ESSAYS ON EXCHANGE RATE POLICIES AND MONETARY INTEGRATION

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Résumé

Cette thèse étudie le choix des régimes de change dans deux contextes économiques particuliers. Elle composée de quatre (4) essais présentés en deux parties.

Ayant à l'esprit la situation des pays asiatiques, la première partie (Chapitres 1 et 2) considère le cas des petits pays dont les dettes sont libellées en monnaies étrangères (donc potentiellement vulnérables aux chocs extérieurs) et celui d'une région constituée de tels petits pays lorsqu'il existe une similitude dans la composition des paniers de monnaies définissant leurs taux de change effectifs.
Partant de l'expérience des crises récentes au niveau mondial, la deuxième partie de la thèse (Chapitres 3 et 4) se penche sur la considération des différents régimes de change dans le contexte monétaire de trappe à liquidité comparativement à un environnement monétaire traditionnel.

En se basant sur une modélisation théorique de type DSGE, l'économétrie bayésienne et des données de panel, la thèse utilise principalement l'analyse des fonctions de réponses, de bien-être et de désalignements monétaires comme critères de comparaison de plusieurs régimes monétaires alternatifs.

Le premier chapitre compare les performances économiques et en termes de bien-être des quatre regimes (le flottement pur, le flottement dirigé, la zone cible et le change fixe) à l'aide d'un modèle d'équilibre général stochastique dynamique (DSGE) de petites économies ouvertes qui intègre le phénomène d'endettement en monnaies étrangères. En utilisant l'économétrie bayésienne, le modèle est estimé sur la base des données de cinq (5) pays d'Asie du Sud-Est, membres fondateurs de l'Association des nations de l'Asie du Sud-est (ASEAN). Nous trouvons que pour des petits pays comme ceux de l'Asie du Sud-Est, le change flexible semble être le meilleur régime, suivi des régimes intermédiaires et du change fixe. Cependant, le degré d'ouverture des pays joue un rôle important dans ce classement.

Le deuxième essai étudie à l'aide d'un modèle théorique multi-pays de type DSGE, les implications de la politique de ciblage du taux de change effectif en termes d'intégration monétaire dans une région caractérisée par une similitude dans la composition des paniers de monnaies définissant les taux de change effectifs des pays. Au niveau régional, il est montré que les allocations sous les régimes d'union monétaire et de ciblage du taux de change effectif sont proches.

De plus, le ciblage effectif conduit à une stabilité des taux de change bilatéraux de la région, une sorte de fixité des taux de change qui ressemblerait à une zone monétaire de facto.

Le troisième essai traite le choix du régime de change approprié à un environnement économique de trappe à liquidité. Un tel environnement est créé par un choc asymétrique déflationniste qui contraint le taux d'intérêt nominal à son niveau plancher de zéro. Dans ce cas on dit que la contrainte de non négativité du taux d'intérêt est active (« Zero Lower Bound (ZLB) constraint » en anglais). Cet essai utilise plusieurs versions d'un modèle DSGE à deux pays et deux secteurs. Nous trouvons que, contrairement à la croyance commune lors de la crise de la zone euro, l'union monétaire est plus performante que les politiques nationales de change flexible. Seule une intervention sur le taux de change nominal pourrait permettre au régime de change indépendant de dominer l'union monétaire.

Le dernier essai de cette thèse étudie théoriquement (à l'aide d'un modèle DSGE à deux pays et deux secteurs) et empiriquement (à l'aide de récent développements de l'économétrie des données de panel) les effets de la trappe à liquidité sur l'ampleur des désalignements monétaires et propose leurs implications en termes d'intégration monétaire et de choix des régimes de change. Nos résultats suggèrent que la contrainte ZLB tend à réduire le désalignement monétaire dans une union monétaire comparativement aux politiques nationales de flottement. Cela plaide en faveur du renforcement de l'intégration monétaire au sein d'une union durant la période de trappe à liquidité.

Finalement cette thèse fournit une grille d'analyse des politiques de change dans des contextes particuliers jusque là ignorés par la littérature dans ce domaine, non seulement aux décideurs des petits pays émergents ou en développement qui seraient à la recherche d'un régime de change approprié à leur situation mais aussi à ceux des pays avancés de la zone euro et ceux disposant de leur indépendance monétaire.

Abstract

This thesis investigates the choice of exchange rate regimes in two specific economic contexts. It consists of four (4) essays presented in form of two parts.
First, based on the experience of southeast Asian countries, the first part of this work (Chapters 1 and 2) considers the case of small open economies with foreign-currency denominated debt and that of a region where there is a similarity among trade-weighted currency baskets of countries which manage their effective exchange rates.
Afterwards, in the light of the experience of the recent crises, the second part of the thesis (Chapters 3 and 4) focuses on the study of exchange rate regimes and monetary integration in a liquidity trap environment (i.e. zero lower bound context) relative to "tranquil" times.

Based on dynamic stochastic general equilibrium (DSGE) models and Bayesian and Panel data econometrics, the thesis mainly uses the analyses of impulse responses, welfare and currency misalignments as comparison criteria among alternative currency regimes.

The key lessons from this work are summarized as follows. For small open economies heavily indebted in foreign currency, like those of Southeast Asia, the flexible exchange rate is the best regime, followed by intermediate and fixed exchange rate regimes. However, the degree of trade openness plays a role in establishing a rank among the regimes. At the regional level, it is shown that economic allocations under an exchange rate targeting (managed float) regime are close to those under a monetary union. Furthermore, the exchange rate targeting regime leads to a stability of intra-regional bilateral exchange rates, which is a sort of fixity of exchange rates similar to a "de facto currency area".
In the context of a liquidity trap, we find that, contrary to common belief during the Euro area crisis, the currency union welfare dominates the independent (national) floating regime. Only a central bank intervention in the form of a managed float policy could allow the independent floating to outperform the monetary union.
Through both the empirical and theoretical analyses of the liquidity trap effects on currency misalignments, it is shown that the ZLB constraint tends to reduce currency misalignments compared with the independent floating policy. This suggests a reinforcement of the monetary integration within a monetary union during the liquidity trap.

Summary

General introduction

"No single currency regime is right for all countries or at all times", Frankel (1999).

The appropriate choice of exchange rate regime is at the heart of exchange rate policies. The above quotation from Frankel (1999) justifies the recurrence of the debate on this issue in international macroeconomics and its controversial aspect. Choosing a monetary regime is one of the most important political and economic decisions to be taken by policy makers.
Despite the fact that practices of exchange rate policies differed across countries and over time, an historical overview identifies some trends in the choice of monetary regimes throughout the world. After early experiments with floating regimes following the collapse of the Bretton Woods system, one can observe a surge in the popularity of fixed exchange rate regimes in the 1980s and early 1990s. This is due to their presumed better track record for inflation stabilization. However, the currency crises experienced in the 1990s and early 2000s (in Mexico (1994), Southeast Asia (1997), Brazil (1998), Argentina (2002) among others) ended the enthusiasm for fixed exchange rate regimes (in particular, pegs and currency boards). In recent years there has been a growing practice of managed exchange rates [1].
At the same time, there has been a significant development of empirical and theoretical researches on this topic in order to understand the causes and consequences of exchange rate regime selection. Following Levy-Yeyati et al. (2010), this body of literature suggests three main competing approaches to explain the choice of exchange rate regimes: the theory of optimal currency area, the financial and political approaches.

1) The optimal currency area (henceforth OCA) theory, presaged by Friedman (1953) and developed by Mundell (1961), McKinnon (1963) and Kenen (1969), explains the choice of exchange rate regime by the country's characteristics such as trade linkage, country's size, trade openness, degree of labour mobility and the nature of shocks that hit the economy [2]. Indeed, in his precursory work "The case for flexible exchange rates", Friedman (1953) argued that the flexible exchange rates are preferable when prices and wages are sticky, since they allow relative prices of home and foreign goods to adjust faster in order to absorb adverse (real) shocks. Mundell (1961) and Fleming (1962) have taken over and developed Friedman's case for flexible

1. See IMF(2014).
2. See Dellas and Tavlas (2009) for a more detailed discussion on the OCA theory.

exchange rates, building what will henceforth be called in the literature the traditional argument of the expenditure switching effect (Mundell-Fleming framework or IS-LM-BP model). Indeed, relative currency depreciation in a country with an initial current account deficit would lead to a switch in demand towards its domestically produced goods leading to a rise in its trade balance. The speed of this adjustment in relative demands highlights the important role of exchange rate flexibility in a sticky-price world.

Recently, in a seminal article, Devereux and Engel (2003) cast doubt on the case for flexible exchange rates, emphasizing that a low exchange rate pass-through weakens the expenditure effect and therefore limits the effectiveness of floating regimes. More specifically, imports are supposed to be priced in the currency of the producer (producer currency pricing-PCP) in the conventional Mundell-Fleming framework and the law of one price holds for tradable goods. Therefore the pass-through of exchange rate to import prices is assumed to be complete and immediate. These authors have considered that, when imports are priced in home currency of buyers (local currency pricing-LCP) - i.e. an incomplete exchange rate pass-through - a flexible exchange regime is powerless to insulate the economy from adverse shocks.

Since, there has been a number of arguments against this point, restoring faith in exchange rate flexibility. For instance, Duarte and Obstfeld (2008) show that, despite LCP, if non-traded consumption goods are introduced in the model, flexible exchange rates perform better than fixed ones. The need for exchange rate flexibility in such a case comes from the risk sharing condition. It arises because of asymmetric responses of domestic and foreign consumption to real shocks. Devereux and Engel (2007) find that optimal exchange rate flexibility depends on the trade-off between expenditure switching and risk sharing. Sutherland (2006) highlights the role of the elasticity of substitution between home and foreign goods in determining the strength of the expenditure switching effect. Furthermore, Sutherland (2005) shows that the optimal exchange rate variability depends on some parameters such as the degree of exchange rate pass-through, the size and openness of the economy among others.

All in all, the influential contributions in the OCA theory remain the triad of papers written by Mundell, McKinnon and Kenen. They identify the conditions which, if satisfied, reduce the case for independent flexible exchange rates and offer criteria for currency area optimality: labour mobility, wage and price flexibility and symmetry of shock from Mundell (1961), country's size, degree of openness and trade integration as stated by McKinnon (1963), fiscal integration, product diversification and the similarity of economic structures among countries introduced by Kenen (1969).

Another take on OCA theory is not to focus on the flexibility of nominal exchange rates, but rather on the deviation of the real exchange rate from a level consistent with economic fundamentals (currency misalignments). According to this view, an optimal exchange rate regime would be that under which the real exchange rate is the least misaligned, i.e. would allow an optimal allocation of demand, maximizing economic performance. Currency misalignments being related to the standard criteria of OCA theory, they can be considered in this sense as an overall indicator of the viability of a currency union (Coulibaly and Gnimassoun (2013)). In this respect, Couharde et al. (2013) define a sustainable currency area as a monetary union in which currency misalignments are not persistently high. Coudert and Couharde (2009) and Holtemöller and Mallick (2013) find that fixed exchange rate regimes generate more currency misalignment than the floating ones.

2) The financial approach is based on the consequences of international financial integration. Two streams of literature are based on this approach. First, the impossible trinity literature according to which financial integration tends to encourage floating regimes among industrialized countries. Second, the view based on the currency denomination of external liabilities, which recommends fixed exchange rates for countries indebted in foreign currency, such as emerging and developing countries.

Introduced by Mundell (1963) and Fleming (1962), the impossible trinity indicates that policy makers are interested in three goals and must give up one of them: exchange rate stability, monetary independence and financial market integration (free capital mobility). In more details:

- Exchange rate stability (fixed exchange rates) can be combined with free capital mobility but monetary independence has to be given up;
- Flexible exchange rates allows a combination of monetary independence and free capital mobility, while exchange rate stability is forfeited;
- Capital control (absence of financial integration) enable a combination of exchange rates stability and monetary independence.

Frankel (1999) emphasizes that the principle of the impossible trinity is the underlying logic in the bipolar view of the choice of exchange rate regime [3].

Using another angle, some works (Cespedes et al. (2004), Choi and Cook (2004), Cook (2004), Devereux et al. (2006), Gertler et al.(2007)) have linked the choice of exchange rate regimes to the phenomenon of the foreign-currency denominated debt. This characterizes most of the non-industrialized countries. Foreign-currency denominated debt is issued when countries are unable to borrow in their own currency and is referred in some contexts as the "original sin" [4]. These works discussed the stabilization properties of exchange rate regimes, considering a financial accelerator *à la* Bernanke et al. (1999). They consider an endogenous external risk premium combined with foreign-currency denominated liabilities. The intuition here is that financial imperfections linked to the endogenous risk premium magnify the shock effects. Due to the foreign currency debt, exchange rate depreciation may worsen firms' balance sheets. This balance sheet effect, magnified by financial imperfections, causes a contraction of investment and therefore could depress output. Fixed exchange rates may then be preferred to floating ones in (emerging) countries which are strongly indebted in foreign currency. A non-negligible part of the crisis literature (Aghion et al. (2001), Eichengreen and Hausmann (1999), Krugman (1999), Calvo and Reinhart (2000)) identify these balance sheet effects as a major factor in the sharp contraction of output during the 1990s currency crises in emerging market economies. This justifies the subsequent "fear of floating" making pegging more attractive in these countries [5].

Yet, there is no consensus in the literature on the superiority of fixed exchange rates when the balance sheet effect is present. Indeed, while Choi and Cook (2004) and Elekdag and Tchakarov (2007) find that fixed exchange rate regimes dominate flexible ones, Cespedes et al. (2004), Devereux et al. (2006) and Gertler et al. (2007) show that, even in the presence of foreign currency debt, the traditional Mundel-Fleming prescription promoting the flexible exchange rate regimes prevails.

3) The political view links the choice of exchange rate regime to the quality of institutions and policy makers in the considered countries. In this approach, the credibility of policy makers and institutions leads to the adoption of some currency regimes against others. Hence, governments with a preference for low inflation but faced to a low institutional quality may

3. The bipolar view is characterized by the rejection of intermediate regimes in favour of corners solutions: floating and fixed exchange rate regimes.

4. See Eichengreen and Hausmann (1999).

5. See Calvo and Reinhart (2002) who analyzed the "fear of floating" syndrome for emerging markets.

adopt a peg in order to control inflationary expectations [6]. Countries with weak institutions (more vulnerable to pressures from interest groups) may be prone to rely on fixed exchange rate regimes as a solution to the commitment problem. But this argument conflicts with the sustainability issue, where a weak government more often subjected to larger deficits and with a lesser ability to reduce them, is unable to make the fixed exchange rate regime sustainable [7]. It thus follows that the literature provides unclear answer regarding the relation between political conditions and exchange rate regimes. For example, Levy-Yeyati et al. (2010) find that the choice of a peg is negatively correlated with institutional quality, but positively correlated with political strength, highlighting the sustainability problem.

This thesis focuses on the first two approaches and aims to investigate a number of shortcomings in these contributions. Although the seminal works of Mundell and Fleming in the 1960s are not based on micro-founded models and performed in partial equilibrium, most of the subsequent studies analysing the choice of monetary regimes in general equilibrium (in a context of foreign currency debt or low degree of exchange rate pass-through) uses micro-founded models which are simply simulated. In the absence of data-based estimated general equilibrium models, those works have ignored some country-specific features in their comparison of currency regimes. They paid little attention to the combination of both incomplete pass-through and foreign currency indebtedness in a single model [8].

It is known that the choice of exchange rate regime is dependent on economic circumstances and countries' characteristics (see Frankel (1999)). But, two new empirical phenomena emerged in international economics in recent years, which consequences in terms of exchange rate policy have not yet been considered in the literature:

- Some countries in Southeast Asia target their nominal effective exchange rates as monetary policy objective. At the same time, there is a similarity in the composition of trade-weighted effective exchange rate index of these countries due to the trade integration [9];

- Many countries in the world recently experienced a liquidity trap environment characterized

6. Pegs have been successful at reducing inflation according to Ghosh et al. (1997) and Levi-Yeyati and Sturzenegger (2001).

7. See Drazen (2000), Tornell and Lane (1999), Giavazzi and Pagano (1988).

8. The study of Devereux et al. (2006) is an exception, but it only tackles the two factors in a theoretical model, whereas our framework is both empirical and theoretical. On the other side of the spectrum, Towbin and Weber (2013) study the two factors only empirically, missing a theoretical model.

9. Ma and McCauley (2008) and Aglietta (2011) presents this stylized fact. For instance, Singapore, Thailand and Indonesia stabilize their exchange rate against currencies of their trading partners.

by a very low short-term interest rate, which is bounded at zero (i.e. zero lower bound or ZLB henceforward). It has been the case for Euro area, United States, Canada, United Kingdom, Switzerland, Japan, among others.

In this context, this thesis aims at answering several questions related to the choice of exchange rate regime, considering different economic settings. Do Southeast Asia countries, mainly indebted in foreign currency, have any interest in stabilizing their exchange rates in the face of external shocks? What is the optimal monetary regime in such a region where there is a similarity between trade-weighted baskets of currencies defining the effective exchange rates? Do the zero lower bound (ZLB) have any particular effect on the choice of monetary regimes and currency misalignments? What are finally the implications of the ZLB constraint and effective exchange rate targeting in terms of monetary integration?

These questions form the bedrock of our investigation of numerous neglected issues in the above-mentioned literature. More generally, this thesis contributes, theoretically and empirically, to the debate on exchange rate policies and monetary integration through four (4) essays presented in two parts.

The first essay (Chapter 1) investigates the choice of the appropriate exchange rate regime in the context where private debt is denominated in foreign currency. To address this issue, we build a dynamic stochastic general equilibrium (DSGE) model of a small open economy that incorporates financial frictions and alternative currency denominations of debt as well as incomplete exchange rate pass-through. We estimate the model using data from the five individual founding members of the Association of Southeast Asian Nations (ASEAN) and compare the welfare performance of four exchange rate regimes (floating, managed floating, target zone and fixed exchange rate). We find the model is able to replicate the magnification role of balance sheet effects in the face of external shocks. More importantly, we find that the flexible exchange rate regime welfare dominates the other ones irrespective of whether debt is denominated in domestic or foreign currency. It is followed by intermediate and fixed exchange rate regimes. In line with the Mundell-Fleming prescription, this finding suggests that the expenditure switching effects outweigh the balance sheet ones due to countries' degree of trade openness.

The second essay (Chapter 2) explores, theoretically, the implications of nominal effective exchange rate targeting policies in terms of monetary integration within a region where there is a similarity among trade-weighted currency baskets defining the effective exchange rates of countries. To this end, we build a three-country DSGE model and use it to compare the independent regime of exchange rate targeting against and monetary union. The model is calibrated on the Southeast Asia region and controls for financial imperfections (risk premium), foreign currency debt, price stickiness and investment adjustment costs. We find that, besides the fact that the allocations are broadly close under the regimes of effective exchange rate targeting and monetary union, the nature of shocks plays a marginal role in minor difference between the two regimes. We further find that targeting independently the nominal effective exchange rate can lead to the stability of bilateral exchange rates within the region, which is a kind of intra-regional fixity of exchange rates. This explains why the allocations and welfare performances of the two considered regimes are too close. We conclude on the feasibility of "de facto currency area" as emphasized by Aglietta (2011).

The third essay (Chapter 3) studies the performance of alternative exchange rate regimes in the wake of a large deflationary shock that pushes the nominal interest rate to its lower bound, using several versions of a two-sector two-country DSGE model. We show that, contrary to common belief during the recent Euro crisis and the Mundell-Fleming recommendation, the currency union can outweigh the independent floating regime in dealing with the duration and depth of a liquidity trap. Although the welfare level is conditional to the asset market structure and the degree of substitution between domestic and foreign goods, we find that the currency union welfare-dominates the independent floating for a plausible model in which asset markets are incomplete and the cross-country substitutability is reasonably high. Introducing exchange rate in the monetary rule, which then defines the independent managed floating regime, allows for independent policy to outperform a monetary union, highlighting the role of the exchange rate regime choice as a preventive strategy to address the adverse effects of deflationary and recessionary shocks.

The fourth essay (Chapter 4) investigates, empirically and theoretically, the effects of the ZLB constraint on the size of currency misalignments and explores their implications in terms of monetary integration and exchange rate regime choices. Using the recent developments in non-stationary panel data econometric techniques, we find that currency misalignment is larger in the independent floating regime compared to the currency union when the zero bound on nominal interest rate is reached. In particular, we show that the ZLB constraint reduces currency misalignments under a currency union. We interpret and rationalize these findings using a two-sector two-country DSGE model in which the duration of the ZLB constraint is endogenous. The model suggests that the high level of currency misalignment under the independent monetary regime relative to the currency union in the liquidity trap can be explained by actual nominal (and real) exchange rate appreciation occurring in the former regime whereas it depreciates under the latter.

Finally, beyond their focus on the exchange rate policy literature, the four essays of this doctoral thesis combine features from several literatures. From the open-macro literature, this work uses one, two and three open-economy DSGE models with sticky prices, endogenous investment dynamics, producer currency pricing, local currency pricing, tradable and non-tradable sectors. From the credit channel literature, it incorporates financial frictions in the form of country-risk premium sensitive to the country's net foreign asset position with respect to GDP and firm's specific risk premium that is sensitive to net wealth relative to purchased capital (leverage ratio). From the crisis literature, it emphasizes the role of foreign-currency denomination of debt. From the zero lower bound literature, it includes the endogenous duration of the liquidity trap and determines the role of the constrained interest rate in the choice of exchange rate regimes and the currency misalignments. From the long-run exchange rate literature, this work uses the efficient long-run exchange rate in order to derive currency misalignments.

Additionally, the thesis also borrows from the empirical literature by estimating several versions of a small open economy DSGE model using Bayesian econometric methods, performing mean comparison tests and by using the recent developments of the panel data econometric to estimate the long-run real exchange rate and panel Vector Error Correction Models (VECM).

PART I EXCHANGE RATE REGIMES AND MONETARY INTEGRATION FOR SMALL OPEN ECONOMIES INDEBTED IN FOREIGN CURRENCY

The research of this part is focused on the exchange rate regime selection and monetary integration in a region made up of small open economies indebted in foreign currency, which manage exchange rates against similar trade-weighted currency baskets defining their effective exchange rates. Two essays are devoted to this part of the thesis. Using an estimated small open "New Keynesian" DSGE model, the first essay (in chapter 1) studies the choice of an appropriate exchange rate regime for each country of such a region. A multi-country model is used in the second essay (chapter 2) in order to account for the regional aspect in the analysis of implications of national independent policies for the regional monetary integration.

Chapter 1

External shocks, exchange rate regimes and foreign-currency indebtedness

CHAPTER 1 - EXTERNAL SHOCKS, EXCHANGE RATE REGIMES AND FOREIGN-CURRENCY INDEBTEDNESS

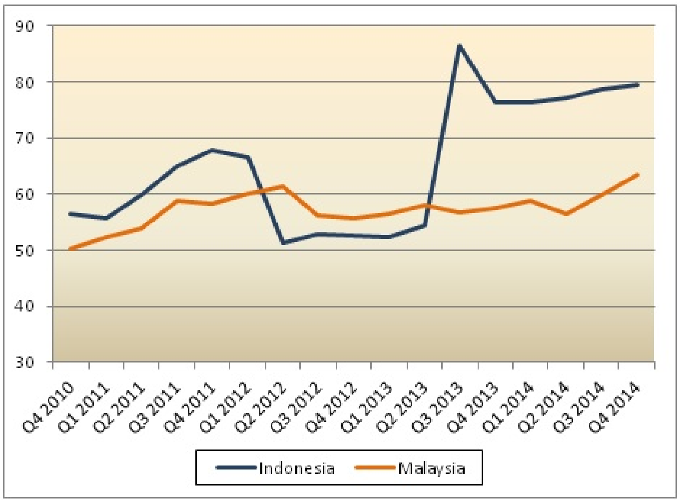
1.1. Introduction

The recent use of the exchange rate as a policy tool by emerging Southeast Asian countries for improving their competitiveness and boosting their economic growth has revived interest in the study of their exchange rate policy. In the aftermath of the 1997 Asian crisis, exchange rate policies in many Asian economies have been marked by a “fear of floating” behaviour (Calvo and Reinart (2002)). This means that countries that claim they are floating do not in practice. One of the reasons for this is linked to the interpretations of the crisis. Indeed, many authors and observers have pointed out the level of debt denominated in foreign currency as one of root causes of the crisis exacerbation (Aghion et al. (2001), Eichengreen and Hausmann (1999), Krugman (1999), Calvo and Reinhart (2000)).
During the Asian crisis, countries have experienced a sharp currency depreciation and a rise in their risk premia. The intuition is that financial imperfections linked to the endogenous risk premium magnify the effect of shocks. Due to the foreign-currency denominated debt, exchange rate depreciation may worsen firms' balance sheets. This balance sheet effect, magnified by financial imperfections, causes a contraction in investment and therefore may depress output. Fixed exchange rates have thence been preferred to floating ones in (emerging) countries which were strongly indebted in foreign currency.
In recent years, most of the Southeast Asian countries have allowed their currencies to float to some extent and are just characterized by a “fear of appreciation” as stated by Levy-Yeyati and Sturzenegger (2007). However, these countries mainly remain indebted in foreign currency when they allow their currencies to depreciate. Figures 1.1 and 1.2 illustrate the high level of debt denominated in foreign currency for selected Southeast Asian countries [1].

In this chapter, we focus on answering three interrelated questions. Is the current level of foreign-currency denominated debt in these countries compatible with floating? What is the best exchange rate regime for Southeast Asian countries? Do these countries mainly indebted

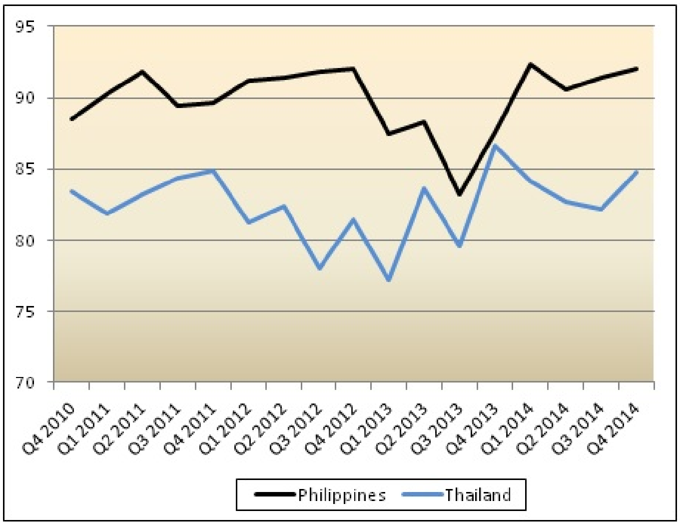
1. Using the Thomson's IFR Platinum database, Cook (2004) mentions that up to 88% of loans to emerging Asian countries (between 1992 and 1997) were denominated either in USD or in Yen.

Figure 1.1 – Percentage of resident bank liabilities denominated in foreign currency



Data source: BIS.

Figure 1.2 – Percentage of gross external (short-term) debt denominated in foreign currency



Data source: The World Bank (Quarterly External Debt Statistics).

in foreign currency have any interest in stabilizing their exchange rates? To this end, we investigate alternative exchange rate regimes for these countries. Besides the high levels of both risk premium and foreign-currency denominated debt, we take into account the low degree of exchange rate pass-through in these countries[2].

Some recent theoretical studies such as Cook (2004), Eleckdag and Tchakarov (2007), Ces-

2. There is empirical evidence highlighting the low degree of exchange rate pass-through in emerging countries (see Aleem and Lahiani (2014), Ca'zorzi et al. (2007), Bussière and Peltonen (2008) for more details).

pedes et al. (2004) and Devereux et al. (2006) include financial frictions in their model in order to analyze different currency regimes. In particular, Cook (2004) and Eleckdag and Tchakarov (2007) find a more important role of fixed exchange rates in stabilizing the macroeconomic fluctuations of emerging economies, whereas Cespedes et al. (2004) and Devereux et al. (2006) underline the primacy of the floating regime over the fixed exchange rate, in accordance with the Mundell-Fleming framework. However, Cook (2004) and Cespedes et al. (2004) use over-simplified models, assuming complete exchange rate pass-through and perfect capital mobility. Eleckdag and Tchakarov (2007)'s model assumes the complete exchange rate pass-through and flexible import prices, which seems less realistic. Furthermore, none of the aforementioned studies have taken into account both the external finance and the country-risk premia in their model with financial sector modelling. Even though these studies were focused on the general issue of exchange rate regimes in emerging countries, they did not provide any specific country analysis and data-based estimation of their models. Finally, these authors did not explore a wide range of exchange rate policies and paid little attention to the optimal policy framework.

This chapter responds to these shortcomings and develops a "New Keynesian" dynamic stochastic general equilibrium model, which is partially estimated for each of the five (5) founding countries of the ASEAN (Thailand, Indonesia, Malaysia, Singapore and the Philippines) using quarterly data from 2000 to 2011. The aim is to compare four alternative exchange rate regimes for these countries using the optimal monetary policy approach. We incorporate the financial accelerator mechanism *à la* Bernanke et al. (1999) and foreign-currency denominated debt in the model in order to take into account the aforementioned financial frictions. We further extend the model for analysing the scenario of domestic-currency denominated debt. We compare for each country the welfare-performance of different monetary regimes in the face of country-risk premium and foreign demand shocks. These external shocks are chosen because of their destabilizing effects on economies characterized by foreign currency indebtedness, such as Southeast Asian economies[3]. For these economies, we find that the floating regime outweighs the other ones in terms of economic stabilization, followed by intermediate and fixed exchange rate regimes. This finding is consistent irrespective of the currency denomination of debt. We also show that the higher the degree of trade openness, the more dominant is the flexible exchange rate regime.

3. See for instance, the 1997 Asian crisis, the 2007 global crisis, and the 2013 emerging currency crisis.

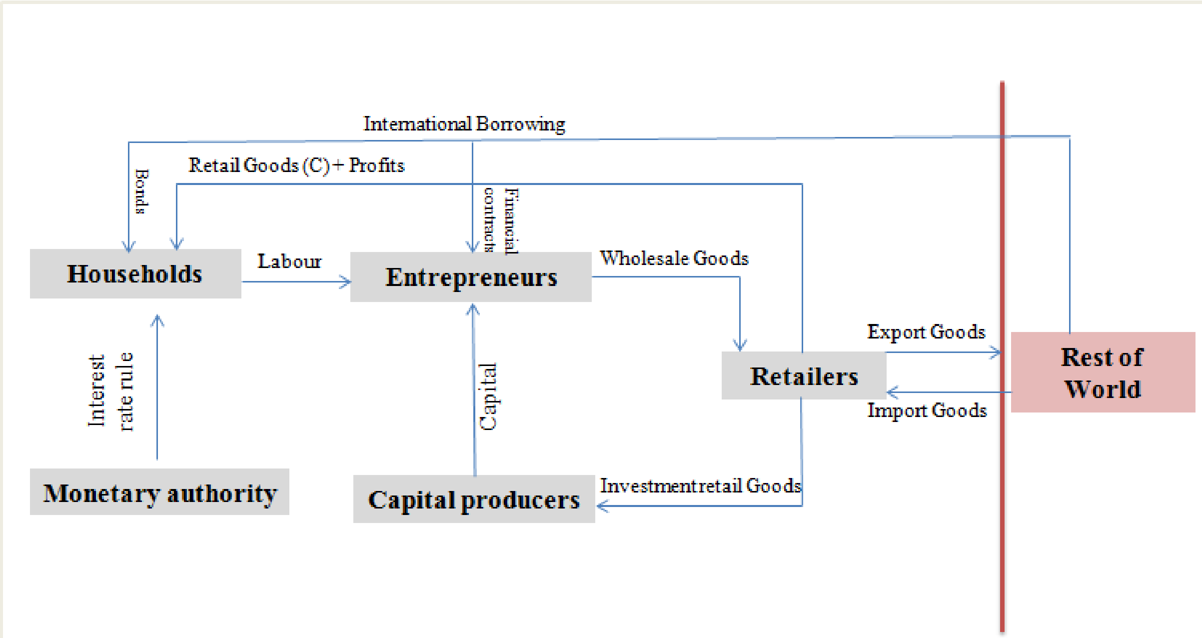
The work is organized in five sections. First, we describe the model in section 1.2. Section 1.3 presents the model parametrization and estimation, and the optimal monetary rules. In section 1.4, we present our results and finally section 1.5 concludes.

1.2. The model

We develop a small open economy DSGE model, which combines the financial accelerator mechanism and foreign-currency denominated debt. The model is characterized by sticky prices, incomplete exchange rate pass-through, capital adjustment costs and imperfect mobility of capital.

The economy is populated by households, entrepreneurs, producers of capital, retailers and the monetary authority. Households consume both the final domestic and foreign retail goods, and provide labour to entrepreneurs. They borrow in both domestic and foreign currencies. Households own retailers and receive their profits. Entrepreneurs produce intermediate (wholesale) goods, using capital and labour, and sell them to domestic goods retailers. They also borrow in the international financial market in foreign currency in order to finance their purchase of capital. The presence of asymmetric information between entrepreneurs and international lenders is the source of a financial friction (firm-specific risk premium), implying the dependence of the entrepreneurial demand on the firms' financial position. Entrepreneurial loans are subject to the country-risk premium as an additional financial friction. Capital producers build new capital and sell it to entrepreneurs. Domestic and imported goods retailers set nominal prices of final goods à la Calvo (1983). This price stickiness justifies the presence of monetary policy in the model.

The structure of the model is summarized by the following flow chart:



1.2.1. Households

The economy is populated by a continuum of infinitely lived households in the unit interval. The representative household maximizes the following intertemporal expected utility:

$$E_t \sum_{t=0}^{\infty} \beta^t \left(\frac{(C_t)^{1-\sigma}}{1-\sigma} - \frac{(L_t)^{1+\eta}}{1+\eta} \right) \tag{1.1}$$

where C_t is the aggregate consumption, L_t represents the number of hours worked, E_t the expectation operator conditional on information available at time t, σ is the inverse of the intertemporal elasticity of substitution, $\eta > 0$ measures the inverse of the labour supply elasticity and $0 < \beta < 1$ is the subjective discount factor of the representative household.

The consumption index C_t is a CES aggregate of the representative household's consumption of domestic and imported goods:

$$C_t = \left[(1-a)^{\frac{1}{\theta}} (C_{H,t})^{\frac{\theta-1}{\theta}} + a^{\frac{1}{\theta}} (C_{M,t})^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{1.2}$$

$C_{H,t}$ and $C_{M,t}$ indicate the aggregate consumption index of domestic and imported goods from the rest of the world, respectively; $\theta > 1$, is the elasticity of substitution between these two types of goods and $a \in [0,1]$ represents the share of imported goods in the consumption basket. The aggregate price index (defined as the minimum expenditure required for buying a consumption unit) associated with (1.2) is given by:

$$P_t = \left[(1-a)(P_{H,t})^{1-\theta} + a(P_{M,t})^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{1.3}$$

where $P_{H,t}$ and $P_{M,t}$ are respectively the domestic price of domestic-produced goods and the domestic price of imported goods from the rest of the world. The baskets of domestic and foreign goods are also a CES aggregate of differentiated varieties of goods, such as $C_{H,t} = (\int_0^1 C_{H,t}(j)^{\frac{\chi-1}{\chi}} d_j)^{\frac{\chi}{\chi-1}}$ and $C_{M,t} = (\int_0^1 C_{M,t}(j)^{\frac{\chi-1}{\chi}} d_j)^{\frac{\chi}{\chi-1}}$, where $j \in [0,1]$ indicates the variety of goods, $\chi > 1$ the elasticity of substitution between goods varieties and finally, $C_{H,t}(j)$ and $C_{M,t}(j)$ represent the consumption of a variety j of the final domestic and imported goods from the rest of the world. The corresponding prices are therefore given by: $P_{H,t} = (\int_0^1 P_{H,t}(j)^{1-\chi} d_j)^{\frac{1}{1-\chi}}$ and $P_{M,t} = (\int_0^1 P_{M,t}(j)^{1-\chi} d_j)^{\frac{1}{1-\chi}}$.

Households choose their consumption $C_{H,t}$ and $C_{M,t}$ in such a way as to minimize their consumption expenditure. The individual demands for domestic and imported goods derived from the expenditure minimization are given by [4]:

$$\begin{aligned} C_{H,t} &= (1-a)(\frac{P_{H,t}}{P_t})^{-\theta} C_t \\ C_{M,t} &= a(\frac{P_{M,t}}{P_t})^{-\theta} C_t \end{aligned} \tag{1.4}$$

The representative household's budget constraint is defined by :

$$P_t C_t + R_{t-1} B_{t-1} + R^{\varpi}_{t-1} \Psi_{D,t-1} S_t D_{H,t-1} = W_t L_t + B_t + S_t D_{H,t} + \Lambda_t \tag{1.5}$$

At each period t, households borrow in the form of two types of bonds: B_t issued in domestic currency with a nominal interest rate $r_t = R_t - 1$, and $D_{H,t}$ in foreign currency with a nominal interest rate $r^{\varpi}_t(\Psi_{D,t}) = (R^{\varpi}_t - 1)(\Psi_{D,t})$ [5]. A financial friction is introduced in the model in order to take into account the imperfect capital mobility and allow stationarity of net foreign assets (Schmitt-Grohé and Uribe, 2003) [6]. In fact, when they borrow from the rest of the world,

4. The minimization problem is:

$$\min_{C_{H,t}, C_{M,t}, C_t} P_{H,t} C_{H,t} + P_{M,t} C_{M,t} = P_t C_t$$

5. Note that $D_{H,t}$ can be either positive (household is net debtor) or negative (household is net creditor).

6. Schmitt-Grohé and Uribe (2003) show that the borrowing cost allows to achieve stationarity in the net foreign asset position.

households pay a country-risk premium $\Psi_{D,t}$ defined as in Adolfson et al. (2008) : $\Psi_{D,t}(d_t, Z_t) = \exp\left(\psi_D(\frac{S_t D_t}{Y P_t} + Z_t)\right)$, where $d_t = \frac{S_t D_t}{Y P_t}$ is the real level of the net foreign asset position in percentage of steady-state output and the risk premium $\Psi_{D,t}$ is increasing in the level of international debt $((\Psi_{D,t})'_d$ and $\Psi_D(0,0) = 1)$; D_t is total debt of the country ($D_t = D_{H,t} + D_{E,t}$) and $D_{E,t}$ measures the external debt of entrepreneurs defined in subsection 1.2.3; ψ_D is the elasticity of the country-risk premium with respect to the debt-output ratio and Z_t represents an exogenous shock that is an unexplained part of the country-risk premium : $Z_t \sim AR(1)$ and $\log(Z_t) = \zeta_Z \log(Z_{t-1}) + \varepsilon_{Z,t}$, with $\varepsilon_{Z,t} \sim i.i.d.(0, \sigma^2_{\varepsilon_Z})$.
The other revenue flows of households come from, at each period t, their nominal wage W_t, the profits Λ_t of firms. S_t represents the effective nominal exchange rate (expressed in terms of units of domestic currency per unit of foreign currency) and $R_{t-1}B_{t-1} + R^{\varpi}_{t-1}\Psi_{D,t-1}S_t D_{H,t-1}$ is the total gross amount of debt that is reimbursed at *t-1*.

