{t+s}})}\right]+\lambda_{19,t+s}\left[\beta E_{t+s}[\frac{C_{t+s+1}^{*-\sigma}}{C_{t+s}^{*-\sigma}}\frac{1+i_{t+s}}{\pi_{t+s+1}^*}]-\frac{1}{\Phi(\frac{B_{F,t+s}}{P_{t+s}^*})}\right] \\
&+\lambda_{20,t+s}\left[C_{t+s}^*+\frac{B_{F,t+s}}{P_{t+s}^*(1+i_{t+s})}\frac{1}{\Phi(\frac{B_{F,t+s}}{P_{t+s}^*})}-\frac{P_{F,t+s}^*}{P_{t+s}^*}(Y_{F,t+s}-G_{t+s}^*)-\frac{B_{F,t+s-1}}{P_{t+s}^*}-\left[\frac{1}{\Phi(\frac{B_{H,t+s}}{P_{t+s}})}-1\right]\frac{\frac{n}{1-n}B_{H,t+s}}{(1+i_{t+s})P_{t+s}^*}\right] \\
&+\lambda_{21,t+s}[nB_{H,t+s}-(1-n)B_{F,t+s}]\Bigg)
\end{aligned}
$$

where $\pi_{H,t+s}\equiv\frac{P_{H,t+s}}{P_{H,t+s-1}}$, $\pi_{F,t+s}^*\equiv\frac{P_{F,t+s}^*}{P_{F,t+s-1}^*}$, $p_{H,t+s}\equiv\frac{P_{H,t+s}}{P_{t+s}}$, and $p_{F,t+s}^*\equiv\frac{P_{F,t+s}^*}{P_{t+s}^*}$.

Appendix B. Welfare results

I compute the consumption-equivalent welfare loss of having incomplete markets in the form specified in this paper, under optimally set fiscal policy and under the optimal spending composition. The welfare gains from setting fiscal policy optimally can thus be deducted.

I follow Schmitt-Grohe and Uribe (2006) and Devereux et al (2004) in computing the second order consumption-equivalent welfare measure. I define the consumption-equivalent welfare cost of having incomplete markets and adopting the optimal spending composition, as compared to complete markets, λ^{OSC}, as to satisfy the equation:

$$
E_0 \sum_{t=0}^{\infty} \beta^t \left\{ nU((1-\lambda^{OSC})C_t^{CM}, G_t^{CM}, L_t^{CM}) + (1-n)U((1-\lambda^{OSC})C_t^{*CM}, G_t^{*CM}, L_t^{*CM}) \right\}
$$

$$
= E_0 \sum_{t=0}^{\infty} \beta^t \left\{ nU(C_t^{OSC}, G_t^{OSC}, L_t^{OSC}) + (1-n)U(C_t^{*OSC}, G_t^{*OSC}, L_t^{*OSC}) \right\} \equiv W_0^{OSC}
$$

Using the functional forms specified in section 2, the above can be rewritten in the following way:

$$
\lambda^{OSC} = 1 - \left\{ \frac{(1-\sigma)(1-\beta)\left[W_0^{OSC} - W_0^{CM} + \sum_{t=0}^{\infty} \beta^t \frac{C_t^{CM1-\sigma} + C_t^{*CM1-\sigma}}{(1-\sigma)(1-\beta)} \right]}{\sum_{t=0}^{\infty} \beta^t \left(C_t^{CM1-\sigma} + C_t^{*CM1-\sigma} \right)} \right\} \tag{27}
$$

