



THE UNIVERSITY *of York*

Discussion Papers in Economics

No. 2005/28

Monetary and Fiscal Policy Coordination for
Small Open Economies in a Monetary Union

by

René Cabral-Torres

Department of Economics and Related Studies
University of York
Heslington
York, YO10 5DD

Monetary and Fiscal Policy Coordination for Small Open Economies in a Monetary Union

René Cabral-Torres
University of York

August 23, 2005

Abstract

Motivated by the accession of new member states into the European Union, this paper examines the appeal of taking part in a large monetary union from the perspective of small open economies. Consistent with existing findings in the literature, we show that in the absence of fiscal policy considerations, taking part in a large monetary union is counterproductive for a small economy. Nevertheless, once the role of fiscal policy is properly incorporated, taking part in the monetary union becomes desirable from a social perspective. Following these results, we explore the prospects of engaging both economies in fiscal coordination and on how different schemes of policy synchronization can provide the grounds to make cooperation beneficial for the members of a monetary union. We find that when monetary and fiscal authorities cooperate and attempt to exploit externalities for their own benefit, a Pareto efficient outcome can be achieved if fiscal policy in the monetary union is coordinated by a central authority and such authority acts as a Stackelberg leader *vis-à-vis* the central bank. Our analysis suggests that this regime result superior to (i) a monetary union in which fiscal authorities conduct their policy in an independent or (ii) coordinated fashion, (iii) to a regime where both authorities internalize the effects of their own externalities by allowing the central bank to act as Stackelberg leader and (iv) event to a regime in which the small open economy decides to stay out of the monetary union.

Key words: Common central bank; policy coordination; monetary union, monetary leadership, fiscal leadership

JEL Classification: E52, E58, E61, F15

*Department of Economics, University of York, Heslington, York, YO10 5DD, UK; E-mail: rct102@york.ac.uk. I would like to thank Gulcin Ozkan, Luis González-Morales, Herb Newhouse and participants at the University of York Research Student Workshops and MMF Research Group 34th Annual Conference for their valuable comments. Any remaining errors are my own.

1 Introduction

By admitting ten new members in 2004, the European Union (EU) undertook the largest expansion in its history. Following their accession into the EU, new member states (NMSs: Poland, the Czech Republic, Hungary, Slovakia, Slovenia, Lithuanian, Latvia, Estonian, Cyprus and Malta) are expected to meet the Maastricht criteria in order to join the euro area in the near future. The likely inclusion of these countries into the European Monetary Union (EMU) may entail substantial benefits for them in terms of lower transaction costs, exchange rate volatility removal, price stability, higher output growth and decline in country risk.

Nevertheless, joining the EMU may also entail some costs for the NMSs in terms of macroeconomic stabilization. By entering into the EMU, NMSs would automatically surrender their monetary policy to the European Central Bank (ECB) and be constrained by the fiscal rules imposed by the Stability and Growth Pact (SGP).¹ Providing that the SGP requires member states to aim for public budget balances which are close to equilibrium or in surplus in the medium term, the allocation of taxes and public expenditure would remain the only instruments in the control of EMU members to stabilize their economies against real shocks.

Prior to the formation of the EMU, the impact of asymmetric shocks and the effectiveness of monetary policy to respond to them was one of the main concerns of the literature assessing the viability of a common European currency. Since the completion of EMU, however, a large amount of literature has been devoted to exploring the implications of fiscal policy on macroeconomic stabilization. Yet, most of those studies which have integrated fiscal stances into the analysis of EMU policies assume that the economies involved are structurally symmetric.

Notably, the difference between the size of the ten NMS listed above and those that shaped EMU in the first stage is significant and their size in relation to the size of EMU is considerably smaller. In fact, any country that decides to join EMU at this stage, including the United Kingdom, will face not only a similar asymmetric position but also the same monetary and fiscal constraints as the NMS. Therefore, the use of fiscal policy towards stabilization seems to be an important matter for those countries that eventually will decide to participate in EMU.

Taking into account the presence of size asymmetries and the role of fiscal policy on macroeconomic stabilization, this paper attempts to shed some light on two particular questions. The first is whether participating in a monetary union is desirable for small open economies. From a monetary policymaking perspective, the adoption of a common currency in the presence of size asymmetries has been addressed by Martin (1995) who employs a three-country model of policy coordination to analyse the possibility of forming EMU in two stages. He finds that those small countries that decide to stay out of EMU in a first stage would be able to free-ride from it by employing their own monetary policy and therefore would choose to stay out of the

¹Non-EMU members are also constrained by SGP rules but are not subject to enhanced fiscal surveillance or economic sanctions.

union permanently. Although our model is different, the argument about the free-riding opportunities of small open economies employed here is similar to Martin's but we extend it to introduce "representative" fiscal authorities that maximize society's welfare and intervene on stabilization. The second question this chapter attempts to answer is whether fiscal coordination is beneficial or counterproductive for those small open economies that surrender their monetary policy to a central authority. Beetsma et al. (2001) address this second question using a symmetric two-country model and find that ex-ante coordination between monetary and fiscal authorities is desirable. Here we explore that issue from the perspective of a small economy employing a benchmark case in which the economies involved conduct their own monetary and fiscal policies in a non-cooperative fashion.

In assessing the viability of taking part in a monetary union, we first concentrate our attention on the monetary policymaking process. We show that, in the absence of fiscal policy considerations, participating in a monetary union results in a counterproductive strategy for a small economy whose only policymaker is exclusively concerned about inflation and employment. Secondly, we consider the interactions between fiscal and monetary authorities on macroeconomic stabilization. We find that the inclusion of fiscal authorities that maximizes society's welfare introduces new spillovers and conflicts between them and the monetary policymakers. Once fiscal authorities are properly incorporated, taking part in the monetary union becomes desirable from a social perspective. Finally, we focus our attention on the viability of engaging both economies in fiscal coordination and on how different schemes of policy synchronization can provide the grounds to make cooperation beneficial for the members of a monetary union. We observe that the pure coordination of fiscal authorities—playing Nash against the central monetary authority—results a counterproductive strategy for the society. We also find that, while a monetary leadership strategy results in a deterioration of the small economy fiscal authority's position, a fiscal leadership strategy leads to a Pareto improvement.

The rest of this chapter is organized as follows. The following section reviews briefly some recent literature on fiscal policy coordination in EMU. Section 3 presents the two-country model employed in this chapter, the reduced forms of the model and an analysis of the inflation employment trade-offs faced by monetary and fiscal authorities under the two main regimes considered. The assessment of inflation–employment trade-offs explains the intuition behind the free-riding opportunities enjoyed by the authorities of small economies when they operate under non-cooperative regimes. Section 4 assesses the viability of forming a monetary union in the absence of fiscal policy consideration. Section 5 introduces fiscal authorities that maximize society's welfare and reconsiders the feasibility of forming a monetary union between a small and a large economy. Once the convenience of participating in a monetary union has been reassessed in the presence of non-cooperative fiscal stances, this section also examines the viability of engaging both economies in fiscal coordination by evaluating three different schemes of fiscal cooperation: simple coordination of fiscal policymakers playing Nash against the monetary authority, monetary and fiscal lead-

ership. Finally, Section 6 summarizes the main conclusion and implications of this chapter.

2 Fiscal policy coordination in EMU

Two strands of literature have addressed the impact of fiscal and monetary policy coordination on the stabilization policies of a monetary union. The first assumes identical economic structures in modelling macroeconomic policymaking and the second implicitly or explicitly uses asymmetric features.

In the first strand of literature, Cooper and Kempf (2004) employ a multi-country overlapping generations model to assess the welfare effects of monetary and fiscal policy interactions in a monetary union. They observe that in the absence of fiscal policy considerations, delegating monetary policy to a single central bank might be costly and only if shocks across the countries are sufficiently positively correlated does the monetary union regime increase welfare. Although Cooper and Kempf do not address the issue of fiscal coordination per se, they find that the inclusion of fiscal intervention by national governments, combined with a central monetary authority that has the ability to commit to its policy, reverses this result. In that scenario, joining a monetary union improves welfare regardless of the degree of correlation of the shocks.

Dixit and Lambertini (2001) also consider a model with n countries participating in a monetary union and in which monetary and fiscal authorities have different targets for output and inflation. They deal explicitly with fiscal and monetary coordination and find that leadership by any of the two authority produces better inflation and output outcomes than a discretionary Nash equilibrium. Using the same model, Dixit and Lambertini (2003) observe that, if authorities agree on the ideal levels of output and inflation, the desired targets can be achieved even if there is disagreement about the relative importance of the two goals, regardless of which authority moves first and despite the lack of cooperation among the policymakers. With this, they suggest that it is more important for EMU members to reach consensus on their policy objectives than to achieve commitment among their authorities.

Using a simpler framework, Lambertini and Rovelli (2004) consider an aggregate-demand–aggregate-supply closed economy model in which fiscal and monetary policymakers' main concern is to minimize the deviations of output and inflation from their commonly agreed targets. Consistent with Dixit and Lambertini (2001), their analysis of alternative regimes suggests that both fiscal and monetary authorities prefer the outcome of a Stackelberg to that of a Nash game, independently of whom is the leader. However, they also notice that the nature of the game authorities play is such that each player prefers to be the follower than the leader. Finally, Beetsma et al. (2001) also analyse the desirability of monetary and fiscal policy coordination in a two-country model in which monetary and fiscal authorities have different objectives. They find that fiscal coordination might be counterproductive because of

the adverse reaction of the monetary authority to the fiscal authorities coordinated efforts but also that ex-ante coordination is desirable when it gives a first mover advantage strategic position to the fiscal authorities.

Literature using implicit or explicit asymmetric structures is less abundant. Levine and Pearlman (2001) analyse the conduct of fiscal and monetary policy in a multi-country setup where all the economies have identical economic structures. A group of “ins” forms a monetary union and a group of “outs” retain monetary sovereignty. Consistent with Martin (1995) they find that there are significant incentives for countries to decide individually not to join EMU and free-ride from the benefits that staying out of the monetary union provides. In their analysis, asymmetric features implicitly arise when fiscal authorities pertaining to a monetary union form coalitions to cooperate on stabilization. They find that, joining can be convenient only if the “ins” conduct their own fiscal policy in a coordinated fashion; when this happens a large monetary union becomes feasible. Engwerda et al. (2002) introduce asymmetric features in a more explicit form. They employ a two-country dynamic model with asymmetries in the authorities’ preferences, some of the model structural parameters and on the bargaining power of the policymakers in collective decisions. In this way, they find that cooperation is often efficient for fiscal players but results in considerable losses for the central monetary authority. In the absence of asymmetries, fiscal players’ cooperation leads in most of their simulations to a Pareto improvement for them but not for the central monetary authority.