The representative household chooses the paths for $\{C_t, L_t, B_t, D_{H,t}\}_0^\infty$ in order to maximize (1.1) subject to the budget constraint (1.5). The following first order conditions hold:

$$\frac{(L_t)^\eta}{(C_t)^{-\sigma}} = \frac{W_t}{P_t} = w_t \tag{1.6}$$

$$(C_t)^{-\sigma} = \beta R_t E_t\left((C_{t+1})^{-\sigma}\frac{P_t}{P_{t+1}}\right) \tag{1.7}$$

$$(C_t)^{-\sigma} = \beta R^{\varpi}_t \Psi_{D,t}(d_t, Z_t) E_t\left((C_{t+1})^{-\sigma}\frac{P_t}{P_{t+1}}\frac{S_{t+1}}{S_t}\right) \tag{1.8}$$

Combining equations (1.7) and (1.8) leads to the usual uncovered interest rate party condition (UIP) under the incomplete market assumption. These last two equations suggest that, in equilibrium, the marginal benefit of saving equals its marginal cost. Condition (1.6) characterizes consumers' optimal labour supply and w_t is the real wage.

1.2.2. Inflation, Terms of trade, Exchange rate and Deviation from the law of one price

In this section, we derive the relations between the CPI- inflation rate, the real exchange rate (RER) and the terms of trade.
The log-linearization around the non-stochastic steady state of equation (1.3) gives the relation between the CPI-inflation rate (π_t), domestic goods inflation ($\pi_{H,t}$) and imported goods inflation

($\pi_{M,t}$) as[7]:

$$\widehat{\pi}_t = (1-a)\widehat{\pi}_{H,t} + a\widehat{\pi}_{M,t} \tag{1.9}$$

where the "hat" on a variable means its deviation from the steady-state. Then, we define the terms of trade by :

$$TOT_t = \frac{P_{M,t}}{P_{H,t}} \tag{1.10}$$

where TOT_t is the terms of trade index between the home country and the rest of the world. Combining the log-linearized versions of equations (1.3) and (1.10) provides an expression of inflation in function of the terms of trade such that:

$$\widehat{\pi}_t = \widehat{\pi}_{H,t} + a\Delta\widehat{tot}_t \tag{1.11}$$

with $\Delta\widehat{tot}_t = \widehat{\pi}_{M,t} - \widehat{\pi}_{H,t}$ and Δ symbolizes the first difference.
Furthermore, S_t being the nominal exchange rate, the definition of the real exchange rate is :

$$RER_t = \frac{S_t P_t^{\varpi}}{P_t} \tag{1.12}$$

Under the assumption of incomplete exchange rate pass-through, the law of one price is not verified and therefore $P_{M,t} \neq S_t P_t^{\varpi}$. The deviations from the law of one price are therefore defined as:

$$LOP_t = \frac{S_t P_t^{\varpi}}{P_{M,t}} \tag{1.13}$$

This price gap is introduced as in Monacelli (2005) by supposing that imports are priced in local currency (local currency pricing) (see Paragraph 1.2.3.3).
Using the log-linearized versions of (1.10), (1.12) and (1.13) with (1.11) we have:

$$\widehat{rer}_t = \widehat{lopg}_t + (1-a)\widehat{tot}_t \tag{1.14}$$

7. The method of the log-linearization is presented in Appendix A.3.2.

1.2.3. Production sector

1.2.3.1. Entrepreneurs and the financial accelerator

The presence of entrepreneurs allows introducing the financial accelerator mechanism in the model and understanding how the foreign-currency denominated debt could affect a small open economy.
In the economy, entrepreneurs manage a continuum of firms $j \in [0,1]$ which produce differentiated intermediate goods in a perfectly competitive market following the Cobb-Douglas technology:

$$Y_t(j) = A_t K_t(j)^{\alpha} L_t(j)^{1-\alpha} \tag{1.15}$$

where A_t is a technological shock which is common to all firms and follows an AR(1) process given by:$\log(A_t) = \zeta_A \log(A_{t-1}) + \varepsilon_{A,t}$, with $\varepsilon_{A,t} \sim i.i.d(0, \sigma^2_{\varepsilon_A})$. K_t denotes capital and L_t represents labour, only supplied by households (for simplicity, we assume that entrepreneurs labour is equal to one) [8]; $\alpha \in [0,1]$ is the share of capital in the production technology. Given the prices of production factors, firms will minimize their costs subject to the production technology (1.15). The first order conditions of the cost minimization problem give the following aggregate factor payments:

$$w_t = (1-\alpha) mc_t \frac{Y_t}{L_t} \frac{P_{H,t}}{P_t} \tag{1.16}$$

$$mpc_t = \alpha mc_t \frac{Y_t}{K_t} \frac{P_{H,t}}{P_t} \tag{1.17}$$

where mc_t is the real marginal cost, $mpc_t = \frac{MPC_t}{P_t}$ denotes the real marginal productivity of capital and w_t is the real wage.

We suppose that entrepreneurs face a constant probability $(1-\nu)$ of leaving the economy in each period t. As in Bernanke et al. (1999), this assumption is made to ensure that entrepreneurs never accumulate enough funds to fully self-finance their own activities. They are therefore subject to a financial constraint. Capital purchased by entrepreneurs is financed

8. Unlike our framework, many authors in the literature (Devereux et al. (2006), Bernanke et al. (1999), Badarau and Levieuge (2011), among others) consider the entrepreneurs' hours worked in a more noticeable way. However, this assumption does not affect our findings.

partly by their net worth and borrowing. We assume that they only borrow from foreign lenders (and thence, in foreign currency). This highlights the financial vulnerability of the countries considered. Let Q_t and N_t be the price of capital sold to entrepreneurs by capital producers and the entrepreneurial net worth predetermined at *t-1*, respectively. At the end of the period t, the entrepreneur's budget constraint is given by:

$$P_t N_{t+1} = Q_t K_{t+1} - S_t D_{E,t+1} \tag{1.18}$$

where S_t represents the exchange rate and $D_{E,t+1}$, the external fund borrowed in t for the purchase of capital used in the next period *t+1*. Equation (1.18) is an accounting identity which means that the entrepreneur's net worth is defined as the difference between its assets and liabilities. An unanticipated depreciation of the domestic currency (corresponding to an increase in S_t) immediately leads to an increase in liabilities and therefore to a rise in the vulnerability of entrepreneurs. Entrepreneurs are risk neutral and choose the level of capital K_{t+1} associated with the debt level $D_{E,t}$ which maximizes their profits. The optimal condition is such that, the expected real return on capital $E_t R_{K,t+1}$ is equal to the marginal cost of external funds [9]:

$$E_t R_{K,t+1} = E_t \left\{ R_t^{\varpi} \Psi_{D,t} \Phi \left(\frac{S_{t+1}}{S_t} \frac{P_t}{P_{t+1}} \right) \right\} \tag{1.19}$$

Φ is the firm's specific risk premium such as $\Phi = \left(\frac{N_{t+1}}{q_t K_{t+1}}\right)^{-\gamma}$, where γ measures the elasticity of the specific risk premium with respect to the capital-to-net worth ratio, q_t is the real price of capital and $(\Phi)' < 0$ with $\Phi(1) = 1$.

The entrepreneur's optimal demand for capital guarantees that the real return on capital $R_{K,t}$ equals the sum of the marginal productivity of a unit of capital mpc_t and the value of this unit of capital (net of depreciation) in t:

$$R_{K,t} = \frac{mpc_t + (1-\delta) q_t}{q_{t-1}} \tag{1.20}$$

where δ is the depreciation rate of capital. Note that, if the condition (1.20) is not satisfied, the entrepreneur's demand for capital would be either zero or infinite.

9. The optimal conditions are derived from the optimal contract between the lender and the borrower, which is presented in Appendix A.1.

Finally, the evolution of the aggregate entrepreneurial net worth in the economy depends on the financial wealth accumulated in previous periods by surviving entrepreneurs plus the bequest, Ω_t, that newly entering entrepreneurs receive from entrepreneurs who leave the economy, and evolves according to:

$$N_{t+1} = \nu[R_{K,t}q_{t-1}K_t - R^{\varpi}_{t-1}\Psi_{D,t-1}\left(\frac{S_t}{S_{t-1}}\frac{P_{t-1}}{P_t}\right)\left(\frac{N_t}{q_{t-1}K_t}\right)^{-\gamma}(q_{t-1}K_t - N_t)] + (1-\nu)\Upsilon_t \quad (1.21)$$

Equation (1.21) clearly shows that there exists three sources of variations in the entrepreneurial net worth: the return on capital ($R_{K,t}$) that affects the entrepreneur's revenue, the second source is the changes in the real cost of debt repayment (i.e. the interest rate of the rest of the world plus both the country-risk and the entrepreneur's specific-risk premia). An increase in the interest rate of the rest of the world, for example, would reduce the entrepreneur's net worth. The third source of change in the entrepreneurial net worth is the exchange rate. Thereby, an unanticipated depreciation reduces the net worth of entrepreneurs.

1.2.3.2. Capital producers

Competitive capital producers use a linear technology to produce new capital $R_{K,t+1}$ using the existing capital and investing in final goods sold by retailers. The basket of investment goods is made up in the same way as the consumption goods basket:

$$I_t = \left[(1-a)^{\frac{1}{\theta}}(I_{H,t})^{\frac{\theta-1}{\theta}} + (a)^{\frac{1}{\theta}}(I_{M,t})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \quad (1.22)$$

We assume that capital production is subject to a quadratic adjustment cost, $\frac{\psi_I}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t$. The aggregate capital stock used in capital production evolves according to:

$$K_{t+1} = [\frac{I_t}{K_t} - \frac{\psi_I}{2}\left(\frac{I_t}{K_t} - \delta\right)^2]K_t + (1-\delta)K_t \quad (1.23)$$

where ψ_I determines the size of capital adjustment costs.

Capital producers choose the level of investment that maximizes their profits ($Q_tI_t - P_t(I_t + \frac{\psi_I}{2}(\frac{I_t}{K_t} - \delta)^2K_t)$). The corresponding optimization problem is :

$$\max_{I_t} q_tI_t - I_t - \frac{\psi_I}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t$$

The following equilibrium condition holds:

$$q_t - \psi_I \left(\frac{I_t}{K_t} - \delta \right) = 1 \tag{1.24}$$

When $\psi_I = 0$ (i.e. absence of adjustment costs), q_t is equal to one. This means that the presence of adjustment costs necessarily implies that the capital price q_t is time-varying. The condition (1.24) defines the standard Tobin's q that relates the price of capital to the marginal adjustment cost.

1.2.3.3. Retailers and Inflation dynamic

In this part of the model, we follow Monacelli (2005). In the economy, there exists retailers of domestic goods, who sell domestic produced goods on the home and foreign markets, and retailers of imported goods. The presence of retailers allows us to introduce price stickiness in the model. Retailers of domestic goods purchase wholesale goods from entrepreneurs at a price equal to the entrepreneur's nominal marginal cost. They repackage these goods without any additional cost and sell them as final goods at the domestic market price $P_{H,t}$ and at the foreign market price $P_{X,t}$. We assume that retailers operate in a monopolistically competitive domestic market. In the perspective of a small open economy, we also suppose that the prices of domestic produced goods at the border of the exporting country are $P_{X,t} = P_{H,t}/S_t$ (expressed in foreign currency).
Following Calvo (1983), a proportion $(1 - \phi)$ of retailers of home produced goods re-optimize their prices by setting $\tilde{P}_{H,t}$ time t, while the rest of the retailers (ϕ) keep their prices unchanged at $P_{H,t-1}$. The representative firm j sets the value of $\tilde{P}_{H,t}$ that maximizes the discounted sum of its expected profits:

$$\max_{\tilde{P}_{H,t}(j)} E_0 \left\{ \sum_{s=0}^{\infty} (\beta\phi)^s \frac{\lambda_{t+s}}{\lambda_t} [Y_{H,t+s}(j)(\tilde{P}_{H,t}(j) - P_{H,t+s} mc_{t+s})] \right\}$$

subject to the following demand function: $Y_{H,t+s}(j) = \left(\frac{\tilde{P}_{H,t+s}(j)}{P_{H,t+s}} \right)^{-\chi} Y_{H,t+s}$ with the corresponding final aggregate goods,$Y_{H,t} = \left(\int_0^1 Y_{H,t}(j)^{\frac{\chi-1}{\chi}} \right)^{\frac{\chi}{\chi-1}}$ where χ is the elasticity of substitution between varieties of goods, $\frac{\lambda_{t+s}}{\lambda_t}$ is the ratio of households' marginal utility in t+s relative to that in t. The first order condition yields [10]:

$$\tilde{P}_{H,t}(j) = \frac{\chi}{\chi - 1}\frac{E_t\{\sum_{s=0}^{\infty}(\beta\phi)^s\lambda_{t+s}Y_{H,t+s}(j)P_{H,t+s}mc_{t+s})\}}{E_t\{\sum_{s=0}^{\infty}(\beta\phi)^s\lambda_{t+s}Y_{H,t+s}(j)\}} \tag{1.25}$$

The aggregate price level evolves according to:

$$P_{H,t} = [(1-\phi)(\tilde{P}_{H,t})^{1-\chi} + \phi(P_{H,t-1})^{1-\chi}]^{\frac{1}{1-\chi}} \tag{1.26}$$

The log-linearization around the steady state of (1.25) and (1.26) leads to the following standard "New Keynesian" Phillips curve:

$$\widehat{\pi}_{H,t} = \beta E_t\widehat{\pi}_{H,t+1} + \frac{(1-\phi)(1-\beta\phi)}{\phi}\widehat{mc}_t \tag{1.27}$$

where $\widehat{\pi}_{H,t}$ is the inflation rate from domestic produced goods.

Retailers of imported goods also operate in a monopolistically competitive market and they purchase final foreign goods at the price: $P^G_{H,t} = S_t P^{\varpi}_t$ (in the domestic currency). They resell these goods on the domestic market at the retail price $P_{M,t}$, such that $P_{M,t} \neq S_t P^{\varpi}_t$, assuming that the law of one price does not hold at the import level. This introduces incomplete exchange rate pass-through in the model.

As previously, retailers of imported goods set their prices *à la* Calvo. Let $(1-\phi^m)$ be the fraction of firms that re-optimizes their prices at each period t and (ϕ^m) the fraction that does not. The optimization problem is identical to that previously described for domestic goods retailers, except the real marginal cost that is $mc_{M,t} = \frac{S_t P^{\varpi}_t}{P_{M,t}}$ for retailers of imported goods. Therefore, the inflation rate of imported goods from the rest of the world satisfies the following "New Keynesian" Phillips curve:

$$\widehat{\pi}_{M,t} = \beta E_t\widehat{\pi}_{M,t+1} + \frac{(1-\phi^m)(1-\beta\phi^m)}{\phi^m}\widehat{lopg}_t \tag{1.28}$$

10. See Appendix A.2. for the method of solving the optimization problem.

1.2.4. Four monetary regimes

In this chapter, we investigate the performances of four (4) alternative monetary regimes for each country. These monetary regimes are identified by the monetary rules described below [11].

1.2.4.1. Managed floating regime

In this regime, the monetary authority follows a policy rule which is augmented to allow the nominal interest rate to react to deviations in nominal exchange rate movements from its steady-state value, in addition to the reaction to deviations in inflation and output from their steady-state values. The policy rule is therefore:

$$\log(\frac{R_t}{R}) = \beta_0 \log(\frac{R_{t-1}}{R}) + (1-\beta_0)[\beta_1 \log(\frac{\pi_t}{\pi}) + \beta_2 \log(\frac{Y_t}{Y}) + \beta_3 \log(\frac{\Delta S_t}{\Delta S})] + \varepsilon_{r,t} \tag{1.29}$$

with $\varepsilon_{r,t} \sim i.i.d.(0, \sigma^2_{\varepsilon_r})$. R, π, Y and ΔS are respectively the steady-state values of R_t, π_t, Y_t and ΔS_t; β_0, β_1, β_2, and β_3 are the policy coefficients chosen by the central bank. β_0 is the smoothing parameter of the interest rate.

1.2.4.2. Floating regime

Under the floating monetary regime, the central bank does not control the dynamic of the exchange rate, which becomes completely flexible. In such a case, $\beta_3 = 0$ (and $\beta_1 > 1$ and $\beta_2 < 1$) in equation (1.29), the policy rule is then assumed to be a standard Taylor rule in which the central bank adjusts the nominal interest rate in response to deviations in CPI-inflation and output from their steady-state values.

1.2.4.3. Fixed exchange rate regime

In the fixed exchange rate regime, the central bank maintains the exchange rate at a predetermined and constant level: $S_t = \bar{S}$ for each t. Therefore, the central bank sets the nominal interest rate in such a way that the uncovered interest rate parity condition holds.

1.2.4.4. Target zone regime

Under this monetary regime, the central bank manages the exchange rate, which would be adjusted around a central parity (different from the steady state). The target zone regime

11. Following Monacelli (2004), Faia (2010), Cook and Devereux (2014) and Born et al. (2013), the monetary regime can be identified by a Taylor-type policy rule.

allows more flexibility in managing the exchange rate compared with the fixed exchange rate regime. There is no empirical evidence showing that the countries considered were in an explicit target zone. Ma and McCauley (2008) argue that Singapore's effective exchange rate crawls against its trade-weighted basket, which is comparable to a target zone. Therefore, the target zone framework explored in this work should be viewed rather as a counterfactual analysis. First, following Svensson (1994) and Curdia and Finocchiaro (2013), we decompose the nominal exchange rate (S_t) as : $S_t = S_t^c + S_t^v$, where S_t^c defines the central parity of the exchange rate and S_t^v represents the deviations of the exchange rate from the central parity. It then follows that the expected realignment is given by :

$$E_t(S_{t+1} - S_t) = E_t(S_{t+1}^c - S_t^c) + E_t(S_{t+1}^v - S_t^v) \tag{1.30}$$

We assume that changes in the expected realignments depend on two components: an endogenous component defined as a linear function of the exchange rate deviations from the central parity (S_t^v) and an exogenous component g_t which folows an AR(1) process:

$$E_t(S_{t+1}^c - S_t^c) = g_t + \rho_\nu S_t^v \tag{1.31}$$

with $g_t = \rho_g g_{t-1} + \varepsilon_{g,t}$ and $\varepsilon_{g,t} \sim i.i.d.(0, \sigma_{\varepsilon_g}^2)$. ρ_ν represents the coefficient associated with the endogenous component of realignment expectations and ρ_g measures the persistence parameter of g_t.
Combining equations (1.30) and (1.31) yields an expression of changes in exchange rate as:

$$E_t(S_{t+1} - S_t) = E_t(S_{t+1}^v) + g_t - (1 - \rho_v) S_t^v \tag{1.32}$$

In the target zone regime, the monetary authority uses the policy instrument to keep the exchange rate close to the central parity and needs to fight expectations of currency realignment. Consequently, the central bank sets the policy rate following an augmented Taylor rule, which takes into account the reaction to exchange rate deviations from the central parity, such as:

$$\log(\frac{R_t}{R}) = \beta_0 \log(\frac{R_{t-1}}{R}) + (1 - \beta_0)[\beta_1 \log(\frac{\pi_t}{\pi}) + \beta_2 \log(\frac{Y_t}{Y}) + \beta_3 \log(\frac{S_t^v}{S^v})] + \varepsilon_{r,t} \tag{1.33}$$

with $\varepsilon_{r,t} \sim i.i.d.(0, \sigma^2_{\varepsilon_r})$. R, π, Y and S^v are respectively the steady-state values of R_t, π_t, Y_t and S^v_t; β_0, β_1, β_2, and β_3 are the responses of the central bank with respect to deviations in inflation, output and exchange rate movements from their steady-state. β_0 is the smoothing parameter of the interest rate.

1.2.5. Foreign sector

The foreign demand for home produced goods is expressed as:

$$C^{\varpi}_{H,t} = a \left(\frac{P^{\varpi}_{H,t}}{P^{\varpi}_t} \right)^{-\theta} Y^{\varpi}_t \tag{1.34}$$

where Y^{ϖ}_t is the aggregate demand from foreign country (the rest of the world). We can rewrite relation (1.34) as:

$$C^{\varpi}_{H,t} = a \left(\frac{P_{H,t}}{P_t} \right)^{-\theta} \left(\frac{P_t}{S_t P^{\varpi}_t} \right)^{-\theta} Y^{\varpi}_t = a \left(\tfrac{P_{H,t}}{P_t} \right)^{-\theta} \left(\tfrac{1}{RER_t} \right)^{-\theta} Y^{\varpi}_t \tag{1.35}$$

Finally, from a small open economy perspective, the rest of the world's variables are assumed to evolve exogenously as the following AR(1) processes :

$$\log(R^{\varpi}_t) = \zeta_{r\varpi} \log(R^{\varpi}_{t-1} + \varepsilon_{r\varpi,t}) \tag{1.36}$$

$$\log(Y^{\varpi}_t) = \zeta_{y\varpi} \log(Y^{\varpi}_{t-1} + \varepsilon_{y\varpi,t}) \tag{1.37}$$

$$\log(\pi^{\varpi}_t) = \zeta_{\pi\varpi} \log(\pi^{\varpi}_{t-1} + \varepsilon_{\pi\varpi,t}) \tag{1.38}$$

where, $\zeta_x \in [0,1]$ (with $x = r\varpi, y\varpi$ and $\pi\varpi$) are the respective coefficients of the AR (1) processes and $\varepsilon_{x,t} \sim i.i.d.(0, \sigma^2_{\varepsilon_x})$ the random shocks associated with these processes.

1.2.6. General equilibrium conditions

The equilibrium of the goods market requires: $Y_t = C_{H,t} + I_{H,t} + X_t$ where X_t denotes exports [12]. Using the demand functions in (1.4) and (1.35), the goods market clearing condition can be expressed as:

$$Y_t = (1-a) \left(\frac{P_{H,t}}{P_t} \right)^{-\theta} (C_t + I_t) + \left(\frac{P_{H,t}}{P_t} \right)^{-\theta} \left[a \left(\frac{1}{RER_t} \right)^{-\theta} Y^{\varpi}_t \right] \tag{1.39}$$

12. Following Bernanke et al. (1999), we have assumed that monitoring cost in aggregate demand is negligible under reasonable parametrizations

The labour market clearing condition implies that $L_t = \int_0^1 L_t(j)dj$. The domestic bond market is zero net supply in equilibrium.

Combining these equilibrium conditions with the households' budget constraint yields the following dynamic of the net foreign assets (NFA) position (i.e. the dynamic of the balance of payments):

$$S_t R^{\varpi}_{t-1} D_{t-1} \Psi_{D,t-1} = S_t D_t + X_t - M_t \tag{1.40}$$

where M_t represents imports.

The expression of equation (1.40) in real terms relative to the steady-state level of output is given by:

$$R^{\varpi}_{t-1} d_{t-1} \Psi_{D,t-1} \frac{S_t}{\pi_t S_{t-1}} = d_t + \frac{(X_t - M_t)}{Y P_t} \tag{1.41}$$

1.3. Calibration, estimation and optimal monetary rules

The log-linearized version of the model around the steady state (in Appendix A.3) is numerically solved [13]. In order to identify the best exchange rate regime for each founding member of the ASEAN, we adopt the following methodology. First, for each monetary regime and using data from each country, we estimate some parameters of the model whereas the rest is calibrated. The calibrated parameters are common across countries and take standard values from the literature on emerging economies, and data do not contain sufficient information to estimate them [14].Second, given the estimated structural parameters, we identify for each exchange rate regime the optimal monetary rule that provides a superior level of welfare. Finally, we incorporate the optimal monetary rules into the model and simulate it in order to assess the responses of variables when shocks occur. Accordingly, we determine the ranking among alternative monetary regimes using impulse responses and a measure of welfare cost.

13. The DYNARE and MATLAB softwares are used to solve the model, by following Sims (2002)'s solution method.

14. The degree of trade openness and the ratio of consumption relative to output, which are calculated using data, are exceptions.

1.3.1. Calibration

Time is measured in quarters. Let us begin with the parameters that have some conventional values in the literature on emerging Asian economies. These parameter values are summarized in Appendix A.4.1.The value of the discount factor, β, is set to 0.99, corresponding to an annualized real interest rate about 4% in steady state. We consider that the inverse of the intertemporal elasticity of substitution of consumption, σ, is equal to 2 (as in Cook (2004) ; Devereux et al. (2006)). Following Christiano et al. (1997), the inverse of the Frisch elasticity of labour supply, η, is evaluated at 1. The share of capital in the domestic production α is set to 0.35. The depreciation rate of capital, δ, is equal to 0.025. The elasticity of the price of capital with respect to the capital adjustment cost, ψ_I, is assumed to be 0.25, close to the value used by Devereux et al. (2006). The steady-state markup is set to $(\chi)/(\chi-1) = 1.1$, consistent with the literature on emerging economies. As in Bernanke et al. (1999), we choose 0.9728 as the probability of the entrepreneur's survival. Following Devereux et al. (2006), we set the steady-state ratio of capital relative to net worth to $K/N = 3$, consistent with a high financial leverage in emerging economies. The elasticity of the country-risk premium ψ_D is provided by Schmitt-Grohé and Uribe (2003). The elasticity of the firm's specific risk premium with respect to the ratio of the net worth relative to capital purchased γ is calibrated to be equal to 1, as in Elekdag and Tchakarov (2007). The degree of trade openness, a, and the ratio (C/Y) [15] are calculated using individual data of the five Southeast Asian countries and are presented in Table 1.1 below. The average of the ratio of imports relative to GDP over the period from 2000 to 2010 is considered as proxy of the trade openness degrees [16].

15. The consumption corresponds to the private consumption.

16. The degree of trade openness for Singapore is calculated using (imports+exports)/(2*GDP) on the period of the study. Only three main partners are considered for trade (United States, China, European Union). This exception for Singapore does not affect our results, since we are not specially comparing one country against another.

Table 1.1 – Parameters calculated from data

Parameters		Thailand	Malaysia	Philippines	Indonesia	Singapore
Degree of trade openness	(a)	0.44	0.71	0.45	0.27	0.33
Consumption-to-Output ratio in the steady state	(C/Y)	0.53	0.45	0.72	0.59	0.40

1.3.2. Estimations

The parameters of the model to be estimated are given in Table A.4.2 of the appendix.These are behavioural and monetary rule parameters as well as those governing exogenous shocks. The Bayesian method is used for estimating them. All data series are quarterly over the 2000Q3-2011Q3 period and are from Oxford Economics and IMF databases. The data series used for estimating the parameters are real GDP, private consumption, CPI-inflation rate, real effective exchange rate and the central bank's short-term interest rate. To fit the model to data, these latter are log-transformed (except the nominal interest rate), seasonally adjusted and Hodrick-Prescott filtered ($\lambda = 1600$).

We choose the prior distributions of parameters following the literature and some theoretical restrictions (for example, the non-negativity of the parameters, the theoretical confidence interval into which the parameter is defined). Indeed, the Beta distribution is chosen for the parameters bounded in the interval [0,1], Gamma and Normal distributions are chosen for the parameters which are supposed to be positive and the Inverse-Gamma distribution is assumed for the standard deviation of shocks. Tables A.4.3-A.4.7 of the appendix summarize the priors of parameters to be estimated. These priors are common across the five countries. The elasticity of substitution between domestic and foreign goods is set to have a gamma distribution with a mean of 0.6 (close to the average value on five Asian countries, previously estimated by Reinhart (1995) and used later by Cook (2004)). The Calvo parameters for domestic and imported goods are assumed to follow a beta distribution with a mean of 0.75, corresponding to a price contract of four quarters (as commonly used in the literature).

The autoregressive coefficients of the foreign interest rate and country-risk premium shocks are supposed to be equal to 0.46 as in Devereux et al. (2006) with a beta distribution. The beta distribution is also chosen for the remaining autoregressive coefficients of shocks with a mean of 0.5 in line with Majuca (2011).The standard deviations of shocks have a mean of 0.02. For the monetary policy rules, we set the priors of coefficients associated with inflation, output gap and exchange rate movements (if it's the case) to have a normal distribution with the respective mean values of $\beta_1 = 2.5$, $\beta_2 = 1.5$ and $\beta_3 = 0.5$. These values are in line with the literature on emerging economies (See Gertler et al. (2007), Ozkan and Unsal (2012), Unsal (2011), among others). The smoothing parameter of the nominal interest rate is assumed to have a beta distribution with a mean of 0.5 as in Alba et al. (2011), and Unsal (2011). In the target zone regime, the coefficient associated with the endogenous component of realignment expectations follows a beta distribution with a mean of 0.5. The standard deviations of the prior distributions are chosen following the literature on estimated "New Keynesian" small open economy models (see Wong et al. (2014) and Justiniano and Preston (2010)).

The model is estimated using Dynare 4.3.2. We use the Metropolis-Hastings algorithm to perform simulations. To check the convergence, we run two markov chains with a total number of draws of 200, 000 and an acceptance rate of 0.23 for each chain. The estimation results for all monetary regimes and for each country are summarized in Tables A.4.3-A.4.7 of the appendix [17]. The estimated parameters evidently vary from one monetary regime to another. The log data densities from estimates show that, the model using the monetary rule of the target zone is the one that better fit the data. The estimation of this model reveals therefore the structural parameters, which are used to perform the optimal monetary policy analysis.

1.3.3. Optimal monetary rules

The framework of optimal monetary regimes aims to find optimal policy coefficients in response to CPI-inflation, output gap and exchange rate, among the class of the policy rules previously estimated [18]. Here, we employ two methods in order to determine the optimal policy rules among the class of estimated policy rules. The purpose of this exercise is to find the coefficients of monetary policy rules that imply the highest levels of welfare for each regime, assuming that the remaining estimated parameters of the model are set to their posterior mean.

17. The graphs of posterior distributions as well as statistics of convergence pointing out the validity of estimates are presented in Appendix A.6.

18. Our approach follows some works on the optimal monetary policy in the perspective of a small open economy, for instance Monacelli (2005), Faia and Monacelli (2008), Faia et Iliopoulos (2011). Note that our methods are quite different from those of these authors.

The first method aims to simply find the optimal values of the policy rule parameters for a given objective function (a loss function) and use later these coefficients in the welfare calculation. The second method, which we use in Sangaré (2015), is to find directly the policy coefficients that maximize the welfare. The use of the two methods is justified by the need to distinguish the central bank's objective for stabilizing the economy (through the stabilization of inflation, output gap and exchange rate variation) from the objective of social welfare maximization. The two methods provide results that are qualitatively similar in terms of model dynamics. The impulse responses and the welfare comparison are discussed later for the first method, the results for the second method being presented in Appendix A.5.9 and A.5.10.

1.3.3.1. Method 1: Minimization of loss function

As in Justiniano and Preston (2010), this approach consist in minimizing a quadratic loss function that is a weighted sum of unconditional variances of some endogenous variables under each regime.

More formally, let $\Omega = \{\Omega_s, \Omega_p\}$ be the set of estimated parameters for each country, where Ω_s represents the subset of the estimated structural parameters other than the estimated coefficients of the policy rule that are denoted by $\Omega_p = \{\beta_0, \beta_1, \beta_2, \beta_3\}$. In order to compare different monetary regimes, we retain the parameters Ω_s at their estimated values but we use the optimal policy coefficients in place of the estimated ones (Ω_p). The comparison across regimes is therefore experienced in an optimal framework.

The optimal coefficients are obtained as in Woodford (2003a ; 2003b). Indeed, we assume that the monetary authority seeks to minimize the following intertemporal objective function:

$$W_0 = E_0 \sum_{t=0}^{\infty} \beta^t \Theta_t \tag{1.42}$$

where $0 < \beta < 1$ is the household's discount factor and Θ_t represents the quadratic loss function of the central bank, such as :

$$\Theta_t = \pi_t^2 + \lambda_y y_t^2 + \lambda_r r_t^2 + \lambda_s \Delta S_t^2 \tag{1.43}$$

for any $t > 0$ and with λ_y, λ_r and λ_s the relative weights associated with each policymaker's objective in terms of the CPI-inflation stabilization, output gap and the nominal exchange

rate stability [19]. For simplicity, we only consider the limiting case of the objective function whenβ tends to unity. This turns the optimal policy problem into one of minimizing the following objective function: $\bar{W}_0(\Omega) = var(\pi_t) + \lambda_y var(y_t) + \lambda_r var(r_t) + \lambda_s var(\Delta S_t)$ defined as the weighted sum of variances, Ω means the objective function explicitly depends on the estimated parameters of the model. To optimize the monetary rules, the relative weights associated with the objectives $(\lambda_y, \lambda_r, \lambda_s)$ are assumed to take values within [0,1], consistent with the relative weight given to the inflation stabilization. From the robustness perspective, we have varied these relative weights over this interval and we have chosen the relative weights $(\lambda_y = 0.5, \lambda_r = 0.1, \lambda_s = 0.1)$ that do not yield aberrant optimal policy coefficients (extremely aggressive or extremely negative).
The coefficients of the optimized simple rules for each country are summarized in Table A.5.8 of the appendix [20].

1.3.3.2. Method 2: Grid search for parameters

This method focuses on the search for the coefficients of the Taylor rules that maximize the following expected utility: $E_0 \sum_{t=0}^{\infty} \beta^t U_t(C_t, L_t)$. The optimal policy coefficients in each regime are those that yield the highest levels of welfare. We proceed as follows. Since there exist a set of monetary rules for each regime, we first assume that this set is finite. Then, we perform a grid search for policy parameters within this set in order to identify the monetary rule that maximizes the expected lifetime utility. In this sense, to ensure the local uniqueness of the rational expectation equilibrium, we limit our attention to values of policy rule coefficients in the interval [1,3] for β_1, [0,1] for β_2 and β_3 (keeping β_0 sets to its estimated value). In particular, the two first intervals are chosen in line with the spirit of Taylor (1993)'s condition that imposes that $\beta_1 > 1$ and $\beta_2 < 1$. Furthermore, in the first case we follow Schmitt-Grohé and Uribe (2007) by assuming that a policy parameter associated with inflation larger than 3 would be difficult to be plausible. The interval chosen for β_3 is that of Monacelli (2004) characterizing the exchange rate-targeting framework. These intervals define the finite set of monetary rules

19. $\lambda_s = 0$ and $\lambda_s \neq 0$ correspond respectively to the floating and intermediate regimes (managed floating or target zone).
20. The fixed exchange rate regime is an exception to this approach. In fact, this regime is not characterized by a Taylor type policy rule and the objective of the monetary authorities in such a regime is simply to maintain a bounded exchange rate as formalized in our model. Consequently, we assume that the monetary authorities could not do better than this objective and that the fixed exchange rate regime is, by definition, optimal with the estimated parameters in the sense that the central bank achieves its objective costlessly. This justifies the absence of coefficients to be optimized in such regime.

among which we choose the policy rule that maximizes the social welfare.
Tables A.5.9 and A.5.10 in Appendix present optimal monetary rules for each regime and country.

1.4. Impulse responses, welfare analysis and exchange rate policy implications

In this section, we focus on the comparison among different monetary regimes in the face of external shocks. The following comparison criteria are used: impulse responses and welfare analyses. The external shocks are chosen because of their destabilizing effects on the foreign-currency indebted economies during crisis episodes (in particular during both the 1997 Asian and global financial crises). They are the main transmission channels of the world's economic turmoil to the Asian economies (for example during the 2007 global financial crisis). We use the optimal values of the monetary rule parameters and the estimated structural parameters in order to analyse the dynamics of the model under the four different regimes discussed before. The impulse responses and welfare costs analysed in this section are provided by the first method of the determination optimal rules. The second method determining optimal policy rules provides similar impulse responses and welfare costs that are presented in Figures A.7.21 and A.7.22 and Table A.8.11 of the appendix.

1.4.1. Impulse responses under optimal monetary regimes

In this subsection, we analyse the dynamic of the estimated model under four alternative optimal monetary regimes in response to the estimated country-risk premium and foreign demand shocks. The effects of shocks are analyzed for each of the five countries. We only present here the results for one country as an example.The impulse responses of the remaining countries are similar and presented in Appendix A.7.

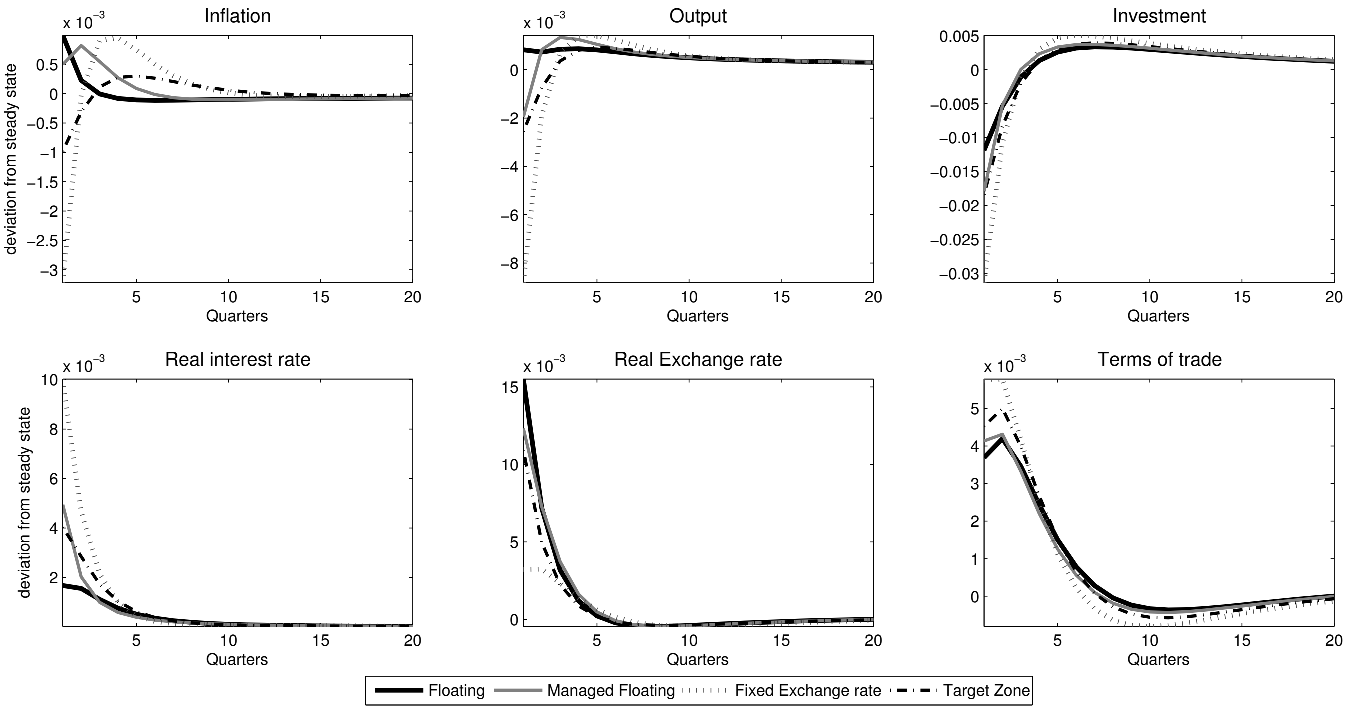
1.4.1.1. Country-risk premium shock

Figure 1.3 below compares the responses of the main variables of Thailand to an unanticipated positive risk premium shock under four optimal exchange rate regimes. This positive shock means an increase in the borrowing cost in foreign currency. Following this shock, investment instantaneously falls. The financial accelerator mechanism amplifies this investment drop due to the balance sheet effects. Indeed, when the country-risk premium increases, the nominal (and real) exchange rate depreciates via the uncovered interest rate parity condition. This nominal exchange rate depreciation increases both the cost of investment purchased abroad and the value of external debt in domestic currency. These two factors reduce the net worth and therefore increase the risk premium, which is unfavorable to investment. This balance sheet effect on investment and output shows the financial fragility of the economies considered. On the other hand, the nominal exchange rate depreciation could generate an increase in investment when it affects positively the anticipated future inflation, which reduces the real domestic cost of investment. In general, the negative effect of depreciation on investment outweighs the positive one. The investment dynamic is obviously different among monetary regimes since the magnitudes of the two opposite effects of the currency depreciation on investment in short and medium terms vary across regimes.