The measure is computed conditionally on being in the deterministic steady state at time zero. A second-order approximation to the above welfare measure requires second-order approximations to welfare and consumption under the different financial market structures and fiscal policy regimes. These approximations are a function of the steady state values and the second derivative of the relevant policy functions, see Schmitt-Grohe and Uribe (2006). For example, given the approximation to the policy function under incomplete markets and optimal spending composition, h^{OSC}, the welfare measure can be computed in the following way

$$
W_0^{OSC} = \bar{W}^{OSC} + h_{\epsilon\epsilon}^{OSC}(W^{OSC})\frac{var(\epsilon_t)}{2} + h_{\epsilon^*\epsilon^*}^{OSC}(W^{OSC})\frac{var(\epsilon_t^*)}{2} + h_{\epsilon\epsilon^*}^{OSC}(W^{OSC})cov(\epsilon_t, \epsilon_t^*)
$$

where $h_{\epsilon\epsilon}^{OSC}(W^{OSC})$ denotes the second derivative of the policy function for W^{OSC} with respect to the technology shock to country H.

Similarly, in order to get a measure of the welfare cost of incomplete markets under Ramsey optimal fiscal policy:

$$
\lambda^R = 1 - \left\{ \frac{(1-\sigma)(1-\beta)\left[W_0^R - W_0^{CM} + \sum_{t=0}^{\infty} \beta^t \frac{C_t^{CM1-\sigma} + C_t^{*CM1-\sigma}}{(1-\sigma)(1-\beta)} \right]}{\sum_{t=0}^{\infty} \beta^t \left(C_t^{CM1-\sigma} + C_t^{*CM1-\sigma} \right)} \right\} \tag{28}
$$

The difference between those two welfare costs constitutes the welfare gains from implementing optimal fiscal policy as opposed to satisfying the optimal spending composition:

$$
\lambda^{OPT,IM} = \lambda^{OSC} - \lambda^R \tag{29}
$$

The welfare gains reported in the table below correspond to welfare gains calculated in percentage of steady state consumption. They are correct up to second order.

Table 2: Welfare gains

	Low trade elasticity (0.5)	High trade elasticity (4)
Welfare gains of Ramsey optimal fiscal policy in percentage of total welfare costs of incomplete markets	66	1.26

References

Asdrubali P., Sorensen, B., and O. Yosha, 1996. "Channels of interstate risk sharing: United States 1963-1990", Quarterly Journal of Economics, Vol. 111, No. 4, pp. 1081-1110.

Backus, David K.; Smith, Gregor W., 1993. "Consumption and real exchange rates in dynamic economies with non-traded goods", Journal of International Economics 35, pp. 297-316

Beetsma, R., Jensen, H., 2005. "Monetary and Fiscal Policy Interactions in a Micro-founded Model of a Monetary Union", Journal of International Economics, vol. 67, no. 2, pp. 320-352

Benigno, G., Thoenissen C., 2008. "Consumption and Real Exchange Rates with Incomplete Markets and Non-traded goods", Journal of International Money and Finance 27, pp. 926-948.

Benigno, P., 2001. "Price Stability with Imperfect Financial Integration", New York University working paper.

Benigno, P., 2004. "Optimal Monetary Policy in a Currency Area", Journal of International Economics, Vol. 63, pp. 293-320.

Benigno, P., 2009. "Price Stability with Imperfect Financial Integration", Journal of Money, Credit and Banking, Vol. 41, No. 1.

Benigno, G., De Paoli, B., 2010. "On the International Dimension of Fiscal Policy", Journal of Money, Credit and Banking, Vol. 42(8), pp. 1523-1542.

Chari V. V., P.J. Kehoe, and E.R. McGrattan, 2002. "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?", Review of Economic Studies 69, pp. 533-563.

Cole, H., and R. Obsfeld, 1991. "Commodity trade and international risk sharing. How much do financial markets matter?", Journal of Monetary Economics 28, pp. 3-24.

Corsetti G., L. Dedola and S. Leduc, 2008. "International Risk-Sharing and the Transmission of Productivity Shocks", Review of Economic Studies 75, pp. 443- 473.

Corsetti G., L. Dedola and S. Leduc, 2010. "Demand Imbalances, Exchange Rate Misalignment and Monetary Policy", Working Paper.