Per se, the importance of fiscal policy for the stabilization of small economies participating in a monetary union appears to have received little or no attention in the literature. This issue, however, becomes especially relevant with the accession of NMSs to the EU and their imminent entrance into EMU. Notably, the difference between the size of the NMSs and those that shaped EMU in the first stage is significant. Table 1 illustrates the nature of some of those asymmetries by comparing the GDP size and trade openness of the new members against that of their EU and prospective EMU partners prior to their accession.

As can be observed, roughly speaking the new members’ output represent less than ten percent of the EMU GDP; Poland being the largest with almost half of that share. Another interesting feature that emerges from Table 1 is the high openness to trade of NMS with the rest of the world and specifically towards the EU. By 2003, prior to their accession, most NMS showed total trade-to-GDP ratios and trade integration shares with the EU above those observed in the 12 EMU members and well over those of their four largest EU partners.

It is well documented that the smaller size and openness of an economy operating under non-cooperative exchange rate regimes provides its policymakers with an advantageous position to stabilize their economies in the presence of real shocks (see for instance Giavazzi and Giovannini, 1998; Martin, 1995, 1998; Ghironi and Giavazzi, 1998; Eichengreen and Ghironi, 2002). In our view, the loss of monetary policy independence and the constraints imposed on fiscal policy by the SGP rules will certainly reduce the capacity of small economies to take advantage of their size to respond

Table 1: New EU members size and trade comparison

Member State	Domestic GDP		Trade-to-GDP		EU Trade (%) ²	
	Total ¹	% EU	Exports	Imports	Export	Import
Poland	374	4.19	0.29	0.32	53.4	48.9
Czech Rep.	149.4	1.67	0.54	0.57	74.9	56.6
Hungary	130.5	1.46	0.52	0.56	58.0	48.8
Slovak Rep.	59.9	0.67	0.67	0.69	73.8	58.3
Lithuania	33.7	0.38	0.42	0.51	48.1	29.8
Slovenia	32.6	0.37	0.46	0.49	45.6	62.8
Latvia	20.3	0.23	0.29	0.47	53.3	49.8
Estonia	14	0.16	0.50	0.68	54.2	34.7
Cyprus	12.6	0.14	0.07	0.31	49	26.9
Malta	6.2	0.07	0.52	0.67	25.9	44.1
EU 15	8,921.6		0.34	0.33		
EMU 12	7,052.7		0.36	0.35		
NMS 10	833.3	9.34	0.43	0.53	53.6	46.1
Germany	1,932.5	21.7	0.31	0.25	47.9	38.9
UK	1,508.9	16.9	0.17	0.21	47.8	37.5
France	1,454.5	16.3	0.21	0.20	50.4	55.3
Italy	1,311.2	14.7	0.20	0.19	40.1	48.7

Source: Eurostat, with information for 2003 and CIA world factbook.

¹ Figures in billions of euros.

² Figures are underestimated due to unreported small flows by the second source.

effectively to economic disturbances. Following this argument, in this chapter we re-examine the issue of economic size asymmetries considering the interdependence of fiscal and monetary policy inside a monetary union.

3 The model

The basic model we employ is based on Canzoneri and Henderson's (1991) two-country model. Asymmetric features are adopted from Ghironi and Giavazzi (1998) and Eichengreen and Ghironi (2002) who have used this model to analyse the optimal size of a currency union and the case for transatlantic policy coordination between the US and Europe. In order to introduce fiscal policy considerations into the analysis, we follow Jensen (1991), Pizzati (2001) and Eichengreen and Ghironi (2002).

3.1 General framework

In the model, all variables are expressed in logarithms except for the interest rate. Each economy specializes in the production of one particular good. Aggregate supplies in both economies are increasing functions of the employment rate (n^j) and

decreasing functions of a productivity disturbance x :

$$y^j = (1 - \alpha)n^j - x \quad (1)$$

where $0 < \alpha < 1$ and $j = h, f$. The superscript h denotes the variables of a small home economy and f those of a large foreign economy (e.g. an already formed monetary union). For simplicity and tractability, we assume that the elasticity of output with respect to employment, α , is the same for both economies.

Total labour demand in each economy is determined by profit maximizing firms for which labor demand is complete when the marginal productivity of labour is equal to the real wage:

$$w^j - p^j = -\alpha n^j - \tau^j - x \quad (2)$$

where τ^j , w^j , and p^j are, respectively, the rate of taxation of revenues, the nominal wage rate and the price of the good produce by economy j .

Consumer Price Indices (CPIs) are weighted averages of the prices of domestic and foreign goods. Residents in the home economy spend a fraction $(1 - \beta)$ of their income on domestic goods and a fraction β on goods produced in the foreign economy. On the other hand, consumers in the foreign economy spend a fraction β of their income on their own goods and a fraction $(1 - \beta)$ on goods produced on the home economy. The CPIs are then described by

$$\begin{aligned} q^h &= (1 - \beta)p^h + \beta(p^f + e) = p^h + \beta z \\ q^f &= \beta p^f + (1 - \beta)(p^h - e) = p^f - (1 - \beta)z \end{aligned} \quad (3)$$

where q^h and q^f denote the CPIs of the home and the foreign economies, and e and $z = e + p^f - p^h$ are, respectively, the nominal and real exchange rates.

In (3), β is an indicator of the relative size of the two economies and of their integration toward each other. Notice that when $\beta = \frac{1}{2}$ the two economies are identical. As β rises the size of the home economy shrinks while that of the foreign economy increases. In the extreme case in which $\beta = 1$, the home economy is so small that it is not able to affect the foreign economy CPI at all.

Demand is positively influenced by the output of both economies according to the proportion of income they allocate to domestic and foreign-produced goods. The marginal propensity to spend ε is the same for both goods and in both economies. Demand is also favourably affected by the two governments' spending on domestic and foreign goods. Residents in the two economies reduce expenditure by the same amount ($0 < v < 1$) after an increase in the real interest rate r^j . The market equilibrium conditions for the two economies are given by

$$\begin{aligned} y^h &= \delta\beta z + \varepsilon [\beta y^f + (1 - \beta)y^h] + [\beta g^f + (1 - \beta)g^h] - vr^h \\ y^f &= -\delta(1 - \beta)z + \varepsilon [\beta y^f + (1 - \beta)y^h] + [\beta g^f + (1 - \beta)g^h] - vr^f \end{aligned} \quad (4)$$

Clearly, a depreciation of the real exchange rate shifts demand away from the foreign toward the home economy. Notice that when, for instance, $\beta = 1$ the real exchange rate does not affect the foreign economy at all.

A priori, the ex ante real interest rate in each economy is defined as the nominal interest rate minus the expected rate of change in its consumer prices index:

$$r^j = i^j - E(q_{+1}^j) + q^j \quad (5)$$

where i^j the nominal interest rate in economy j .

Each economy issues bonds denominated in domestic currency which investors regard as perfect substitutes. They hold positive amounts of both kind of bonds when expected interest rates measured in a common currency are equal to

$$i^f = i^h - E(e_{+1}) + e \quad (6)$$

Money demand on both economies is described by

$$m^j - p^j = y^j - \lambda i^j \quad (7)$$

where $\lambda > 0$ and m^j represents the nominal money supply in economy j .

By substituting (1) and (2) into (7) we obtain the semi-reduced form for employment as

$$n^j = m^j - w^j - \tau^j + \lambda i^j \quad (8)$$

Employment rises with increases in money supply and decreases with higher wage rates and taxes. In (8), the nominal interest rate has a positive effect on employment.

At the end of period $t - 1$, trade unions set the nominal wage rate prevailing in period t . Their purpose is to minimize the expected deviations of employment from its full employment target (here normalized to zero). Thus, they minimize the following loss function:

$$W^j = -\frac{1}{2} E_{-1} (n^j)^2 \quad (9)$$

Substituting (8) into (9) and minimizing with respect to n^j , we obtain the nominal wage rates set by the trade unions as

$$w^j = E[m^j - \tau^j + \lambda i^j] \quad (10)$$

Trade unions set nominal wages according to the expected stances of monetary and fiscal policymakers in period t and the effect of those stances on the domestic interest rate.

In order to focus our attention on the role of strategic interactions between the two economies and on the importance of size asymmetries for the choice of the most appropriate exchange rate regime, we neglect the time inconsistency problems that might arise between the trade unions and the monetary and fiscal authorities in each

economy.² Since shocks are random and non-observable by unions at period $t - 1$, in the absence of time inconsistency problems expected money supplies and taxes are equal to zero. Hence, the rational decision for trade unions is to set wages equal to zero, $w^j = 0$.³

Finally, with no time inconsistency problems, the government budget constraint abstracts from seigniorage as a possible source of revenue. Fiscal authorities face a budget constraint given by

$$\tau^j = g^j \quad (11)$$

Since our framework is static, we assume that the fiscal authorities cannot issue debt either and consequently are subject to a balanced budget constraint.⁴

3.2 Policymakers' preferences

The money supply is the only instrument that monetary authorities possess. They chose their instrument, m^j , to minimize the quadratic loss functions described by

$$L_{CB}^j = \frac{1}{2}[\sigma_1(n^j)^2 + (q^j)^2] \quad (12)$$

The monetary authorities' losses increase with deviations of employment from zero and positive changes in their CPIs. The parameter σ_1 reflects the weight that policymakers attach to employment and inflation deviations from their targets of zero.

In the event that the home and the foreign economies decide to constitute a monetary union, a single central authority minimizes the weighted sum of both economies losses as given by

$$L_{MU} = \beta L_{CB}^f + (1 - \beta)L_{CB}^h \quad (13)$$

For simplicity, we assume that the weight of each economy on the central authority's decisions is proportional to its size in the monetary union.⁵

Fiscal authorities' only policy instrument is the rate of taxation of revenues; hence, government spending is obtained residually. In addition to unemployment and inflation, fiscal authorities dislike the volatility of taxation and the exchange rate. Fiscal authorities care about exchange rate volatility because of the cost it brings on so-

²This is not unrealistic providing that the Maastricht Treaty prevents in principle the inflationary bias by stipulating that one year before joining EMU, the accession country's inflation rate should not exceed by more than 1.5% the average rate of the three EU countries where inflation is the lowest.

³Interest rates in (8) also depend on shocks and on the stances of monetary and fiscal authorities.

⁴Consistently with SGP requirements, in our model fiscal deficits in both economies equal zero over time.