Accordingly, the effect of the shock on output varies across regimes and countries. Indeed, the real depreciation due to the increase in country-risk premium affects output via two main channels: an income effect of exports resulting from an increase in the value of output (in domestic currency) that is necessary to satisfy the demand expressed in foreign currency (i.e. export revenue effect on net worth) and a substitution effect of the demand (i.e. expenditure-switching effect) which comes from the change in relative prices of domestic and foreign goods (implying an increase in exports). The degree of exchange rate pass-through mainly affects the relative prices. The income effect immediately occurs in the short term following the currency depreciation. This effect is all the more present since the law of one price is verified at the border as in Monacelli (2005). We find that the more flexible the exchange rate is, the more it is able to dampen the adverse effects of shocks on output.

The monetary policy magnifies the difference among different regimes because of the impact of the real interest rate on investment, and therefore on output. Indeed, under the floating regime, the nominal interest rate slightly increases in reaction to the short term rise in output following the currency depreciation. Consequently, the real interest rate increases less strongly under the flexible exchange rate regime than under all other regimes. Under the latter, the sharp decrease in inflation or the high increase in the nominal interest rate following the nominal exchange rate depreciation tends to strongly increase the real interest rate. This amplifies the decline in investment and output. The output stabilizing cost under the flexible exchange rate regime translates into instability of the exchange rate and into inflation. For all countries, the impulse responses of different variables (in particular that of output) when the economy faces the country-risk premium shock underscore the superiority of the floating regime, followed by the intermediate exchange rate regimes (managed floating and target zone) and the fixed exchange rate regime. For example, a rise of 1% in Thailand's risk premium leads to a decline of 3.2%, 1.56% and 1.3% in investment, respectively under the fixed exchange rate, target zone and floating regime; the analogous shock leads to a decline of 9% and 2.6% in output, respectively under the fixed exchange rate and target zone, while it leads to an increase in output under the floating regime.

Figure 1.3 – Responses of Thailand's key variables to a positive country-risk premium shock



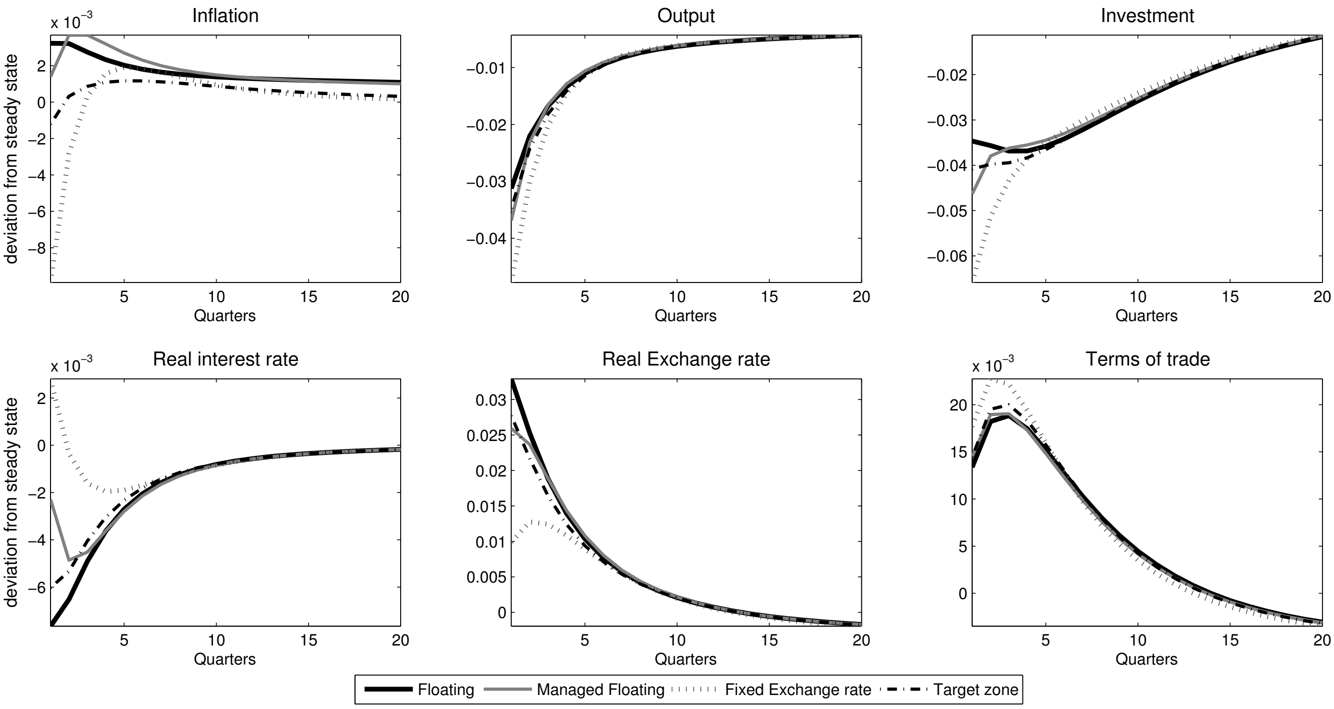
1.4.1.2. Foreign demand shock

The behaviour of Thailand's economy in response to a negative foreign demand shock under alternative policy regimes is displayed in Figure 1.4.

This shock leads to a contraction of output in all countries studied. This fall in output is much more pronounced under the fixed exchange rate regime than under the target zone and managed floating regimes; it is even more pronounced under the latter regimes than under the floating regime. Investment also decreases in line with the decline in demand. Consequently, the nominal (real) exchange rate depreciates, which increases the risk premium, further exacerbating the effect of the shock on investment and output as shown in the case of the country-risk premium shock. The relative stabilization of output under the more flexible exchange rate regimes costs in terms of volatility in inflation and exchange rates for all countries. This is in line with the conclusions of Friedman (1953), and Mundell (1961): "when prices are sticky in a small open economy, the exchange rate flexibility dampens better the effects of external shock since it allows an instantaneous adjustment of the relative prices". The dynamics of the real interest rate and inflation in response to the shock shows a clear difference between the fixed exchange rate regime and the other exchange rate regimes. In the former case, the nominal interest rate increases since it should be equal to the foreign interest rate, whereas it decreases under the Taylor-type monetary rules (i.e. floating, managed floating, and target zone) because the central bank responds to the decrease in output - all else equal - which is more pronounced than the increase or decline in current inflation. Consequently, the real interest rate increases under the fixed exchange rate regime and declines under a relatively more flexible exchange rate regime.

Finally, for all countries examined, the effects of a foreign demand shock on the main variables (as in the case of a country-risk premium shock) depend on the degree of the exchange rate flexibility in the model. Indeed, the flexibility of the exchange rate allows an immediate income effect on exports expressed in domestic currency, a positive effect on investment via the decline in its real domestic cost due to higher inflation expectations and a gradual substitution effect of demand generating a smooth adjustment of output in reaction to the currency depreciation. The results show that the magnitude of the effects of the shock is different from one country to another. The more the economy is open to trade, the more the positive effects of the currency depreciation outweigh the negative ones and output rapidly recovers.

Figure 1.4 – Responses of Thailand's key variables to a negative foreign demand



1.4.1.3. Role of currency denomination of firms' external finance

We have seen that if firms' loans are denominated in foreign currency, depending on the exchange rate regimes, the currency depreciation caused by an external shock could worsen the firms' balance sheet conditions. Despite this mechanism, our impulse response analysis suggests that the flexible exchange rate regime outperforms the other ones because of the direct income effect of the currency depreciation on output. To what extent could this ranking among regimes vary when firms are indebted in domestic currency? Answering this question is our goal in this paragraph.

Since the economies studied are mainly indebted in foreign currencies, we have considered the scenario of foreign-currency indexation of debt as the benchmark case. Now we consider the counterfactual scenario where we assume that the entrepreneurial sector fully borrows in domestic currency. In this case, the entrepreneurial net worth and the external finance cost relations are modified as follows:

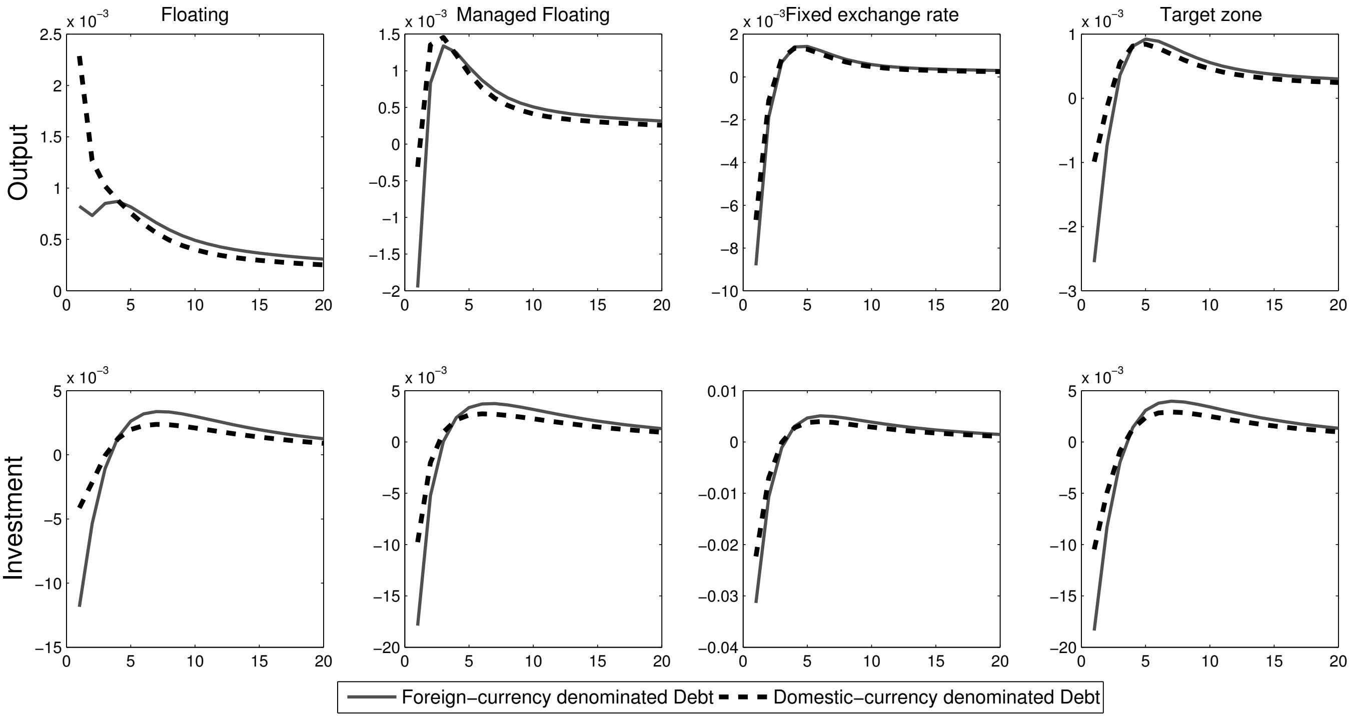
$$N_{t+1} = \nu[R_{K,t}q_{t-1}K_t - R_{t-1}\frac{P_{t-1}}{P_t}\left(\frac{N_t}{q_{t-1}K_t}\right)^{-\gamma}(q_{t-1}K_t - N_t)] + (1-\nu)\Upsilon_t \tag{1.44}$$

$$E_t R_{K,t+1} = E_t\left\{R_t\frac{P_t}{P_{t+1}}\left(\frac{N_{t+1}}{q_t K_{t+1}}\right)^{-\gamma}\right\} \tag{1.45}$$

In equations (1.44) and (1.45), respectively, the direct effects of the exchange rate movement on the entrepreneur's net worth and the cost of external fund disappear.
Figure 1.5 shows the effects of a rise in the country borrowing cost on output and investment under alternative monetary regimes.

As one would expect, domestic-currency denominated debt improves the responses of output and investment in the wake of the risk premium shock. Indeed, output and investment allocations in the domestic-currency denominated debt scenario are superior in the short-term to those in the foreign currency-denominated debt case, regardless of the monetary regime considered. But this superiority is slightly reversed in the medium-term when the positive effect of the currency depreciation on demand from abroad becomes very large in the foreign-currency denominated debt case, since its impact on investment can be amplified by the financial accelerator mechanism. Even though the effect of the currency depreciation on the entrepreneur's net worth does not exist under the fixed exchange rate when the debt is denominated in foreign currency, the direct effect of the country-risk premium on the net worth under this regime generates a difference between the two types of debt indexation at the impact of the shock. In the medium-term, there is no difference between the different cases of the debt indexation under the fixed exchange rate regime.
If we further look at the ranking among different monetary regimes, it is straightforward to observe that output and investment remain higher under the flexible exchange rate regime than under other regimes, irrespective of the currency denomination of debt. Finally, even though the domestic-indexed debt relatively insulates the economies from higher adverse effects of the country-risk premium shock, our previous results on the ranking among regimes remain unchanged.

Figure 1.5 – Responses of output and investment to a positive country-risk premium shock



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in log deviations from the steady state

1.4.2. Welfare analysis

In this subsection, we compute the welfare costs associated with the two external shocks under the four alternative exchange rate regimes. We assess the welfare loss with respect to the steady-state level of the welfare. The welfare metric we use is, as in Lucas (1987), the fraction of the steady-state consumption needed to equate the unconditional expected utility under uncertainty with the steady-state level of the utility under the monetary regime considered, as described below:

$$U((1+u)C, L) = E(U(C_t, L_t)) \tag{1.46}$$

The second-order approximation of the unconditional expected utility around the steady-state is given by :

$$E(U(C_t, L_t)) = U(C, L) + C^{1-\sigma}E(\widehat{C}_t) - \frac{1}{2}\sigma C^{1-\sigma}var(\widehat{C}_t) - L^{1+\eta}E(\widehat{L}_t) - \frac{1}{2}\eta L^{1+\eta}var(\widehat{L}_t) \quad (1.47)$$

where the variables without subscript t denote the steady-state values of variables and those with a hat represent the deviations of variables from their steady states.

u, being the measure of the welfare cost which verifies the relation (1.46), represents the fraction of steady-state consumption given up due to the shock effect on the unconditional moments of consumption and worked hours and u can be easily solved as :

$$u = \left[1 + (1-\sigma)E(\widehat{C}_t) - \frac{(1-\sigma)L^{1+\eta}}{C^{1-\sigma}}E(\widehat{L}_t) - \frac{1}{2}\sigma(1-\sigma)var(\widehat{C}_t) - \frac{1}{2}\eta\frac{(1-\sigma)L^{1+\eta}}{C^{1-\sigma}}var(\widehat{L}_t)\right]^{\frac{1}{1-\sigma}} - 1 \quad (1.48)$$

The values of u, which represents the welfare cost following the two types of shocks, under different monetary regimes and for each country are presented in Table 1.2 (the foreign-currency denominated case) and Table 1.3 (the domestic-currency denominated debt case). The negative figures mean that the welfare has decreased relative to its steady-state value. As the tables show, we find that for each country the welfare cost decreases with the flexibility of exchange rates, irrespective of the currency denomination of debt. The floating regime outperforms the other ones, followed by the managed floating, target zone and fixed exchange rate regime. These results are in line with the intuitions already presented in section 1.4.1.

Table 1.2 – Welfare cost (in terms of % of the steady-state consumption) under different regimes with the foreign-currency denomination of debt

External Shocks	Monetary Regimes	Thailand	Indonesia	Malaysia	Philippines	Singapore
Country-risk premium shock	Floating	-0.0057	-0.0057	-0.0318	0.0056	-0.0016
	Managed Floating	-0.0070	-0.0117	-0.0380	-0.0076	-0.0026
	Target Zone	-0.0090	-0.0126	-0.0374	-0.0092	-0.0034
	Fixed Exchange Rate	-0.0260	-0.0720	-0.1036	-0.0212	-0.0227
Foreign demand shock	Floating	-0.3572	-0.0218	-1.3290	-0.2028	-0.2640
	Managed Floating	-0.4009	-0.0252	-1.5849	-0.2208	-0.3033
	Target Zone	-0.3979	-0.0265	-1.6482	-0.2192	-0.3051
	Fixed Exchange Rate	-0.5528	-0.0340	-3.2576	-0.2883	-0.4510

Table 1.3 – Welfare cost (in terms of % of the steady-state consumption) under different regimes with the domestic-currency denomination of debt

External Shocks	Monetary Regimes	Thailand	Indonesia	Malaysia	Philippines	Singapore
Country-risk premium shock	Floating	-0.0060	-0.0064	-0.0362	0.0062	-0.0015
	Managed Floating	-0.0070	-0.0104	-0.0390	-0.0077	-0.0020
	Target Zone	-0.0086	-0.0113	-0.0396	-0.0092	-0.0026
	Fixed Exchange Rate	-0.0214	-0.0564	-0.0948	-0.0194	-0.0170
Foreign demand shock	Floating	-0.3645	-0.0243	-1.3290	-0.2028	-0.2721
	Managed Floating	-0.4009	-0.0252	-1.5938	-0.2208	-0.3033
	Target Zone	-0.3979	-0.0265	-1.6482	-0.2192	-0.3051
	Fixed Exchange Rate	-0.5477	-0.0368	-3.2419	-0.2883	-0.4510

1.4.3. Role of trade openness

We perform a sensitivity analysis on the degree of trade openness because of its importance in our model. This parameter measures the degree of trade integration between the domestic economy and the rest of the world. To this end, we present as an example among the five countries the effects of varying the degree of openness in the face of the country-risk premium shock. Indeed, Figure A.7.19 in Appendix displays for Thailand the effects of this shock on output and investment under the fixed and flexible exchange regime. We find that under the fixed exchange rate regime, changing the degree of trade openness does not affect the effects of the risk premium shock on the key macroeconomic variables, notably output and investment.

This is due to the absence of positive income effects of the nominal exchange rate depreciation previously mentioned under the fixed exchange rate regime.

In contrast, Figure A.7.20 in Appendix shows that, under the flexible exchange rate regime, the positive impact of the risk premium shock on output increases with the degree of openness, in particular because of the positive effects of the nominal exchange rate depreciation on output: the instantaneous export revenue effect which impacts positively the entrepreneurial net worth, the positive effect on investment due to the decline in its real domestic cost and a gradual substitution effect of the demand. Furthermore, the negative effect of the shock on investment is also correlated to the degree of trade openness. This result does not change qualitatively in the case of foreign demand shock and it strengthens the previously established ranking among monetary regimes.

1.5. Conclusions

This work studies the performance of four exchange rate regimes in the face of both country-risk premium and foreign demand shocks, using an estimated small open economy model and data from each of the five founding members of the ASEAN. The model incorporates the foreign-currency denomination of debt, financial accelerator *à la* Bernanke et al. (1999) and incomplete exchange rate pass-through. We have been able to conduct a counterfactual experiment with a version of the model in which debt is denominated in the domestic currency.
In the perspective of the optimal exchange rate regime, we find that the floating regime welfare-dominates the other ones, followed by the intermediate (i.e. managed floating and target zone) and fixed exchange rate regimes, irrespective of the currency indexation of debt. The superiority of a regime reflects its benefits in terms of the optimal macroeconomic stabilization when external shocks occur. We also find that the domestic-currency denomination of debt provides allocations relatively superior when compared to those of the model with foreign currency-denominated debt, since the exchange rate depreciation has negative effects on the entrepreneur's net worth in the latter case. The robustness analysis suggests that the more flexible the exchange rate is , the more the degree of trade openness matters for the magnitude of the external shock effects on output.

These findings are consistent with the theoretical conclusions of Devereux et al. (2006) and Cespedes et al. (2004) which emphasize that the flexible exchange rate regime outweighs the fixed exchange rate regime in terms of output stabilization. Our results are in line with the hypothesis of Friedman (1953) and Mundell (1961). Indeed, in a sticky price world, the flexibility of the exchange rate is powerful for stabilizing output in the face of external shocks. Even though the incomplete exchange rate pass-through seems to reduce the role of the nominal exchange rate in a standard model, the high degree of trade openness tends to enhance stabilizing properties of the exchange rate. More precisely, for a reasonably large degree of trade openness, the positive effects of the nominal exchange rate depreciation on investment and on export revenues are amplified by the short-term increase in entrepreneurs' net worth. In our model with foreign-currency indexed debt, the exchange rate depreciation induces a negative direct effect on the entrepreneurial net worth, but also a positive effect on this wealth from the rise in export revenues. The overall effect depends on the degree of trade openness and the exchange rate regime considered. Therefore, the flexible exchange rate implying a higher income effect of the exchange rate depreciation remains dominant.

Appendix A

A.1. Financial contract

In this appendix, we describe and detail the derivation of the optimal financial contract between entrepreneurs and lenders used in the chapter. We closely follow the model of Bernanke et al.(1999) and introduce some extensions in their baseline model.

The financial contract consists of two parties: an entrepreneur with net worth and a foreign lender with resources that may be lend to the entrepreneur. Both are assumed to be risk neutral. As in Bernanke et al.(1999), the contract covers two periods: the entrepreneur's project requires funding in each period t and yields return on capital (i.e. revenue) in *t+1*.

At time t the entrepreneur who manages the firm j purchases capital K_{t+1} to the unfinished capital goods producer for use at *t+1*. The price paid per unit of capital in period t is Q_t; Thus, the cost of investment in the entrepreneur's project is given by $Q_t K_{t+1}$. The entrepreneur begins his project with an available nominal net worth in domestic currency defined by $P_t N_{t+1}$, which is insufficient to entirely finance the project. Unlike Bernanke et al. (1999), we assume that the domestic entrepreneur must borrow abroad an amount $D_{E,t+1}$ (in foreign currency) in order to finance the difference between the expenditures on capital goods and the net worth such that:

$$S_t D_{E,t+1} = Q_t K_{t+1} - P_t N_{t+1} \tag{A.1.1}$$

As in Bernanke et al. (1999), we assume that each entrepreneur has a constant probability ν of surviving to the next period. This assumption is made in order to preclude the possibility that the entrepreneur accumulates enough wealth to be fully self-financing.

The return to capital is subject to both aggregate and idiosyncratic risk. The aggregate disturbance affects all firms in the same way and comes from the fact that the return to capital in the economy is unknown at t. The idiosyncratic one is specific to each project of the entrepreneur. Let us define by $\omega_t \in [0, \infty)$, the idiosyncratic shock that follows a log-normal distribution with mean $-\frac{\sigma_\omega^2}{2}$ and variance σ_ω^2, so that $E(\omega_t) = 1$. The random variable ω_t is i.i.d. across time and firms. We assume that $H(\omega_t)$ is the continuous and one-differentiable cumulative distribution function, such as $H(x_t) = Prob(\omega_t \leq x_t)$ and $H(0) = 0$, and denote by

$h(x_t)$ the probability density function.

The total return on capital is therefore $\omega_{t+1}R_{K,t+1}Q_tK_{t+1}$, with $R_{K,t+1}$ the gross return per unit of capital investment. We assume that ω_{t+1} is unknown to both the entrepreneur and the lender prior to the investment decision. After the investment decision is made, the realisation of ω_{t+1} (and thus the return) can be costlessly observed by the entrepreneur but the lender can only observe ω_{t+1} by paying a fixed "auditing cost" (informational asymmetry). This "costly state verification" problem analysed by Townsend (1979) explains why the uncollateralized external finance may be more expansive than internal finance since the financial intermediary must undertake an extensive and costly audit [21]. We follow Williamson (1987) by assuming that the audit process is conducted by the lender only when the borrower defaults. The monitoring cost is assumed to be a fixed proportion (μ) of the entrepreneur's realised gross return on capital, i.e. $\mu\omega_{t+1}R_{K,t+1}Q_tK_{t+1}$, where $0 < \mu < 1$.

We assume that the country-risk premium is taken in to account by the foreign lender in such a manner that its required contractual rate is $R^{\varpi}_{t+1}\Psi_{D,t+1}$, with $\Psi_{D,t+1}$ the domestic country-risk premium of the borrower (as defined in the text). The real borrowing cost is $R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}$. Thus, the entrepreneur operates if $R_{K,t+1} \geq R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}$ and, in particular, its demand for funds is infinite when $R_{K,t+1} > R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}$.

The optimal contract is characterised by a real world opportunity cost $R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}$ and a threshold value of the idiosyncratic risk, $\bar{\omega}_{t+1}$, below which the entrepreneur defaults. This value corresponds to the state of the world under which the return on capital can only serve to reimburse the lender (in domestic currency net of inflation), such as:

$$\bar{\omega}_{t+1}R_{K,t+1}Q_tK_{t+1} = R^{\varpi}_{t+1}\Psi_{D,t+1}S_tD_{E,t+1}\frac{P_t}{P_{t+1}} \tag{A.1.2}$$

The contract then works as follows:

- if $\omega_{t+1} \geq \bar{\omega}_{t+1}$, the investment project succeeds. The borrower pays the lender the amount $\bar{\omega}_{t+1}R_{K,t+1}Q_tK_{t+1}$ and keeps the remaining payoff $(\omega_{t+1} - \bar{\omega}_{t+1})R_{K,t+1}Q_tK_{t+1}$.

- if $\omega_{t+1} < \bar{\omega}_{t+1}$, the return on capital is insufficient to entirely reimburse the lender's funds and the borrower announces default. Consequently, it receives nothing, while the lender monitors

21. In the absence of monitoring, the entrepreneur may wish to misreport the true value of ω_{t+1} characterising a moral hazard problem (informational asymmetry). The optimal contract will be structured in such a way that the firm will always truthfully report the realisation of ω_{t+1}.

the borrower and receives, as payoff, the full proceeds of investment net of monitoring cost $(1-\mu)\omega_{t+1}R_{K,t+1}Q_tK_{t+1}$.

Accordingly, the entrepreneur's expected payoff is given by:

$$[E(\omega_{t+1}|\omega_{t+1} \geq \bar{\omega}_{t+1})Prob(\omega_{t+1} \geq \bar{\omega}_{t+1}) - \bar{\omega}_{t+1}Prob(\omega_{t+1} \geq \bar{\omega}_{t+1})]R_{K,t+1}Q_tK_{t+1}$$
$$= [\int_{\bar{\omega}_{t+1}}^{\infty} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1} - \bar{\omega}_{t+1}\int_{\bar{\omega}_{t+1}}^{\infty} h(\omega_{t+1})d\omega_{t+1}]R_{K,t+1}Q_tK_{t+1} \quad \text{(A.1.3)}$$

The foreign lender's expected gross payment is:

$$[\bar{\omega}_{t+1}Prob(\omega_{t+1} \geq \bar{\omega}_{t+1}) + (1-\mu)E(\omega_{t+1}|\omega_{t+1} < \bar{\omega}_{t+1})Prob(\omega_{t+1} < \bar{\omega}_{t+1})]R_{K,t+1}Q_tK_{t+1}$$
$$= [\bar{\omega}_{t+1}\int_{\bar{\omega}_{t+1}}^{\infty} h(\omega_{t+1})d\omega_{t+1} + \int_{0}^{\bar{\omega}_{t+1}} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1}$$
$$- \mu\int_{0}^{\bar{\omega}_{t+1}} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1}]R_{K,t+1}Q_tK_{t+1} \quad \text{(A.1.4)}$$

In equilibrium, the lender's payoff must at least equal to the real world opportunity cost that supports the entrepreneur, $R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}$, such that its participation constraint is (in terms of the foreign currency):

$$[\bar{\omega}_{t+1}\int_{\bar{\omega}_{t+1}}^{\infty} h(\omega_{t+1})d\omega_{t+1} + \int_{0}^{\bar{\omega}_{t+1}} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1} - \mu\int_{0}^{\bar{\omega}_{t+1}} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1}]\frac{R_{K,t+1}Q_tK_{t+1}}{S_{t+1}}$$
$$= R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}D_{E,t+1} = R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}\frac{(Q_tK_{t+1} - P_tN_{t+1})}{S_t} \quad \text{(A.1.5)}$$

We define $\mathit{\Gamma}(\bar{\omega}_{t+1})$ and $\mu G(\bar{\omega}_{t+1})$, respectively, as the expected gross share of returns going to the lender and the expected monitoring costs:

$$\mathit{\Gamma}(\bar{\omega}_{t+1}) \equiv [\bar{\omega}_{t+1}\int_{\bar{\omega}_{t+1}}^{\infty} h(\omega_{t+1})d\omega_{t+1} + \int_{0}^{\bar{\omega}_{t+1}} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1}]$$

and

$$\mu G(\bar{\omega}_{t+1}) \equiv \mu\int_{0}^{\bar{\omega}_{t+1}} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1}.$$

With the above definitions, the share of returns going to the lender is thus $\mathit{\Gamma}(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})$ and the share going to the entrepreneur is $1 - \mathit{\Gamma}(\bar{\omega}_{t+1})$ where by construction $0 < \mathit{\Gamma}(\bar{\omega}_{t+1}) < 1$ and $E(\omega_{t+1}) = \int_0^{\infty} \omega_{t+1}h(\omega_{t+1})d\omega_{t+1} = 1$.

By noting that,

$\Gamma'(\bar{\omega}_{t+1}) = [1 - H(\bar{\omega}_{t+1})] > 0$, $\Gamma''(\bar{\omega}_{t+1}) = -h(\bar{\omega}_{t+1}) < 0$ and $\mu G'(\bar{\omega}_{t+1}) = \mu\bar{\omega}_{t+1}h(\bar{\omega}_{t+1}) > 0$,

we have,

$\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1}) > 0$ for $\omega_t \in (0, \infty)$, $\lim_{\bar{\omega}_{t+1} \longrightarrow 0}(\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})) = 0$ and

$\lim_{\bar{\omega}_{t+1} \longrightarrow \infty}(\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})) = 1 - \mu$.

An optimal contract chooses the cutoff value $\bar{\omega}_{t+1}$ and K_{t+1} to solve the following problem:

$$\max_{\bar{\omega}_{t+1}, K_{t+1}} [1 - \Gamma(\bar{\omega}_{t+1})] R_{K,t+1} Q_t K_{t+1} \tag{A.1.6}$$

subject to the equation (A.1.5)

$$[\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})] \frac{R_{K,t+1} Q_t K_{t+1}}{S_{t+1}} = R^{\varpi}_{t+1} \Psi_{D,t+1} \frac{P_t}{P_{t+1}} \frac{(Q_t K_{t+1} - P_t N_{t+1})}{S_t}$$

Note that the entrepreneur and lender face the exchange rate risk as an aggregate uncertainty when the foreign currency loans must be repaid. As in Devereux et al.(2006), it is assumed that the risk-neutral entrepreneur bear all the aggregate risk. Thus, the return of investment $R_{K,t+1}$ and the optimal threshold level $\bar{\omega}_{t+1}$ will be state contingent on the realisation of the exchange rate and the participation constraint holds with equality at the every possible state ex post.

Let $\Phi = \frac{R_{K,t+1}}{R^{\varpi}_{t+1} \Psi_{D,t+1} \frac{P_t}{P_{t+1}} \frac{S_{t+1}}{S_t}}$ denote the wedge between the expected rate of return on capital and the real safe rate demanded by lender, and Λ_{t+1} the Lagrange multiplier associated with the participation constraint. The fist-order conditions for the interior solution to the maximisation problem are :

$$\bar{\omega}_{t+1} : \Lambda_{t+1}(\zeta) = \frac{\pi(\zeta)\Gamma'(\bar{\omega}_{t+1}(\zeta)) S_{t+1}(\zeta)}{[\Gamma'(\bar{\omega}_{t+1}(\zeta)) - \mu G'(\bar{\omega}_{t+1}(\zeta))]} \tag{A.1.7}$$

$$K_{t+1} : (1 - \Gamma(\bar{\omega}_{t+1})) + E_t[\Lambda_{t+1}((\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})) \frac{1}{S_{t+1}} - \frac{R^{\varpi}_{t+1} \Psi_{D,t+1}}{R_{K,t+1}} \frac{1}{S_t} \frac{P_t}{P_{t+1}})] = 0 \tag{A.1.8}$$

$$\Lambda_{t+1} : (\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})) E_t[\frac{R_{K,t+1}}{R^{\varpi}_{t+1} \Psi_{D,t+1}} \frac{S_t}{S_{t+1}} \frac{P_{t+1}}{P_t}] = (1 - \frac{P_t N_{t+1}}{Q_t K_{t+1}}) \tag{A.1.9}$$

where ζ is the state of the world, $\pi(\zeta)$ is the probability of the state ζ.

Substituting (A.1.7) into (A.1.8) gives:

$$\underbrace{\frac{R_{K,t+1}}{E_t[R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}\frac{S_{t+1}}{S_t}]}}_{\equiv\Phi} = \frac{\mathit{\Gamma}'(\bar{\omega}_{t+1})}{[(1-\mathit{\Gamma}(\bar{\omega}_{t+1}))(\mathit{\Gamma}'(\bar{\omega}_{t+1})-\mu G'(\bar{\omega}_{t+1}))+\mathit{\Gamma}'(\bar{\omega}_{t+1})(\mathit{\Gamma}(\bar{\omega}_{t+1})-\mu G(\bar{\omega}_{t+1}))]} \tag{A.1.10}$$

The "specific" premium on external funds can be written as follows:

$$\Phi = \frac{\mathit{\Gamma}'(\bar{\omega}_{t+1})}{[(1-\mathit{\Gamma}(\bar{\omega}_{t+1}))(\mathit{\Gamma}'(\bar{\omega}_{t+1})-\mu G'(\bar{\omega}_{t+1}))+\mathit{\Gamma}'(\bar{\omega}_{t+1})(\mathit{\Gamma}(\bar{\omega}_{t+1})-\mu G(\bar{\omega}_{t+1}))]} \tag{A.1.11}$$

Using (A.1.11), (A.1.10) can be rewritten as:

$$R_{K,t+1} = \Phi E_t[R^{\varpi}_{t+1}\Psi_{D,t+1}\frac{P_t}{P_{t+1}}\frac{S_{t+1}}{S_t}] \tag{A.1.12}$$

The equation (A.1.12) is that used in the text, meaning that the return to capital will be equated to the real marginal cost of external finance for an entrepreneur in equilibrium. By using (A.1.12) and (A.1.9), we can write the external risk premium Φ as:

$$\Phi = \frac{1-(\frac{P_tN_{t+1}}{Q_tK_{t+1}})}{\mathit{\Gamma}(\bar{\omega}_{t+1})-\mu G(\bar{\omega}_{t+1})} \tag{A.1.13}$$

implying that Φ is a decreasing function of the wealth/capital ratio $(\frac{P_tN_{t+1}}{Q_tK_{t+1}})$ since $\Phi'(\cdot) < 0$. Therefore, the external finance premium must decrease with the share of the firm's capital investment that is financed by the entrepreneur's own net worth. In the text, we have chosen a function (Φ) which satisfies this condition.

Denoting the fraction of entrepreneurs who remain in business each period by ν and the real price of capital at t by $q_t = \frac{Q_t}{P_t}$, as in Gertler et al. (2007), Elekdag and Tchakarov (2007), we define the aggregate entrepreneurial net worth at the end of period t, N_{t+1}, as the ex-post value of the firm capital net of ex-post borrowing cost carried over the previous period augmented by the wealth left by entrepreneurs who leave the business :

$$N_{t+1} = \nu[R_{K,t}q_{t-1}K_t - R^{\varpi}_{t-1}\Psi_{D,t-1}(\frac{P_{t-1}}{P_t})(\frac{S_t}{S_{t-1}})\Phi(q_{t-1}K_t - N_t)] + (1-\nu)\Upsilon_t \tag{A.1.14}$$

where Υ_t is the residual equity or "bequest" left by the entrepreneurs who fail and depart from the economy. This value is assumed to be distribute to the newly entering entrepreneurs in order to begin the business with a positive net worth.

A.2. Firms' optimal price setting

The problem of retail firm j is to set $\tilde{P}_{H,t}$ in such a way to maximize its profits:

$$\max_{\tilde{P}_{H,t}(j)} E_0 \left\{ \sum_{s=0}^{\infty} (\beta\phi)^s \frac{\lambda_{t+s}}{\lambda_t} [Y_{H,t+s}(j)(\tilde{P}_{H,t}(j) - P_{H,t+s} mc_{t+s})] \right\} \tag{A.2.15}$$

subject to the demand function: $Y_{H,t+s}(j) = \left(\frac{\tilde{P}_{H,t+s}(j)}{P_{H,t+s}} \right)^{-\chi} Y_{H,t+s}$.
The first order condition with respect to $\tilde{P}_{H,t}$ is

$$E_0 \left\{ \sum_{s=0}^{\infty} (\beta\phi)^s \;\; \frac{\lambda_{t+s}}{\lambda_t} \left[(-\chi) Y_{H,t+s}(j) \frac{1}{\tilde{P}_{H,t}(j)} \left(\tilde{P}_{H,t}(j) - P_{H,t+s} mc_{t+s} \right) + Y_{H,t+s}(j) \right] \right\} = 0 \tag{A.2.16}$$

$$\Leftrightarrow E_0 \left\{ \sum_{s=0}^{\infty} (\beta\phi)^s \frac{\lambda_{t+s}}{\lambda_t} \left[(1-\chi) Y_{H,t+s}(j) + \chi Y_{H,t+s}(j) \frac{P_{H,t+s} mc_{t+s}}{\tilde{P}_{H,t}(j)} \right] \right\} = 0 \tag{A.2.17}$$

$$\Leftrightarrow \tilde{P}_{H,t}(j) = \frac{\chi}{\chi - 1} \frac{E_t \{ \sum_{s=0}^{\infty} (\beta\phi)^s \lambda_{t+s} Y_{H,t+s}(j) P_{H,t+s} mc_{t+s}) \}}{E_t \{ \sum_{s=0}^{\infty} (\beta\phi)^s \lambda_{t+s} Y_{H,t+s}(j) \}} \tag{A.2.18}$$

which is the expression of the first order condition (1.25) in the text.