Corsetti G., L. Dedola and S. Leduc, 2011. "Optimal Monetary Policy in Open Economies" in Handbook of Monetary Economics, vol. 3B, edited by Friedman and Woodford.

Corsetti, G. and Paolo Pesenti, (2001). "Welfare and Macroeconomic Interdependence", Quarterly Journal of Economics 116 (2): 421-446

Cooper R. and H. Kempf, 2004. "Overturning Mundell: Fiscal Policy in a Monetary Union", Review of Economic Studies 71, 371396.

Demyanyk, Y., Ostergaard, C. and B. Sorensen, 2008. "Risk sharing and portfolio allocation in EMU", European Economy Economic Papers 334.

Devereux, M., Lane, P., and J. Xu, 2004. "Exchange Rates and Monetary Policy in Emerging Market Economies", IIIS Discussion Paper, No.36.

Ferrero (2009). "Fiscal and Monetary Rules for a Currency Union", Journal of International Economics 77, pp.1-10.

Gali, J., M. Gertler, and D. Lopez-Salido, 2001. "European Inflation Dynamics.", European Economic Review, June 45(7), pp. 1121-1150.

Gali and Monacelli, 2008. "Optimal monetary and fiscal policy in a currency union", Journal of International Economics 76, 116-132.

Heathcote, J., and F. Perri, 2002. "Financial autarky and international business cycles", Journal of Monetary Economics, 49(3), 601-627.

Hooper, P., Johnson, K. and Marquez, J., 2000. Trade Elasticities for the G-7 Countries, Princeton Studies in International Economics No. 87.

Koenig, G., and I. Zeyneloglu, 2010. "When does financial integration matter for fiscal policy in a currency union? A welfare-based approach", Economic Modelling No. 27, pp. 620630

Kollmann, R., 1995. "Consumption, real exchange rates and the structure of international asset markets", Journal of International Money and Finance, Vol. 14, No. 2, pp.191-211.

Levin, A., Lopez-Salido, J.D., 2004. "Optimal Monetary Policy with Endogenous Capital Accumulation", manuscript, Federal Reserve Board.

Obstfeld, M. and K. Rogoff, 1995. "Exchange Rate Dynamics Redux", Journal of Political Economy, Vol. 103(3), pp. 624-660.

Obstfeld, M. and K. Rogoff, 2002. "Global Implications of Self-Oriented National Monetary Rules", Quarterly Journal of Economics, May 2002.

Pierdzioch, C., 2004. "Financial Market Integration and Business Cycle Volatility in a Monetary Union", Scottish Journal of Political Economy, Vol. 51(3).

Ravn, M., 2001. "Consumption Dynamics and Real Exchange Rates", CEPR Discussion Paper No. 2940.

Schmitt-Grohe S. and M. Uribe, 2003. "Closing Small Open-Economy Models", Journal of International Economics, No. 61, pp. 163-185.

Schmitt-Grohe 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.

Schmitt-Grohe S. and Uribe M., 2006. "Optimal simple and implementable monetary and fiscal rules", NBER Working Paper 12402.

Smets, F. and R. Wouters, 2003. "An estimated dynamic stochastic general equilibrium model of the euro area", Journal of the European Economic Association, Vol. 1, No. 5, pp. 1123-1175.

Sutherland, A., 1996. "Financial Market Integration and Macroeconomic Volatility", Scandinavian Journal of Economics, Vol. 98 (4), pp.521-539.

Taylor, J., 1993. Macroeconomic Policy in a World Economy: From Economic Design to Practical Operation (New York, NY: Norton).

Woodford, M., 2003. Interest and Prices: Foundations of a Theory of Monetary Policy. Princeton University Press.

Woodford, M., 2010. "Simple Analytics of the Government Expenditure Multiplier", working paper.

Yun, T., 1996. "Nominal Price Rigidity, Money Supply Endogeneity, and Business Cycles", Journal of Monetary Economics, No. 37, pp. 345-370.