⁵Considering the present size of EMU, this assumption is to some extent consistent with the current voting system of "one country one vote" and with the new proposed system of rotating groups in which larger countries have more power in the European Central Bank's monetary policy decisions and which will replace the former voting system as soon as the number of member states in EMU exceeds 15 (European Council, 2003).

ciety's welfare in terms of uncertainty and transaction costs and they dislike the volatility of taxation due to the distortions it imposes on society. Thus, each fiscal authority chooses its instrument, τ^j , to minimize:

$$L_{FA}^j = \frac{1}{2}[\sigma_3(n^j)^2 + (1 - \sigma_3)(q^j)^2 + (1 - \sigma_{2,j})(\tau^j)^2] + \chi^j$$

$$\text{with } \chi^j = \frac{1}{2} [\sigma_{2,j}(e)^2] \quad (14)$$

where χ^j is the cost that the volatility of the exchange rate imposes on society's welfare in economy j , $\sigma_{2,j}$ represents the relative dislike of the fiscal authorities for the volatility of taxation and the nominal exchange rate, and σ_3 measures their relative dislike for employment and inflation.

An important point to notice in equation (14) is the j subscript in $\sigma_{2,j}$. This suggests that, according to their relative size and integration with one another, the two economies' dislike for the volatility of taxation and the exchange rate may differ. As $\beta \rightarrow 1$, the home economy becomes not only smaller but also more and more integrated to the foreign; hence, the weight that the home fiscal authority attaches to the exchange rate volatility also increases. Notice that the larger aversion of the small economy for exchange rate volatility raises its activism in fiscal policymaking (i.e. it reduces its dislike for the volatility of taxation).

In the event that the two economies form a single currency union, the nominal exchange rate volatility is not a concern for their residents anymore (i.e. $\sigma_{2,j} = 0$). In that scenario, the loss function observed by the two fiscal authorities is identical and defined as

$$L_{FA}^j = \frac{1}{2}[\sigma_3(n^j)^2 + (1 - \sigma_3)(q^j)^2 + (\tau^j)^2] \quad (15)$$

where σ_3 measures the relative aversion of the fiscal authorities for employment and inflation relative to taxation volatility.

3.3 Reduced forms

In this section, we express the employment and inflation endogenous variables of the model in terms of exogenous, predetermined or control variables for the non-cooperative and monetary union regimes.

3.3.1 Non-cooperative (flexible exchange rates) regime

In the absence of cooperation, each economy possesses its own currency and conducts its macroeconomic policy independently. Fiscal and monetary policymakers in both economies chose their instruments by playing Nash against each other.

Since the algebra to solve the reduced forms for employment and inflation under flexible exchange rates is cumbersome, we present the derivations of those expressions in Appendix A.1. In compact notation and leaving the size parameters (β and $(1 - \beta)$)

Table 2: Non-structural parameters

$A = \alpha - \frac{\alpha\lambda\xi}{\theta}$	$\Lambda = 1 - \frac{\lambda\xi}{\theta}$	$H = \frac{\lambda\zeta}{\theta}$
$E = \Gamma - \alpha\lambda\Delta$	$\Phi = \lambda\Delta$	$\Omega = 1 - \frac{\lambda\omega}{\theta}$
$\Sigma = 1 - \frac{\alpha\lambda\zeta}{\theta}$	$T = \gamma(1 + \lambda) + \alpha\lambda\pi$	$\Theta = \lambda\pi$
$P = (1 - \alpha) + \frac{\alpha\lambda\omega}{\theta}$	$Q = \frac{\alpha\lambda\omega}{\theta} + \iota$	$N = \lambda\eta$
where:		
$\gamma = \frac{1-\alpha}{(1+\alpha\lambda)\delta+\lambda(1-\alpha)}$	$\theta = 1 + \alpha\lambda + \frac{(1-\varepsilon)(1-\alpha)\lambda}{\nu}$	$\iota = \frac{(1-\alpha)}{1-\alpha+\alpha\delta}$
$\phi = \frac{(1-\alpha+\alpha\delta)}{(1+\alpha\lambda)\delta+\lambda(1-\alpha)}$	$\xi = \alpha + \frac{(1-\varepsilon)(1-\alpha)}{\nu}$	$\eta = \frac{\omega}{\theta} - \kappa$
$\rho = (1 - \delta)\gamma$	$\omega = \frac{(1-\varepsilon)(1-\alpha)}{\nu} - (1 - \alpha) + \frac{1}{\nu}$	$\kappa = \frac{(1-\alpha)(1-\delta)}{(1-\alpha+\alpha\delta)\lambda}$
$\pi = \frac{\omega}{\theta} - \rho$	$\zeta = 1 - \frac{1-\varepsilon}{\nu}$	
$\Delta = \phi - \frac{\xi}{\theta}$	$\psi = \frac{\delta}{1-\alpha+\alpha\delta}$	

clearly expressed, those reduced forms are summarized as

$$n^h = [\Lambda - \Phi\beta] m^h + \Phi\beta m^f - [\Omega + \Theta\beta] \tau^h + \Theta\beta\tau^f - Hx$$

$$n^f = [\Lambda - \Phi(1 - \beta)] m^f + \Phi(1 - \beta)m^h - [\Omega + \Theta(1 - \beta)] \tau^f + \Theta(1 - \beta)\tau^h - Hx \quad (16)$$

$$q^h = [A + E\beta] m^h - E\beta m^f + [P - T\beta] \tau^h + T\beta\tau^f + \Sigma x$$

$$q^f = [A + E(1 - \beta)] m^f - E(1 - \beta)m^h + [P - T(1 - \beta)] \tau^f + T(1 - \beta)\tau^h + \Sigma x \quad (17)$$

where the capital Greek letters A , E , Λ , Φ , Σ and H are a group of positive non-structural parameters of the model defined in Table 2.

In addition to shocks, employment and inflation in both economies are affected by inter- and intra-economy policy spillovers. For both economies, regardless of their size, an increase of their own money supply raises domestic inflation and employment, while an expansion of its neighbour's money supply decreases domestic inflation and raises employment. An increase in domestic taxation raises inflation in both economies, causes domestic job losses and increases employment abroad. Meanwhile, the supply shock triggers unemployment and raises inflation in both economies.

Observing the effect of size asymmetries on these reduced forms, notice that when $\beta = 1$ the monetary and fiscal authorities in the trivially small home economy are incapable of affecting the large foreign economy employment and inflation through changes in their monetary or fiscal stances. Meanwhile, when both economies are size symmetric (i.e. $\beta = \frac{1}{2}$), they both affect each other equally.

3.3.2 Monetary union

We consider now the case in which the home and foreign economies decide to constitute a monetary union. In this scenario, the nominal exchange rate disappears and the real exchange rate is simply determined by relative prices (i.e. $e = 0$ and $z = p^f - p^h$). Monetary policy is controlled by a single central bank that issues a single currency; hence, changes in the money supply are identical in both economies. Taking this into consideration, the reduced forms for employment and inflation when the two economies take part in a monetary union are simply given by⁶

$$\begin{aligned} n^f &= \Lambda m^u - [\Omega + N(1 - \beta)] \tau^f + N(1 - \beta) \tau^h - Hx \\ n^h &= \Lambda m^u - [\Omega + N\beta] \tau^h + N\beta \tau^f - Hx \end{aligned} \quad (18)$$

$$\begin{aligned} q^f &= A m^u + [P - Q(1 - \beta)] \tau^f + Q(1 - \beta) \tau^h + \Sigma x \\ q^h &= A m^u + [P - Q\beta] \tau^h + Q\beta \tau^f + \Sigma x \end{aligned} \quad (19)$$

where m^u is the money supply in the union and N and Q are positive non-structural parameters defined in Table 2. Notice how under this regime the two economies are equally affected by the central authority's monetary policy. An increase in the taxation of revenues by any of the two governments raises inflation in both economies, generates domestic job losses and increases employment abroad. Meanwhile, the supply shock reduces employment and increases inflation in the same direction and proportion than under flexible regimes.

3.4 Inflation–employment trade-offs

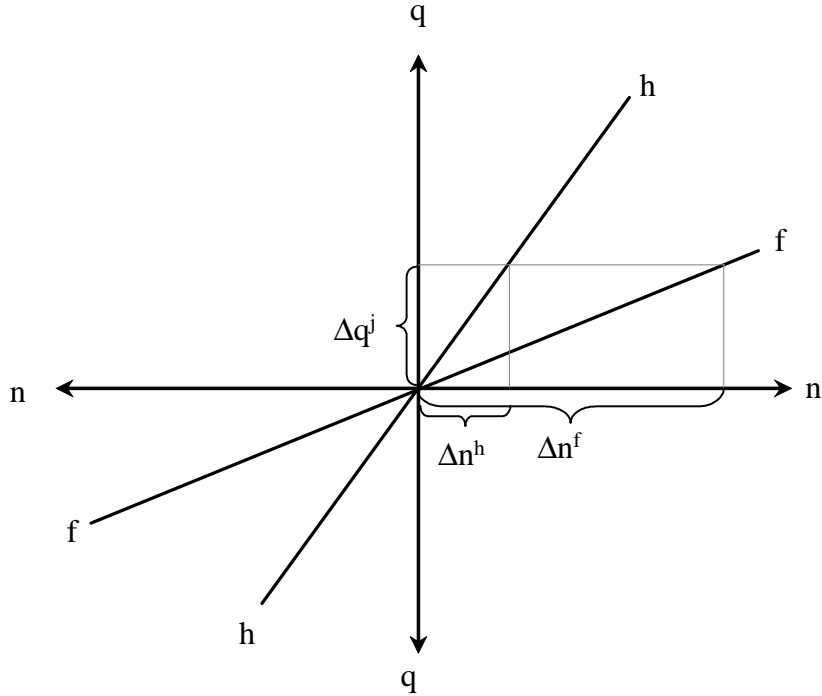
Eichengreen and Ghironi (2002) show that under non-cooperative regimes, size asymmetries give rise to different inflation–employment trade-offs for policymakers.⁷ In general, they show that authorities in relatively smaller economies face more favourable employment-inflation trade-offs than those confronted by relatively larger economies.

For instance, for the reduced forms presented in (16) and (17), the trade-off faced by the central bank in the home economy is steeper as its size gets smaller (i.e. $\frac{\partial q^h}{\partial n^h} > \frac{\partial q^f}{\partial n^f}$ for $\beta > \frac{1}{2}$; see Appendix B.1 for proof). The advantage of having a steeper inflation–employment trade-off for the small economy is illustrated graphically in Figure 1. As can be observed, a larger positive trade-off allows the central bank in the small home economy to exchange a large (given) inflation reduction for a smaller employment loss. Hence, if—as we assume later—central banks care more about inflation than about employment (i.e. $\sigma_1 < 1$), a steeper trade-off is also more

⁶These reduced forms are also fully derived in Appendix A.2.