A.3. The model log-linearization

A.3.1. The non-stochastic steady-state conditions

The steady state requires that all endogenous variables are constant, and therefore the full set of steady-state conditions of the model is the following:

$$R = R^{\varpi} = \frac{1}{\beta} \tag{A.3.19}$$

$$D = B = d = 0 \tag{A.3.20}$$

$$\Psi_D(0,0) = 1 \tag{A.3.21}$$

$$w = \frac{L^{\eta}}{C^{-\sigma}} \tag{A.3.22}$$

$$\frac{w}{mc} = (1-\alpha)\frac{Y}{L} \tag{A.3.23}$$

$$\frac{mpc}{mc} = \alpha\frac{Y}{L} \tag{A.3.24}$$

$$P = P_H = P_M \tag{A.3.25}$$

$$\pi = \pi_H = \pi_M = 1 \tag{A.3.26}$$

$$mc = \frac{(\chi - 1)}{\chi} \tag{A.3.27}$$

$$S = 1 \tag{A.3.28}$$

$$Y = AL^{1-\alpha}K^{\alpha} \tag{A.3.29}$$

$$I = \delta K \tag{A.3.30}$$

$$q = 1 \tag{A.3.31}$$

$$R_K = R^{\varpi}(\frac{N}{K})^{-\gamma} \tag{A.3.32}$$

$$R_K = mpc + (1-\delta) \tag{A.3.33}$$

$$\nu R_K = 1 \tag{A.3.34}$$

$$Y = C + I \tag{A.3.35}$$

$$\tag{A.3.36}$$

A.3.2. Log-linearized version of the model around the steady state

We define the log-linearization as taking the log-deviation around the steady-state value. Assume x is the steady-state value of the variable x_t , then the log-linearized value of x_t, denoted by $\widehat{x}_t$, is defined as: $\widehat{x}_t \equiv ln(x_t) - ln(x) \approx \frac{x_t - x}{x}$, where ln means the natural logarithm. We can therefore write that $x_t \approx (1 + \widehat{x}_t)$. For instance, let's log-linearize the equation (1.20): $R_{K,t} = \frac{mpc_t + (1-\delta)q_t}{q_{t-1}}$, in the text as follow:

$$R_K q\,(1 + \widehat{r}_{K,t} + \widehat{q}_{t-1}) = mpc(1 + \widehat{mpc}_t) + (1-\delta)q(1 + \widehat{q}_t) \tag{A.3.37}$$

using the fact that $q = 1$ in the steady state, we get the log-linearized version of (1.20):

$$\widehat{r}_{K,t} = \left(\frac{mpc}{R_K}\right)\widehat{mpc}_t + \left(\frac{1-\delta}{R_K}\right)\widehat{q}_t - \widehat{q}_{t-1} \tag{A.3.38}$$

From steady state, $\left(\frac{mpc}{R_K}\right) = \left(1 - (\frac{1-\delta}{R_K})\right)$, implying that:

$$\widehat{r}_{K,t} = \left(1 - (\frac{1-\delta}{R_K})\right)\widehat{mpc}_t + \left(\frac{1-\delta}{R_K}\right)\widehat{q}_t - \widehat{q}_{t-1} \tag{A.3.39}$$

Accordingly, the full set of log-linearized equations of the model are:

(a) Demand side

$$\widehat{y}_t = (1-a)(\frac{C}{Y}\widehat{c}_t + \frac{I}{Y}\widehat{i}_t) + a\widehat{y}_t^{\varpi} + \theta a(\frac{2-a}{1-a})\widehat{rer}_t - \frac{\theta a}{1-a}\widehat{lopg}_t \tag{A.3.40}$$

$$\widehat{c}_t = E_t\widehat{c}_{t+1} - \frac{1}{\sigma}(\widehat{r}_t - E_t\widehat{\pi}_{t+1}) \tag{A.3.41}$$

$$E_t(\widehat{r}_{K,t+1}) = (\widehat{r}_t^{\varpi} - E_t\widehat{\pi_{t+1}^{\varpi}}) + \psi_D\widehat{d}_t + \widehat{z}_t - \gamma(\widehat{n}_{t+1} - \widehat{q}_t - \widehat{k}_{t+1}) + E_t\widehat{rer}_{t+1} - \widehat{rer}_t \tag{A.3.42}$$

$$\widehat{r}_{K,t} = \left(1 - (\frac{1-\sigma}{R_K})\right)\widehat{mpc}_t + (\frac{1-\sigma}{R_K})\widehat{q}_t - \widehat{q}_{t-1} \tag{A.3.43}$$

$$\widehat{q}_t = \psi_I(\widehat{i}_t - \widehat{k}_t) \tag{A.3.44}$$

(b) Supply Side

$$\widehat{y}_t = \widehat{A}_t + \alpha\widehat{k}_t + (1-\alpha)\widehat{l}_t \tag{A.3.45}$$

$$\widehat{l}_t = \frac{1}{\eta}(\widehat{w}_t - \sigma\widehat{c}_t) \tag{A.3.46}$$

$$\widehat{w}_t = \widehat{y}_t + \widehat{mc}_t - \widehat{l}_t - \frac{a}{1-a}(\widehat{rer}_t - \widehat{lopg}_t) \tag{A.3.47}$$

$$\widehat{mpc}_t = \widehat{y}_t + \widehat{mc}_t - \widehat{k}_t - \frac{a}{1-a}(\widehat{rer}_t - \widehat{lopg}_t) \tag{A.3.48}$$

$$\widehat{\pi}_t = (1-a)\widehat{\pi}_{H,t} + a\widehat{\pi}_{M,t} \tag{A.3.49}$$

$$\widehat{\pi}_{H,t} = \beta E_t\widehat{\pi}_{H,t+1} + \frac{(1-\phi)(1-\beta\phi)}{\phi}\widehat{mc}_t \tag{A.3.50}$$

$$\widehat{\pi}_{M,t} = \beta E_t\widehat{\pi}_{M,t+1} + \frac{(1-\phi^m)(1-\beta\phi^m)}{\phi^m}\widehat{lopg}_t \tag{A.3.51}$$

$$\widehat{rer}_t = \widehat{lopg}_t + (1-a)\widehat{tot}_t \tag{A.3.52}$$

$$\Delta\widehat{lopg}_t = \Delta\hat{S}_t + \widehat{\pi}^{\varpi}_t - \widehat{\pi}_{M,t} \tag{A.3.53}$$

(c) Dynamics of State variables

$$\widehat{k}_{t+1} = \delta\widehat{i}_t + (1-\delta)\widehat{k}_t \tag{A.3.54}$$

$$\widehat{n}_{t+1} = \nu R_K[(\frac{K}{N})\widehat{r}_{K,t} + (1-\frac{K}{N})(\widehat{r}^{\varpi}_{t-1} + \psi_D\widehat{d}_{t-1} + \widehat{z}_{t-1} + \widehat{rer}_t - \widehat{rer}_{t-1} - \widehat{\pi}^{\varpi}_t)$$

$$+\,\gamma(1-\frac{K}{N})(\hat{q}_{t-1} + \hat{k}_t) + \left(1+\gamma(\frac{K}{N}-1)\right)\widehat{n}_t] \tag{A.3.55}$$

$$\frac{1}{\beta}\widehat{d}_{t-1} = \widehat{d}_t + \widehat{y}_t - \frac{C}{Y}\widehat{c}_t - \frac{I}{Y}\widehat{i}_t - \frac{a}{1-a}(\widehat{rer}_t - a\times\widehat{lopg}_t) \tag{A.3.56}$$

$$E_t\widehat{rer}_{t+1} = \widehat{rer}_t + (\hat{r}_t - E_t\widehat{\pi}_{t+1}) - (\widehat{r}^{\varpi}_t - E_t\widehat{\pi}^{\varpi}_{t+1}) - \psi_D\widehat{d}_t - \hat{z}_t \tag{A.3.57}$$

$$\Delta\widehat{S}_t = \Delta\widehat{rer}_t - \widehat{\pi}^{\varpi}_t + \widehat{\pi}_t$$

(d) Monetary policy rules

$$\widehat{r}_t = \beta_0\widehat{r}_{t-1} + (1-\beta_0)(\beta_1\widehat{\pi}_t + \beta_2\widehat{y}_t) + \varepsilon_{r,t} \tag{A.3.58}$$

$$\widehat{r}_t = \beta_0\widehat{r}_{t-1} + (1-\beta_0)(\beta_1\widehat{\pi}_t + \beta_2\widehat{y}_t + \beta_3\Delta\widehat{S}_t) + \varepsilon_{r,t} \tag{A.3.59}$$

$$\widehat{S}_t = \widehat{S}_{t-1} \tag{A.3.60}$$

$$\hat{r}_t = \beta_0\widehat{r}_{t-1} + (1-\beta_0)(\beta_1\widehat{\pi}_t + \beta_2\widehat{y}_t + \beta_3\hat{S}^{\upsilon}_t) + \varepsilon_{r,t} \tag{A.3.61}$$

$$\widehat{S}^{\upsilon}_t = \Delta\widehat{S}_t - \widehat{g}_t + (1-\rho_\upsilon)\widehat{S}^{\upsilon}_{t-1}$$

(e) Foreign variables

$$\widehat{r}_t^{\varpi} = \zeta_{r\varpi}\widehat{r}_{t-1}^{\varpi} + \varepsilon_{r\varpi,t} \tag{A.3.62}$$

$$\widehat{y}_t^{\varpi} = \zeta_{y\varpi}\widehat{y}_{t-1}^{\varpi} + \varepsilon_{y\varpi,t} \tag{A.3.63}$$

$$\widehat{\pi}_t^{\varpi} = \zeta_{\pi\varpi}\widehat{\pi}_{t-1}^{\varpi} + \varepsilon_{\pi\varpi,t} \tag{A.3.64}$$

(f) Exogenous shocks

$$\widehat{a}_t = \zeta_A\widehat{a}_{t-1} + \varepsilon_{A,t} \tag{A.3.65}$$

$$\widehat{z}_t = \zeta_z\widehat{z}_{t-1} + \varepsilon_{z,t} \tag{A.3.66}$$

A.4. Calibration, Estimation and Optimal policy rules

A.4.1. Calibration and Estimation

Table A.4.1 – Calibration

Parameters	Description	Value
σ	Inverse of the intertemporal elasticity of substitution in consumption	2
η	Inverse of Frisch elasticity of labour supply	1
β	Subjective discount factor	0.99
ϕ_D	Elasticity of the country-risk premium	0.0007
α	Share of capital in the domestic production	0.35
v	Probability of the entrepreneur's survival	0.9728
γ	Elasticity of the firm's specific risk premium	1
δ	Depreciation rate of capital	0.025
ϕ_I	Elasticity of capital price with respect to the capital adjustment cost	0.25
K/N	Steady-state ratio of capital to net worth	3
$\chi/(\chi-1)$	Steady-state markup	1.1

Table A.4.2 – Estimated parameters

Parameters	Description
θ	Elasticity of substitution between home and foreign goods
ϕ	Calvo parameter for domestic goods
ϕ^m	Calvo parameter for imported goods
ζ_z	Autoregressive coefficient of the country-risk premium shock
ζ_A	Autoregressive coefficient of the productivity shock
$\zeta_{r\varpi}$	Autoregressive coefficient of the foreign interest rate process
$\zeta_{y\varpi}$	Autoregressive coefficient of the foreign demand process
$\zeta_{\pi\varpi}$	Autoregressive coefficient of the foreign inflation rate process
σ_r	Standard deviation of the monetary policy shock
σ_{ε_Z}	Standard deviation of the country-risk premium shock
σ_{ε_A}	Standard deviation of the productivity shock
$\sigma_{\varepsilon_{r\varpi}}$	Standard deviation of the foreign interest rate shock
$\sigma_{\varepsilon_{y\varpi}}$	Standard deviation of the foreign demand shock
$\sigma_{\varepsilon_{\pi\varpi}}$	Standard deviation of the foreign inflation rate shock
β_0	Smoothing parameter of the interest rate
β_1	Policy coefficient in reaction to inflation
β_2	Policy coefficient in reaction to output gap
β_3	Policy coefficient in reaction to the exchange rates
ρ_v	Coefficient associated with the endogenous component of the changes in expected realignments
ρ_g	Autoregressive coefficient of the exogenous component of the changes in expected realignments
σ_{ε_g}	Standard deviation of the parity modification shock

Table A.4.3 – Estimation results for Thailand

Parameters	Prior distribution			Posterior distribution							
				Fixed Exchange		Managed Floating		Floating		Target Zone	
	type	Mean	Std. dev.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int
ϕ	Beta	0.75	0.025	0.705	[0.660 0.751]	0.695	[0.648 0.746]	0.695	[0.648 0.751]	0.673	[0.630 0.718]
ϕ_m	Beta	0.75	0.025	0.741	[0.692 0.790]	0.733	[0.696 0.780]	0.664	[0.613 0.709]	0.651	[0.600 0.703]
$\zeta_{y\varpi}$	Beta	0.5	0.15	0.823	[0.742 0.917]	0.393	[0.230 0.549]	0.623	[0.470 0.775]	0.713	[0.600 0.847]
$\zeta_{r\varpi}$	Beta	0.46	0.15	0.398	[0.173 0.639]	0.401	[0.164 0.624]	0.458	[0.254 0.648]	0.507	[0.389 0.630]
$\zeta_{\pi\varpi}$	Beta	0.5	0.15	0.142	[0.065 0.220]	0.938	[0.907 0.970]	0.583	[0.504 0.654]	0.022	[0.015 0.029]
ζ_z	Beta	0.46	0.15	0.241	[0.130 0.359]	0.187	[0.043 0.346]	0.775	[0.741 0.806]	0.556	[0.441 0.675]
ζ_A	Beta	0.5	0.15	0.559	[0.450 0.671]	0.578	[0.409 0.734]	0.597	[0.510 0.683]	0.558	[0.444 0.666]
θ	Gamma	0.6	0.01	0.591	[0.575 0.608]	0.601	[0.584 0.617]	0.596	[0.580 0.614]	0.594	[0.580 0.611]
σ_r	Inv. Gamma	0.020	∞	0.02	[0.005 0.040]	0.447	[0.367 0.523]	0.364	[0.298 0.431]	0.661	[0.547 0.774]
$\sigma_{\varepsilon_{y\varpi}}$	Inv. Gamma	0.02	∞	0.104	[0.070 0.139]	0.494	[0.355 0.646]	0.081	[0.059 0.113]	0.099	[0.073 0.126]
$\sigma_{\varepsilon_{r\varpi}}$	Inv. Gamma	0.02	∞	0.014	[0.005 0.025]	0.021	[0.005 0.042]	0.017	[0.005 0.031]	0.009	[0.005 0.012]
$\sigma_{\varepsilon_{\pi\varpi}}$	Inv. Gamma	0.02	∞	0.435	[0.354 0.523]	0.028	[0.011 0.045]	1.517	[1.051 2.004]	1.118	[0.905 1.331]
σ_{ε_Z}	Inv. Gamma	0.02	∞	0.294	[0.232 0.355]	0.627	[0.385 0.850]	0.393	[0.317 0.463]	0.008	[0.005 0.012]
σ_{ε_A}	Inv. Gamma	0.02	∞	0.892	[0.529 1.232]	0.719	[0.436 0.990]	0.666	[0.396 0.947]	0.671	[0.421 0.893]
β_0	Beta	0.5	0.02			0.493	[0.460 0.526]	0.504	[0.461 0.536]	0.503	[0.468 0.536]
β_1	Normal	2.5	0.02			2.495	[2.464 2.528]	2.493	[2.464 2.526]	2.499	[2.466 2.530]
β_2	Normal	1.5	0.02			1.507	[1.472 1.539]	1.513	[1.480 1.545]	1.501	[1.469 1.534]
β_3	Normal	0.5	0.02			0.507	[0.475 0.544]			0.502	[0.469 0.536]
ζ_g	Beta	0.5	0.15							0.475	[0.252 0.705]
ρ_υ	Beta	0.5	0.02							0.053	[0.009 0.095]
σ_{ε_g}	Inv. Gamma	0.02	∞							0.418	[0.341 0.495]
Log data density				5.583		-81.575		-54.351		89.550	

Table A.4.4 – Estimation results for Indonesia

Parameters	Prior distribution			Posterior distribution							
				Fixed Exchange rate		Managed Floating		Floating		Target Zone	
	type	Mean	Std. dev.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int
ϕ	Beta	0.75	0.025	0.652	[0.608 0.695]	0.673	[0.628 0.724]	0.669	[0.617 0.713]	0.642	[0.585 0.684]
ϕ_m	Beta	0.75	0.025	0.791	[0.743 0.834]	0.774	[0.730 0.815]	0.726	[0.674 0.775]	0.817	[0.788 0.846]
$\zeta_{y\varpi}$	Beta	0.5	0.15	0.799	[0.699 0.896]	0.421	[0.263 0.581]	0.615	[0.442 0.791]	0.715	[0.568 0.852]
$\zeta_{r\varpi}$	Beta	0.46	0.15	0.384	[0.274 0.499]	0.414	[0.165 0.676]	0.786	[0.756 0.815]	0.447	[0.286 0.608]
$\zeta_{\pi\varpi}$	Beta	0.5	0.15	0.153	[0.068 0.232]	0.863	[0.791 0.931]	0.528	[0.440 0.616]	0.041	[0.020 0.062]
ζ_z	Beta	0.46	0.15	0.527	[0.257 0.744]	0.066	[0.019 0.117]	0.436	[0.195 0.742]	0.462	[0.338 0.587]
ζ_A	Beta	0.5	0.15	0.306	[0.223 0.378]	0.533	[0.418 0.645]	0.285	[0.201 0.370]	0.202	[0.115 0.275]
θ	Gamma	0.6	0.01	0.595	[0.579 0.611]	0.601	[0.582 0.618]	0.596	[0.580 0.613]	0.584	[0.570 0.599]
σ_r	Inv. Gamma	0.02	∞	0.029	[0.004 0.098]	0.380	[0.312 0.450]	0.306	[0.248 0.361]	0.267	[0.217 0.326]
$\sigma_{\varepsilon_{y\varpi}}$	Inv. Gamma	0.02	∞	0.032	[0.018 0.044]	0.266	[0.181 0.349]	0.046	[0.030 0.061]	0.028	[0.018 0.038]
$\sigma_{\varepsilon_{r\varpi}}$	Inv. Gamma	0.02	∞	0.112	[0.086 0.138]	0.018	[0.005 0.032]	0.191	[0.151 0.226]	0.016	[0.006 0.028]
$\sigma_{\varepsilon_{\pi\varpi}}$	Inv. Gamma	0.02	∞	0.308	[0.246 0.368]	0.044	[0.012 0.078]	1.014	[0.626 1.396]	0.587	[0.480 0.694]
σ_{ε_Z}	Inv. Gamma	0.02	∞	0.017	[0.005 0.031]	0.530	[0.404 0.670]	0.021	[0.005 0.049]	0.020	[0.007 0.030]
σ_{ε_A}	Inv. Gamma	0.02	∞	0.464	[0.296 0.632]	0.458	[0.294 0.621]	0.561	[0.340 0.789]	0.464	[0.263 0.650]
β_0	Beta	0.5	0.02			0.488	[0.455 0.516]	0.500	[0.467 0.531]	0.517	[0.483 0.550]
β_1	Normal	2.5	0.02			2.490	[2.456 2.522]	2.489	[2.455 2.521]	2.498	[2.465 2.533]
β_2	Normal	1.5	0.02			1.509	[1.475 1.540]	1.511	[1.480 1.545]	1.504	[1.472 1.535]
β_3	Normal	0.5	0.02			0.517	[0.488 0.553]			0.494	[0.459 0.526]
ζ_g	Beta	0.5	0.15							0.498	[0.281 0.705]
ρ_v	Beta	0.5	0.02							0.043	[0.006 0.080]
σ_{ε_g}	Inv. Gamma	0.02	∞							0.242	[0.189 0.294]
Log data density				118.823		20.923		59.126		202.218	

Table A.4.5 – Estimation results for Malaysia

Parameters	Prior distribution			Posterior distribution							
				Fixed Exchange rate		Managed Floating		Floating		Target Zone	
	type	Mean	Std. dev.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int
ϕ	Beta	0.75	0.025	0.720	[0.671 0.764]	0.721	[0.679 0.768]	0.680	[0.632 0.726]	0.733	[0.688 0.777]
ϕ_m	Beta	0.75	0.025	0.651	[0.606 0.700]	0.653	[0.611 0.694]	0.625	[0.578 0.665]	0.666	[0.626 0.709]
$\zeta_{y\varpi}$	Beta	0.5	0.15	0.758	[0.656 0.862]	0.401	[0.269 0.542]	0.330	[0.177 0.477]	0.421	[0.287 0.547]
$\zeta_{r\varpi}$	Beta	0.46	0.15	0.504	[0.361 0.655]	0.407	[0.154 0.586]	0.254	[0.125 0.371]	0.329	[0.142 0.504]
$\zeta_{\pi\varpi}$	Beta	0.5	0.15	0.121	[0.052 0.200]	0.930	[0.901 0.962]	0.939	[0.913 0.968]	0.923	[0.885 0.963]
ζ_z	Beta	0.46	0.15	0.435	[0.214 0.621]	0.281	[0.141 0.440]	0.449	[0.256 0.631]	0.405	[0.183 0.591]
ζ_A	Beta	0.5	0.15	0.721	[0.530 0.896]	0.932	[0.909 0.956]	0.953	[0.937 0.970]	0.926	[0.898 0.953]
θ	Gamma	0.6	0.01	0.589	[0.574 0.606]	0.580	[0.558 0.603]	0.584	[0.569 0.600]	0.595	[0.579 0.610]
σ_r	Inv. Gamma	0.02	∞	0.021	[0.004 0.043]	0.561	[0.457 0.667]	0.471	[0.387 0.557]	0.574	[0.466 0.669]
$\sigma_{\varepsilon_{y\varpi}}$	Inv. Gamma	0.02	∞	0.244	[0.180 0.306]	0.190	[0.152 0.226]	0.173	[0.139 0.208]	0.206	[0.163 0.247]
$\sigma_{\varepsilon_{r\varpi}}$	Inv. Gamma	0.02	∞	0.074	[0.007 0.103]	0.016	[0.005 0.029]	0.159	[0.110 0.204]	0.118	[0.006 0.169]
$\sigma_{\varepsilon_{\pi\varpi}}$	Inv. Gamma	0.02	∞	0.456	[0.364 0.547]	0.012	[0.006 0.018]	0.012	[0.005 0.018]	0.014	[0.005 0.022]
σ_{ε_Z}	Inv. Gamma	0.02	∞	0.032	[0.004 0.090]	0.142	[0.101 0.183]	0.015	[0.005 0.030]	0.037	[0.005 0.114]
σ_{ε_A}	Inv. Gamma	0.02	∞	1.711	[1.105 2.354]	0.811	[0.623 1.013]	0.582	[0.458 0.703]	0.904	[0.676 1.159]
β_0	Beta	0.5	0.02			0.480	[0.447 0.510]	0.469	[0.437 0.501]	0.486	[0.457 0.521]
β_1	Normal	2.5	0.02			2.503	[2.470 2.535]	2.516	[2.485 2.547]	2.501	[2.469 2.535]
β_2	Normal	1.5	0.02			1.498	[1.464 1.530]	1.488	[1.457 1.523]	1.501	[1.469 1.535]
β_3	Normal	0.5	0.02			0.505	[0.474 0.536]			0.504	[0.472 0.537]
ζ_g	Beta	0.5	0.15							0.458	[0.213 0.678]
ρ_υ	Beta	0.5	0.02							0.693	[0.539 0.844]
σ_{ε_g}	Inv. Gamma	0.02	∞							0.5396	[0.373 0.710]
Log data density				-8.831		9.282		5.866		13.544	

Table A.4.6 – Estimation results for Philippines

Parameters	Prior distribution			Posterior distribution							
				Fixed Exchange rate		Managed Floating		Floating		Target Zone	
	type	Mean	Std. dev.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int
ϕ	Beta	0.75	0.025	0.711	[0.662 0.758]	0.713	[0.671 0.756]	0.704	[0.657 0.758]	0.701	[0.652 0.748]
ϕ_m	Beta	0.75	0.025	0.687	[0.639 0.736]	0.714	[0.675 0.759]	0.693	[0.650 0.731]	0.642	[0.593 0.693]
$\zeta_{y\varpi}$	Beta	0.5	0.15	0.769	[0.654 0.875]	0.400	[0.276 0.517]	0.317	[0.198 0.442]	0.693	[0.588 0.818]
$\zeta_{r\varpi}$	Beta	0.46	0.15	0.483	[0.291 0.695]	0.391	[0.208 0.569]	0.423	[0.242 0.594]	0.431	[0.239 0.606]
$\zeta_{\pi\varpi}$	Beta	0.5	0.15	0.134	[0.055 0.212]	0.928	[0.893 0.961]	0.946	[0.926 0.967]	0.043	[0.029 0.059]
ζ_z	Beta	0.46	0.15	0.501	[0.360 0.627]	0.421	[0.204 0.599]	0.406	[0.215 0.581]	0.561	[0.433 0.688]
ζ_A	Beta	0.5	0.15	0.624	[0.510 0.757]	0.733	[0.623 0.823]	0.796	[0.686 0.899]	0.683	[0.582 0.776]
θ	Gamma	0.6	0.01	0.589	[0.573 0.605]	0.599	[0.583 0.616]	0.597	[0.583 0.614]	0.593	[0.577 0.610]
σ_r	Inv. Gamma	0.02	∞	0.019	[0.004 0.037]	0.449	[0.368 0.535]	0.371	[0.300 0.434]	0.362	[0.286 0.428]
$\sigma_{\varepsilon_{y\varpi}}$	Inv. Gamma	0.02	∞	0.086	[0.062 0.112]	0.185	[0.142 0.224]	0.191	[0.151 0.231]	0.082	[0.062 0.103]
$\sigma_{\varepsilon_{r\varpi}}$	Inv. Gamma	0.02	∞	0.033	[0.006 0.067]	0.087	[0.005 0.147]	0.066	[0.005 0.137]	0.010	[0.005 0.015]
$\sigma_{\varepsilon_{\pi\varpi}}$	Inv. Gamma	0.02	∞	0.335	[0.270 0.402]	0.013	[0.005 0.021]	0.009	[0.005 0.014]	0.605	[0.456 0.736]
σ_{ε_Z}	Inv. Gamma	0.02	∞	0.048	[0.007 0.074]	0.046	[0.005 0.107]	0.063	[0.006 0.130]	0.011	[0.006 0.015]
σ_{ε_A}	Inv. Gamma	0.02	∞	0.748	[0.416 1.019]	0.566	[0.368 0.762]	0.462	[0.290 0.646]	0.574	[0.348 0.798]
β_0	Beta	0.5	0.02			0.497	[0.463 0.529]	0.488	[0.454 0.519]	0.511	[0.481 0.543]
β_1	Normal	2.5	0.02			2.493	[2.458 2.522]	2.498	[2.466 2.528]	2.499	[2.467 2.532]
β_2	Normal	1.5	0.02			1.508	[1.473 1.539]	1.5	[1.470 1.535]	1.501	[1.466 1.533]
β_3	Normal	0.5	0.02			0.502	[0.468 0.536]			0.498	[0.466 0.528]
ζ_g	Beta	0.5	0.15							0.429	[0.236 0.635]
ρ_υ	Beta	0.5	0.02							0.214	[0.099 0.318]
σ_{ε_g}	Inv. Gamma	0.02	∞							0.257	[0.099 0.318]
Log data density				94.129		74.692		72.183		166.827	

Table A.4.7 – Estimation results for Singapore

Parameters	**Prior distribution**			**Posterior distribution**							
				Fixed Exchange rate		**Managed Floating**		**Floating**		**Target Zone**	
	type	Mean	Std. dev.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int.	Mean	Conf. Int
ϕ	Beta	0.75	0.025	0.684	[0.642 0.730]	0.719	[0.692 0.746]	0.681	[0.636 0.738]	0.664	[0.624 0.712]
ϕ_m	Beta	0.75	0.025	0.734	[0.679 0.780]	0.746	[0.718 0.772]	0.673	[0.620 0.723]	0.694	[0.646 0.748]
$\zeta_{y\varpi}$	Beta	0.5	0.15	0.821	[0.728 0.915]	0.472	[0.332 0.619]	0.716	[0.595 0.847]	0.690	[0.544 0.841]
$\zeta_{r\varpi}$	Beta	0.46	0.15	0.391	[0.181 0.604]	0.390	[0.166 0.619]	0.832	[0.810 0.856]	0.373	[0.196 0.580]
$\zeta_{\pi\varpi}$	Beta	0.5	0.15	0.174	[0.087 0.270]	0.918	[0.878 0.961]	0.596	[0.513 0.675]	0.018	[0.010 0.024]
ζ_z	Beta	0.46	0.15	0.348	[0.235 0.458]	0.056	[0.014 0.099]	0.439	[0.183 0.675]	0.362	[0.169 0.541]
ζ_A	Beta	0.5	0.15	0.354	[0.259 0.450]	0.375	[0.246 0.501]	0.355	[0.270 0.437]	0.329	[0.251 0.420]
θ	Gamma	0.6	0.01	0.590	[0.575 0.606]	0.602	[0.585 0.618]	0.594	[0.577 0.610]	0.590	[0.573 0.607]
σ_r	Inv. Gamma	0.02	∞	0.019	[0.004 0.034]	0.814	[0.673 0.957]	0.662	[0.543 0.775]	0.914	[0.743 1.068]
$\sigma_{\varepsilon_{y\varpi}}$	Inv. Gamma	0.02	∞	0.103	[0.061 0.145]	0.568	[0.398 0.734]	0.083	[0.052 0.111]	0.084	[0.058 0.110]
$\sigma_{\varepsilon_{r\varpi}}$	Inv. Gamma	0.02	∞	0.015	[0.006 0.026]	0.018	[0.005 0.039]	0.300	[0.242 0.357]	0.013	[0.006 0.020]
$\sigma_{\varepsilon_{\pi\varpi}}$	Inv. Gamma	0.02	∞	0.463	[0.371 0.562]	0.052	[0.018 0.086]	1.457	[0.930 1.984]	1.021	[0.826 1.219]
σ_{ε_Z}	Inv. Gamma	0.02	∞	0.275	[0.371 0.562]	1.167	[0.887 1.435]	0.018	[0.005 0.036]	0.014	[0.007 0.021]
σ_{ε_A}	Inv. Gamma	0.02	∞	1.2579	[0.801 1.727]	1.408	[0.979 1.830]	1.103	[0.618 1.583]	1.110	[0.656 1.520]
β_0	Beta	0.5	0.02			0.482	[0.450 0.514]	0.4696	[0.463 0.532]	0.502	[0.469 0.535]
β_1	Normal	2.5	0.02			2.496	[2.465 2.534]	2.492	[2.457 2.523]	2.497	[2.464 2.529]
β_2	Normal	1.5	0.02			1.505	[1.471 1.536]	1.507	[1.474 1.539]	1.500	[1.467 1.535]
β_3	Normal	0.5	0.02			0.516	[0.484 0.549]			0.506	[0.473 0.539]
ζ_g	Beta	0.5	0.15							0.462	[0.220 0.670]
ρ_υ	Beta	0.5	0.02							0.059	[0.014 0.107]
σ_{ε_g}	Inv. Gamma	0.02	∞							0.462	[0.363 0.562]
Log data density				-26.490		-162.991		-109.077		61.065	

A.5. Optimal monetary rules

Table A.5.8 – Optimal policy coefficients from Method 1 determining optimal policy rules

	Floating	Managed Floating	Target Zone
Thailand			
Coefficients			
β_0	0.497	0.509	0.468
β_1	3.293	3.057	2.545
β_2	0.622	0.707	1.178
β_3	0.000	0.904	1.256
Indonesia			
Coefficients			
β_0	0.549	0.360	0.458
β_1	3.264	2.769	2.512
β_2	0.704	1.134	1.293
β_3	0.000	1.024	1.091
Malaysia			
Coefficients			
β_0	0.253	0.198	0.220
β_1	2.689	2.553	2.554
β_2	1.593	1.561	1.555
β_3	0.000	0.678	0.720
Philippines			
Coefficients			
β_0	0.483	0.487	0.467
β_1	3.386	3.109	2.675
β_2	0.572	0.664	1.055
β_3	0.000	0.996	1.248
Singapore			
Coefficients			
β_0	0.508	0.514	0.468
β_1	3.258	3.028	2.546
β_2	0.643	0.746	1.205
β_3	0.000	0.855	1.165

Table A.5.9 – Optimal policy coefficients from Method 2 determining optimal rules (in the face of the risk premium shock)

	Floating	Managed Floating	Target Zone
Thailand			
Coefficients			
β_1	2.2	1.1	1.1
β_2	0.2	0.3	0.3
β_3		0.3	0.3
Indonesia			
Coefficients			
β_1	1.1	1.1	1.1
β_2	0.2	0.3	0.3
β_3		0.3	0.3
Malaysia			
Coefficients			
β_1	1.3	1.1	1.1
β_2	0.7	0.3	0.3
β_3		0.3	0.3
Philippines			
Coefficients			
β_1	2.2	1.1	1.1
β_2	0.2	0.3	0.3
β_3		0.3	0.3
Singapore			
Coefficients			
β_1	2.2	1.1	1.1
β_2	0.2	0.3	0.3
β_3		0.3	0.3

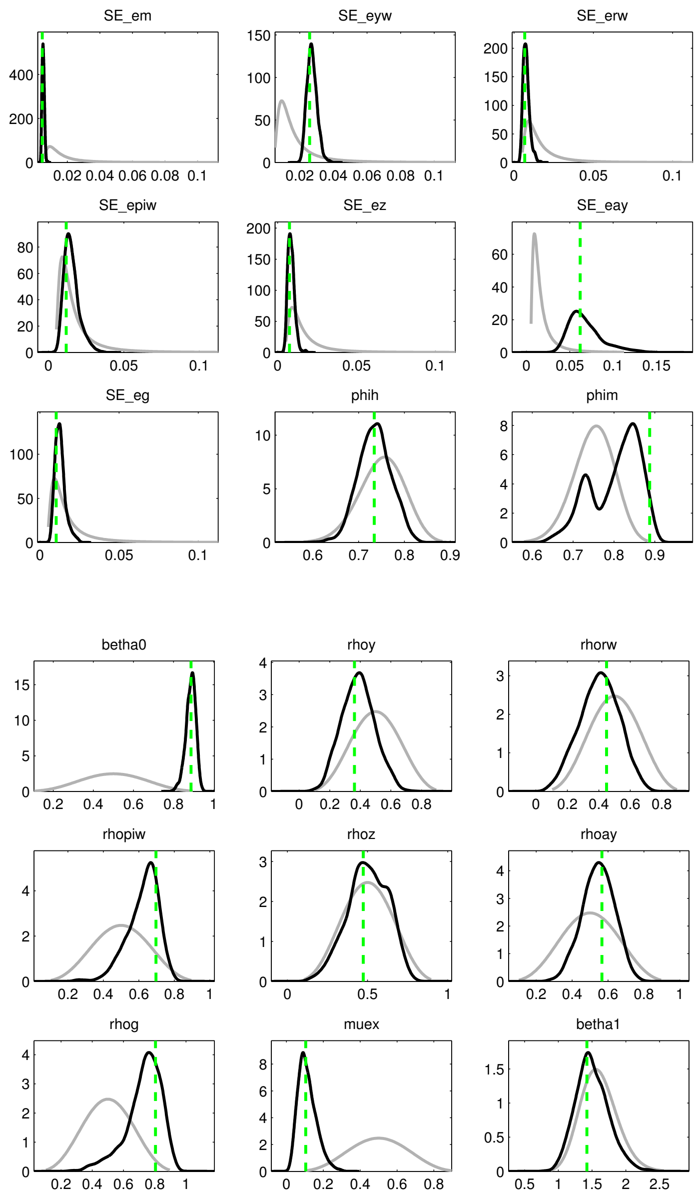
Table A.5.10 – Optimal policy coefficients from Method 2 determining optimal policy rules (in the face of the foreign demand shock)

	Floating	Managed Floating	Target Zone
Thailand			
Coefficients			
β_1	2.4	1.1	2.8
β_2	0.8	0.4	0.8
β_3		0.8	0.2
Indonesia			
Coefficients			
β_1	2.4	1.1	1.5
β_2	0.8	0.7	0.7
β_3		0.3	0.3
Malaysia			
Coefficients			
β_1	2.4	1.7	1.7
β_2	0.8	0.8	0.9
β_3		0	0
Philippines			
Coefficients			
β_1	2.4	1.5	1.5
β_2	0.8	0.7	0.7
β_3		0.3	0.3
Singapore			
Coefficients			
β_1	2.7	1.5	1.5
β_2	0.3	0.7	0.7
β_3		0.3	0.3

A.6. Estimation diagnostics

Priors, Posteriors and multivariate convergence statistics (MCMC diagnostics) Here, we only present the diagnostics for the estimates that better fit the data. The grey, black, dotted green lines respectively represent the prior, posterior and posterior mode. In convergence diagnostic Figure, the red and blue lines represent specific within and between chain measures (See Brooks and Gelman (1998) for more information). "Interval" is constructed around the parameter mean, "m2", being a measure of the variance and "m3" is based on third moments.