⁷Utilizing a three-country version of this model, Eichengreen and Ghironi (2002) study the determinants of policy trade-offs and incentives for central banks and governments in the US and Europe. In their analysis, they consider the specific case of policy coordination between the US and an EMU that consists of two equal size economies.

Figure 1: Central banks' inflation–employment trade-offs



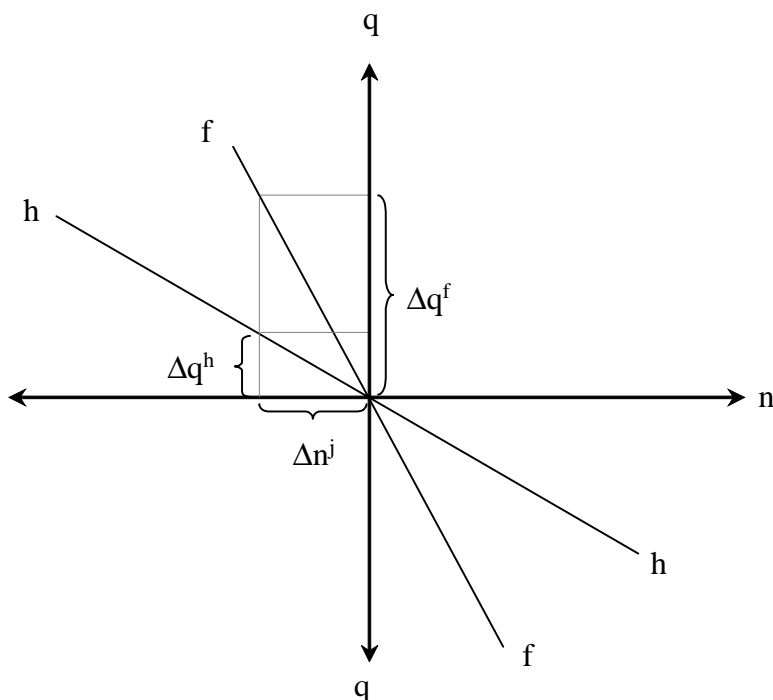
advantageous for the small home economy.

A similar situation arises in the case of fiscal authorities. For the reduced forms presented in (16) and (17), the trade-off faced by the government in the home economy is flatter as its size gets smaller (i.e. $-\frac{\partial q^h}{\partial n^h} < -\frac{\partial q^f}{\partial n^f}$ for $\beta > \frac{1}{2}$; see Appendix B.2 for proof). As shown in Figure 2, the small economy fiscal authority is capable of exchanging a higher (given) employment gain for a small price stability loss. Considering that fiscal authorities are more concerned about employment than about inflation, a negative flatter inflation–employment trade-off allows the government of the home economy to hold a more favourable position regardless of the exchange rate regime considered.

Nevertheless, cooperation between the two economies' monetary and fiscal authorities eliminates the advantage of possessing a more favourable trade-off. Employing the reduced forms for the monetary union regime presented in (18) and (19), it is straightforward to show that once the home economy takes part in the monetary union, the inflation–employment trade-off faced by the central monetary authority is one and the same for both economies. Irrespective of the size of the countries involved, the centralization of monetary policy decisions provides the same inflation–employment trade-off for both economies.

The elimination of their more favourable inflation–employment trade-off will have an influence over the ability of the home policymakers to react to shocks. In what follows, we first observe how relinquishing monetary policy independence—with and

Figure 2: Fiscal authorities' inflation–employment trade-offs



without fiscal policy considerations—affect the macroeconomic stability of a small economy. Then, we examine how alternative schemes of fiscal cooperation can help to ameliorate the stabilization costs endured by the small economy that decides to take part in a monetary union.

4 Assessing a monetary union regime without fiscal policy considerations

The purpose of this section is twofold. The first is to draw attention to the relevance of size asymmetries for macroeconomic policymaking. The second is to set a point of reference to analyse the role of fiscal policy on macroeconomic stabilization that we carry out in the next section.

The starting point in this analysis is a situation where both economies have their own currency and policymaking is only delegated to central banks whose main objective is to achieve price stability. This forms the benchmark with which we assess the decision of taking part in a monetary union. As in early studies exploring this issue (see for instance Martin, 1995; Lane, 1996, 2000; Rantala, 2001), in this section fiscal authorities are excluded from the analysis. In order to do so, we simply eliminate the taxation of revenues and the effect of government spending from the equations in the general framework of the model (i.e. equations (2), (4) and (11)). The resulting

reduced forms under both regimes are identical to those in (16) to (19) setting τ^j for $j = h, f$ equal to zero.

To illustrate the importance of size asymmetries on stabilization policies, we observe the policymaking process under two different states of the world. In the first, we examine the constitution of a monetary union between two equal size economies. In the second, we consider the case of a small economy forming a monetary union with a considerably larger economy or region (e.g. an already formed monetary union).

Employing the reduced forms in (16) to (19) and the central banks preferences in (12) and (13), we solve the policy game under the two regimes considered assigning numerical values to the structural parameters of the model and computing the resulting equilibrium. The parameter values employed to solve the model are given by $\alpha = 0.34$, $\delta = 0.7$, $\lambda = 0.34$, $v = 0.4$, $\varepsilon = 0.65$, and $\sigma_1 = 0.2$. These structural parameters are not assigned arbitrarily; they are justified based on empirical evidence or are set to reflect the expected environment faced by policymakers. A value of $\alpha = 0.34$ implies that from the original Cobb–Douglas production function where capital is constant and normalized to unity, labour requires two-thirds of the total inputs.⁸ A choice of $\delta = 0.7$ intends to reflect a high sensitivity of trade to variations in the real exchange rate.⁹ $\lambda = 0.34$ is the mean value of the elasticity of the money demand with respect to the interest rate found by Knell and Stix (2003) in a survey of 500 individual money demand estimations. The values of $\varepsilon = 0.65$ is about the average of the marginal propensity to consume found by Osada (1999) for a group of 12 industrial and developing economies. The parameter $v = 0.4$ is the same employed by Ghironi and Giavazzi (1998) and Eichengreen and Ghironi (2002) in a numerical estimation of a similar model.¹⁰ Finally, assuming that $\sigma_1 = 0.2$ realistically implies that the central banks cares more about inflation than about employment.

For the two alternative states of the world, we consider the values of $\beta = 0.5$ and $\beta = 0.9$. The first parameter value refers to the scenario in which the two economies are size symmetric, while the second correspond to a state of the world in which the home economy is only one-tenth of the size of the large foreign economy.

Flexible exchange rate regime In the absence of fiscal policy considerations, the central banks are the sole authorities responsible for dealing with stabilization in the event that disturbances affect their economies. Under flexible exchange rates, individual central banks respond by contracting their money supplies to fight the inflationary pressure provoked by the supply shock; a strategy that produces a negative externality on their neighbour via the real exchange rate. For instance, a decrease in

⁸This proportion is consistently employed in different macroeconomic models calibration (see for instance Cooley and Prescott, 1996; Kiley, 2004; Andres et al., 2004).

⁹This parameter value is consistent with empirical evidence testing the Marshall–Lerner condition which suggests that elasticity of the demand with respect to imports and exports is usually below unity.

¹⁰More details about the numerical reduced forms associated with this parameter value are presented in the following section.

Table 3: Welfare evaluations without fiscal authorities

A. Symmetric size economies ($\beta = 0.5$)										
<i>Econ</i>	Flexible exchange rates					Monetary union				
	<i>n</i>	<i>q</i>	<i>m</i>	$\frac{\partial q^j}{\partial n^j}$	L_{CB}	<i>n</i>	<i>q</i>	<i>m</i>	$\frac{\partial q^j}{\partial n^j}$	L_{CB}
<i>f</i>	-1.685	0.427	-2.170	0.790	0.375	-1.077	0.634	-1.371	0.340	0.317
<i>h</i>	-1.685	0.427	-2.170	0.790	0.375	-1.077	0.634	-1.371	0.340	0.317
B. Asymmetric size economies ($\beta = 0.9$)										
<i>Econ</i>	Flexible exchange rates					Monetary union				
	<i>n</i>	<i>q</i>	<i>m</i>	$\frac{\partial q^j}{\partial n^j}$	L_{CB}	<i>n</i>	<i>q</i>	<i>m</i>	$\frac{\partial q^j}{\partial n^j}$	L_{CB}
<i>f</i>	-1.268	0.594	-1.618	0.427	0.337	-1.077	0.634	-1.371	0.340	0.317
<i>h</i>	-1.528	0.260	-1.992	1.180	0.267	-1.077	0.634	-1.371	0.340	0.317

the money supply of the home economy will appreciate the exchange rate and then increase inflation on the foreign economy.

Under the flexible exchange rate regime, both central bankers play Nash against each other and minimize their loss function in (12) taking the money supply of their neighbour as given. The solution to the minimization problem of both central bankers yields the following First Order Conditions (FOC):

$$(0.2)n^j \frac{\partial n^j}{\partial m^j} + q^j \frac{\partial q^j}{\partial m^j} = 0 \text{ for } j = h, f \quad (20)$$

Solving the resulting two equations for m^h and m^f simultaneously, we obtain the equilibrium money supplies for both economies. Substituting those equilibrium money supplies on the employment and inflation reduced forms presented in (16) and (17), and then the resulting expressions on the loss functions of the monetary authorities, we obtain the flexible exchange rate equilibrium outcomes presented in Table 3 for both states of the world ($\beta = 0.5$ and $\beta = 0.9$).

Monetary union regime By adopting a common currency the members of a monetary union loose control over their own money supply. When a symmetric supply shock affects them, a central monetary authority that minimizes the weighted average of the two economies losses contracts the world money supply to restore price stability in the union.

Considering that $m^j = m^u$ for $j = h, f$, we obtain the equilibrium money supply set by the central monetary authority by minimizing the loss function defined in (13). The central monetary authority minimization problem results in the following FOC:

$$\beta \left(0.2n^f \frac{\partial n^f}{\partial m^u} + q^f \frac{\partial q^f}{\partial m^u} \right) + (1 - \beta) \left(0.2n^h \frac{\partial n^h}{\partial m^u} + q^h \frac{\partial q^h}{\partial m^u} \right) = 0 \quad (21)$$

Solving this equation for m^u , plugging the resulting equilibria in (18) and (19), and

subsequently the expressions obtained on the loss functions of the individual monetary authorities, we arrive at the monetary union regime equilibrium outcomes shown in Table 3.

We first contrast the equilibrium outcomes for the two regimes in the state of the world in which a currency union is formed between two equal size economies (i.e. $\beta = 0.5$). As can be observed in Table 3 Panel A, when the two economies are size symmetric the inflation–employment trade-offs (i.e. $\frac{\partial q^j}{\partial n^j}$) faced by them in each regime are identical. Under this state of the world, gains from participating in a monetary union for both economies stem from ameliorating the externalities that each economy exerts on its neighbour through the real exchange rate. After adopting a common currency, the central monetary authority contracts the world money supply less aggressively than the individual policymakers. By reducing the employment losses of the two economies without increasing inflation substantially, adopting a common currency ultimately allows a better position for both economies in terms of the losses they endure.

The implications of the analysis change when we compare a state of the world in which a monetary union is constituted between economies that differ in size (i.e. $\beta = 0.9$). As we observed earlier, under a non-cooperative regime the asymmetries in the size of the economies give rise to dissimilar inflation–employment trade-offs which are more favourable for a relatively smaller economy.

As shown in Table 3 panel B, while both economies continue attaining the same trade-off participating in a monetary union, the small economy faces a (steeper) more advantageous trade-off than the large economy policymaker when it operates under a flexible regime. Due to its steeper trade-off, the small home economy policymaker is capable of responding more effectively to the supply shock. As a result, the home money supply is contracted more aggressively, shifting the inflation burden arising from the shock to the foreign economy and reducing domestic inflation more effectively.

Assessing the decision faced by the policymaker in the small economy about taking part in a monetary union, we observe that by abandoning the flexible regime his economy experiences considerably higher losses. Clearly, the small home economy would be better off “free riding” from its size—by using its own monetary policy—to counteract the inflationary pressure provoked by the supply shock.¹¹

5 A monetary union with fiscal authorities

As in early models evaluating the desirability of forming a currency union, in the previous section we assumed that monetary authorities were the only policymakers concerned with output and price stability. Nevertheless, to better assess the decision faced by small economies, we need to consider that the coexistence of fiscal

¹¹As pointed out earlier, similar results were found by Martin (1995) studying the incentives of small open economies to join an already formed monetary union.

and monetary authorities generates additional interactions and spillovers in the policymaking process. As we observe later on, these interactions influence the way in which stabilization policies affect the members of a monetary union and the way that policymakers respond to each other's strategic decisions.

In order to incorporate the role of government policies on macroeconomic stabilization, in this section we introduce into the model benevolent fiscal authorities that maximize the welfare of their residents and care not just about inflation and employment, but also about taxation and exchange rate volatility. Following the inclusion of fiscal authorities, we begin by reconsidering the feasibility of forming a monetary union between a small and a large economy. Once the convenience of participating in a monetary union has been reassessed in the presence of non-cooperative fiscal stances, we focus our attention on the viability of engaging both economies in fiscal coordination and on how different schemes of policy synchronization can provide the grounds for beneficial cooperation among the members of a monetary union. We evaluate three different schemes of fiscal coordination: simple cooperation between fiscal authorities (playing Nash against the central monetary authority), monetary and fiscal leadership strategies.

5.1 Reassessing participation in a monetary union

From now on, we concentrate on the asymmetric state of the world (i.e. the case when $\beta = 0.9$). The timing of events is similar to that described earlier in the absence of fiscal policy considerations. At period $t - 1$, trade unions form expectations and set wages accordingly. Thereafter, at period t , the shock x is realized and observed by monetary and fiscal authorities in both economies. Following this, under the flexible exchange rate regime the four authorities chose their instruments simultaneously taking the actions of the other policymakers as given. The exchange rate is then endogenously determined according to the responses of the four policymakers to the shock. The nominal exchange rate reduced form is shown in Appendix A.1 to be

$$e = -\phi(m^f - m^h) + \rho(\tau^f - \tau^h) \quad (22)$$

where ϕ and ρ are defined in Table 2. Given the forms of the respective preferences of monetary and fiscal authorities described in (12) and (14), monetary authorities reduce their money supplies to ameliorate the inflation pressure provoked by the shock and fiscal authorities decrease taxation to counteract the reduction in employment. As a result, the actions of monetary and fiscal authorities have opposite effects over the nominal exchange rate. For instance, when—in response to a supply shock—the home monetary authority reduces its money supply (by more than the foreign central bank thanks to its steeper trade-off), this appreciates the nominal exchange rate. Meanwhile, the reduction in taxation by the home fiscal authority (above the foreign fiscal authority) reduces the extent of the appreciation and brings the nominal exchange rate back towards its original level.

Table 4: Numerical reduced forms

A. Flexible regime	
n^h	$=0.703m^h+0.059m^f-0.877\tau^h+0.503\tau^f-0.033x$
n^f	$=0.756m^f+0.006m^h-0.429\tau^f+0.056\tau^h-0.033x$
q^h	$=0.829m^h-0.570m^f+0.501\tau^h+0.372\tau^f+0.989x$
q^f	$=0.323m^f-0.063m^h+0.831\tau^f+0.041\tau^h+0.989x$
B. Monetary union	
n^h	$=0.762m^u-0.870\tau^h+0.496\tau^f-0.033x$
n^f	$=0.762m^u-0.428\tau^f+0.055\tau^h-0.033x$
q^h	$=0.259m^u+0.479\tau^h+0.393\tau^f+0.989x$
q^f	$=0.259m^u+0.830\tau^f+0.044\tau^h+0.989x$

In the presence of fiscal policy considerations, monetary authorities continue minimizing the loss function described by equation (12). Meanwhile, fiscal authorities minimize the deviations of employment, inflation, taxes and the nominal exchange rate from zero, as shown in equation (14). The preferences of the fiscal authorities, under flexible exchange rates feature the values of $\sigma_{21} = 0.06$, $\sigma_{22} = 0.6$, and $\sigma_3 = 0.9$. Numerically, these values provide the following loss functions:

$$L_{FA}^h = [0.45(n^h)^2 + 0.05(q^h)^2 + 0.20(\tau^h)^2 + 0.30(e)^2]$$

$$L_{FA}^f = [0.45(n^f)^2 + 0.05(q^f)^2 + 0.47(\tau^f)^2 + 0.03(e)^2] \quad (23)$$

In order to make the fiscal authorities' preferences consistent with the size of the two economies and their integration towards each other, we assume that the small economy cares ten times more about the volatility of the exchange rate than the large economy. Its higher dislike for variations of the exchange rate increases the activism of the government on managing fiscal policy (i.e. reduces the home fiscal authority dislike for taxation volatility). Finally, both policymakers care more about employment than about inflation.

Under the monetary union regime, the adoption of a common currency eliminates the exchange rate volatility concern from the fiscal authorities loss functions. As a result, the preferences of the fiscal authorities are described by (15). Numerically, the loss functions minimized by the two fiscal authorities are in this case identical and given by

$$L_{FA}^j = [0.45(n^j)^2 + 0.05(q^j)^2 + 0.50(\tau^j)^2] \quad (24)$$

In the absence of exchange rate volatility, the activism of two authorities is reduced and they continue caring more about employment than about inflation. Meanwhile, the central monetary authority minimizes the weighted sum of both central bank losses as described in equation (13).

Using the structural parameters values defined above ($\alpha = 0.34$, $\delta = 0.7$, $\lambda = 0.34$, $\nu = 0.4$ and $\varepsilon = 0.65$), the reduced forms under flexible exchange rates (in (16) and

Table 5: Welfare evaluations with fiscal authorities

A. Flexible exchange rate regime						Trade-offs ($\frac{\partial q^j}{\partial n^j}$)		Losses	
<i>Econ</i>	<i>n</i>	<i>q</i>	<i>m</i>	τ	<i>e</i>	<i>CB</i>	<i>FA</i>	<i>L_{CB}</i>	<i>L_{FA}</i>
<i>f</i>	-0.775	0.363	-1.090	-0.345	-0.283	0.427	-1.937	0.128	0.335
<i>h</i>	-0.473	0.080	-1.555	-1.016	-0.283	1.180	-0.571	0.025	0.331
B. Monetary union without fiscal coordination						Trade-offs ($\frac{\partial q^j}{\partial n^j}$)		Losses	
<i>Econ</i>	<i>n</i>	<i>q</i>	<i>m</i>	τ	<i>e</i>	<i>CB</i>	<i>FA</i>	<i>L_{CB}</i>	<i>L_{FA}</i>
<i>f</i>	-0.683	0.401	-1.020	-0.360	-	0.340	-1.935	0.126	0.150
<i>h</i>	-0.531	0.329	-1.020	-0.527	-	0.340	-0.551	0.082	0.135

(17)) and the monetary union regime (in (18) and (19)) are numerically presented in Table 4. As expected, foreign instruments have a considerable higher impact on home employment and inflation than home instruments on foreign variables. Only when a monetary union is constituted, the impact of the union money supply is the same in both economies employment and inflation.

Flexible exchange rate regime Employing the loss functions in (23), under the flexible exchange rates the fiscal authorities' minimization problem yields the following two FOCs:

$$0.03e \frac{\partial e}{\partial \tau^f} + 0.47\tau^f + 0.45n^f \frac{\partial n^f}{\partial \tau^f} + 0.05q^f \frac{\partial q^f}{\partial \tau^f} = 0 \quad (25)$$

$$0.30e \frac{\partial e}{\partial \tau^h} + 0.20\tau^h + 0.45n^h \frac{\partial n^h}{\partial \tau^h} + 0.05q^h \frac{\partial q^h}{\partial \tau^h} = 0 \quad (26)$$

Meanwhile, central banks continue facing the FOCs defined in (20). Plugging the numerical reduced forms in Table 4 on the FOCs in (20) and (26), and solving simultaneously for m^j and τ^j , we obtain the equilibrium outcomes presented in Table 5 panel A.

Contrasting the equilibrium outcomes for the flexible exchange rate regimes in Tables 2 (panel B) and 5 (panel A), the first thing to notice is how both central bankers operating under flexible exchange rate regimes are better off once fiscal authorities exert their own effort towards stabilization. Following the inflation and unemployment tolls yielded by the shock, the actions of the fiscal policymakers produce a positive externality on the central bankers. This happens because the contraction of taxes—and hence government spending—by the fiscal authorities reduces inflation.

Nonetheless, this positive externality does not extend to the actions of the central bankers. Following the supply shock, the tightening of the central banks money supplies reduces the level of employment in conjunction with the shock. Hence, the stabilization efforts of the central bankers produce a negative externality on the fiscal authorities that care more about employment than about inflation.