Figure A.6.1 – Thailand: Prior versus Posterior



Thailand: Prior versus Posterior, continued

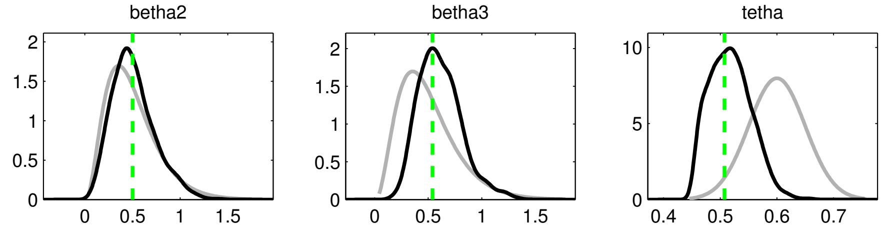


Figure A.6.2 – Thailand: Multivariate convergence diagnostic

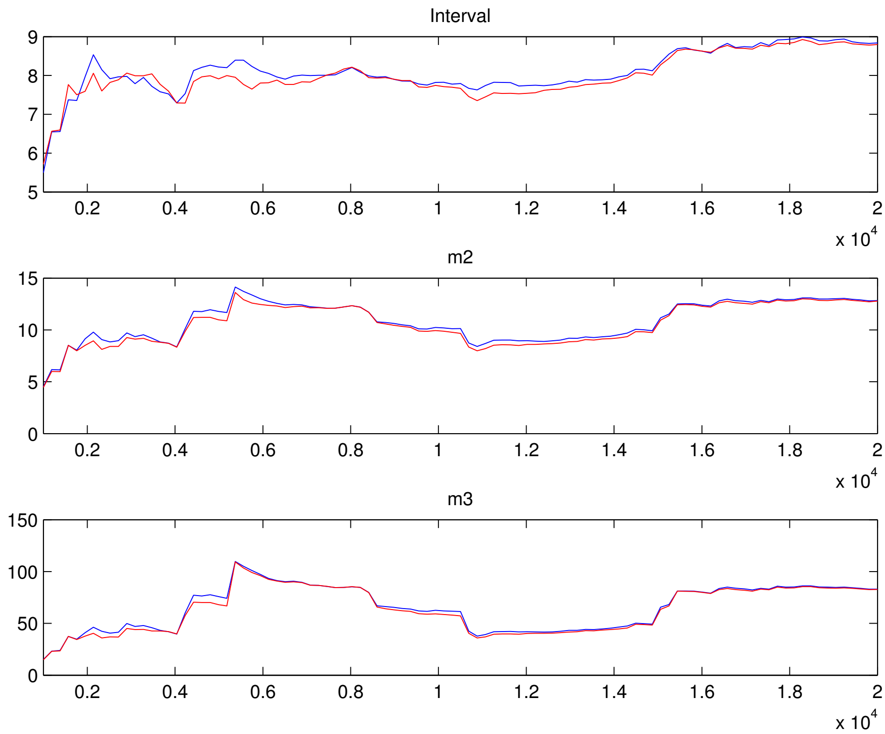
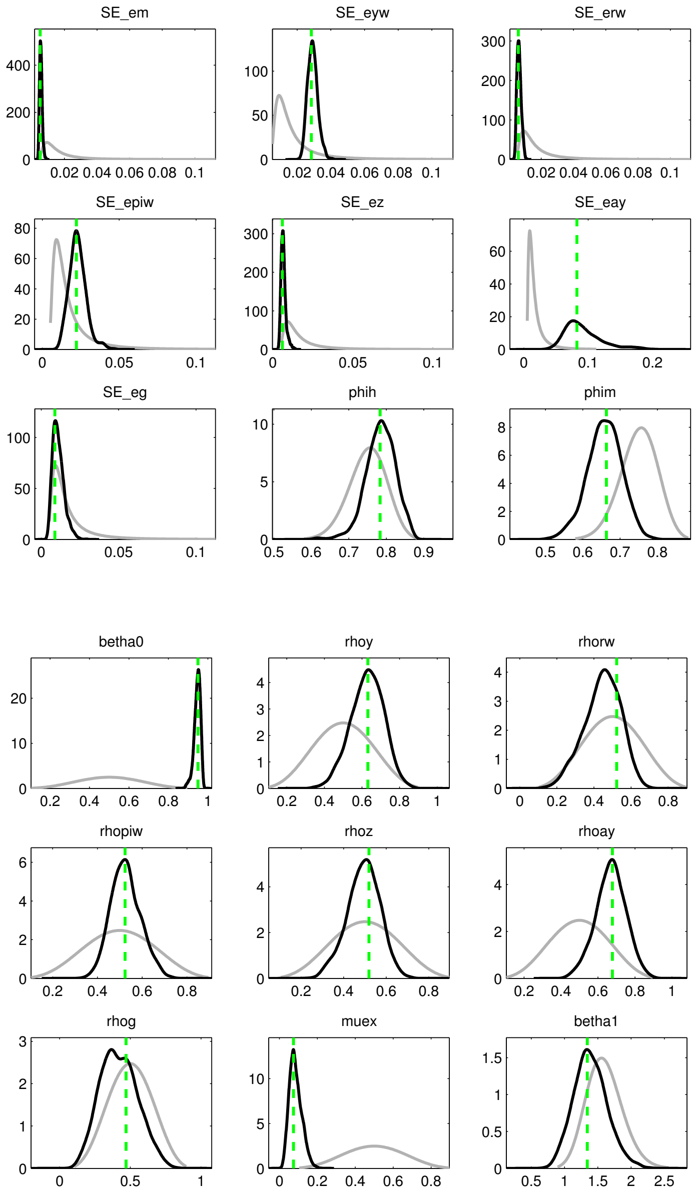


Figure A.6.3 – Singapore: Prior versus Posterior



Singapore: Prior versus Posterior, continued

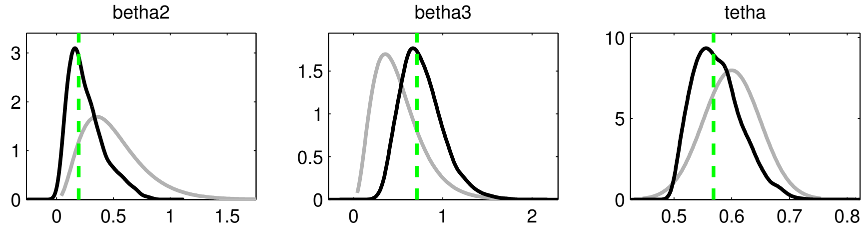


Figure A.6.4 – Singapore: Multivariate convergence diagnostic

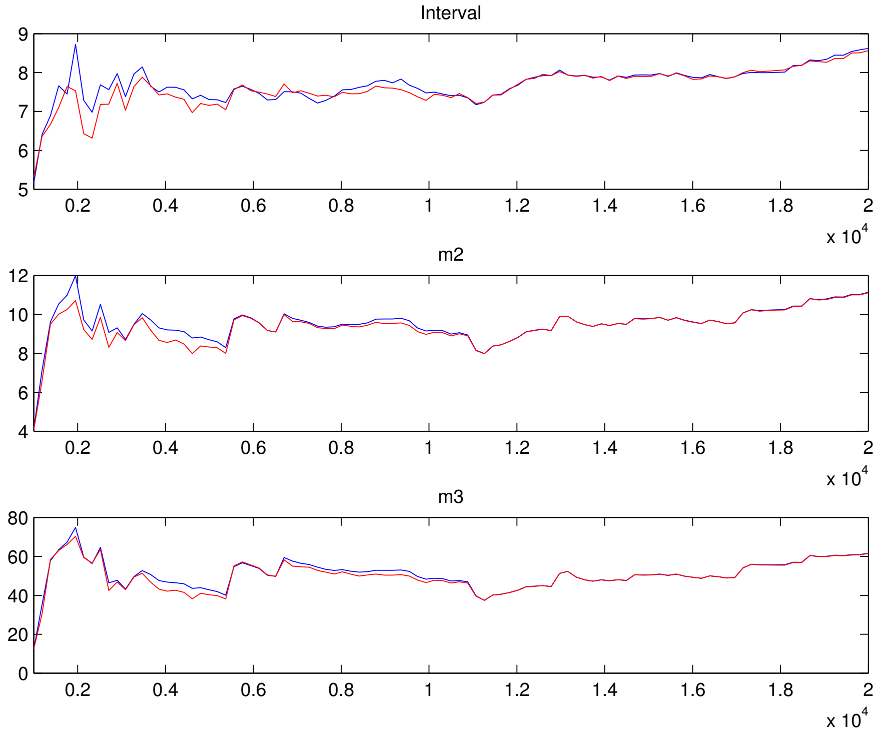
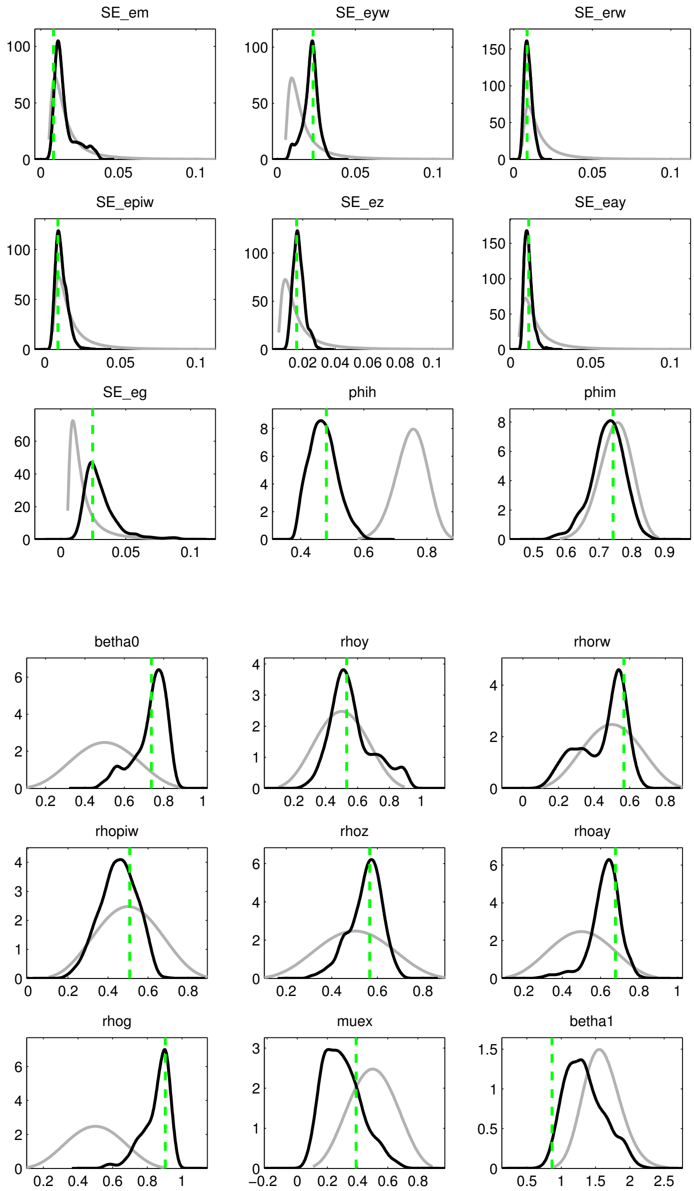


Figure A.6.5 – Indonesia: Prior versus Posterior



Indonesia: Prior versus Posterior, continued

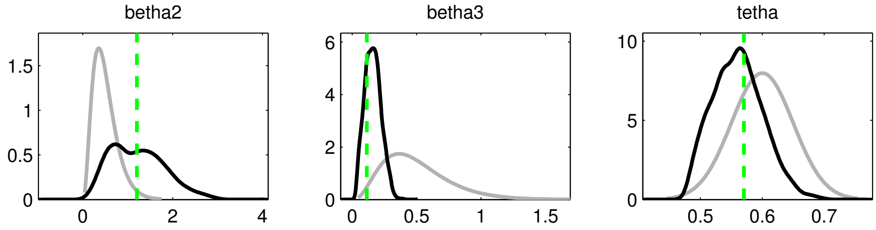


Figure A.6.6 – Indonesia: Multivariate convergence diagnostic

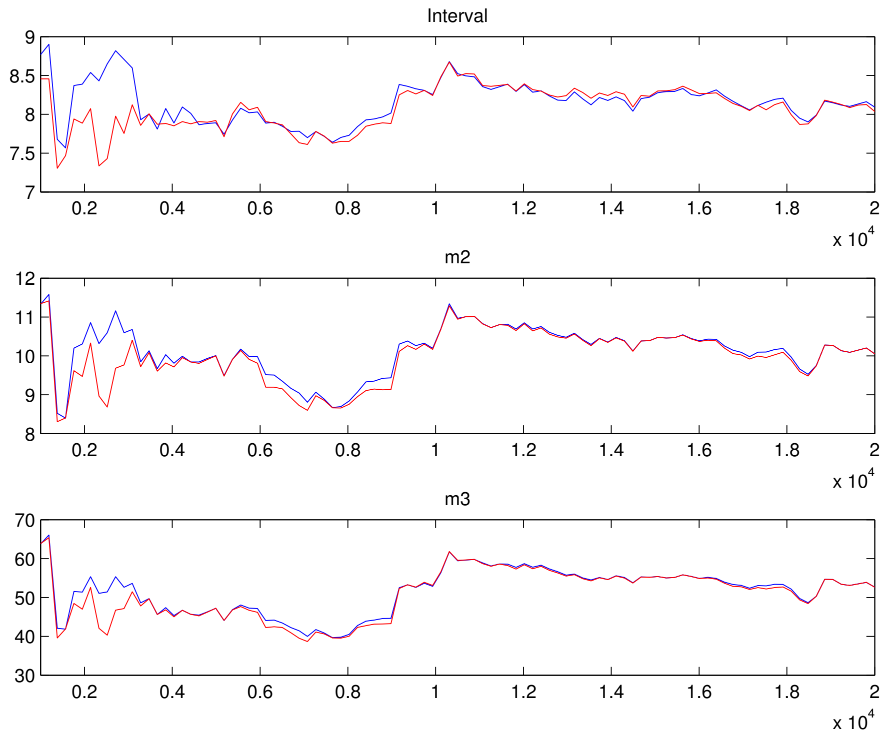
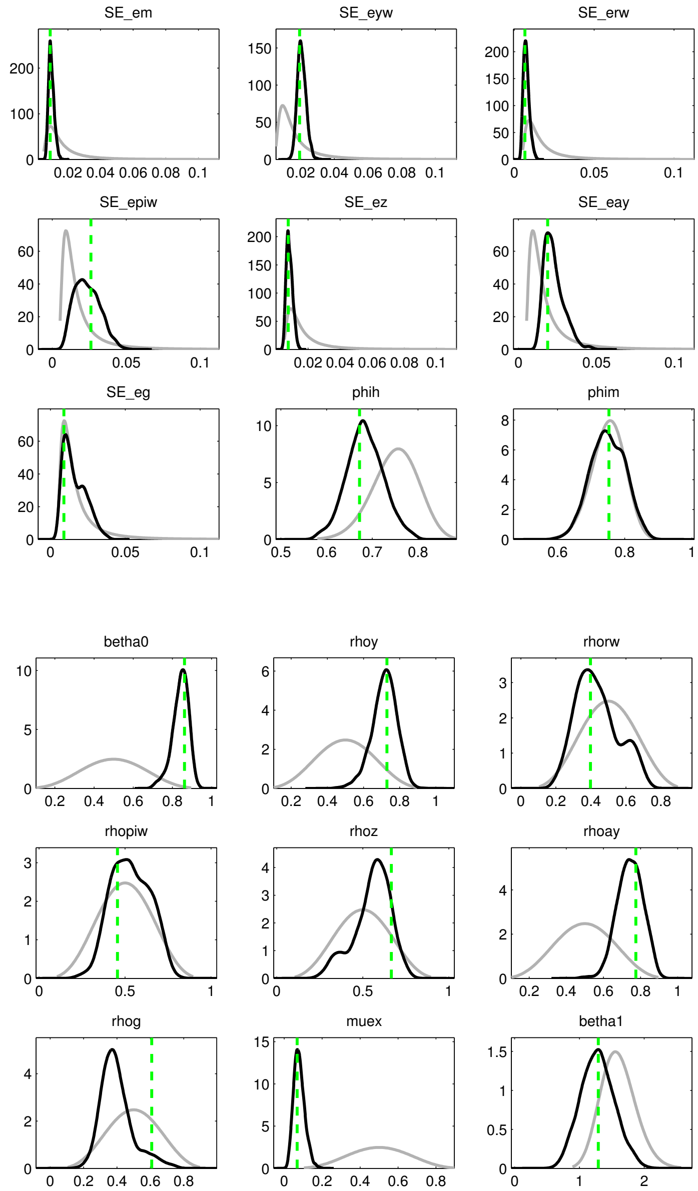


Figure A.6.7 – Philippines: Prior versus Posterior



Philippines: Prior versus Posterior, continued

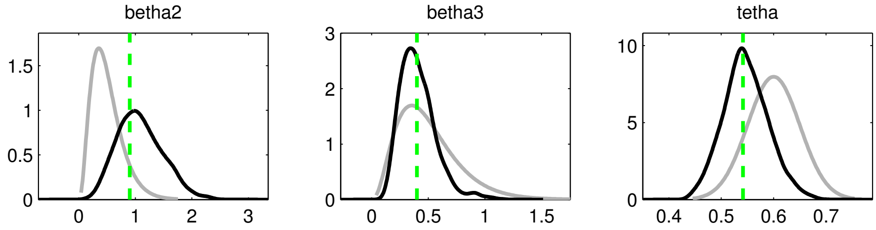


Figure A.6.8 – Philippines: Multivariate convergence diagnostic

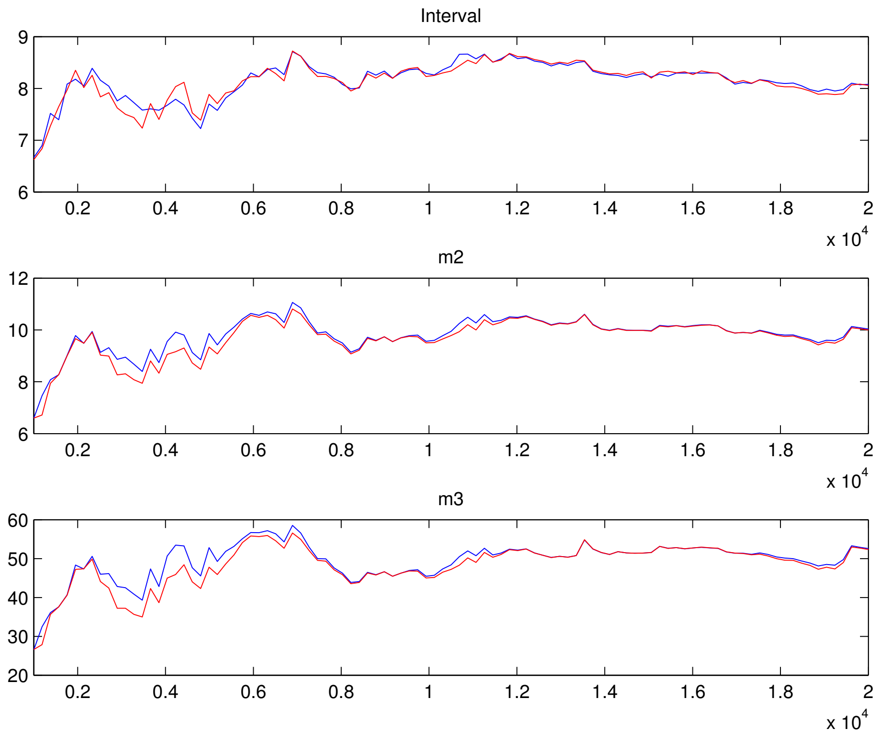
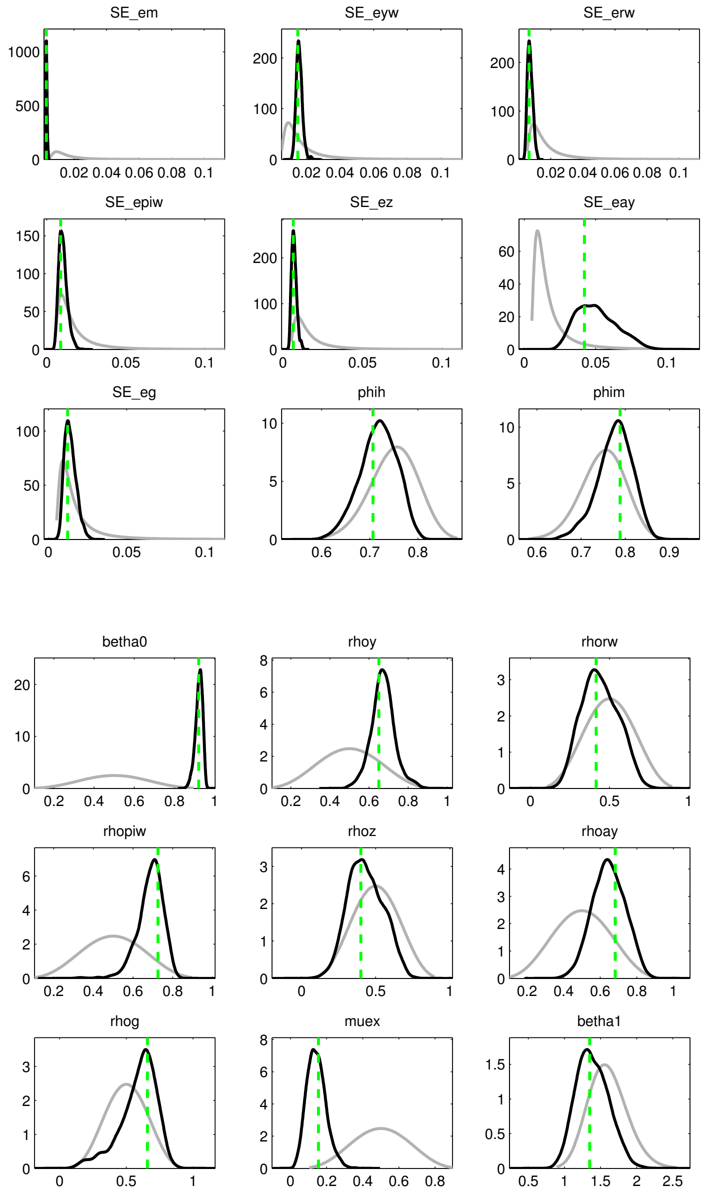


Figure A.6.9 – Malaysia: Prior versus Posterior



Malaysia: Prior versus Posterior, continued

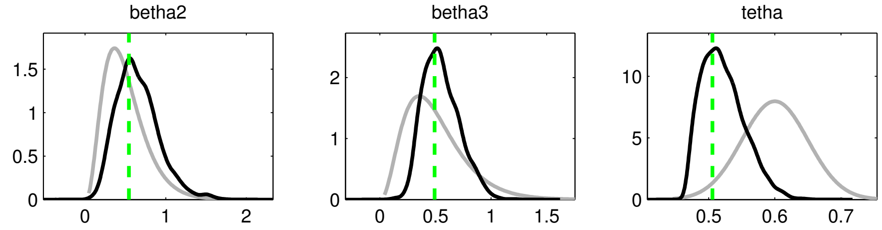
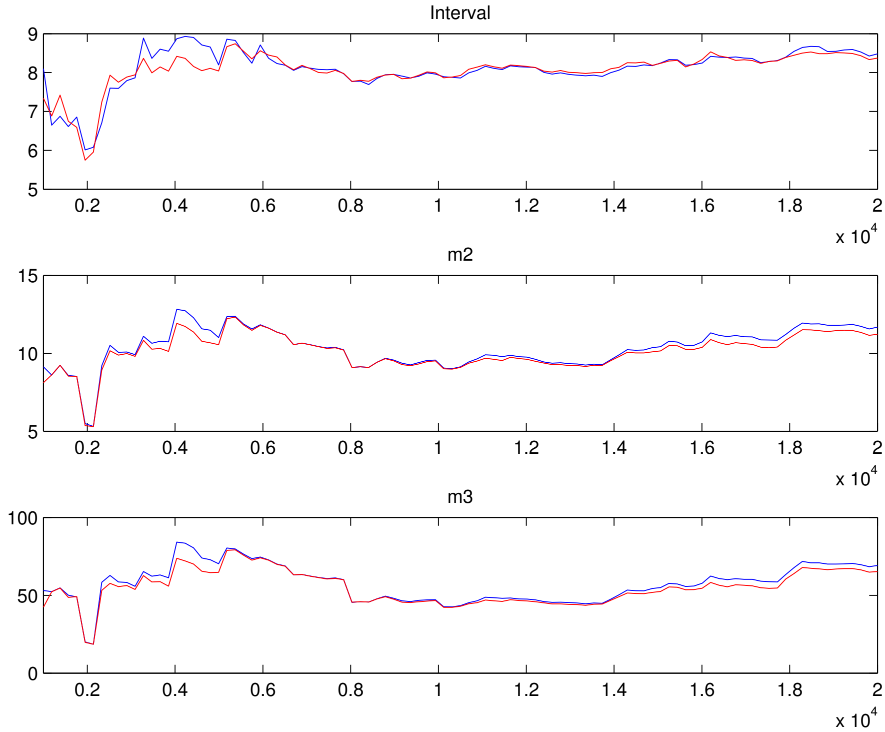


Figure A.6.10 – Malaysia: Multivariate convergence diagnostic



A.7. Complementary impulse responses

Figure A.7.11 – Responses of Singapore's key variables to a positive country-risk premium shock

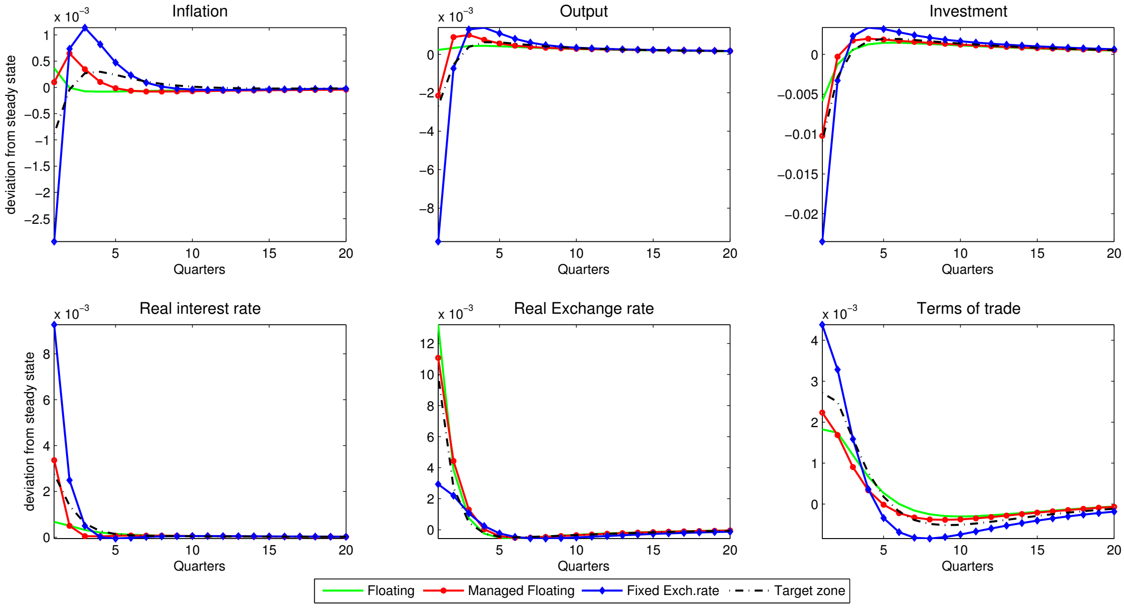


Figure A.7.12 – Responses of Singapore's key variables to a negative foreign demand

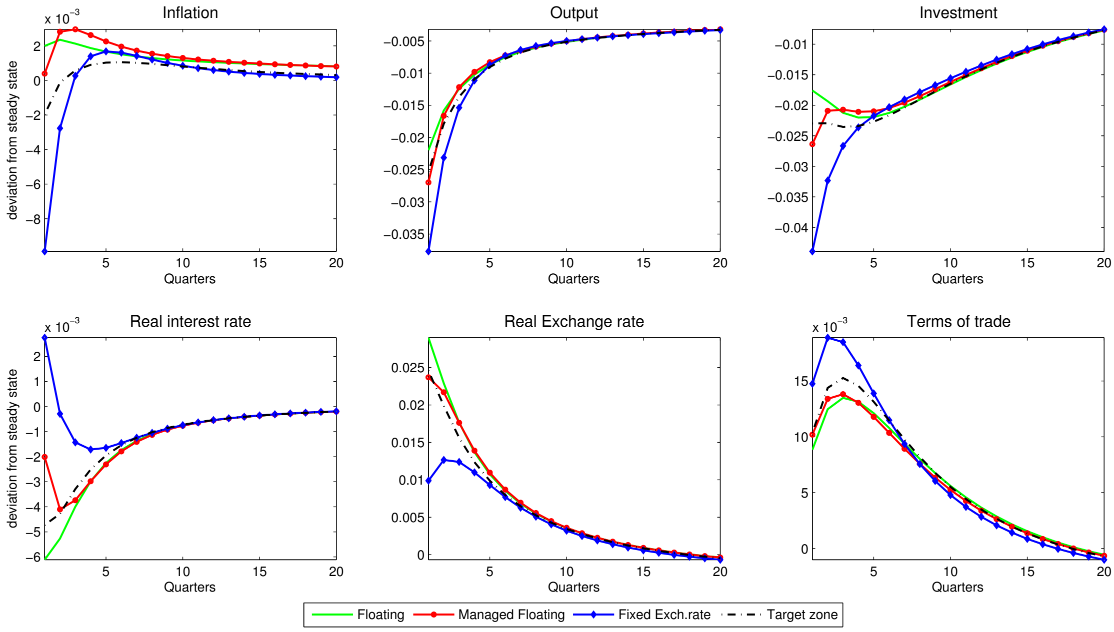


Figure A.7.13 – Responses of Malaysia's key variables to a positive country-risk premium shock

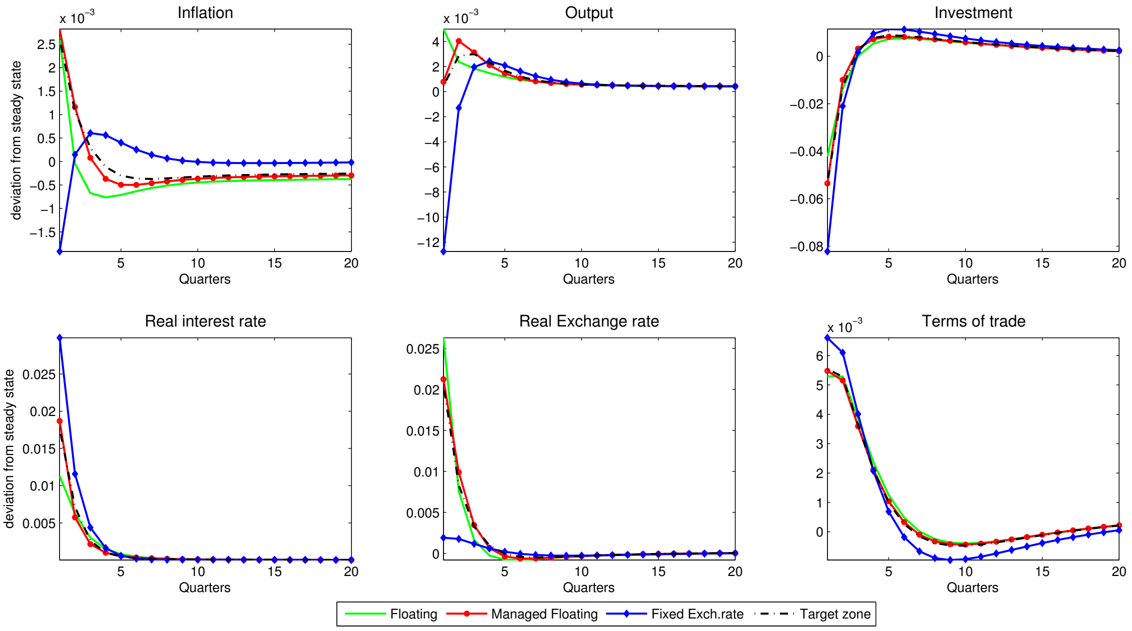


Figure A.7.14 – Responses of Malaysia's key variables to a negative foreign demand

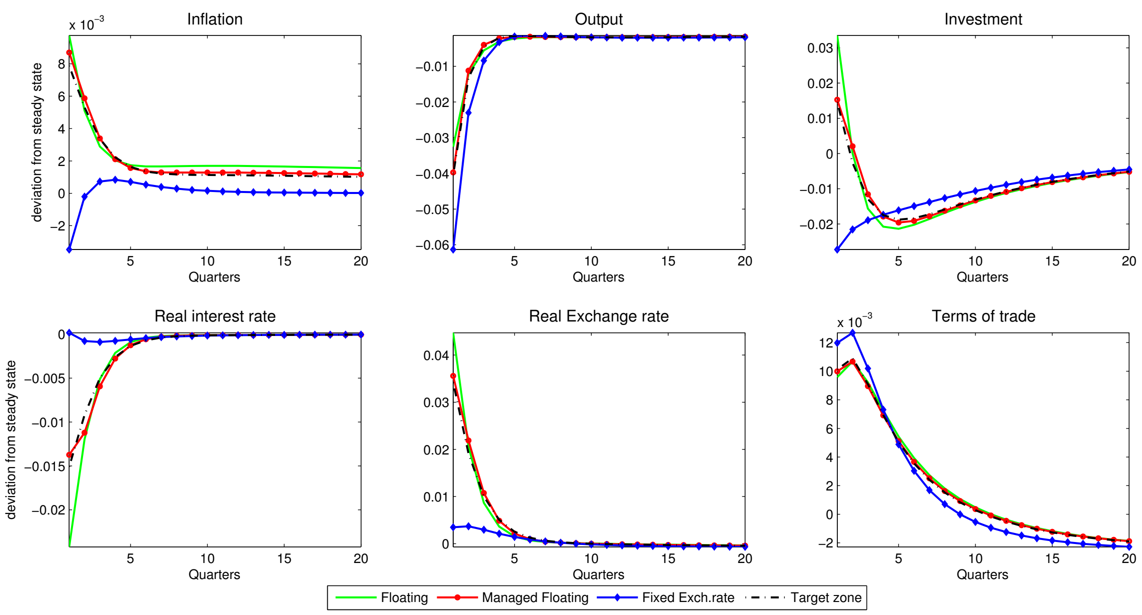


Figure A.7.15 – Responses of Indonesia's key variables to a positive country-risk premium shock

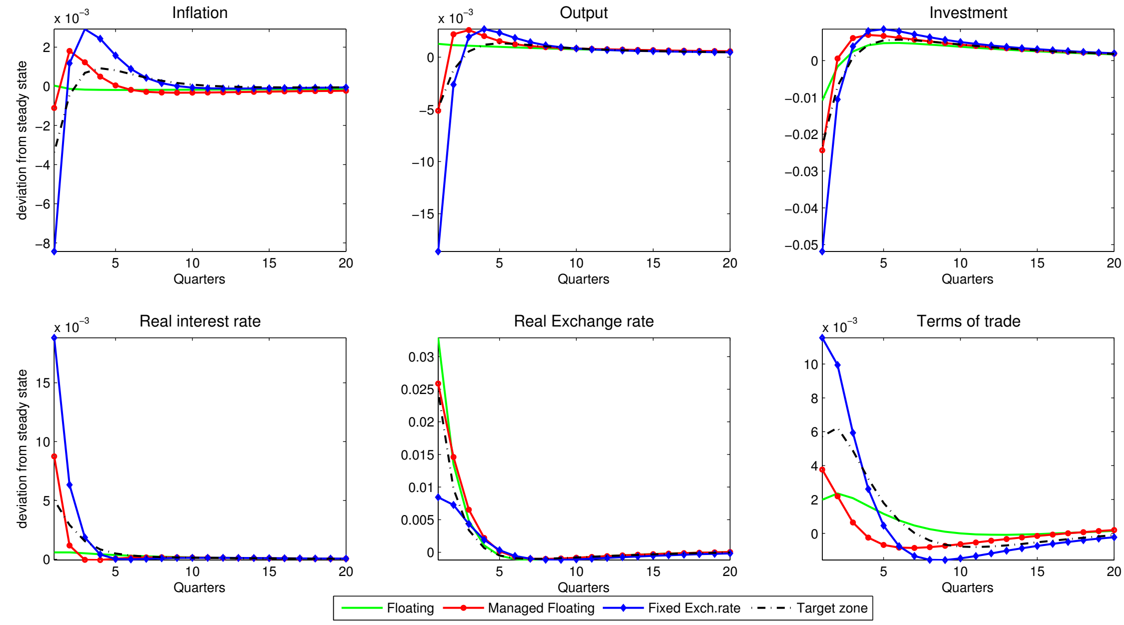


Figure A.7.16 – Responses of Indonesia's key variables to a negative foreign demand

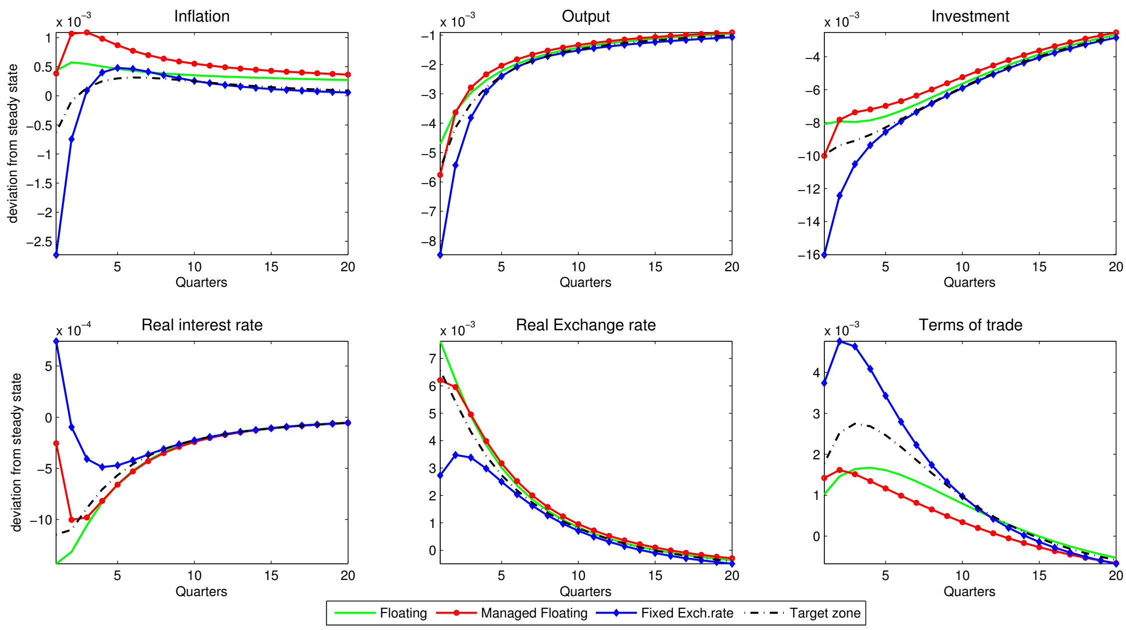


Figure A.7.17 – Responses of Philippines' key variables to a positive country-risk premium shock

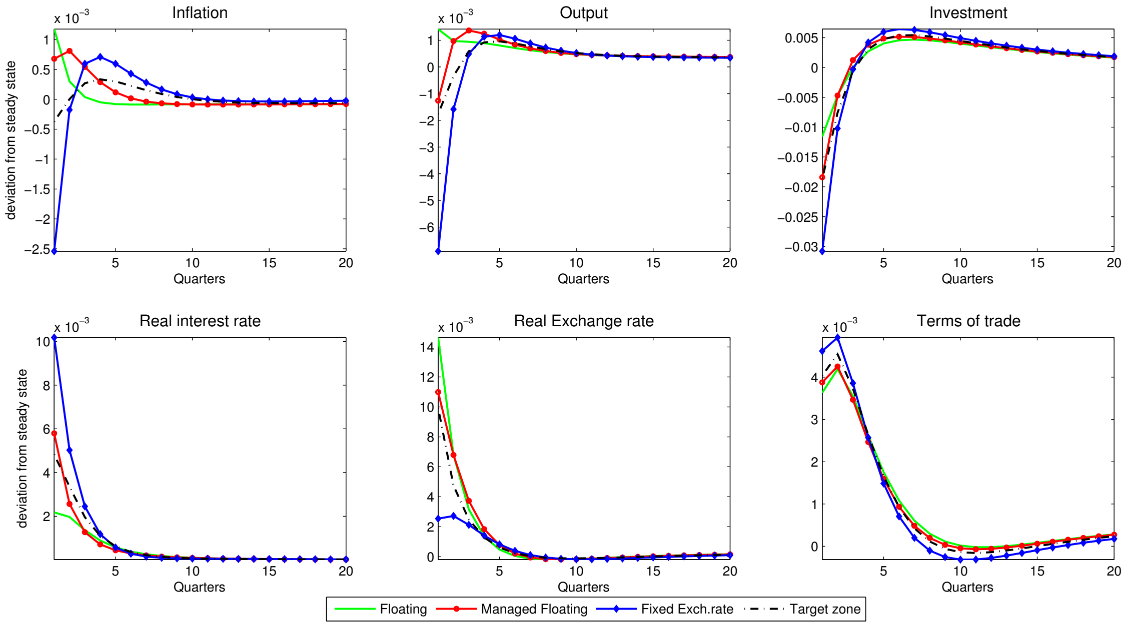


Figure A.7.18 – Responses of Philippines' key variables to a negative foreign demand