Comparing the equilibrium outcomes for the two economies under flexible ex-

change rates in Table 5, we observe how the flatter inflation employment trade-off faced by the small economy fiscal authority allows it to (contract taxes more aggressively and) experience lower unemployment. Similarly, as a result of his steeper trade-off, the central banker in the small economy (contract its money supply by more than its counterpart and) experiences less inflation.¹² The combination of lower inflation and unemployment results in considerable lower losses for the small economy central banker. On the other hand, despite its more favourable trade-off, the activism required to reduce unemployment (i.e. a larger contraction of τ^h) and its higher concern for the volatility of the exchange rate, lead the fiscal authority in the small economy to endure similar losses than its counterpart in the large economy.

Monetary union regime Under this arrangement, the fiscal authorities' minimization problem yields the following two FOCs:

$$0.50\tau^j + 0.45n^j \frac{\partial n^j}{\partial \tau^j} + 0.05q^j \frac{\partial q^j}{\partial \tau^j} = 0 \quad (27)$$

Meanwhile, using (13) the central monetary authority FOC is given by

$$(0.9) \left(0.2n^f \frac{\partial n^f}{\partial m^u} + q^f \frac{\partial q^f}{\partial m^u} \right) + (0.1) \left(0.2n^h \frac{\partial n^h}{\partial m^u} + q^h \frac{\partial q^h}{\partial m^u} \right) = 0 \quad (28)$$

Solving the FOCs in (27) and (28) simultaneously for m^u and τ^j , we obtain the equilibrium outcomes presented in Table 5 panel B.

Looking at the desirability of taking part in the monetary, we observe that giving up monetary policy implies the small economy abandoning its ability to exploit the exchange rate to react to the shock (i.e. giving up its more favourable trade-off). As a result, the small economy experiences more inflation than under the flexible regime. In terms of employment, the fiscal authority retains its flatter trade-off and endures fewer job losses than its counterpart after the formation of the monetary union. However, the lower contraction of the central authority money supply and the higher concern of the fiscal authorities for the taxation of revenues (i.e. its lower activism in fiscal policy once the exchange rate volatility is eliminated) produce a less aggressive reaction from the small economy fiscal authority. As a result, both unemployment and inflation are larger for the small economy under the monetary union than under the flexible regime. This results in considerable larger losses from the monetary authority's perspective.

Nevertheless, participating in the monetary union allows the small economy's fiscal authority to reduce the social welfare losses arising after the shock. There are two explanations for this result. The first is that under the monetary union regime the exchange rate volatility disappears and that eliminates the level of losses

¹²The trade-offs faced by monetary authorities are obviously the same than those presented before for the analysis of stabilization policies without fiscal authorities.

suffered by its society in terms of transaction costs and uncertainty. The second has to do with the reduction in the volatility of taxation. Although the small economy experiences higher inflation and unemployment participating in the monetary union than operating under a flexible regime, the less aggressive response of the central monetary authority and the absence of exchange rate volatility concerns challenge a lower restraining of taxes from the fiscal authority. This reduces the welfare losses associated with a fall in taxation of revenues and government spending.

Despite the lower social welfare losses arising under the monetary union regime, inflation and employment are larger than under the non-cooperative regime. In episodes of prolonged instability, this of course would be a cause for concern for monetary and fiscal authorities. Particular discomfort may arise in the foreign large economy, as it endures more inflation and unemployment than the small economy. In what follows, we explore whether fiscal coordination can help to ameliorate the inflation and unemployment experienced by the members of the monetary union.

5.2 Fiscal coordination

The treaty establishing the European Union provides some room for fiscal coordination by suggesting that “Member states shall regard their economic policy as a matter of common concern and shall coordinate them within the (European) Council”.¹³ Nevertheless, up until now, coordination in the EU has not involved explicit schemes of cooperation between fiscal authorities at the Economic and Finance Council (ECOFIN) level or a full formal agreement between the ECB and the ECOFIN Council.

Although coordination among authorities thus far has been rather limited to the commitment towards the rules imposed by the SGP and the mutual attendance of ECB and ECOFIN representatives at each other’s Council meetings, the interaction of monetary and fiscal policy remains an increasingly crucial issue for the EU; especially as the monetary union prepares to embrace additional members. Indeed, bringing together the presence of a supranational monetary authority and coordinated fiscal agents is an interesting research topic relevant for the future design of Europe’s fiscal and monetary institutions.

In this section we explore a simple scheme of cooperation in which fiscal authorities in both economies are coordinated by a central fiscal authority but no involvement of the monetary authority exists (i.e. fiscal authorities cooperate against the central monetary authority). In other words, monetary and fiscal central authorities play Nash against each other. While the monetary authority chooses the money supply of the union, the fiscal authority sets the rate for the taxation of revenues.

Under fiscal cooperation, the central authority that coordinates fiscal policymaking in the monetary union minimizes the weighted sum of the two fiscal authorities’

¹³Extract from the Treaty of Amsterdam, Article 99 (European Council, 1997).

A. Monetary union with fiscal coordination						Losses	
<i>Economy</i>	<i>n</i>	<i>q</i>	<i>m</i>	τ	<i>e</i>	L_{CB}	L_{FA}
<i>f</i>	-0.714	0.420	-1.059	-0.338	-	0.140	0.157
<i>h</i>	-0.714	0.420	-1.059	-0.338	-	0.140	0.157
B. Monetary authority Stackelberg leader						Losses	
<i>Economy</i>	<i>n</i>	<i>q</i>	<i>m</i>	τ	<i>e</i>	L_{CB}	L_{FA}
<i>f</i>	-0.928	0.275	-1.377	-0.410	-	0.124	0.254
<i>h</i>	-0.928	0.275	-1.377	-0.410	-	0.124	0.254
C. Fiscal authority Stackelberg leader						Losses	
<i>Economy</i>	<i>n</i>	<i>q</i>	<i>m</i>	τ	<i>e</i>	L_{CB}	L_{FA}
<i>f</i>	-0.463	0.272	-0.845	-0.570	-	0.059	0.128
<i>h</i>	-0.463	0.272	-0.845	-0.570	-	0.059	0.128

loss functions:

$$\min L_{FU} = \beta L_{FA}^f + (1 - \beta)L_{FA}^h \quad (29)$$

with respect to the fiscal authority instruments τ^f and τ^h . The corresponding FOCs of this minimization problem are

$$0.9 \left(0.5\tau^f + 0.45n^f \frac{\partial n^f}{\partial \tau^f} + 0.05q^f \frac{\partial q^f}{\partial \tau^f} \right) + 0.1 \left(0.5\tau^h + 0.45n^h \frac{\partial n^h}{\partial \tau^f} + 0.05q^h \frac{\partial q^h}{\partial \tau^f} \right) = 0$$

$$0.9 \left(0.5\tau^f + 0.45n^f \frac{\partial n^f}{\partial \tau^h} + 0.05q^f \frac{\partial q^f}{\partial \tau^h} \right) + 0.1 \left(0.5\tau^h + 0.45n^h \frac{\partial n^h}{\partial \tau^h} + 0.05q^h \frac{\partial q^h}{\partial \tau^h} \right) = 0 \quad (30)$$

Substituting the numerical reduced forms for the monetary union regime presented in Table 4 and solving the system of three equation involving (28) and (30), the resulting equilibrium outcomes for the regime are presented in Table 6 panel A.¹⁴

As in the case of monetary unification (without fiscal cooperation), coordination of fiscal policies leads to a less aggressive response of the central fiscal authority to the shock. This happens because centralization of fiscal stances allows the fiscal authorities to internalize (and eliminate) the negative external effects that a larger contraction of taxes by both economies has on each other's employment. However, this less significant contraction by the fiscal authority translates into a smaller positive externality on price stability. Consequently, the central monetary authority responds more aggressively to the shock than in the absence of fiscal coordination.

For the two economies involved in the regime, the more aggressive reaction of the central monetary authority to the shock and the weaker response of the central fiscal authority lead to higher inflation and unemployment than in the absence of fiscal

¹⁴Assuming that the central fiscal authority harmonizes the taxation of revenues in the two economies (i.e. that $\tau = \tau^1 = \tau^2$) and that it minimizes the weighted sum of the two fiscal authorities loss function as in (29) provides exactly the same result.

coordination. As a result, despite the lower activism of fiscal policy (i.e. the lower contraction of taxes than under no coordination), both economies experience higher losses from a monetary or fiscal perspective. Hence, centralization of fiscal policies results in a counterproductive strategy for the members of the monetary union.

In order to control for the more aggressive reaction of the central monetary authority and the weaker response of the central fiscal authority, coordination can be extended to harmonize the stabilization efforts of both policymakers. In what follows, we examine schemes of coordination comprising the fiscal and the monetary central authorities committed to follow the stabilization efforts of each other.

5.3 Monetary and fiscal policy coordination

Since fiscal policy centralization against the monetary authority results in a counterproductive strategy for the members of a monetary union, in this section we explore forms of international coordination that involve synchronizing the stabilization effort of both, fiscal and monetary central authorities. We present the solution for two alternative arrangements. In the first, the central monetary authority acts as Stackelberg leader, while in the second the fiscal authority acts as such. Under both arrangements, the authority that acts as leader minimizes its own losses taking into account the reaction of the other player.¹⁵

Monetary leadership First, we consider the case where, following the supply shock, the central monetary authority chooses the money supply for the union taking into account the response of the central fiscal authority to its actions. In this case, the monetary authority's problem is to

$$\begin{aligned} \min L_{MU} &= \beta L_{CB}^f + (1 - \beta)L_{CB}^h \\ s.t. &: \text{FOCs in (30)} \end{aligned} \tag{31}$$

Employing the reduced forms in Table 4, the resulting equilibrium for the monetary leadership regime are presented in Table 6 panel B.

The more significant is the monetary authority reaction to the disturbance, the more aggressively the fiscal authority responds after the shock. This is because a greater contraction of the money supply triggers more unemployment which the fiscal authority tries to ameliorate by cutting taxes. This, of course, creates a larger positive externality for the central monetary authority. Hence, the latter takes advantage of its leadership to contract its money supply more aggressively than in previous regimes. As a result, it is capable of achieving lower inflation and losses than under no cooperation with the central fiscal authority. Nonetheless, due to the more aggressive reaction by both authorities, unemployment and taxation volatility increase considerably; as a result, social welfare losses significantly exceed those under the previous

¹⁵For some insight into the implementation of fiscal coordination schemes like those we have proposed see, for instance, Fatas et al. (2003) and von Hagen (2004).

regimes (i.e. monetary union without fiscal cooperation or pure coordination of fiscal authorities playing Nash against the central bank). In the end, cooperation under monetary leadership is counterproductive for the fiscal authorities and the societies they represent.