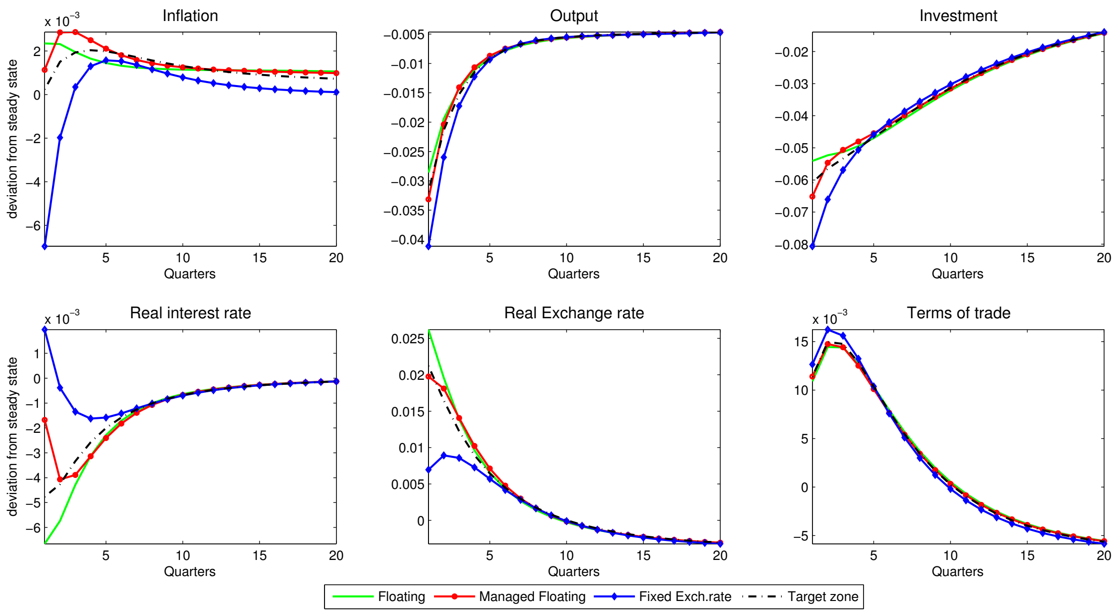


Figure A.7.19 – A country-risk premium shock under the fixed exchange rate regime with different degrees of trade openness

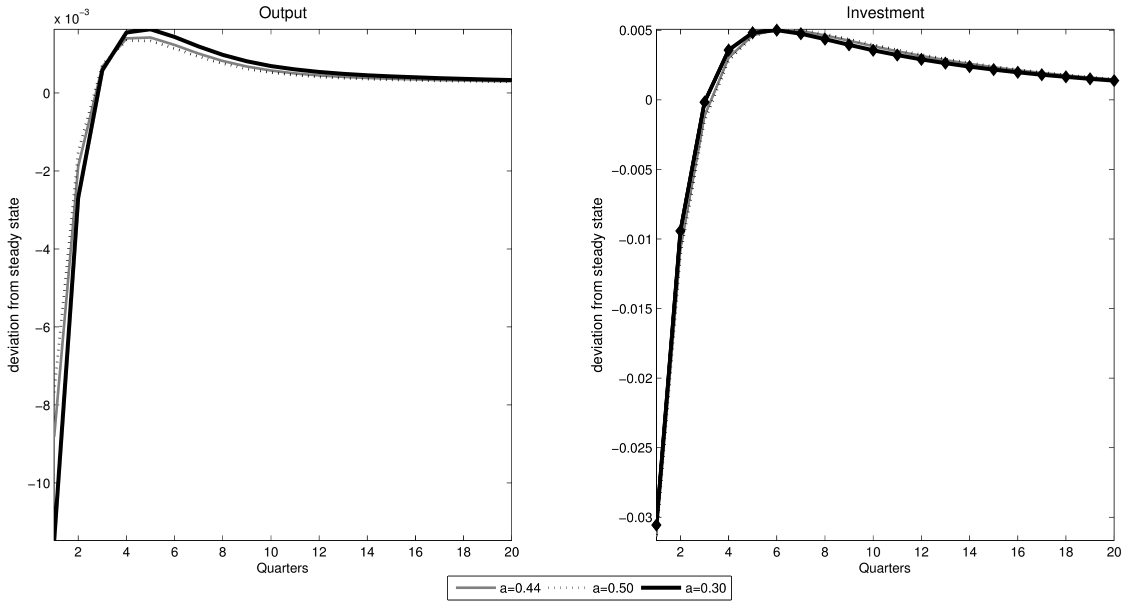


Figure A.7.20 – A country-risk premium shock under the flexible exchange rate regime with different degrees of trade openness

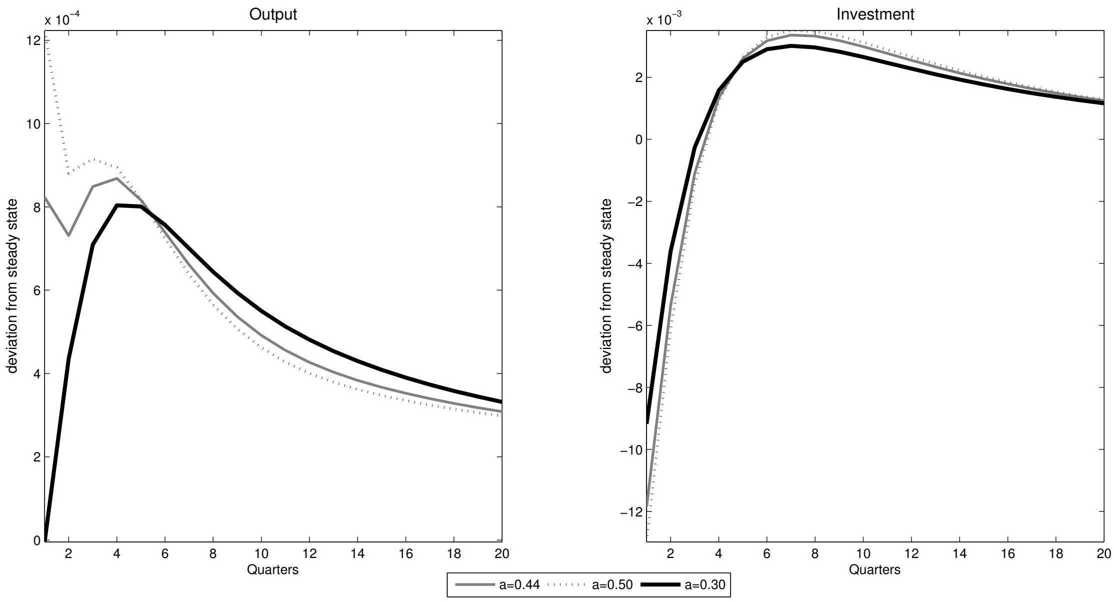
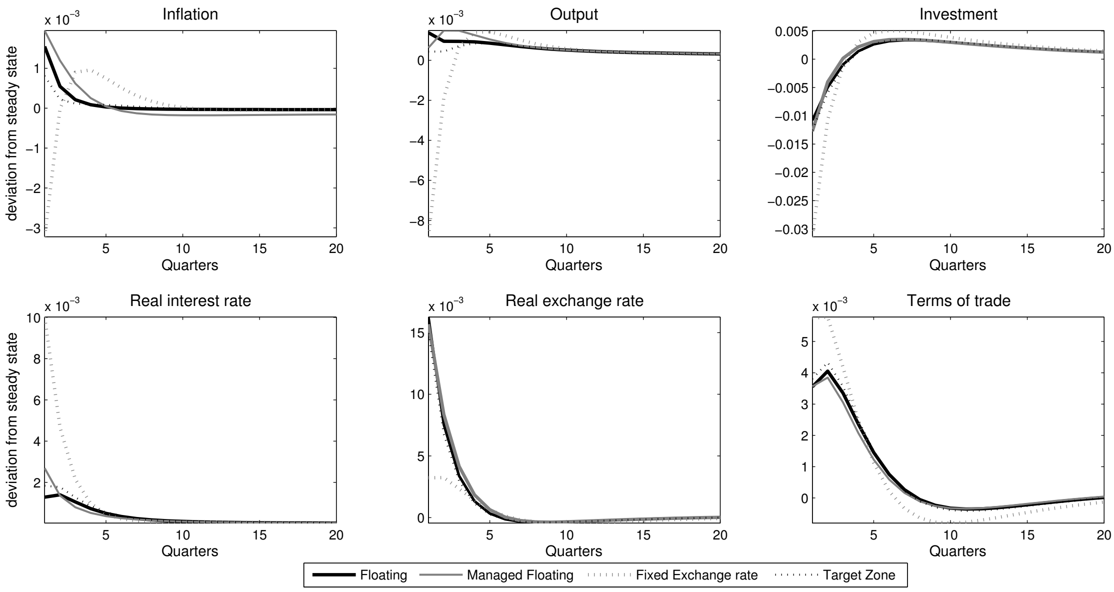
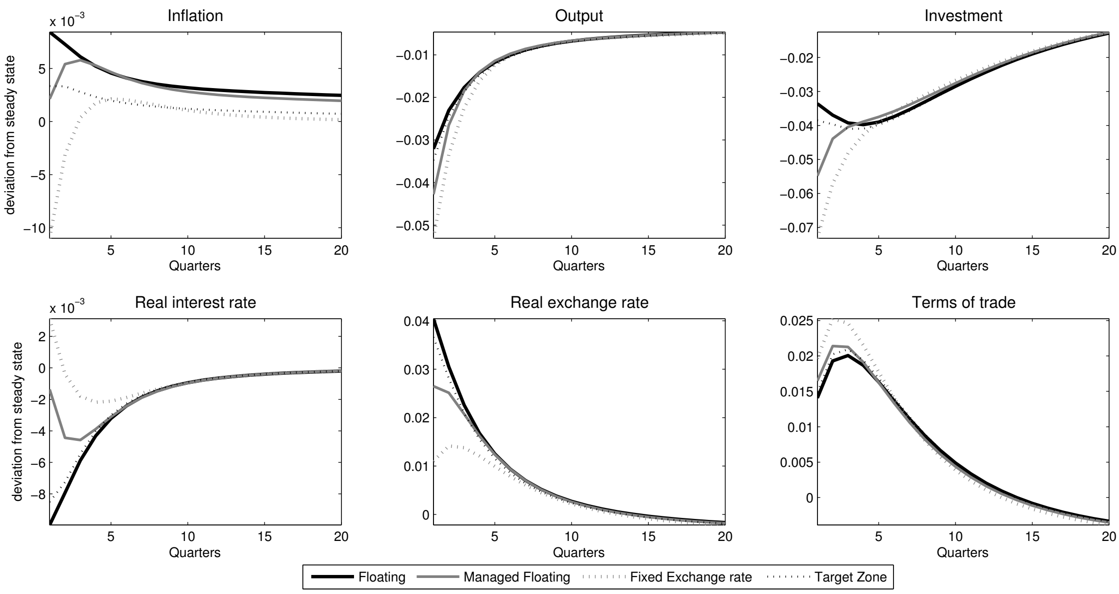


Figure A.7.21 – Responses of Thailand's key variables to a positive country-risk premium shock - Method 2



Note: These impulse responses are obtained using optimal policy rules provided by the second method of the determination of optimal parameters.

Figure A.7.22 – Responses of Thailand's key variables to a negative foreign demand - Method 2



Note: These impulse responses are obtained using optimal policy rules provided by the second method of the determination of optimal parameters.

A.8. Welfare costs

Table A.8.11 – Welfare costs from Method 2 determining optimal policy rules

External Shocks	Monetary Regimes	Thailand	Indonesia	Malaysia	Philippines	Singapore
Country-risk premium shock	Floating	- 0.0048	- 0.0173	- 0.0653	- 0.0048	- 0.0048
	Managed Floating	- 0.0048	- 0.0175	- 0.0725	- 0.0052	- 0.0113
	Target Zone	- 0.0052	- 0.0119	- 0.0697	- 0.0062	- 0.0114
	Fixed Exchange Rate	- 0.0269	- 0.1044	- 0.4107	- 0.0269	- 0.0269
Foreign demand shock	Floating	- 0.4925	- 0.0421	- 1.9631	- 0.3139	- 0.3139
	Managed Floating	- 0.5034	- 0.0427	- 1.9951	- 0.3904	- 0.3554
	Target Zone	- 0.5081	- 0.0456	- 1.9951	- 0.3242	- 0.3847
	Fixed Exchange Rate	- 0.6681	- 0.0563	- 2.6580	- 0.4255	- 0.4255

Chapter 2

Effective exchange rate targeting and monetary integration

CHAPTER 2 - EFFECTIVE EXCHANGE RATE TARGETING AND MONETARY INTEGRATION

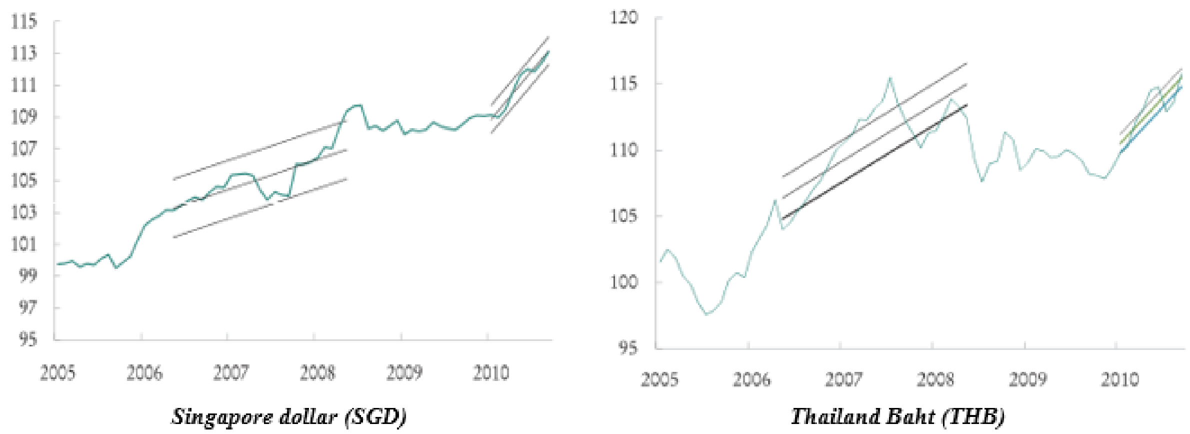
2.1. Introduction

The sovereign debt crisis in the euro area rouses the question of whether or not the monetary union is ultimately the best exchange rate regime for all participating countries, since some of them have encountered adjustment difficulties with regard to current account deficits.
In accordance with the theory of the optimum currency area (henceforth OCA), there are a number of criteria that must be met in order to ensure the success of a monetary union. These criteria, developed by Mundell (1961), McKinnon (1963) and Kenen (1969) are specifically linked to the trade intensity, the similarity of shocks and the degree of factor mobility.
The recent literature on this issue is focused on the finding that the greater are the linkages between countries using any of the three criteria, the more it becomes a suitable context for a common currency (see Bayoumi (1994), Eichengreen and Bayoumi (1999), Lee and Azali (2012), Lee and Koh (2012)). In summarizing the results of this literature, we finally esteem that only two conditions are sufficient for the suitability of a monetary union: the symmetry of shocks and the absence of structural heterogeneity among countries. It is within this ideal setting that a monetary union proves therefore its advantages, becoming the best monetary regime which should be adopted.

This work questions this conclusion, showing that it is possible to replicate the performance of a monetary union, even possible to outperform it, in the face of a symmetric shock.
We theoretically analyze the opportunity of transitioning to a monetary union in a region characterized by a relatively large degree of trade openness, foreign-currency denominated debt and where there is similarity among trade-weighted currency baskets of countries.
Using the experience of countries of the Southeast Asian region, we consider the nominal effective exchange rate (henceforth NEER) targeting regime as the benchmark regime. Indeed, as indicated in the "de facto" classification of exchange rate arrangements presented by the IMF (2008), the managed floating regime (called, the NEER targeting regime) is the ongoing trend in the monetary system of major ASEAN' countries. The nominal effective exchange rate therefore serves as the nominal anchor or intermediate target of monetary policy. This is

illustrated by Figure 2.1. Indeed, according to Ma and McCauley (2008) and Aglietta et al. (2011), from mid-2006 to mid-2008 the exchange rate policies of Singapore and Thailand were characterized by a crawling band resulting from managing their currencies against the weighted average of trading partner currencies. Thus, monetary authorities of these countries have used a target for their nominal effective exchange rate.

Figure 2.1 – Examples of the recent behaviour of nominal effective exchange rates [1]



Source: Aglietta et al. (2011).

Furthermore, these countries are characterized by similarities among their trade-weighted currency baskets (in terms of weights and structure) as indicated in Table 2.1.

Table 2.1 – Currency weights in the baskets of some Southeast Asian currencies (1999-2009)

Countries	US Dollar	Euro	CII [2]
Thailand	0.48	0.10	0.30
Malaysia	0.55	0.21	0.17
Singapore	0.45	0.17	0.34
Philippines	0.49	0.19	0.36
Indonesia	0.55	0.45	

Source: Girardin (2011)

1. The NEER is expressed in terms of units of commercial partners' currencies per unit of domestic currency. The trend line is estimated by the Least Squares method over the following periods (January 2006-January 2008 and January-September 2010).
2. 11 Currencies in East Asia, such as the ASEAN's currencies excluding the currency of the Lao People's Democratic Republic, Chinese Renminbi and South Korea's Won.

Our analysis is performed in an ideal setting of a region composed of countries that are structurally identical and hit by symmetric shocks. Under this assumption, we first question whether or not the transition towards a “de jure“ monetary union is desirable in such a region compared to a regime of managed nominal effective exchange rate in the presence of foreign-currency denominated debt. Secondly, we investigate how the NEER targeting regime can lead to the transition towards a kind of fixity of bilateral exchange rates (that we call “de facto” currency area) through the independent but similar national policies. We conduct a welfare analysis to strengthen our results.

In this perspective, we build a suitable two-country DSGE model open to the rest of the world, which incorporates nominal and real rigidities, incomplete pass-through of exchange rate, financial frictions, and foreign-currency denominated debt. To our knowledge, the subject has not been addressed before in the DSGE literature. Most existing literature on two-country DSGE models concerns the euro area (unlike to our model, which is not initially a monetary union) and are often modeled as two countries closed to the rest of the world (see for example Badarau and Levieuge (2011), Gali and Monacelli (2008), Smets and Wouters (2003), Vogel et al. (2013)). Furthermore, besides the stylized facts in Aglietta (2011) and Ma and McCauley (2008), the implications of nominal effective exchange rate targeting in terms of monetary integration when trade-weighted currency baskets are similar have not still been rigorously explored. Our model is calibrated on the five founding members of the ASEAN (Thailand, Indonesia, Malaysia, Singapore and Philippines) [3] and we analyze the effects of supply and demand shocks on the economies. We compare the impacts of shocks under the monetary union regime against those under the exchange rate targeting regime.

We first show that, despite the fact that the allocations under the two regimes considered are almost identical, the nature of shocks introduces a marginal difference between the performances of the regimes. For instance, in the face of an external demand shock, the monetary union is slightly less preferable than the exchange rate targeting regime.

Next, we numerically demonstrate that if each country of a region would manage its exchange rate against its own trade-weighted currency basket, the stability of bilateral exchange rates within the region is possible. It is not therefore interesting for these countries to be members of a “de jure” monetary union because the national policies with the management of currencies

3. We consider the average level of data from these countries.

against their own respective currency baskets would be enough to have a kind of intra-regional fixity of bilateral exchange rate. This “de facto” fixed exchange rate regime within the region seems more advantageous than the “de jure” monetary union.

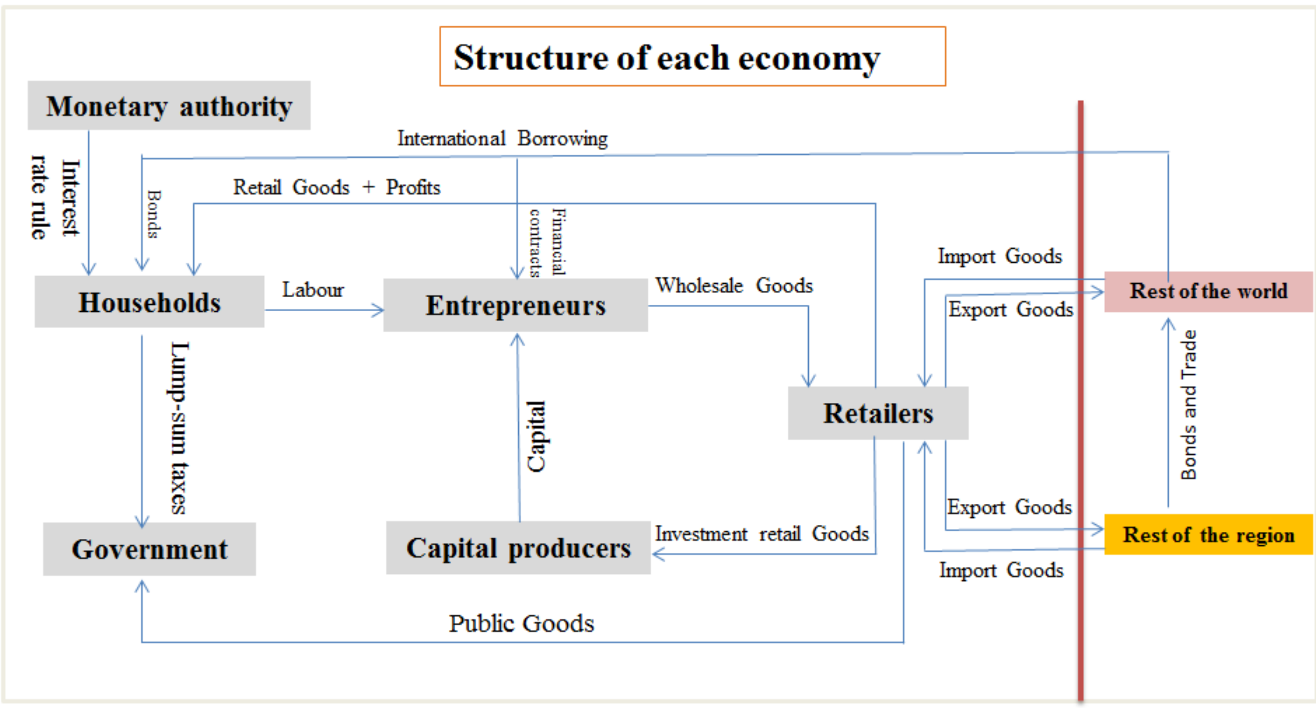
The remainder of the chapter is organized as follows: Section 2.2 lays out the multi-country general-equilibrium model. Section 2.3 presents the calibration of the model and the results. Section 2.4 concludes.

2.2. A two open-region DSGE model

The model consists of two symmetric countries of equal size, respectively a part of the ASEAN region, denoted as home country (H) and the rest of the region (RoR) that represents the foreign country. They are open to the rest of the world (RoW) which is fully exogenous. The model contains price stickiness, capital adjustment costs, incomplete exchange rate pass-through and financial frictions.

Each region is populated by households, government and three types of producers: entrepreneurs, capital producers, and retailers (domestic and imported goods retailers). There is a monetary authority that sets the risk-free nominal interest rate for each country, but in the case of the formation of a currency union there is a unified monetary policy setting the unique nominal interest rate for both countries. Capital producers build new capital and sell it to entrepreneurs. The latter produce wholesale goods and sell them to domestic goods retailers. Domestic and imported goods retailers set the nominal prices of final goods *à la* Calvo (1983). The government finances its expenditures on aggregate public goods through lump-sum taxes.

The structure of the model is summarized by the following flow chart:



2.2.1. Households

Each economy $i \in \{H, RoR\}$ is populated with a unit mass continuum of infinitely lived households. The representative household of country i has the following expected discounted sum of utilities:

$$E_t \sum_{t=0}^{\infty} \beta^t \left(\frac{(C_t^i)^{1-\sigma}}{1-\sigma} - \frac{(N_t^i)^{1+\eta}}{1+\eta} \right) \tag{2.1}$$

where C_t^i is the aggregate consumption and N_t^i denotes the number of hours worked. E_t is the conditional expectation operator. The parameters $0 < \beta < 1, \sigma > 0$ and $\eta > 0$ are respectively the subjective discount factor, the inverse of the intertemporal elasticity of substitution and the inverse of Frisch labour supply elasticity.
Households face the following period-by-period budget constraint:

$$\begin{aligned} P_t^i C_t^i + R_{t-1}^i B_{t-1}^i + R_{w,t-1} \Psi_{d,t-1}^i (d_{t-1}^i, Z_{t-1}^i) S_{2,t}^i D_{h,t-1}^i \\ = W_t^i N_t^i + B_t^i + S_{2t}^i D_{h,t}^i + \Lambda_t^i - \tau_t^i \end{aligned} \tag{2.2}$$

where P_t^i is the consumer price index (CPI), W_t^i the nominal wage, B_t^i the nominal stock of domestic-currency debt and $D_{h,t}^i$ is the nominal debt that is denominated in the currency of the rest of the world. R_t and $R_{w,t}$ are the domestic and RoW gross nominal interest rates, respectively. $S_{2,t}^i$ is the bilateral nominal exchange rate between country $i \in \{H, RoR\}$ and the rest of the world (expressed in terms of units of domestic currency per unit of the RoW currency) [4], τ_t^i denotes lump-sum taxes paid to the government and Λ_t^i is the nominal profit from the monopolistic sector. Finally, $\Psi_{d,t}^i$ represents a risk premium on foreign debt defined as follows:

$$\Psi_{d,t}^i (d_t^i, Z_t^i) = exp \left(\psi_d^i \Big(\frac{S_{2,t}^i D_t^i}{Y P_t^i} \Big) + Z_t^i \right) \tag{2.3}$$

4. We define the bilateral nominal exchange rate within the region by $S_{1,t}^i$ such as, $S_{1,t}^H$ is the bilateral nominal exchange rate between H and RoR, and $S_{1,t}^{RoR} = 1/S_{1,t}^H$ is the bilateral nominal exchange rate between RoR and H. In this case, the bilateral nominal exchange rate between RoR and RoW can be expressed as a function of $S_{1,t}^H$ and the bilateral nominal exchange rate between H and RoW, $(S_{2,t}^H)$, as : $S_{2,t}^{RoR} = S_{2,t}^H / S_{1,t}^H$. Notice that the formation of a currency union implies that $S_{1,t}^H = S_{1,t}^{RoR} = 1$.

where $d_t^i \equiv \frac{S_{2,t}^i D_t^i}{Y P_t^i}$ is the real aggregate net foreign asset position in percentage of steady-state output; $D_t^i \equiv D_{h,t}^i + D_{E,t}^i$ represents the total debt of each country [5]; $\psi_d^i > 0$ is a measure of the risk premium elasticity with respect to the net foreign asset position.The variable Z_t^i is an exogenous shock on the risk premium defined by $\log(Z_t^i) = \rho_z \log(Z_{t-1}^i) + e_{z,t}$ with $e_{z,t} \sim i.i.d(0, \sigma_{e_z}^2)$. The term $\Psi_{d,t}^i(d_t^i, Z_t^i\ )$ satisfies $\Psi_d^i(0,0) = 1$. It captures the degree of financial capital mobility at the international level and ensures a well-defined steady state in the model (Schmitt-Grohé and Uribe, 2003) [6].

The representative household chooses the paths for $\{C_t^i, N_t^i, B_t^i, D_t^i\}_0^\infty$ in order to maximize (2.1) subject to the budget constraint in (2.2). The following optimal conditions hold:

$$\frac{(N_t^i)^\eta}{(C_t^i)^{-\sigma}} = \frac{W_t^i}{P_t^i} \equiv w_t^i \tag{2.4}$$

$$(C_t^i)^{-\sigma} = \beta R_t^i E_t\left((C_{t+1}^i)^{-\sigma} \frac{P_t^i}{P_{t+1}^i}\right) \tag{2.5}$$

$$(C_t^i)^{-\sigma} = \beta R_{w,t} \Psi_{d,t}^i(d_t^i, Z_t^i) E_t\left((C_{t+1}^i)^{-\sigma} \frac{P_t^i}{P_{t+1}^i} \frac{S_{2,t+1}^i}{S_{2,t}^i}\right) \tag{2.6}$$

The final good, X_t^i, is allocated to consumption, C_t^i, investment, I_t^i and public spending, G_t^i. It is an aggregate of the goods produced in the domestic country, $X_{i,t}^i$, in the country k , $X_{k,t}^i$, and in the rest of the world, $X_{w,t}^i$:

$$X_t^i = \left[(1 - a_1^i - a_2^i)^{\frac{1}{\theta}} (X_{i,t}^i)^{\frac{\theta-1}{\theta}} + (a_1^i)^{\frac{1}{\theta}} (X_{k,t}^i)^{\frac{\theta-1}{\theta}} + (a_2^i)^{\frac{1}{\theta}} (X_{w,t}^i)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{2.7}$$

for $X = \{C, I, G\}$; $i, k \in \{H, RoR\}$ and $i \neq k$.

The parameters $\theta > 1$, a_1^i, and a_2^i are respectively the intratemporal elasticity of substitution between the three types of goods, the share of imported goods from the country k and the share of imported goods from the RoW. We assume that these shares are reciprocally identical between each country $i \in \{H, RoR\}$ of the region and the RoW. Therefore, the fraction $(1 - a_1^i - a_2^i)$ is the degree of home bias in consumption, investment and public goods.

5. $D_{E,t}^i$ is the entrepreneurial debt defined in subsection 2.3.1.

6. We assume perfect capital mobility at the regional level, i.e. there is no risk premium between the two countries of the region. Thus, the uncovered interest rate parity (UIP) holds inside the region but it doesn't hold between the economy $i \in \{H, RoR\}$ of the region and the rest of the world.

The price index (CPI) associated with (2.7) is given by:

$$P_t^i = \left[(1-a_1^i-a_2^i)(P_{i,t}^i)^{1-\theta} + a_1^i(P_{k,t}^i)^{1-\theta} + a_2^i(P_{w,t}^i)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{2.8}$$

where P_t^i, $P_{k,t}^i$ and $P_{w,t}^i$ are respectively the domestic price of domestic goods, the domestic price of imported goods from the country k and the domestic price of imported goods from the RoW. Let's define $X_{i,t}^i \equiv \left(\int_0^1 X_{i,t}^i(j)^{\frac{\chi-1}{\chi}} d_j\right)^{\frac{\chi}{\chi-1}}$, $X_{k,t} \equiv \left(\int_0^1 X_{k,t}^i(j)^{\frac{\chi-1}{\chi}} d_j\right)^{\frac{\chi}{\chi-1}}$ and $X_{w,t}^i \equiv \left(\int_0^1 X_{w,t}^i(j)^{\frac{\chi-1}{\chi}} d_j\right)^{\frac{\chi}{\chi-1}}$ as the aggregates of differentiated varieties of goods produced domestically, in the rest of the region and the rest of the world, respectively. χ is the elasticity of substitution between varieties of goods coming from the same country; $X_{i,t}^i(j)$, $X_{k,t}^i(j)$ and $X_{w,t}^i(j)$ being a typical variety j of domestic goods, imported goods from the country k and imported goods from the RoW, respectively. The corresponding prices are derived easily and are given by, respectively:
$P_{i,t}^i = \left(\int_0^1 P_{i,t}^i(j)^{1-\chi} d_j\right)^{\frac{1}{1-\chi}}$, $P_{k,t}^i = \left(\int_0^1 P_{k,t}^i(j)^{1-\chi} d_j\right)^{\frac{1}{1-\chi}}$, $P_{w,t}^i = \left(\int_0^1 P_{w,t}^i(j)^{1-\chi} d_j\right)^{\frac{1}{1-\chi}}$, where $P_{i,t}^i(j)$ (respectively $P_{k,t}^i(j)$ and $P_{w,t}^i(j)$) is the price of a typical variety j produced in the domestic country (respectively imported prices from the country k and the RoW).
The optimal domestic demands for home, country k and RoW goods, are derived from the expenditure minimization [7]

$$X_{i,t}^i = (1-a_1^i-a_2^i)\Big(\frac{P_{i,t}^i}{P_t^i}\Big)^{-\theta} X_t^i \tag{2.9}$$

$$X_{k,t}^i = a_1^i\left(\frac{P_{k,t}^i}{P_t^i}\right)^{-\theta} X_t^i \tag{2.10}$$

$$X_{w,t}^i = a_1^i\left(\frac{P_{w,t}^i}{P_t^i}\right)^{-\theta} X_t^i \tag{2.11}$$

$\forall\ i,k \in \{H, RoR\}$ and $i \neq k$.

2.2.2. Open-economy relations

This section outlines the key relations that define the terms of trade, real exchange rates and law of one price gaps. For each country $i,k \in \{H, RoR\}$ and $i \neq k$, We define the bilateral

7. The optimization problem is $\min_{C_{i,t}^i, C_{k,t}^i, C_{w,t}^i, C_t^i} P_{i,t}^i C_{i,t}^i + P_{k,t}^i C_{k,t}^i + P_{w,t}^i C_{w,t}^i = P_t^i C_t^i$ subject to the following constraint: $C_t^i = \left[(1-a_1-a_2)^{\frac{1}{\theta}}(C_{i,t}^i)^{\frac{\theta-1}{\theta}} + (a_1)^{\frac{1}{\theta}}(C_{k,t}^i)^{\frac{\theta-1}{\theta}} + (a_2)^{\frac{1}{\theta}}(C_{w,t}^i)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}$.

terms of trade as:

$$
\begin{aligned}
TOT^i_{k,t} &= \frac{P^i_{k,t}}{P^i_{i,t}} \\
TOT^i_{w,t} &= \frac{P^i_{w,t}}{P^i_{i,t}}.
\end{aligned}
\tag{2.12}
$$

From (8), the terms of trade can be related to the CPI-DPI [8] ratio as follows:

$$
\frac{P^i_t}{P^i_{i,t}} = \left[(1 - a^i_1 - a^i_2) + a^i_1\left(TOT^i_{k,t}\right)^{1-\theta} + a^i_2\left(TOT^i_{w,t}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{2.13}
$$

We assume that the law of one price (LOP) holds for the export sector, but there is incomplete exchange rate pass-through in the import sector. This assumption introduces the local-currency pricing practice (Devereux and Engel (2003)) implying that the prices of foreign goods in the domestic market temporarily deviate from producer price levels in the originating country. The wedge between these two prices is called the law of one price gap (LOPG) and bilaterally given by:

$$
\begin{aligned}
LOPG^i_{k,t} &= \frac{S^i_{1,t}P^k_{k,t}}{P^i_{k,t}} \\
LOPG^i_{w,t} &= \frac{S^i_{2,t}P^w_{w,t}}{P^i_{w,t}}
\end{aligned}
\tag{2.14}
$$

where $P^k_{k,t}$ and $P^w_{w,t}$ are domestic prices in country k of the region and the RoW, respectively. Similarly, we define the bilateral real exchange rates as follows:

$$
\begin{aligned}
RER^i_{k,t} &= \frac{S^i_{1,t}P^k_t}{P^i_t} \\
RER^i_{w,t} &= \frac{S^i_{2,t}P^w_t}{P^i_t}
\end{aligned}
\tag{2.15}
$$

8. DPI means Domestic Price Index.

Finally, one can express the effective terms of trade, the effective law of one price gap and the real effective exchange rate, for each country $i \in \{H, RoR\}$ as [9]:

$$TOT_t^i = \left(TOT_{k,t}^i\right)^{a_1^i}\left(TOT_{w,t}^i\right)^{a_2^i} \tag{2.16}$$

$$LOPG_t^i = \left(LOPG_{k,t}^i\right)^{a_1^i}\left(LOPG_{w,t}^i\right)^{a_2^i} \tag{2.17}$$

$$RER_t^i = \left(RER_{k,t}^i\right)^{a_1^i}\left(RER_{w,t}^i\right)^{a_2^i} \tag{2.18}$$

Assuming that the two countries $\{H, RoR\}$ have decided to form a monetary union and they will have the same size in the union. The real effective exchange rate for the union is therefore:

$$RER_t^u = \left(RER_t^H\right)^{\frac{1}{2}}\left(RER_t^{RoR}\right)^{\frac{1}{2}} = \left(RER_{w,t}^H\right)^{\frac{a_2^i}{2}}\left(RER_{w,t}^{RoR}\right)^{\frac{a_2^i}{2}} \tag{2.19}$$

which can be written also in terms of the union's nominal exchange rate (S_t):

$$RER_t^u = \frac{S_t P_t^w}{P_t^u} \tag{2.20}$$

where P_t^u and P_t^w are CPI of the monetary union and the rest of the world, respectively.

2.2.3. Production sector

2.2.3.1. Entrepreneurs

The presence of entrepreneurs introduces the financial accelerator mechanism into the model. As in Bernanke et al. (1999), entrepreneurs manage a continuum of firms $j \in [0,1]$ that produce, by using K_t^i units of capital and N_t^i units of labour, wholesale (intermediate) goods in a perfectly competitive market according to the following technology:

$$Y_t^i(j) = A_t^i K_t^i(j)^\alpha N_t^i(j)^{1-\alpha} \tag{2.21}$$

where A_t^i is a technological shock that is common to all firms and follows a stationary first-order autoregressive process : $\log(A_t^i) = \rho_A \log(A_{t-1}^i) + e_{A,t}$, with $e_{A,t} \sim i.i.d.(0, \sigma_{e_A}^2)$; $\alpha \in [0,1]$ is the share of capital in the technology of production . The representative firm maximizes its profit

9. The nominal effective exchange rate (NEER) for each country is $S_t^i = (S_{1,t}^i)^{a_1^i}(S_{2,t}^i)^{a_2^i}$.

by choosing K_t^i and N_t^i subject to the production function (2.21). The first-order conditions for this optimization problem are:

$$w_t^i = (1-\alpha) mc_t^i \frac{Y_t^i}{N_t^i} \frac{P_{i,t}^i}{P_t^i} \tag{2.22}$$
$$mpc_t^i = \alpha mc_t^i \frac{Y_t^i}{K_t^i} \frac{P_{i,t}^i}{P_t^i} \tag{2.23}$$

where mc_t^i denotes the real marginal cost, w_t^i is the real wage, and mpc_t^i is the real marginal productivity of capital. Entrepreneurs are risk neutral and borrow from outside the region to finance a share of capital used in the production process. This debt is issued in the currency of the rest of the world and therefore characterizes the original sin phenomenon. As in Bernanke et al. (1999), to ensure that they never accumulate enough funds to fully self-finance their own activities, assume that they have a finite expected horizon. In each period t, entrepreneurs face a constant probability $(1-v)$ of leaving the economy. We follow Christensen and Dib (2008) in allowing newly entering entrepreneurs to inherit a fraction of the net worth of those that exit the business. This assumption is made in order to ensure that new entrepreneurs start out with a positive net worth [10]. At the end of each period, entrepreneurs purchase capital, K_{t+1}^i, which is used in the next period, at the real price q_t^i. Thus, the entrepreneurial total fund needed to purchase capital is $q_t^i K_{t+1}^i$. The capital acquisition is financed partly by their net worth, NW_{t+1}^i, and by borrowing from the RoW.

$$S_{2,t} D_{E,t+1}^i = q_t^i K_{t+1}^i - NW_{t+1}^i$$

As demonstrated in Appendix A, the optimal financial contract between the borrower and the lender implies an external finance premium (the difference between the costs of external and internal finance), $\Psi_{E,t+1}^i(\cdot)$, which depends on the entrepreneur's leverage ratio (capital to net worth ratio).

The optimal condition is such that the entrepreneur's demand for capital satisfies the equality between the expected real return on capital and the expected marginal financing cost, such

10. Unlike our approach, Bernanke et al. (1999) assumes that entrepreneurs also work. This assumption does not affect the results.

as[11]:

$$E_t(R^i_{K,t+1}) = E_t\left[R_{w,t}\Psi^i_{d,t}(d^i_t, Z^i_t)\Psi^i_{E,t}(.)\frac{S^i_{2,t+1}}{S^i_{2,t}}\frac{P^i_t}{P^i_{t+1}}\right] \tag{2.24}$$

where $\Psi^i_{E,t+1}(\cdot)$ is the specific external risk premium that depends on the financial position of the entrepreneur and is given by: $\Psi^i_{E,t+1}(\cdot) = \left(\frac{NW^i_{t+1}}{q^i_t K^i_{t+1}}\right)^{-\gamma}$ with $\left(\Psi^i_{E,t+1}(\cdot)\right)' < 0$, $\Psi^i_E(1) = 1$. γ is the external finance premium elasticity with respect to the firm's leverage ratio. Thus, the external finance premium is inversely proportional to the aggregate financial position of firms, which is defined by the leverage ratio. Equation (2.24) provides the basis of the financial accelerator mechanism. If the entrepreneur's net worth increases, the external finance premium falls, the cost of borrowing falls and thus firms get cheaper access to credit. The entrepreneurial demand for capital must satisfy the following relation between the ex post marginal return on capital, $E_t(R^i_{K,t+1})$, and the marginal productivity of capital at *t+1*, mpc^i_t, defined as the rental rate of capital:

$$E_t(R^i_{K,t+1}) = E_t\left[\frac{mpc^i_{t+1} + (1-\delta)q^i_{t+1}}{q^i_t}\right] \tag{2.25}$$

where δ is the capital depreciation rate and $(1-\delta)q^i_{t+1}$ is the value of one unit of capital used in *t+1*. The aggregate entrepreneurial net worth accumulation in the economy depends on profits earned in previous periods and the bequest, Ω^i_t, that newly entering entrepreneurs receive from entrepreneurs who leave the economy, and evolves according to:

$$NW^i_{t+1} = v\left[R^i_{K,t}q^i_{t-1}K^i_t - R_{w,t-1}\Psi^i_{d,t-1}\frac{S^i_{2,t}}{S^i_{2,t-1}}\frac{P^i_{t-1}}{P^i_t}\left(\frac{NW^i_t}{q^i_{t-1}K^i_t}\right)^{-\gamma}\right.$$
$$\left.(q^i_{t-1}K^i_t - NW^i_t)\right] + (1-v)\Omega^i_t \tag{2.26}$$

2.2.3.2. Capital producers

Competitive capital producers use a linear technology to produce new capital K^i_{t+1} from final investment goods I^i_t and existing capital stock leased from entrepreneurs without costs. We assume that the production of capital is subject to a quadratic capital adjustment cost

11. For details, see Appendix A.

specified as

$$\frac{\psi_I}{2}\Big(\frac{I_t^i}{K_t^i}-\delta\Big)^2 K_t^i$$

where $\psi_I > 0$ is the parameter that measures the elasticity of the adjustment cost. The aggregate capital stock used by producers in each economy i evolves as follows:

$$K_{t+1}^i = \left[\frac{I_t^i}{K_t^i} - \frac{\psi_I}{2}\Big(\frac{I_t^i}{K_t^i}-\delta\Big)^2\right] K_t^i + (1-\delta)K_t^i \tag{2.27}$$

Capital producers face an optimization problem that requires choosing the investment level that maximizes their profits:

$$\max_{I_t^i}\left\{q_t^i I_t^i - I_t^i - \frac{\psi_I}{2}\left(\frac{I_t^i}{K_t^i}-\delta\right)^2 K_t^i\right\} \tag{2.28}$$

The following equilibrium condition holds:

$$q_t^i - \psi_I\left(\frac{I_t^i}{K_t^i}-\delta\right) = 1 \tag{2.29}$$

which is the standard Tobin's Q relation defining the capital price in function of the marginal adjustment cost.

When $\Psi_I = 0$ (no adjustment costs), the capital price, q_t^i is constant and equal to 1. This shows that capital adjustment costs necessarily imply that the capital price (q_t^i) is time-varying and therefore contribute to the volatility of the entrepreneurial net worth.

2.2.3.3. Retailers: price and inflation dynamics

The existence of retailers is the source of nominal rigidity in the model. Retailers take wholesale goods as inputs, repackage these costlessly, and sell them in a monopolistically competitive market. There are domestic goods retailers and imported goods retailers. Following Calvo (1983), we assume that retailers set nominal prices on a staggered basis: at each period, a fraction $(1-\phi^i)$ of retailers are randomly selected to set new prices while the remaining fraction ϕ^i of retailers keep their prices unchanged. For simplicity, these fractions are assumed to be equals across types of retailers.

Home goods retailers purchase wholesale goods from entrepreneurs at a price equal to the entrepreneurs' nominal marginal cost. Each retailer j setting the price at t will choose the optimal price, $\tilde{P}^i_{i,t}$, that maximizes its expected profits for s periods, so that:

$$\max_{\widetilde{P}^i_{i,t}(j)} E_t \Bigg\{ \sum_{s=0}^{\infty} (\beta\phi i)^s \frac{\lambda^i_{t+s}}{\lambda^i_t} \Big[Y^i_{i,t+s}(j) \Big(\widetilde{P}^i_{i,t}(j) - P^i_{i,t+s} mc^i_{t+s} \Big) \Big] \Bigg\} \tag{2.30}$$

subject to the demand function, $Y^i_{t+s}(j) = \left(\frac{\tilde{P}^i_{i,t+s}(j)}{P^i_{i,t+s}}\right)^{-\chi} Y^i_{i,t+s}$ where $\frac{\lambda^i_{t+s}}{\lambda^i_t}$ is the ratio of the representative household's marginal utility in $t+s$ relative to that in t.

The first-order condition for this problem yields,

$$\widetilde{P}^i_{i,t}(j) = \frac{\chi}{\chi - 1} \frac{E_t\{\sum_{s=0}^{\infty} (\beta\phi^i)^s \lambda^i_{t+s} Y^i_{i,t+s}(j) P^i_{i,t+s} mc^i_{t+s}\}}{E_t\{\sum_{s=0}^{\infty} (\beta\phi^i)^s \lambda^i_{t+s} Y^i_{i,t+s}(j)} \tag{2.31}$$

After aggregating across all retailers, the price index of domestically produced goods is given by,

$$P^i_{i,t} = \left[\left(1 - \phi^i\right) \left(\widetilde{P}^i_{i,t}\right)^{1-\chi} + \phi^i \left(P^i_{i,t-1}\right)^{1-\chi} \right]^{\frac{1}{1-\chi}} \tag{2.32}$$

Combining log-linearized versions of equations (2.31) and (2.32) yields an expression of the inflation rate from domestically produced goods, defined by the following "New Keynesian" Phillips curve:

$$\widehat{\pi}^i_{i,t} = \beta E_t \widehat{\pi}^i_{i,t+1} \frac{(1 - \phi^i)(1 - \beta\phi^i)}{\phi^i} \widehat{mc}^i_t \tag{2.33}$$

where mc^i_t is the real marginal cost, $\pi^i_{i,t} = \left(\frac{P^i_{i,t}}{P^i_{i,t-1}}\right)$ is the domestic inflation and variables with hats are log deviations from the steady-state values.

Similarly, imported goods retailers purchase products from foreign producers at the wholesale price, $P^i_{G,t}$. At the wholesale level, the law of one price holds. Thus, $P^i_{G,t} = S^i_{1,t} P^k_{k,t}$ and $P^i_{G,t} = S^i_{2,t} P^w_{w,t}$ are the wholesale prices of imported goods from the country k and the RoW, respectively. But at the retail level, we assume that the law of one price does not hold (such as $P^i_{k,t} \neq S^i_{1,t} P^k_{k,t}$ and $P^i_{w,t} \neq S^i_{2,t} P^w_{w,t}$). This introduces the incomplete exchange rate pass-through in the model. Analogously to the home goods retailers, imported goods retailers set their prices according to a calvo-style price setting method. The optimization problem of imported goods retailers is analogous to that of domestic goods retailers, except the real marginal costs that differ from case to case. Indeed, real marginal costs are respectively $\left(\frac{S^i_{1,t}P^k_{k,t}}{P^i_{k,t}}\right) \equiv LOPG^i_{k,t}$ and $\left(\frac{S^i_{2,t}P^w_{w,t}}{P^i_{w,t}}\right) \equiv LOPG^i_{w,t}$ for imported goods from country k and the RoW. The inflation rates from imported goods prices therefore satisfy these following "New Keynesian" Phillips curves:

$$\widehat{\pi}^i_{k,t} = \beta E_t \widehat{\pi}^i_{k,t+1} \frac{(1-\phi^i)(1-\beta\phi^i)}{\phi^i} \widehat{lopg}^i_{k,t} \tag{2.34}$$

$$\widehat{\pi}^i_{w,t} = \beta E_t \widehat{\pi}^i_{w,t+1} \frac{(1-\phi^i)(1-\beta\phi^i)}{\phi^i} \widehat{lopg}^i_{w,t} \tag{2.35}$$

where $\pi^i_{k,t}$ and $\pi^i_{w,t}$ are imported inflation rates from the prices of goods produced in country k and the RoW, respectively.

Finally, from equation (2.8), CPI inflation, $\widehat{\pi}^i_t$, is a combination of domestic and imported inflation from country k and the rest of the world, such that:

$$\widehat{\pi}^i_t = (1 - a^i_1 - a^i_2)\widehat{\pi}^i_{i,t} + a^i_1 \widehat{\pi}^i_{k,t} + a^i_2 \widehat{\pi}^i_{w,t} \tag{2.36}$$

2.2.4. Monetary regimes

2.2.4.1. Independent managed floating regime

Empirically, it is well known that most of the monetary authorities in the ASEAN area target their exchange rates in pursuing their monetary policies. We follow Monacelli (2004) which shows that a positive coefficient associated with the exchange rate variation in the policy rule can be used to model a managed floating regime. Each country $i \in \{H, RoR\}$ has its national policy and the monetary authorities practice a managed floating regime according to the following augmented Taylor-type rule:

$$\log\left(\frac{R^i_t}{R^i}\right) = \beta^i_0 \log\left(\frac{R^i_{t-1}}{R^i}\right) + (1-\beta^i_0)E_t\Bigg[\beta^i_1 \log\left(\frac{\pi^i_{t+1}}{\pi^i}\right) + \beta^i_2 \log\left(\frac{Y^i_t}{Y^i}\right) + \beta^i_3 \log\left(\frac{\Delta S^i_{t+1}}{\Delta S^i}\right)\Bigg] + e_{r,t} \tag{2.37}$$

with $e_{r,t} \sim i.i.d.(0, \sigma^2_{e_r})$; R^i, π^i, Y^i and ΔS^i are the steady-state values of R^i_t, π^i_t, Y^i_t and ΔS^i_t ; β^i_1, β^i_2, β^i_3 are the coefficients that measure central bank responses to expected inflation, output deviation from its steady state and expected NEER variations (ΔS^i_t). $0 < \beta^i_0 < 1$ is the interest rate smoothing parameter.

2.2.4.2. Monetary union

We assume that when countries decide to form a monetary union, they would opt for flexible exchange rate. Therefore, the common central bank sets the nominal interest rate according to the following Taylor-type interest rate rule:

$$\log\left(\frac{R_t}{R}\right) = \beta_0 \log\left(\frac{R_{t-1}}{R}\right) + (1-\beta_0)E_t\left[\beta_1 \log\left(\frac{\pi^{um}_{t+1}}{\pi^{um}}\right) + \beta_2 \log\left(\frac{Y^{um}_t}{Y^{um}}\right)\right] + e_{r,t} \quad (2.38)$$

with $e_{r,t} \sim i.i.d.(0, \sigma^2_{e_r})$; R, π^{um} and Y^{um} are the steady-state values of R_t, π^{um}_t and Y^{um}_t, that are, respectively, the nominal interest rate, the inflation rate and output of the union. The variables π^{um}_t and Y^{um}_t are the average values of inflation and output of the two equal-size countries:

$$\pi^{um}_t = \frac{1}{2}(\pi^h_t + \pi^f_t) \quad \text{and} \quad Y^{um}_t = \frac{1}{2}(Y^h_t + Y^f_t) \quad (2.39)$$

$\beta_1 > 1$ and $\beta_2 < 1$ are coefficients that measure central bank responses to expected inflation and output deviation from its steady state. The parameter $0 < \beta_0 < 1$ captures the degree of interest rate smoothing.

2.2.5. Government

In this model, we abstract from public debt and assume that the government finances its expenditures in purchases of aggregate public goods G^i_t through lump-sum taxes, such that:

$$P^i_t G^i_t = \tau^i_t \quad (2.40)$$

Public spending is fully exogenous and follows the autoregressive process:

$$\log(G^i_t) = \rho_g \log(G^i_{t-1}) + e_{g,t} \quad (2.41)$$

where $e_{g,t} \sim i.i.d.(0, \sigma^2_{e_g})$

2.2.6. General equilibrium conditions

In equilibrium, the factor markets, the final goods market and the balance of payments must clear in each country $i \in \{H, RoR\}$.
Equilibrium in factor markets requires:

$$N_t^i = \int_0^i N_t^i(j)dj \quad \text{and} \quad K_t^i = \int_0^i K_t^i(j)dj \tag{2.42}$$

Let $Y_t^i \equiv \left(\int_0^i Y_t^i(j)^{\frac{\chi}{\chi-1}} d_j \right)^{\frac{\chi}{\chi-1}}$ be aggregate output. Thus, the goods market clearing condition satisfies:

$$Y_t^i = C_{i,t}^i + I_{i,t}^i + G_{i,t}^i + EX_t^i \tag{2.43}$$

where $EX_t^i = a_1^i \left(\frac{P_{i,t}^i}{S_{1,t}^i P_t^k} \right)^{-\theta} AB_t^k + a_2^i \left(\frac{P_{i,t}^i}{S_{2,t}^i P_t^w} \right)^{-\theta} AB_t^w$. The variable EX_t^i represents total exports and AB_t^i (with $i \in \{k, w\}$) stands for absorption.
AB_t^i, AB_t^k and AB_t^w are, respectively, absorption for economy i, country k and the RoW such that,

$$AB_t^i = C_t^i + I_t^i + G_t^i \tag{2.44}$$

$$AB_t^k = C_t^k + I_t^k + G_t^k \tag{2.45}$$

and AB_t^w is an exogenous process. Then the domestic economy's aggregate resource constraint can be rewritten as:

$$Y_t^i = \left(\frac{P_{i,t}^i}{P_t^i} \right)^{-\theta} \left[(1 - a_1^i - a_2^i) AB_t^i + a_1^i \left(\frac{1}{RER_{k,t}^i} \right)^{-\theta} AB_t^k + a_2^i \left(\frac{1}{RER_{w,t}^i} \right)^{-\theta} AB_t^w \right] \tag{2.46}$$

The evolution of aggregate net foreign assets can be expressed for each country as:

$$S_{2,t}^i R_{w,t-1} \Psi_{d,t-1}^i \left(d_{t-1}^i, Z_{t-1}^i \right) D_{t-1}^i = S_{2,t}^i D_t^i + EX_t^i - \left(IM_{k,t}^i + IM_{w,t}^i \right) \tag{2.47}$$

where $IM_{k,t}^i$ and $IM_{w,t}^i$ are imports of country i originating from country k and from the RoW, respectively. The expression of the evolution of the total real NFA position in percentage of steady-state output is:

$$S^i_{2,t}R_{w,t-1}\Psi^i_{d,t-1}\frac{S^i_{2,t}}{\pi^i_t S^i_{2,t-1}}d^i_{t-1} = d^i_t + \frac{1}{Y}\left(\frac{P^i_{i,t}}{P^i_t}Y^i_t - C^i_t - I^i_t - G^i_t\right) \tag{2.48}$$

$\forall\ i,k \in \{H, RoR\}$ and $i \neq k$

2.2.7. Rest of the world

We assume that the RoW is fully exogenous and its variables follow an autoregressive process such that:

$$\log(AB^w_t) = \rho_{ABw}\log(AB^w_{t-1}) + e_{ABw,t} \tag{2.49}$$

$$\log(R_{w,t}) = \rho_{Rw}\log(R_{w,t-1}) + e_{rw,t} \tag{2.50}$$

$$\log(\pi_{w,t}) = \rho_{\pi w}\log(\pi_{w,t-1}) + e_{\pi w,t} \tag{2.51}$$

where $\rho_x \in [0,1]$ with $x = ABw$, Rw and πw are the coefficients of the autoregressive process and $e_{x,t} \sim i.i.d.(0, \sigma_{e^2_x})$ are the associated exogenous shocks.

2.3. Calibration of the model and results

We now solve the log-linearized version of the model around the steady state in order to perform the impulse response and welfare analyses [12].

2.3.1. Calibration

The calibration of the model is summarized in Table 2.2 below. For each country $i \in \{H, RoR\}$, some parameters are taken from the literature on the emerging market economies (henceforth EME) and others are calculated using data from Asian Development Bank (ADB) databases.

12. The linearized version of the model and the steady-state conditions are available in Appendix B.

Table 2.2 – Parameter calibration

Description	Parameter	Value	References
Preferences			
Subjective discount factor	β	0.99	Literature on EME
Inverse of Frisch elasticity of labour supply	η	1	Christiano and al. (1997) Devereux and al. (2006)
Inverse of intertemporal elasticity of substiution in consumption	σ	2	Backus and al. (1994)
Share of imported goods from the rest of the region	a_1^i	0.10	ADB database
Share of imported goods from the rest of the world	a_2^i	0.27	ADB database
Elasticity of substitution between domestic and imported goods	θ	1.4	Cook (2004)
Elasticity of the risk premium with respect to NFA position	ψ_d^i	0.0007	Schmitt-Grohé and Uribe (2003)
Technology			
Capital contribution to the production function	α	0.35	Choi and Cook (2004)
Capital depreciation rate	δ	0.025	Cook (2004), Choi and Cook (2004)
Internal adjustment cost parameter	ψ_I	0.25	Bernanke and al. (1999)
Probability of not adjusting prices	ϕ^i	0.75	Gertler and al. (2007)
Steady-state markup	$\chi/(\chi$- 1)	1.1	Literature on EME
Financial frictions parameters			
Steady-state value of capital to net worth ratio	K^i/NW^i	3	Devereux and al. (2006)
Steady-state quartely risk spread	$R_K^i - R^i$	0.02	Elekdag and Tchakarov (2007), Devereux and al. (2006)
Elasticity of the external finance premium with respect to the firm's leverage ratio	γ	1	Literature on EME
Entrepreneurs' probability of leaving the economy	(1 - v)	0.0272	Bernanke and al.(1999)
Macroeconomic Ratios			
Consumption/GDP ratio	C^i/Y^i	0.57	ADB database
Public expenditures/GDP ratio	G^i/Y^i	0.11	ADB database
Monetary policy			
Smoothing coefficient in the monetary rule	β_0^i	0.5	Literature on EME
Inflation stabilizing coefficient in te monetary rule	β_1^i	2	Gertler and al. (2007)
Output stabilizing coefficient in te monetary rule	β_2^i	0.8	Literature on EME
NEER targeting coefficient in te monetary rule	β_3^i	0.7	Literature on EME
Persistence of shocks			
Autocorrelation of technology shock	ρ_A	0.7	
Autocorrelation of foreign demand shock	ρ_{ABw}	0.6	

2.3.2. Comparison of exchange rate regimes

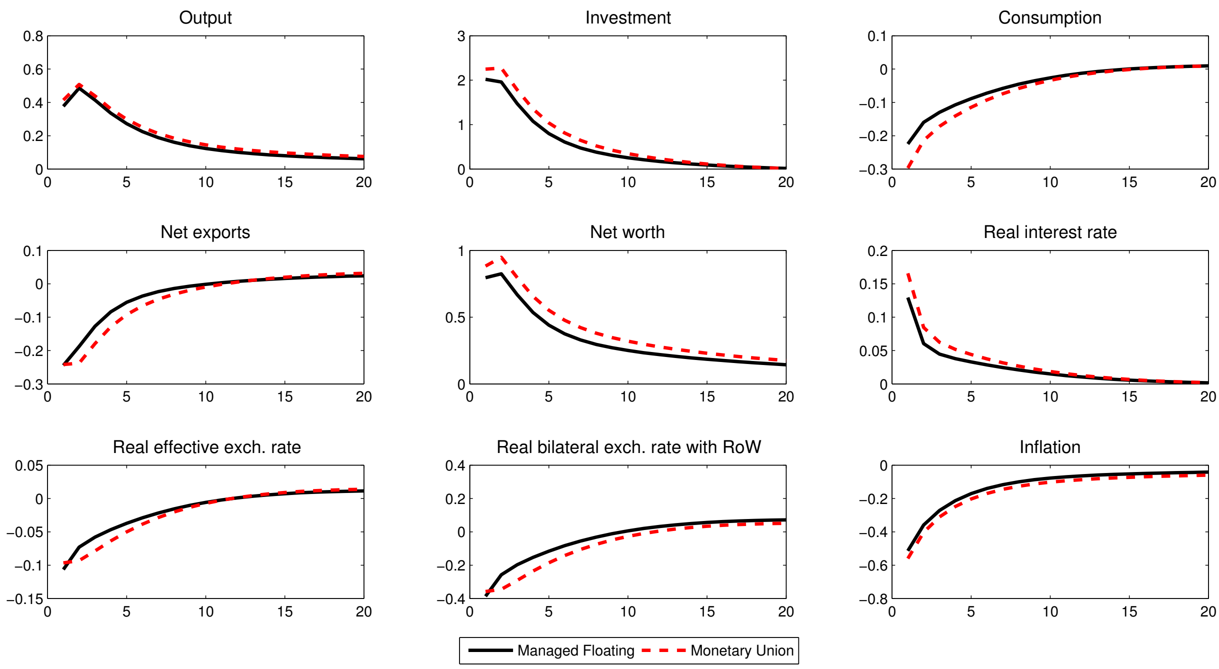
As indicated in the introduction, the current exchange rate policies in Southeast Asia are characterized by a trend in managing currencies against their own trade-weighted currency baskets. Indeed, the ASEAN-5 countries (except Philippines) target the baskets of currencies based on their own, rather than common, trade weights.

In this section, we focus on the following framework: under the assumption that a monetary union has been built in the ASEAN-5, the question is whether participating countries are better off in this union if an economic shock occurs compared to the managed floating regime. First, we evaluate the dynamics of the two versions of the model under symmetric (supply/demand) shocks (which is theoretically considered as one of the preconditions for forming a monetary union), and later we perform a welfare comparison across the two exchange rate policies [13].

2.3.2.1. Supply shock

Figure 2.2 displays the dynamics of the main variables of a country in response to a one-standard deviation positive productivity shock, under the two regimes (monetary union and managed floating).

Figure 2.2 – Effects of a positive productivity shock on the home country



13. The two versions of the model are defined by the monetary regimes to be compared: the model with independent managed floating regime and the one with a single currency.

A persistent growth in factor productivity would lead to a rise in investment and output. The hump-shaped pattern of output is generated by the real and nominal rigidities in the model. This shock induces a decrease in marginal cost and inflation. Under both regimes, the central bank revises downwards the nominal interest rates for stabilizing the expected inflation. But this decline is less than the fall in inflation, leading to higher real interest rates. As a result, a decline in consumption and an appreciation of the current real effective exchange rate (REER) and bilateral real exchange rate (with respect to the RoW) are observed. The REER appreciation reduces net exports. The appreciation of the bilateral real exchange rate increases the net worth (because the current value of the foreign currency denominated debt decreases) and that is favourable to investment. Moreover, the share of investment purchased abroad is cheaper in domestic currency, which boosts investment a little more. These effects of increasing investment are adding to its initial rise due to the growth in productivity.

The reactions of monetary authorities introduce a difference between the two monetary regimes. Indeed, the monetary union's central bank does not react to changes in the NEER, because we assume that if countries decide to form a monetary union, the union would opt for a floating exchange rate. In the wake of the productivity shock, the appreciation pressure of the exchange rate leads the central bank to lower the nominal interest rate in the managed float, while the latter remains unchanged in the monetary union under such a pressure (an initial drop in interest rates being caused by the decrease in inflation). Inflation falls (consequently, the real interest rate rises) more under the currency union than under the managed floating regime. This relative increase in the real interest rate under the monetary union implies the largest decline in consumption, the lesser appreciation of REER/bilateral real exchange rate (since the fall in inflation is more marked under the monetary union) at the impact of the shock, and the greatest increase in net worth, investment and output. Finally, the impulse responses of different variables show that (domestic supply) shock effects are higher under the currency union regime than those under the managed floating regime. Nonetheless, the responses of output under the two regimes are similar.

2.3.2.2. Demand shock

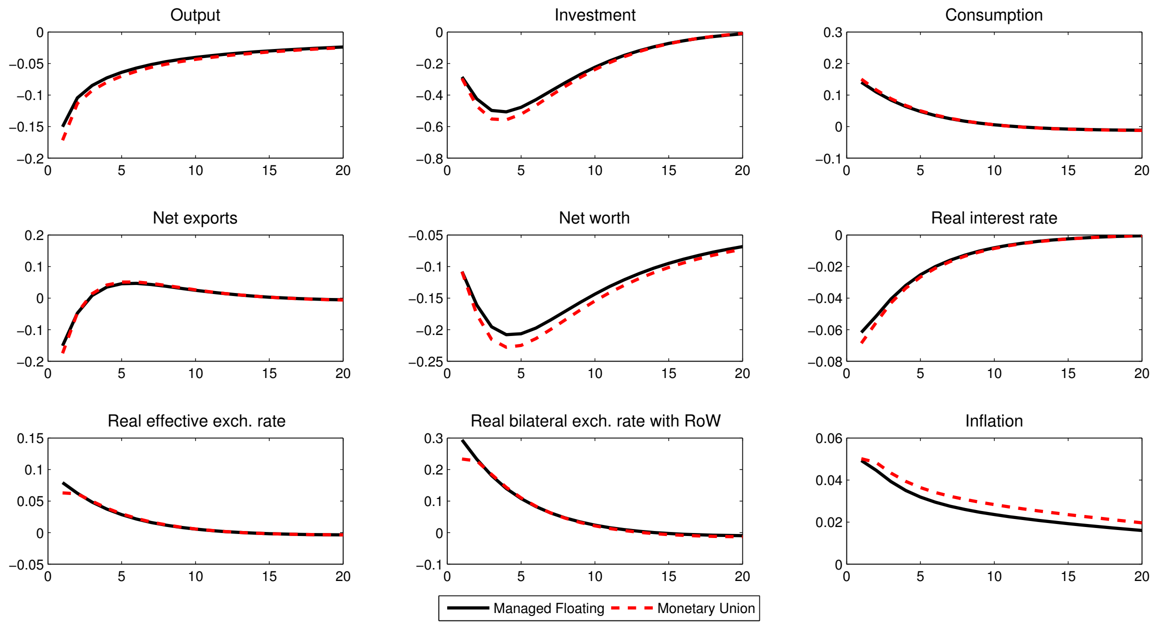
In the presence of foreign-currency denominated debt, the analysis of external shocks is very informative. The foreign demand shock is chosen because of its much more destabilizing effects on the Southeast Asia countries.

Under the two monetary regimes (monetary union and managed floating), the dynamics of main variables in response to a one standard deviation fall in current exports are depicted in Figure 2.3. The shock induces the adverse effects on both investment and output. The entrepreneurial demand for borrowing declines and this leads to a lower real interest rate. In addition, to cope with contractionary effects of the shock, monetary authorities decrease the nominal interest rate (all things being equal). Consequently, the current inflation rate increases, the real interest rate goes down and this leads to the rise in consumption. Through the uncovered interest rate parity, the bilateral real exchange rate (with respect to the RoW) depreciates and therefore the REER depreciates. The real depreciation with respect to the RoW increases the cost of investment purchased abroad and decrease the entrepreneurial net worth (since the debt value increases in local currency). These currency depreciations increase the risk premium, which is unfavourable to investment.

Comparing the managed exchange rate regime and the monetary union, we can note that the first regime provides slightly more stability than the latter. Indeed, given the contraction in foreign demand and the relative low level of expected inflation, the central bank must lower less its nominal interest rate under the managed exchange rate regime because of the current and expected depreciation pressure. Therefore, the current inflation goes up more under the monetary union than under the managed floating. As a result, under the latter regime the decrease in real interest rate is limited and, the bilateral and effective real exchange rates are more depreciated. Finally, net exports and output decrease a little more under the monetary union. This shows that the monetary union is slightly less desirable than the managed exchange rate regime facing a negative foreign demand shock.

In general the quantitative difference among the two regimes is negligible.

Figure 2.3 – Effects of a negative foreign demand shock on the home country



2.3.2.3. Welfare comparison

To obtain a robust ranking among exchange rate arrangements, the welfare cost comparison is relevant. Following Lucas (1987), we use a measure of the welfare costs in terms of business cycles given by the fraction of steady state consumption that households would be willing to give up in order to negate the effect of the shocks, i.e. to be indifferent between a constant sequence of consumption and working hours and the stochastic sequences of the same variables under the monetary regime considered. Formally:

$$U\Big((1+u)C, N\Big) = E\Big(U(C_t, N_t)\Big) \tag{2.52}$$

A second-order Taylor approximation of the unconditional expectation of utility function around the steady state yields:

$$E\Big(U(C_t, N_t)\Big) = U(C, N) + C^{1-\sigma}E(\widehat{C}_t) - \frac{1}{2}\sigma C^{1-\sigma}var(\widehat{C}_t) - N^{1+\eta}E(\widehat{N}_t) - \frac{1}{2}\eta C^{1+\eta}var(\widehat{N}_t) \tag{2.53}$$

The welfare metric then has two components: a part that measures the effect of the shocks on the variances of the variables (u^{var}) and a part that captures the effect of uncertainty on the means of these variables (u^{m}), such as:

$$U\Big((1+u^{m})C,N\Big) = U(C,N) + C^{1-\sigma}E(\widehat{C}_t) - N^{1+\eta}E(\widehat{N}_t) \tag{2.54}$$

$$U\Big((1+u^{var})C,N\Big) = U(C,N) - \frac{1}{2}\sigma C^{1-\sigma}var(\widehat{C}_t) - \frac{1}{2}\eta N^{1+\eta}var(\widehat{N}_t) \tag{2.55}$$

From (54-55), u^{m} and u^{var} can be found, respectively:

$$u^{m} = \left[1 + (1-\sigma)E(\widehat{C}_t) - \frac{(1-\sigma)N^{1+\eta}}{C^{1-\sigma}}E(\widehat{N}_t)\right]^{\frac{1}{1-\sigma}} - 1 \tag{2.56}$$

$$u^{var} = \left[1 - \frac{1}{2}\sigma(1-\sigma)var(\widehat{C}_t) - \frac{1}{2}\eta\frac{(1-\sigma)N^{1+\eta}}{C^{1-\sigma}}var(\widehat{N}_t)\right]^{\frac{1}{1-\sigma}} - 1 \tag{2.57}$$

The total welfare cost values reported in Table 2.3 are obtained by adding u^{m} to u^{var}. Table 2.3 presents the welfare cost of shocks under alternative regimes. Indeed, despite the fact that the difference among the two regimes is small, the monetary union is slightly better in terms of welfare than the managed float in the face of a domestic productivity shock, whereas the latter regime is slightly more desirable in the presence of a foreign demand shock. Note that, in the two cases the managed floating outperforms the currency union with respect to the economy stabilization which is a goal of the central bank. These findings are in line with those previously shown in the impulse response analysis.

Table 2.3 – Welfare costs (in percentage of steady-state consumption) across different monetary regimes

Types of shocks	**Monetary Union**	**Managed Float**
Productivity shock	-0.26	-0.27
Foreign demand shock	-0.09	-0.08

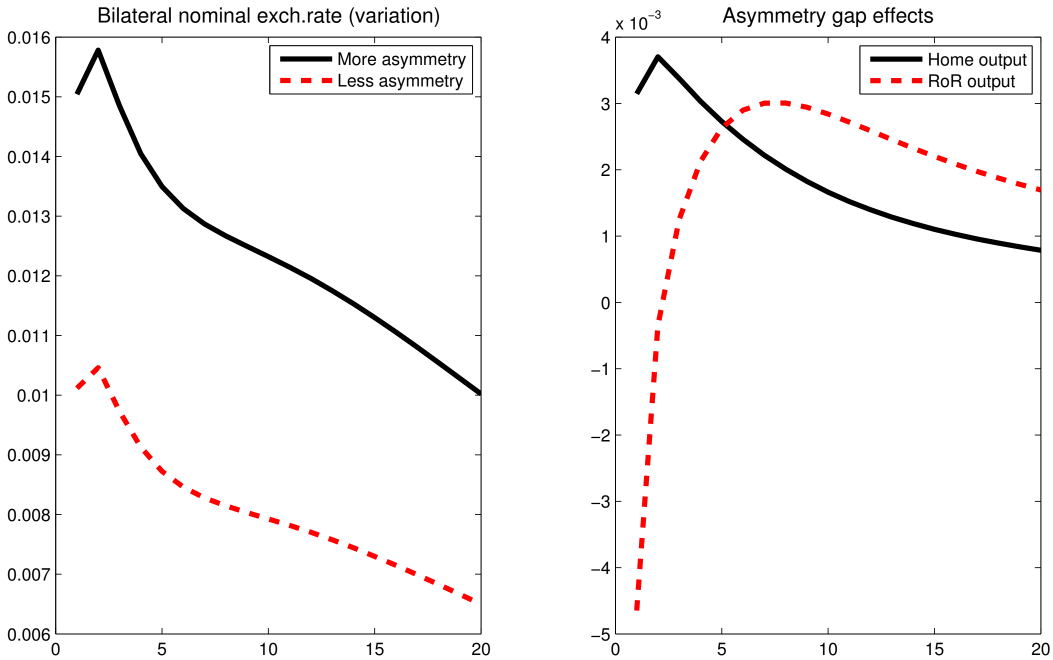
2.3.3. Asymmetry in exchange rate policies and "de facto" monetary cooperation

Managing the NEER is "de facto" exchange rate policy of the major countries of the ASEAN. Rajan (2012) finds that the coefficients associated with the nominal effective exchange rate in targeting rules differ among countries that practice this policy. In a sensitivity analysis framework, we introduce an asymmetry in the targeting degree (coefficient) of the NEER.
There are countries that exhibit more "fear of floating" (high β_3^i) than others (low β_3^i). β_3^i is then the preference parameter for exchange rate stabilization. In a two-country model framework, the countries of the region are gathered into two groups: one group (home country) for which the parameter associated with the NEER target is high and the second (RoR) for which this parameter is low. The gap between these two parameters measures the degree of asymmetry in the NEER targeting framework.
Considering more (less, respectively) asymmetry between the two countries in terms of exchange rate targeting, we calibrate $\beta_3^H = 0.7$ and $\beta_3^{RoR} = 0.001$ ($\beta_3^H = 0.7$ and $\beta_3^{RoR} = 0.2$, respectively) [13].
Figure 2.4 shows the effect of a symmetric and positive productivity shock on domestic (and RoR) output and the intra-regional bilateral nominal exchange rate. The domestic bilateral exchange rate relatively depreciates with respect to the previous period because the nominal interest rate of RoR drops more than that of the domestic country (via the UIP with perfect mobility of capital between the two countries). Indeed, the domestic central bank reacts to the expected appreciation of the NEER following a productivity shock less than that of the RoR, because of the relative high level of output caused by the most stability for the NEER in the home country. The graph shows that less asymmetry in the NEER target causes less depreciation of the bilateral nominal exchange rate, therefore this latter stabilizes in accordance to our first intuition. Indeed, the less asymmetry there is, the more the bilateral exchange rate is stabilized.
The gap between the effects of more and less asymmetry on home (or RoR) output is plotted on the right side of Figure 2.4. Let's define the effect of an asymmetry gap, which is the difference between the effects of the shock on output under a scenario with more asymmetry and the same effects under the one with less asymmetry. In other words, the asymmetry gap effect is mea-

13. The value of β_3^H is calibrated on the average of the literature on EME, whereas β_3^{RoR} values vary depending on the needs of the robustness analysis.

sured by the difference between allocation levels obtained when the values of β_3^H and β_3^{RoR} are distant and those obtained when β_3^H is too close to β_3^{RoR}. The finding is that more asymmetry is favourable to the home country (the positive gap between the output levels under the two degrees of asymmetry), because of its higher degree of the NEER stabilization (and thus its higher degree of the bilateral nominal exchange rate stabilization). The asymmetry gap effect on the RoR output is directly negative after the shock and becomes afterwards positive. This means that less asymmetry is favourable to the RoR output in the short term, but this effect tends to be reversed in the long term since the output returns more quickly to the steady state following the dynamic of the bilateral nominal exchange rate (in particular, the speed of return to the equilibrium).

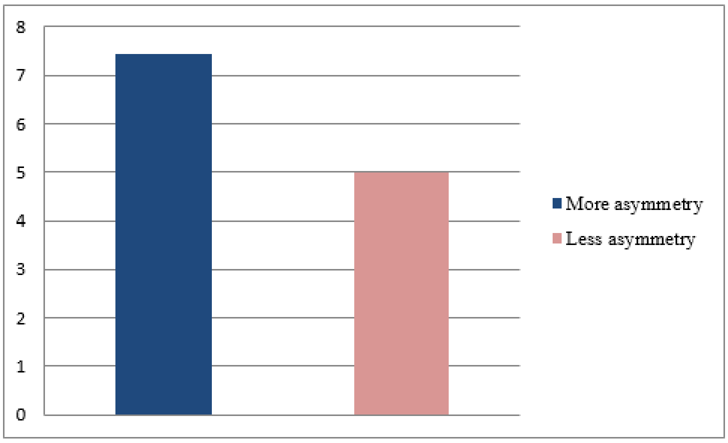
Figure 2.4 – Effect of a positive productivity shock on the home/RoR output and bilateral nominal exchange rate under different degrees of asymmetry



One can observe in Figure 2.5 that when the asymmetry in the NEER management is reduced by 28.43% in terms of variation [14], the volatility of the bilateral nominal exchange rate between the home country and the RoR decreases by 33.10% [15] (in the case of a productivity shock) [16].