Fiscal leadership When the fiscal authority acts as leader and the monetary authority performs as follower, the optimization problem of the former is defined as follows:

$$\begin{aligned} \min L_{FU} &= \beta L_{FA}^f + (1 - \beta)L_{FA}^h \\ \text{s.t.} &: \text{FOCs in (28)} \end{aligned} \tag{32}$$

The equilibrium outcomes for this arrangement when employing the numerical reduced forms presented in Table 4 are shown in Table 6 panel C.

Comparing the outcomes in Table 6 panels B and C with those in panel A, it is apparent that whoever has the first mover advantage determines the equilibrium ranking of inflation, employment and welfare for the two authorities. In the event that the fiscal authority acts as Stackelberg leader, it also uses its first mover advantage to reduce unemployment more actively than in the absence of coordination. It realizes that—despite its aversion for the volatility of taxation—a more contractionary fiscal policy conveys a positive externality over the monetary authority which responds tightening its money supply less aggressively after the shock. Hence, by challenging a lower money supply contraction from the central monetary authority, the fiscal authority also achieves considerably lower employment losses. The combination of lower inflation and unemployment with a moderate cutback in taxes leads to a reduction on the losses experienced by monetary and fiscal authorities. As a result, the fiscal leadership strategy brings a Pareto gain from the perspective of all the policymakers involved and the societies they represent.

Ranking the social welfare losses experienced by both economies over all the arrangements examined, it is clear that the fiscal leadership strategy makes engaging in monetary and fiscal coordination attractive for the residents of both economies and their authorities. Fiscal leadership is preferred by policymakers to a monetary union where fiscal authorities play Nash against the central monetary authority and to a monetary leadership regime. Moreover, the fiscal leadership regime is superior to a fully non-cooperative equilibrium in which both countries have their own currency and possess their own fiscal policy.

In terms of feasibility, whether a fiscal leadership regime can be a realistic option for EMU would depend on the commitment of fiscal and monetary authorities to achieving effective coordination. Lambertini and Rovelli (2004) suggest that looking at the fiscal authority as the leader is naturally embedded in the institutional policymaking process. This happens because in practice fiscal policy is set prior to monetary policy and revised much less frequently. Typically, fiscal policy is defined on an annual basis, whereas monetary policy is constantly monitored and may change

several times over the course of a year. These circumstances point towards the fiscal authority as the natural first mover (i.e. the Stackelberg leader), a situation that in our model is indeed desirable for policymakers and the residents of both economies.

6 Conclusion

The aim of this chapter has been to assess the desirability of taking part in a monetary union from the perspective of a small open economy. In particular, the analysis intends to shed some light on the potential participation of the EU's new members in the EMU.

The chapter addresses two important questions. The first is whether participation in a monetary union is desirable for a small open economy. We find that, leaving fiscal policy considerations aside, it is straightforward to conclude that participation in a monetary union is counterproductive for a small economy. The key point to this result is that a small open economy is better off “free riding”, and using its own monetary policy to counteract the inflationary pressures provoked by supply shocks.

Following this result, we expand the analysis to consider the interactions between fiscal and monetary authorities on macroeconomic stabilization. We find that, once representative fiscal policymakers are incorporated into the model, taking part in the monetary union becomes desirable from a social welfare perspective. The reason for this is that, by taking part in stabilization fiscal authorities concerned about employment respond to the shock reducing taxes and spending, offsetting with this inflationary pressures and ameliorating unemployment. In addition, under a monetary union regime, the absence of exchange rate volatility and the reduction in taxation are both factors that contribute to decreasing the losses that society experiences in the face of the shock.

The second question this chapter explores is whether monetary and fiscal coordination can help to improve the macroeconomic stability of the members of a monetary union. Evaluating three alternative forms of cooperation, it is shown that the pure coordination of fiscal authorities (playing Nash against the central monetary authority) results in a counterproductive strategy for both economies. Harmonizing the interaction between fiscal and monetary authorities, it is found that while a monetary leadership strategy results in a deterioration of the small economy fiscal authority's position, a fiscal leadership strategy leads to a Pareto improvement from the perspective of both economic authorities and the societies they represent. With respect to the latter finding, we concur with other papers in the literature in suggesting that, given the timing required to implement and change monetary and fiscal policies, a fiscal leadership strategy is not only the most efficient coordination solution but also the most feasible one.

Clearly, our model leaves aside many issues potentially relevant for small open economies facing the decision of participating in a monetary union. First, although we try to set asymmetric structures, our model assumes, for instance, that the pro-

ductivity of labour in the two economies is the same. Integration could potentially create this effect but in the short term this may not be the case. Second, we assume a balanced budget constraint for the two economies. Indeed the SGP aims at “balanced budget or in surplus in the medium term” but this hardly means that debt should be excluded from the analysis in the short term.¹⁶ At least in the short run, debt sustainability deserves more attention. Finally, this paper does not address the mechanism through which the schemes of coordination examined here could be implemented. Clearly, the commitment of fiscal and monetary policymakers is necessary in order to achieve effective cooperative solutions like the ones we have proposed. However, the necessary agreements and mechanisms to achieve coordination are beyond the scope of this paper.

References

- [1] Andres, J., Domenech, R. and Fatas, A. (2004). “The Stabilizing Role of Government Size”, CEPR Discussion Paper No. 4384.
- [2] Artis, M. and Buti, M. (2001). “Setting Medium Term Fiscal Targets in EMU” in Brunilla, A., Buti, M. and Franco, D. (Eds.), *The Stability and Growth Pact: The Architecture of Fiscal Policy in EMU*, Palgrave Macmillan Ltd., Chippenham, Wiltshire.
- [3] Beetsma R., Debrun X. and Klaassen F. (2001). “Is Fiscal Policy Coordination in EMU Desirable”, *Swedish Economic Policy Review* 8(1): 57–98.
- [4] Canzoneri, M. B. and Henderson, D. (1991). *Monetary Policy in Interdependent Economies: A Game-Theoretic Approach*, MIT Press, Cambridge MA.
- [5] Clausen, V. and Wohltmann, H. (2005). “Monetary and Fiscal Policy Dynamics in an Asymmetric Monetary Union”, *Journal of International Money and Finance* 24(1): 139–167.
- [6] Cooley, T. F. and Prescott, E. C. (1995): “Economic Growth and Business Cycles” in T. F. Cooley (Ed.): *Frontiers of Business Cycle Research*, Princeton University Press, Princeton NJ.
- [7] Cooper, R. and Kempf, H. (2004) “Overturning Mundell: Fiscal Policy in a Monetary Union”, *Review of Economic Studies* 71(2): 371–397.
- [8] Dixit A. and Lambertini, L. (2001). “Monetary-fiscal Policy Interactions and Commitment versus Discretion in a Monetary Union”, *European Economic Review* 45(4–6): 997–987.

¹⁶Without taking into account the new EU members, Artis and Buti (2001) estimate that an additional margin of 0.5 to 1 percent of GDP would be necessary to make room for unforeseen circumstances before balanced budgets are achieved in the EMU.

- [9] Dixit A. and Lambertini, L. (2003). “Symbiosis of Monetary and Fiscal Policies in a Monetary Union”, *Journal of International Economics* 60(2): 977–987.
- [10] Eichengreen B. and Ghironi F. (2002). “Transatlantic Trade-offs in the Age of Balanced Budgets and European Monetary Union”, *Open Economies Review* 13(4): 381–411.
- [11] Engwerda, J. C., van Aarle, B. and Plasmans, J. (2002). “Monetary and Fiscal Policy Interaction in the EMU: A Dynamic Game Approach”, *Annals of Operational Research* 109(1-4): 229–264.
- [12] European Council (2003). “Recommendation, under Article 10.6 of the Statute of the European System of Central Banks and of the European Central Bank”, *Official Journal of the European Union* C/29–6.
- [13] European Council (1997). Treaty of Amsterdam, available on line at <http://europa.eu.int/eur-lex/lex/en/treaties/index.htm>
- [14] Fatas, A., Sibert, A., Strauch, R., von Hagen, J. and Hughes Hallet, A. (2003). *Stability and Growth in Europe: Towards a Better Pact*, Monitoring European Integration 13, Bonn/London: ZEI/CEPR.
- [15] Giavazzi, F. and Giovannini, A. (1998). “Monetary Policy Interactions under Managed Exchange Rates”, *Economica* 56(222): 199–213.
- [16] Giavazzi, F. and Pagano, M. (1988). “The Advantages of Tying One’s Hands: EMS Discipline and Central Bank Credibility”, *European Economic Review* 32(5): 1055–1075.
- [17] Ghironi, F. and Giavazzi, F. (1998). “Currency Areas, International Monetary Regimes, and the Employment-Inflation Trade-off”, *Journal of International Economics* 45(2): 259–296.
- [18] Jensen, H. (1991). “Tax Distortion, Unemployment and International Policy Cooperation”, available online at <http://www.econ.ku.dk/personal/Henrikj/pdf/taxweb.pdf>.
- [19] Kiley, M. T. (2004). “Is Moderate-To-High Inflation Inherently Unstable?”, *Finance and Economics Discussion Series (Federal Reserve Board) No. 2004–43*.
- [20] Knell, M. and Stix, H. (2003). “How Robust are Money Demand Estimations? A Meta-Analytic Approach”, *Oesterreichische Nationalbank Working Paper No. 81*.
- [21] Lambertini, L. and Rovelli, R. (2004). “Monetary and Fiscal Policy Coordination and Macroeconomic Stability: A theoretical Analysis”, *Dipartimento di Scienze Economiche-Università di Bologna, Working Paper No. 464*.

- [22] Lane, P. R. (1996). “Stabilization Policy in a Currency Union”, *Economic Letters* 53(1): 53–60.
- [23] Lane, P. R. (2000). “Asymmetric Shocks and Monetary Policy in a Currency Union”, *Scandinavian Journal of Economics* 102(4): 585–604.
- [24] Levine, P. and Pearlman, J. (2001). “Monetary Union: the Ins and Outs of Strategic Delegation”, *The Manchester School* 69(3): 285–309.
- [25] Martin, P. (1995). “Free Riding, Convergence and Two Speed Monetary Unification in Europe”, *European Economic Review* 39(7): 1345–1364.
- [26] Osada, H. (1999). “Intra-regional Multiplier Effects through Trade Linkages in the APEC Area”, *APEC Discussion Paper Series No.27*.
- [27] Pizzati, L. (2000). “Monetary Policy Coordination and the Level of National Debt”, *Economica* 27(4): 389–409.
- [28] Rantala, A. (2001). “Does Monetary Union Reduce Employment?”, *Bank of Finland Discussion Papers* 7/2001.
- [29] von Hagen, J. (2004). “Fiscal Sustainability in EMU: From the Stability and Growth Pact To a Sustainability Council for EMU”, CESifo working paper, available online at http://www.cesifo-group.de/portal/page?_pageid=36,103017&_dad=portal&_schema=PORTAL&item_link=del04-porogramme.htm.

Appendices

A. Derivation of the reduced forms of the model

A.1 Flexible exchange rates

We start by obtaining the reduced forms for the flexible regime. Utilizing (8) and assuming $w^j = 0$, the semi-reduced form for employment becomes simply

$$n^j = m^j - \tau^j + \lambda i^j \quad (\text{A.1})$$

To obtain the home price semi-reduced form, we solve (2) for p^j to arrive at

$$p^j = \alpha n^j + \tau^j + x \quad (\text{A.2})$$

Substituting the employment semi-reduced form into (A.2) we obtain that

$$p^j = \alpha m^j + (1 - \alpha)\tau^j + \lambda i^j + x \quad (\text{A.3})$$

The derivation of the real exchange rate reduced form requires several steps. Using equation (6) and assuming no speculative bubbles, we define the nominal exchange rates as

$$e = i^f - i^h \quad (\text{A.4})$$

Solving z for e and substituting (A.3) into the resulting expression, the nominal exchange rate semi-reduced form is simply

$$e = \frac{1}{1 + \alpha\lambda} [z - \alpha(m^f - m^h) - (1 - \alpha)(\tau^f - \tau^h)] \quad (\text{A.5})$$

Now, subtracting home supply and demand in (1) and (4) from those same expressions for the foreign economy, we obtain that

$$y^f - y^h = (1 - \alpha)(n^f - n^h) \quad (\text{A.6})$$

$$y^f - y^h = -\delta z \quad (\text{A.7})$$

Substituting the employment semi-reduced form in (A.1) into (A.6) and plugging equation (A.5) into (A.7), equalizing the two expressions and solving for z , the resulting real exchange rate reduced form is simply

$$z = \Gamma [(m^f - m^h) + (1 + \lambda)(\tau^f - \tau^h)] \quad (\text{A.8})$$

where $\Gamma = \frac{1 - \alpha}{(1 + \alpha\lambda)\delta + (1 - \alpha)\lambda}$. To obtain the nominal exchange rate reduced form, simply

substitute (A.8) into (A.5) to obtain

$$e = i^f - i^h = -\phi (m^f - m^h) + \rho (\tau^f - \tau^h) \quad (\text{A.9})$$

where $\phi = \frac{(1-\alpha+\alpha\delta)}{(1+\alpha\lambda)\delta+(1-\alpha)\lambda}$ and $\rho = (1-\delta)\Gamma$.

Now, we need to obtain the interest rate reduced forms. Using (5) and assuming no speculative bubbles it follows that

$$r^w = i^w + q^w \quad (\text{A.10})$$

Since real exchange movement cancel each other around the world and shocks are symmetric, it can be shown that $q^w = p^w$ and $x^w = x$. Using (A.3) r^w can be expressed as

$$r^w = \alpha m^w + (1-\alpha)\tau^w + (1+\alpha\lambda)i^w + x \quad (\text{A.11})$$

World demand is given by the weighted sum of the demands in the two economies. Using (4), the world demand is equal to

$$y^w = \beta y^f + (1-\beta)y^h = \varepsilon y^w + g^w - v r^w \quad (\text{A.12})$$

Solving for r^w we get that world real interest rate is simply

$$r^w = -\frac{1-\varepsilon}{v} y^w + \frac{1}{v} g^w \quad (\text{A.13})$$

On the other hand, using (1) and (8), the world supply can be written as

$$y^w = (1-\alpha)n^w - x = (1-\alpha)[m^w - \tau^w + \lambda i^w] - x \quad (\text{A.14})$$

Substituting the above expression on (A.13), it follows that

$$r^w = -\frac{(1-\varepsilon)(1-\alpha)}{v} [m^w - \tau^w + \lambda i^w] + \frac{1-\varepsilon}{v} x + \frac{1}{v} g^w \quad (\text{A.15})$$

Equalizing (A.11) and (A.15) and solving for i^w we obtain

$$i^w = \beta i^f + (1-\beta) i^h = -\frac{\xi}{\theta} m^w + \frac{\omega}{\theta} \tau^w - \frac{\zeta}{\theta} x \quad (\text{A.16})$$

where $\xi = \alpha + \frac{(1-\varepsilon)(1-\alpha)}{v}$, $\theta = 1 + \alpha\lambda + \frac{(1-\varepsilon)(1-\alpha)\lambda}{v}$, $\omega = \frac{1}{v} + \frac{(1-\varepsilon)(1-\alpha)}{v} - (1-\alpha)$ and $\zeta = 1 - \frac{1-\varepsilon}{v}$. Finally, to obtain the interest rate reduced forms we combine (A.9) and (A.16) to obtain

$$i^f = -\left[\frac{\xi}{\theta} + \Delta(1-\beta)\right] m^f + \Delta(1-\beta)m^h + \left[\frac{\omega}{\theta} - \pi(1-\beta)\right] \tau^f + \pi(1-\beta)\tau^h - \frac{\zeta}{\theta} x \quad (\text{A.17})$$

$$i^h = \Delta\beta m^f - \left[\frac{\xi}{\theta} + \Delta\beta \right] m^h + \pi\beta\tau^f + \left[\frac{\omega}{\theta} - \pi\beta \right] \tau^h - \frac{\zeta}{\theta}x \quad (\text{A.18})$$

where $\Delta = \phi - \frac{\xi}{\theta}$ and $\pi = \frac{\omega}{\theta} - \rho$.

Finally, we employ the domestic prices (A.3), interest rates (A.18) and real exchange rate in (A.8) to obtain the employment and inflation reduced forms under a flexible regime presented in (16) and (17).

A.2 Monetary union regime

Following the adoption of a common currency, money supply in the union is controlled by the central monetary authority. Since there are only two countries, the central monetary authority has full command over the world money supply (i.e. $m^u = m^w$). The nominal exchange rate disappears once the two economies employ a single currency, hence the real exchange rate becomes simple $z = p^f - p^h$.

Plugging the equations for the price semi-reduced form defined in (A.2) on z , considering that $m^u = m^j$ and solving for $i^f - i^h$, we obtain

$$i^f - i^h = \frac{1}{\alpha\lambda} [z + (1 - \alpha)\tilde{\tau}] \quad (\text{A.19})$$

Equalizing (A.7) and (A.6), substituting (A.19) and solving for z we obtain the real exchange rate reduced form

$$z = \iota(\tau^f - \tau^h) \quad (\text{A.20})$$

where $\iota = \frac{(1-\alpha)}{1-\alpha+\alpha\delta}$. Substituting (A.20) into (A.19) we obtain that

$$i^f - i^h = \kappa(\tau^f - \tau^h) \quad (\text{A.21})$$

where $\kappa = \frac{(1-\alpha)(1-\delta)}{(1-\alpha+\alpha\delta)\lambda}$. Combining equations (A.21) and (A.16), the interest rate reduced forms are given by

$$\begin{aligned} i^f &= -\frac{\xi}{\theta}m^u + \left[\frac{\omega}{\theta} - \eta(1 - \beta) \right] \tau^f + \eta(1 - \beta)\tau^h - \frac{\zeta}{\theta}x \\ i^h &= -\frac{\xi}{\theta}m^u + \left[\frac{\omega}{\theta} - \eta\beta \right] \tau^h + \eta\beta\tau^f - \frac{\zeta}{\theta}x \end{aligned} \quad (\text{A.22})$$

Finally, we employ the domestic prices (A.3), interest rates (A.22) and real exchange rate in (A.20) to obtain the employment and inflation reduced forms under the monetary union presented in (18) and (19).

B. Trade-off proofs

B.1 Proof that a smaller economy monetary authority faces a steeper trade-off

The trade-offs for both economies' monetary authorities are given by

$$\frac{\partial q^h}{\partial n^h} = \frac{\frac{\partial q^h}{\partial m^h}}{\frac{\partial n^h}{\partial m^h}} = \frac{A + E\beta}{\Lambda - \Phi\beta} \text{ and } \frac{\partial q^f}{\partial n^f} = \frac{\frac{\partial q^f}{\partial m^f}}{\frac{\partial n^f}{\partial m^f}} = \frac{A + E(1 - \beta)}{\Lambda - \Phi(1 - \beta)} \quad (\text{B.1})$$

The statement that a small economy faces a steeper trade-off implies that

$$\frac{A + E\beta}{\Lambda - \Phi\beta} > \frac{A + E(1 - \beta)}{\Lambda - \Phi(1 - \beta)} \quad (\text{B.2})$$

Cross multiplying both sides we obtain that this requires

$$A\Phi[\beta - (1 - \beta)] > -\Lambda E[\beta - (1 - \beta)] \quad (\text{B.3})$$

Providing that the capital Greek letters are positive, this inequality holds if $\beta > (1 - \beta)$. That is, whenever the home economy is relatively smaller than the foreign. Intuitively, the smaller home economy consumes a larger proportion of its goods from the foreign. Therefore, a contraction of its money supply, which appreciates the exchange rate produces a larger reduction of its CPI.

B.2 Proof that a smaller economy fiscal authority faces a flatter trade-off

The trade-offs for both economies' monetary authorities are given by

$$\frac{\partial q^h}{\partial n^h} = \frac{\frac{\partial q^h}{\partial \tau^h}}{\frac{\partial n^h}{\partial \tau^h}} = -\frac{P - T\beta}{\Omega + \Theta\beta} \text{ and } \frac{\partial q^f}{\partial n^f} = \frac{\frac{\partial q^f}{\partial \tau^f}}{\frac{\partial n^f}{\partial \tau^f}} = -\frac{P - T(1 - \beta)}{\Omega + \Theta(1 - \beta)} \quad (\text{B.4})$$

The statement that a small home economy faces a steeper trade-off implies that

$$-[P - T\beta][\Omega + \Theta(1 - \beta)] > -[P - T(1 - \beta)][\Omega + \Theta\beta] \quad (\text{B.5})$$

Simplifying this expression shows that the domestic economy has a flatter trade-off when $\beta > (1 - \beta)$. A similar proof can be derived by employing the reduced forms for the monetary union regime.