14. The variation in asymmetry is calculated using the gap between the values of coefficients associated with the exchange rate target in the two countries, such as $28.43\% = 100 \times \frac{(0.7-0.001)-(0.7-0.2)}{(0.7-0.001)}$.
15. The change in the exchange rate volatility is calculated as follows $33.10\% = 100 \times \frac{(7.437991-4.976382)}{7.437991}$.
16. The volatility is measured after the simulation for 10000 periods.

Figure 2.5 – Bilateral nominal exchange rate volatility in the face of the productivity shock (in percentage)



Note: The value of the volatility (standard deviation) under more asymmetry is 7.437991, whereas that under less asymmetry is 4.976382.

Figure 2.6 displays the effect of a symmetric and negative foreign demand shock on the home/RoR output and the intra-regional bilateral nominal exchange rate. The harmful effects of shocks on economies lead the monetary authorities in both countries to first cut the nominal interest rates, and then to increase them in response to high inflation rates and expected depreciation pressure. But the magnitude of the change in interest rate is higher in the RoR than in the domestic country. Through UIP, this implies the appreciation of the bilateral nominal exchange rate between the two countries. As before, the bigger the gap between the targeting coefficients, the more the intra-regional bilateral nominal exchange rate appreciates. The gap between the output levels under the two degrees of the asymmetry (asymmetry gap effect) is plotted on the right side of Figure 2.6. It is interpreted analogously to the previous case of the productivity shock. According to Figure 2.7, a 28.43% fall in asymmetry leads to a reduction of 32.98% in the volatility of the bilateral nominal exchange rate (when a foreign demand shock occurs).

Figure 2.6 – Effect of negative foreign demand shock on the home/RoR output and bilateral nominal exchange rate under different degrees of asymmetry

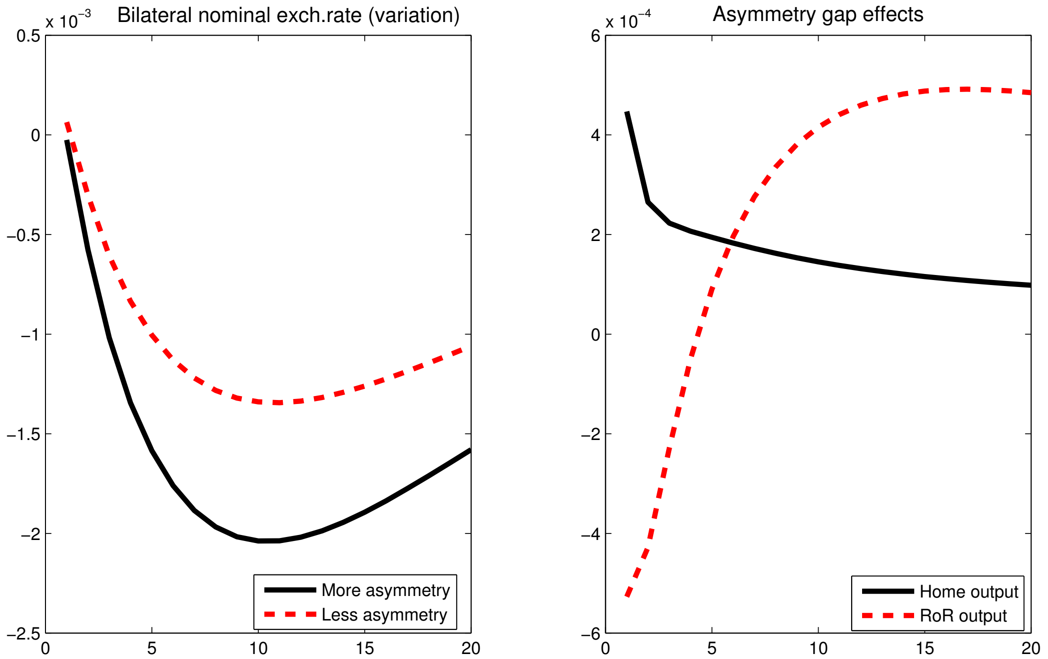
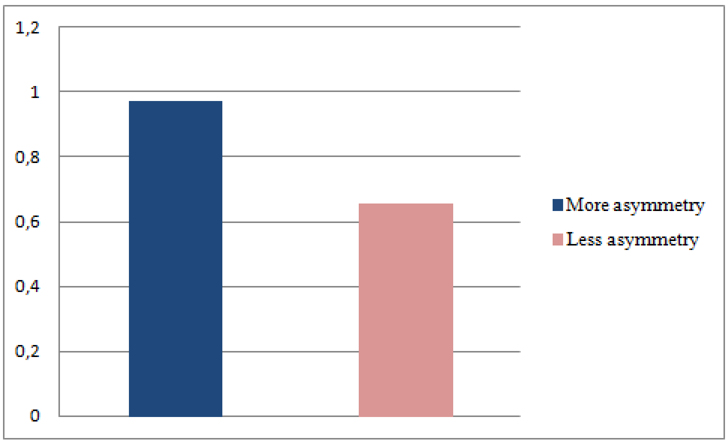


Figure 2.7 – Bilateral nominal exchange rate volatility in the face of the foreign demand shock (in percentage)



Note: The value of the volatility (standard deviation) under more asymmetry is 0,009703, whereas that under less asymmetry is 0,006566.

Notice that the degree of asymmetry in NEER targeting influences output and the bilateral nominal exchange rate between the two countries. The smaller the gap between authorities' preferences with respect to the NEER target, the more the intra-regional bilateral nominal exchange rate is stabilized. The less there is asymmetry in the degree of NEER targeting, the more the home country, which has a higher degree of NEER targeting, loses in terms of asymmetry benefit on its output (the RoR output benefits from less asymmetry in the very short term before to be reversed in the long run). The beneficial equilibrium for both countries occurs in a scenario where there is the full absence of asymmetry among the targeting coefficients. In this case, the intra-regional exchange rate could be perfectly stabilized.

Table 2.4 presents the welfare losses for the home country in the face of productivity and foreign demand shocks. The results confirm what has been said previously: the reduction of asymmetry in exchange rate policies implies a decrease in the welfare losses in the wake of shocks.

Table 2.4 – Welfare costs (Percentage of steady-state consumption) under different degrees of asymmetry in the degree of NEER targeting

Types of shocks	More Asymmetry	Less Asymmetry
Productivity shock	-0.28	-0.27
Foreign demand shock	-0.082	-0.081

Finally, when the preferences in terms of stabilization of the NEER in a region are similar, one can expect a "de facto" stability of their reciprocal bilateral nominal exchange rates. This "de facto" consistency of bilateral exchange rates is a kind of unconcerted monetary cooperation that could eventually lead to the formation of a ("de facto") currency area. The unconcerted fixity of bilateral exchange rates arises because of the absence of asymmetry between the NEER targeting degrees and the similarity among national trade-weighted currency baskets.

2.4. Conclusions

The traditional theory of the optimal currency area argued in favour of the symmetry of shocks and the structural homogeneity of countries as ideal conditions for forming a monetary union.

Based on the experience of countries of the ASEAN, this chapter shows that there exists an alternative exchange rate regime that is able to reproduce the performance of the monetary union under such ideal conditions. Indeed, the NEER targeting regime yields a result in terms of welfare similar to that provided by the monetary union, since the former regime implies, to some extent, a stability of the intra-regional exchange rates. Nevertheless, the characteristic of the shock exhibits a marginal difference between the two regimes. In this respect, faced with a foreign demand shock, the managed floating regime is slightly preferable to the currency union whereas the opposite is true in the face of a domestic productivity shock.

It is also shown in this chapter that the intra-regional exchange rate stability occurs when currencies are separately managed against their own similar trade-weighted currency baskets. This is a kind of fixity of bilateral exchange rates that could defines a “de facto” currency area.

The economic policy implication is that in a region characterized by a similarity among trade-weighted currency baskets of countries the adoption of an alternative exchange rate arrangement such as the managed floating regime can replicate the allocations under the monetary union, even outweigh the performance of the latter regime depending on the nature of shock. In this case, it would be preferable to keep the monetary independence in such a region.

The choice of ASEAN countries is just an example. These results could be generalized to others regions. In the perspective of the robustness analysis, change in degrees of intra-regional trade openness does not qualitatively modify our findings [16].

Throughout this work, the regime comparison has been conducted by assuming that if the countries under consideration decide for forming a monetary union, the resulting exchange rate would float. We can think to another scenario that consists of forming a monetary union with a managed exchange rate regime. Comparing the latter case against that of the managed floating regime at the national level (studied in this chapter) is an interesting topic of our future researches.

16. We have conducted a sensitivity analysis by increasing the value of the degree of intra-regional trade openness; our results have not been qualitatively modified.

Appendix B

B.1. Steady-state conditions

The full set of the steady-state conditions of the multi-country model is such that, $\forall\ i \in \{H, RoR\}$:

$$R^i = R_w = \frac{1}{\beta} \tag{B.1.1}$$

$$D_h^i = B^i = D^i = 0 \tag{B.1.2}$$

$$\Psi_D^i(0,0) = 1 \tag{B.1.3}$$

$$w^i = \frac{(N^i)^\eta}{(C^i)^{-\sigma}} \tag{B.1.4}$$

$$\frac{w^i}{mc^i} = (1-\alpha)\frac{Y^i}{L^i} \tag{B.1.5}$$

$$\frac{mpc^i}{mc^i} = \alpha\frac{Y^i}{N^i} \tag{B.1.6}$$

$$P^i = P_i^i = P_k^i = P_w^i \tag{B.1.7}$$

$$\pi^i = \pi_i^i = \pi_k^i = \pi_w^i = 1 \tag{B.1.8}$$

$$mc^i = \frac{(\chi - 1)}{\chi} \tag{B.1.9}$$

$$S^i = S_1^i = S_2^i = 1 \tag{B.1.10}$$

$$TOT^i = TOT_k^i = TOT_w^i = 1 \tag{B.1.11}$$

$$RER^i = RER_k^i = RER_w^i = 1 \tag{B.1.12}$$

$$LOPG^i = LOPG_k^i = LOPG_w^i = 1 \tag{B.1.13}$$

$$Y^i = A^i(N^i)^{1-\alpha}(K^i)^\alpha \tag{B.1.14}$$

$$I^i = \delta K^i \tag{B.1.15}$$

$$q^i = 1 \tag{B.1.16}$$

$$R_K^i = R_w(\frac{NW^i}{K^i})^{-\gamma} \tag{B.1.17}$$

$$R_K^i = mpc^i + (1-\delta) \tag{B.1.18}$$

$$vR_K^i = 1 \tag{B.1.19}$$

$$Y^i = C^i + I^i + G^i \tag{B.1.20}$$

$$\tag{B.1.21}$$

B.2. The log-linearized version of the model

We present the log-linearized version of the model for domestic country, H, and foreign country, RoR (i.e. the rest of the region).

B.2.1. Domestic country

The presence of both the superscript "H" and the subscript "RoR" or "w" indicates that the variable relates the rest of the region (RoR) or the world (w) to the home country (H) in terms of flows. For example, $\widehat{\pi}^H_{RoR,t}$ denotes imported inflation from the rest of the region to the home country and $\widehat{rer}^H_{w,t}$ means the bilateral real exchange rate between the home country and the rest of the world.

$$\widehat{c}^H_t = -\frac{1}{\sigma}(\widehat{r}^H_t - E_{t,}\widehat{\pi}^H_{t+1}) + E_t(\widehat{c}^H_{t+1}) \tag{B.2.22}$$

$$\widehat{rer}^H_{w,t+1} - \widehat{rer}^H_{w,t} = (\widehat{r}^H_t - E_{t,}\widehat{\pi}^H_{t+1}) - (\widehat{r}_{w,t} - E_{t,}\widehat{\pi}_{w,t+1} + \psi^H_D \widehat{d}^H_{t+1} + \widehat{z}^H_t) \tag{B.2.23}$$

$$\widehat{n}^H_t = \frac{1}{\eta}(\widehat{w}^H_t - \sigma\widehat{c}^H_t) \tag{B.2.24}$$

$$\widehat{w}^H_t = \widehat{y}^H_t + \widehat{mc}^H_t - \widehat{n}^H_t - a^H_1 \widehat{tot}^H_{RoR,t} - a^H_2 \widehat{tot}^H_{w,t} \tag{B.2.25}$$

$$\widehat{mpc}^H_t = \widehat{y}^H_t + \widehat{mc}^H_t - \widehat{k}^H_t - a^H_1 \widehat{tot}^H_{RoR,t} - a^H_2 \widehat{tot}^H_{w,t} \tag{B.2.26}$$

$$\widehat{\pi}^H_{H,t} = \beta E_t \widehat{\pi}^H_{t+1} + \frac{(1-\phi^H)(1-\beta\phi^H)}{\phi^H}\widehat{mc}^H_t \tag{B.2.27}$$

$$\widehat{\pi}^H_{RoR,t} = \beta E_t \widehat{\pi}^H_{RoR,t+1} + \frac{(1-\phi^H)(1-\beta\phi^H)}{\phi^H}\widehat{lopg}^H_{RoR,t} \tag{B.2.28}$$

$$\widehat{\pi}^H_{w,t} = \beta E_t \widehat{\pi}^H_{w,t+1} + \frac{(1-\phi^H)(1-\beta\phi^H)}{\phi^H}\widehat{lopg}^H_{w,t} \tag{B.2.29}$$

$$\widehat{\pi}^H_t = (1 - a^H_1 - a^H_2)\widehat{\pi}^H_{H,t} + a^H_1 \widehat{\pi}^H_{RoR,t} + a^H_2 \widehat{\pi}^H_{w,t} \tag{B.2.30}$$

$$\widehat{y}^H_t = \widehat{a}^H_t + \alpha\widehat{k}^H_t + (1-\alpha)\widehat{n}^H_t \tag{B.2.31}$$

$$\widehat{k}^H_{t+1} = \delta\widehat{i}^H_t + (1-\delta)\widehat{k}^H_t \tag{B.2.32}$$

$$\widehat{q}^H_t = \psi_I(\widehat{i}^H_t - \widehat{k}^H_t) \tag{B.2.33}$$

$$\begin{aligned} E_t(\widehat{r}^H_{K,t+1}) = (\widehat{r}_{w,t} - E_t\widehat{\pi}_{w,t+1}) + \psi^H_D \widehat{d}^H_t + \widehat{z}^H_t - \\ \gamma(\widehat{nw}^H_{t+1} - \widehat{q}^H_t - \widehat{k}^H_{t+1}) + \widehat{rer}^H_{w,t+1} - \widehat{rer}^H_{w,t} \end{aligned} \tag{B.2.34}$$

$$\widehat{r}^H_{K,t} = \left(\frac{mc^H}{R^H_K}\right)\widehat{mpc}^H_t + \left(\frac{1-\delta}{R^H_K}\right)\widehat{q}^H_t - \widehat{q}^H_{t-1} \tag{B.2.35}$$

$$\widehat{nw}^H_{t+1} = \upsilon\left(\frac{K^H}{NW^H}\right)\hat{r}^H_{K,t} + \left(1 - \frac{K^H}{NW^H}\right)(\hat{r}_{w,t-1} - \hat{\pi}_{w,t} + \psi^H_D \hat{d}^H_{t-1} + \hat{z}^H_{t-1} + \Delta\widehat{rer}^H_{w,t}) + \gamma\Big(1 - \frac{K^H}{NW^H}\Big)(\hat{q}^H_{t-1} + \hat{k}^H_t) + \left[1 + \gamma\left(\frac{K^H}{NW^H} - 1\right)\right]\widehat{nw}^H_t \tag{B.2.36}$$

$$\hat{y}^H_t = (1 - a^H_1 - a^H_2)\left[\frac{C^H}{Y^H}\hat{c}^H_t + \frac{I^H}{Y^H}\hat{i}^H_t + \frac{G^H}{Y^H}\hat{g}^H_t\right] + a^H_1\hat{y}^{RoR}_t + a^H_2\hat{y}^w_t + \theta\left[a^H_1\left(\widehat{rer}^H_{RoR,t} + \widehat{tot}^H_{RoR,t}\right) + a^H_2\left(\widehat{rer}^H_{w,t} + \widehat{tot}^H_{w,t}\right)\right] \tag{B.2.37}$$

$$\widehat{rer}^H_{RoR,t} = \widehat{rer}^H_{RoR,t-1} + \hat{\pi}^{RoR}_t - \hat{\pi}^H_t + \Delta\hat{S}^H_{1,t} \tag{B.2.38}$$

$$\widehat{tot}^H_{RoR,t} = \widehat{tot}^H_{RoR,t-1} + \hat{\pi}^H_{RoR,t} - \hat{\pi}^H_{H,t} \tag{B.2.39}$$

$$\widehat{tot}^H_{w,t} = \widehat{tot}^H_{w,t-1} + \hat{\pi}^H_{w,t} - \hat{\pi}^H_{H,t} \tag{B.2.40}$$

$$\widehat{lopg}^H_{RoR,t} = \Delta\hat{S}^H_{1,t} + \hat{\pi}^{RoR}_{RoR,t} - \hat{\pi}^H_{RoR,t} \tag{B.2.41}$$

$$\widehat{lopg}^H_{w,t} = \Delta\hat{S}^H_{2,t} + \hat{\pi}^w_{w,t} - \hat{\pi}^H_{w,t} \tag{B.2.42}$$

$$\widehat{rer}^H_{w,t} = \widehat{rer}^H_{w,t-1} + \hat{\pi}^w_t - \hat{\pi}^H_t + \Delta\hat{S}^H_{2,t} \tag{B.2.43}$$

$$\hat{S}^H_t = a^H_1\hat{S}^H_{1,t} + a^H_2\hat{S}^H_{2,t} \tag{B.2.44}$$

$$\frac{1}{\beta}\hat{d}^H_{t-1} = \hat{d}^H_t + \hat{y}^H_t - \frac{C^H}{Y^H}\hat{c}^H_t - \frac{I^H}{Y^H}\hat{i}^H_t - \frac{G^H}{Y^H}\hat{g}^H_t - a^H_1\widehat{tot}^H_{RoR,t} - a^H_2\widehat{tot}^H_{w,t} \tag{B.2.45}$$

$$\widehat{ab}^w_t = \rho_{ABw}\widehat{ab}^w_{t-1} + e_{ABw,t} \tag{B.2.46}$$

$$\hat{r}_{w,t} = \rho_{Rw}\hat{r}_{w,t-1} + e_{rw,t} \tag{B.2.47}$$

$$\hat{\pi}_{w,t} = \rho_{\pi w}\hat{\pi}_{w,t-1} + e_{\pi w,t} \tag{B.2.48}$$

$$\hat{z}^H_t = \rho_z\hat{z}^H_{t-1} + e_{zt} \tag{B.2.49}$$

$$\hat{g}^H_t = \rho_g\hat{g}^H_{t-1} + e_{gt} \tag{B.2.50}$$

- Monetary Union

$$\hat{r}_t = \beta_0\hat{r}_{t-1} + (1 - \beta_0)\left[\frac{\beta_1}{2}(\hat{\pi}^H_{t+1} + \hat{\pi}^{RoR}_{t+1}) + \frac{\beta_2}{2}(\hat{y}^H_t + \hat{y}^{RoR}_t)\right] + e_{r,t} \tag{B.2.51}$$

- Managed Floating

$$\hat{r}^H_t = \beta^H_0\hat{r}^H_{t-1} + (1 - \beta^H_0)\left(\beta^H_1\hat{\pi}^H_{t+1} + \beta^H_2\hat{y}^H_t + \beta_3\Delta\hat{S}^H_{t+1}\right) + e_{r,t} \tag{B.2.52}$$

$$\hat{r}^{RoR}_t = \beta^{RoR}_0\hat{r}^{RoR}_{t-1} + (1 - \beta^{RoR}_0)\left(\beta^{RoR}_1\hat{\pi}^{RoR}_{t+1} + \beta^{RoR}_2\hat{y}^{RoR}_t + \beta^{RoR}_3\Delta\hat{S}^{RoR}_{t+1}\right) + e_{r,t} \tag{B.2.53}$$

B.2.2. The rest of the region

The foreign country corresponds to the rest of the region (RoR).

$$\widehat{c}_t^{RoR} = -\frac{1}{\sigma}(\widehat{r}_t^{RoR} - E_{t,}\widehat{\pi}_{t+1}^{RoR}) + E_t(\widehat{c}_{t+1}^{RoR}) \tag{B.2.54}$$

$$\widehat{rer}_{w,t+1}^{RoR} - \widehat{rer}_{w,t}^{RoR} = (\widehat{r}_t^{RoR} - E_{t,}\widehat{\pi}_{t+1}^{RoR}) - (\widehat{r}_{w,t} - E_{t,}\widehat{\pi}_{w,t+1} + \psi_D^{RoR}\widehat{d}_{t+1}^{RoR} + \widehat{z}_t^{RoR}) \tag{B.2.55}$$

$$\widehat{n}_t^{RoR} = \frac{1}{\eta}(\widehat{w}_t^{RoR} - \sigma\widehat{c}_t^{RoR}) \tag{B.2.56}$$

$$\widehat{w}_t^{RoR} = \widehat{y}_t^{RoR} + \widehat{mc}_t^{RoR} - \widehat{n}_t^{RoR} - a_1^{RoR}\widehat{tot}_{H,t}^{RoR} - a_2^{RoR}\widehat{tot}_{w,t}^{RoR} \tag{B.2.57}$$

$$\widehat{mpc}_t^{RoR} = \widehat{y}_t^{RoR} + \widehat{mc}_t^{RoR} - \widehat{k}_t^{RoR} - a_1^{RoR}\widehat{tot}_{H,t}^{RoR} - a_2^{RoR}\widehat{tot}_{w,t}^{RoR} \tag{B.2.58}$$

$$\widehat{\pi}_{RoR,t}^{RoR} = \beta E_t\widehat{\pi}_{t+1}^{RoR} + \frac{(1-\phi^{RoR})(1-\beta\phi^{RoR})}{\phi^{RoR}}\widehat{mc}_t^{RoR} \tag{B.2.59}$$

$$\widehat{\pi}_{H,t}^{RoR} = \beta E_t\widehat{\pi}_{H,t+1}^{RoR} + \frac{(1-\phi^{RoR})(1-\beta\phi^{RoR})}{\phi^{RoR}}\widehat{lopg}_{H,t}^{RoR} \tag{B.2.60}$$

$$\widehat{\pi}_{w,t}^{RoR} = \beta E_t\widehat{\pi}_{w,t+1}^{RoR} + \frac{(1-\phi^{RoR})(1-\beta\phi^{RoR})}{\phi^{RoR}}\widehat{lopg}_{w,t}^{RoR} \tag{B.2.61}$$

$$\widehat{\pi}_t^{RoR} = (1 - a_1^{RoR} - a_2^{RoR})\widehat{\pi}_{RoR,t}^{RoR} + a_1^{RoR}\widehat{\pi}_{H,t}^{RoR} + a_2^{RoR}\widehat{\pi}_{w,t}^{RoR} \tag{B.2.62}$$

$$\widehat{y}_t^{RoR} = \widehat{a}_t^{RoR} + \alpha\widehat{k}_t^{RoR} + (1-\alpha)\widehat{n}_t^{RoR} \tag{B.2.63}$$

$$\widehat{k}_{t+1}^{RoR} = \delta\widehat{i}_t^{RoR} + (1-\delta)\widehat{k}_t^{RoR} \tag{B.2.64}$$

$$\widehat{q}_t^{RoR} = \psi_I(\widehat{i}_t^{RoR} - \widehat{k}_t^{RoR}) \tag{B.2.65}$$

$$\begin{aligned} E_t(\widehat{r}_{K,t+1}^{RoR}) = (\widehat{r}_{w,t} - E_t\widehat{\pi}_{w,t+1}) + \psi_D^{RoR}\widehat{d}_t^{RoR} + \widehat{z}_t^{RoR} - \\ \gamma(\widehat{nw}_{t+1}^{RoR} - \widehat{q}_t^{RoR} - \widehat{k}_{t+1}^{RoR}) + \widehat{rer}_{w,t+1}^{RoR} - \widehat{rer}_{w,t}^{RoR} \end{aligned} \tag{B.2.66}$$

$$\widehat{r}_{K,t}^{RoR} = \left(\frac{mc^{RoR}}{R_K^{RoR}}\right)\widehat{mpc}_t^{RoR} + \left(\frac{1-\delta}{R_K^{RoR}}\right)\widehat{q}_t^{RoR} - \widehat{q}_{t-1}^{RoR} \tag{B.2.67}$$

$$\begin{aligned} \widehat{nw}_{t+1}^{RoR} = v\left(\frac{K^{RoR}}{NW^{RoR}}\right)\widehat{r}_{K,t}^{RoR} + \left(1 - \frac{K^{RoR}}{NW^{RoR}}\right)(\widehat{r}_{w,t-1} - \widehat{\pi}_{w,t} + \psi_D^{RoR}\widehat{d}_{t-1}^{RoR} + \widehat{z}_{t-1}^{RoR} + \\ \Delta\widehat{rer}_{w,t}^{RoR}) + \gamma\left(1 - \frac{K^{RoR}}{NW^{RoR}}\right)(\widehat{q}_{t-1}^{RoR} + \widehat{k}_t^{RoR}) + \left[1 + \gamma\left(\frac{K^{RoR}}{NW^{RoR}} - 1\right)\right]\widehat{nw}_t^{RoR} \end{aligned} \tag{B.2.68}$$

$$\begin{aligned} \widehat{y}_t^{RoR} = (1 - a_1^{RoR} - a_2^{RoR})\left[\frac{C^{RoR}}{Y^{RoR}}\widehat{c}_t^{RoR} + \frac{I^{RoR}}{Y^{RoR}}\widehat{i}_t^{RoR} + \frac{G^{RoR}}{Y^{RoR}}\widehat{g}_t^{RoR}\right] + a_1^{RoR}\widehat{y}_t^{H} + \\ a_2^{RoR}\widehat{y}_t^{w} + \theta\left[a_1^{RoR}\left(\widehat{rer}_{H,t}^{RoR} + \widehat{tot}_{H,t}^{RoR}\right) + a_2^{RoR}\left(\widehat{rer}_{w,t}^{RoR} + \widehat{tot}_{w,t}^{RoR}\right)\right] \end{aligned} \tag{B.2.69}$$

$$\widehat{rer}_{H,t}^{RoR} = \widehat{rer}_{H,t-1}^{RoR} + \widehat{\pi}_t^{H} - \widehat{\pi}_t^{RoR} + \Delta\widehat{S}_{1,t}^{RoR} \tag{B.2.70}$$

$$\widehat{tot}_{H,t}^{RoR} = \widehat{tot}_{H,t-1}^{RoR} + \widehat{\pi}_{H,t}^{RoR} - \widehat{\pi}_{RoR,t}^{RoR} \tag{B.2.71}$$

$$\widehat{tot}_{w,t}^{RoR} = \widehat{tot}_{w,t-1}^{RoR} + \widehat{\pi}_{w,t}^{RoR} - \widehat{\pi}_{RoR,t}^{RoR} \tag{B.2.72}$$

$$\widehat{lopg}_{H,t}^{RoR} = \Delta\widehat{S}_{1,t}^{RoR} + \widehat{\pi}_{H,t}^{H} - \widehat{\pi}_{H,t}^{RoR} \tag{B.2.73}$$

$$\widehat{lopg}_{w,t}^{RoR} = \Delta\widehat{S}_{2,t}^{RoR} + \widehat{\pi}_{w,t}^{w} - \widehat{\pi}_{w,t}^{RoR} \tag{B.2.74}$$

$$\widehat{rer}_{w,t}^{RoR} = \widehat{rer}_{w,t-1}^{RoR} + \widehat{\pi}_t^{w} - \widehat{\pi}_t^{RoR} + \Delta\widehat{S}_{2,t}^{RoR} \tag{B.2.75}$$

$$\widehat{S}_t^{RoR} = a_1^{RoR}\widehat{S}_{1,t}^{RoR} + a_2^{RoR}\widehat{S}_{2,t}^{RoR} \tag{B.2.76}$$

$$\begin{aligned}\frac{1}{\beta}\widehat{d}_{t-1}^{RoR} = \widehat{d}_t^{RoR} + \widehat{y}_t^{RoR} - \frac{C^{RoR}}{Y^{RoR}}\widehat{c}_t^{RoR} - \frac{I^{RoR}}{Y^{RoR}}\widehat{i}_t^{RoR} - \\ \frac{G^{RoR}}{Y^{RoR}}\widehat{g}_t^{RoR} - a_1^{RoR}\widehat{tot}_{H,t}^{RoR} - a_2^{RoR}\widehat{tot}_{w,t}^{RoR}\end{aligned} \tag{B.2.77}$$

$$\widehat{z}_t^{RoR} = \rho_z \widehat{z}_{t-1}^{RoR} + e_{zt} \tag{B.2.78}$$

$$\widehat{g}_t^{RoR} = \rho_g \widehat{g}_{t-1}^{RoR} + e_{gt} \tag{B.2.79}$$

$$\tag{B.2.80}$$

PART II EXCHANGE RATE REGIMES AND MONETARY INTEGRATION IN A LIQUIDITY TRAP

This part of the thesis investigates the choice of exchange rate regimes and monetary integration in a liquidity trap. It consists of two essays. The first essay (chapter 3) compares the welfare-performances of three alternative exchange rates using several versions of a two-country two-sector DSGE model. The second essay completes the latter by investigating empirically and theoretically the implications of the size of currency misalignments for the exchange rate policy and monetary integration in a liquidity trap.

Chapter 3

Exchange rate regimes in a liquidity trap

CHAPTER 3 - EXCHANGE RATE REGIMES IN A LIQUIDITY TRAP

3.1. Introduction

One of the main features of recent crises in developed counties (such as the United States, Euro Area, United Kingdom and Japan), is that the central banks' policy interest rates are reduced to unprecedentedly low levels due to a large negative demand shock. In such a context where the nominal interest rates are constrained by the zero bound, the effectiveness of the monetary policy to stimulate the economy or respond to shocks via its standard instrument is limited. This macroeconomic situation is known as a liquidity trap.

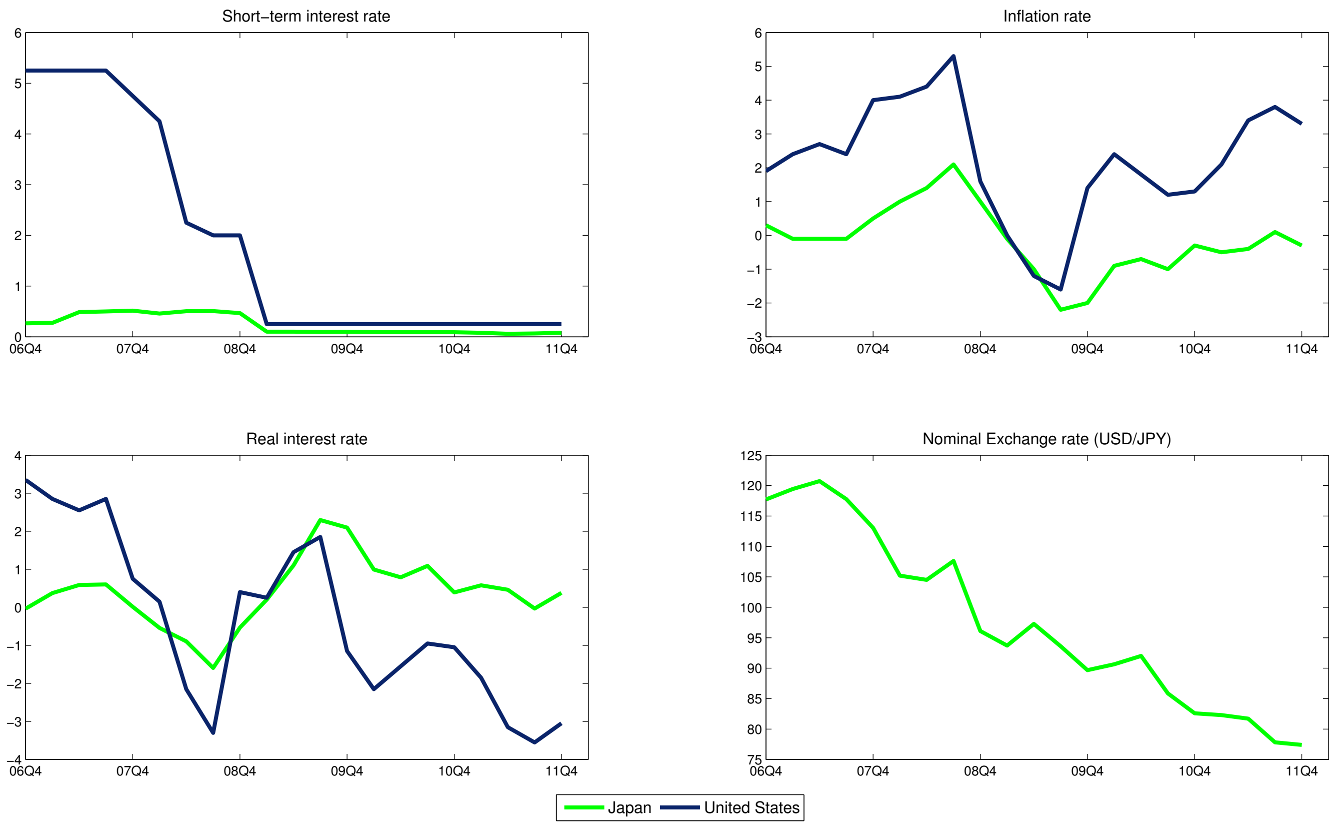
The usual conclusion of the theory of the optimum currency area is that it is advantageous for a country faced with an asymmetric shock to conduct an independent monetary policy rather than joining a monetary union (Mundell (1961), Kenen (1969)). The advantage of an independent policy comes from the possibility of interest rate cuts and currency depreciation, which dampen the adverse impact of asymmetric shocks on aggregate demand. It is by the way the reason why many commentators on the Euro area crisis have indicated that the lack of independent monetary policy is the one of the biggest obstacles to the rapid economic adjustment in southern Eurozone countries following their debt crisis, ignoring the new environment of the Zero Lower Bound (henceforth ZLB) constraint.
When countries with independent policies are hit by asymmetric recessionary shocks that constrain interest rates at their zero floors, it is unclear that currencies depreciate, still less likely that the independent monetary policy keeps its comparative advantage, because it all depends on expected future levels of some variables such as inflation and nominal interest rate. For instance, Figures 3.1 and 3.2 present some stylised facts highlighting the nominal appreciation of the Swiss franc (resp. Japanese yen) relative to Euro (resp. US dollars) during some recent episodes of the ZLB. Indeed, in 2008 the Swiss National Bank and the European Central Bank have sharply reduced their policy rates. The decline has been more pronounced for the Swiss interest rate, which reaches quickly its zero floor, than the ECB's interest rate. At the same time, the inflation rate decreased sharply in Switzerland which experienced deflation. Therefore, the Swiss real interest rate exceeded the one of the Eurozone, leading to a continuous appreciation of the Swiss franc against Euro. The similar fact has been observed for the Japanese yen against

US dollars from 2008 to 2011 (see Figure 3.2).

Figure 3.1 – Switzerland versus Eurozone

Notes: Data are sourced from OECD and Datastream. The short-term interest rates are ECB refi rate and 3 month libor for the Swiss National Bank. Inflation rates are the year on year growth rates in the CPI. The exchange rate is expressed in units of Swiss franc per one unit of Euro.

Figure 3.2 – Japan versus United States



Notes: : Data are sourced from OECD and Datastream. The short-term interest rates are US Fed fund rate and the uncollateralized overnight call money rate for the Bank of Japan. Inflation rates are the year on year growth rates in the CPI. The exchange rate is expressed in units of Yen per one unit of US Dollar.

In this chapter, we focus on this issue by addressing two interrelated questions. First, what is the desirable exchange rate regime when the liquidity trap occurs? Second, is it favourable for a country to be member of a monetary union when a deflationary shock constrains the policy rate at its zero floor? The answers to these questions could provide lessons for countries that wonder if it is suitable to belong to a monetary union (for instance, the southern Eurozone countries) in a context of liquidity trap, and those that are not concerned by the monetary union, but seek to know the exchange rate regime that could alleviate the ZLB effects.

The recent literature on the zero bound has focused on exit strategies from the liquidity trap, underlining the role of the fiscal policy, in the form of tax cuts or government spending increases, in order to stimulate the economy (Christiano et al. (2011), Eggertsson (2011), Correia et al. (2013), Erceg and Lindé (2014), among others). This standard Keynesian prescription could be effective in a liquidity trap because of the lack of crowding-out effects through high interest rates. Other analyses in the meaning of strategies to escape from a liquidity trap, which are relatively older, propose to use the channel of the currency depreciation either by a direct intervention in foreign-exchange markets (Coenen and Wieland (2003), Orphanides and Wieland (2000)) or switching to a peg with a substantially devalued exchange rate and announcing a price-level target path (Svensson (2001)). The intentional currency depreciation, recommended by these analyses, allows the economy to escape from the liquidity trap because of its direct effects on aggregate demand and inflation.

However, the role of exchange rate regimes in the mitigation of deep deflation effects, as a preventive strategy, has been neglected in the literature so far. This is our purpose in this chapter.

Instead of investigating strategies to escape from a liquidity trap, our approach should be viewed as the search for ways of insulating the economy from worst and prolonged effects of a liquidity trap. We want to know whether or not it is relevant for a country to belong to a monetary union rather than keeping its own currency when the liquidity trap occurs. The most related work to ours is Cook and Devereux (2014), who were interested in the similar question in a very stylized two-country model, but our analysis is performed with a more realistic model of two countries and two sectors. Our contributions are both theoretical and normative. From a theoretical perspective, unlike Cook and Devereux (2014), we do not assume the absence of predetermined state variables in the model [1] and our framework allows the duration of the liquidity trap to be affected endogenously by the dynamic of the exchange rate, in this way by the choice of exchange rate regime. We also extend our baseline model with complete markets and producer currency pricing by incorporating incomplete international asset market and local currency pricing assumptions. In normative terms, we provide a welfare-performance grid of exchange regimes under the ZLB constraint and with a variety of models.

As Cook and Devereux (2014), we assume that the liquidity trap is caused by an adverse preference (or negative demand) shock sufficiently large to push one or both countries into a liquidity trap. We compare exchange rate regimes in “tranquil” (i.e. normal) times and in a liquidity trap. Our welfare analysis strengthens the results based on the dynamic of the model (i.e. impulse responses).

1. For simplicity, these authors assume that there are no predetermined state variables and therefore all endogenous variables have the same persistence characteristics of the shock that generates the liquidity trap.

We find that, under complete asset markets and producer currency pricing, the traditional ranking between the independent floating regime and the monetary union regime is reversed when the nominal interest rate is constrained at zero, consistent with the results of Cook and Devereux (2014). Indeed, the monetary union outweighs the independent floating regime in dealing with shock effects under a binding zero bound, reflecting the real exchange rate depreciation that occurs under the former regime while the latter faces an appreciation of exchange rate. Consequently, we show that the independent floating prolongs the duration of the liquidity trap compared to the monetary union due to the perverse adjustment of exchange rate.

The extensions of our model taking into account a third alternative exchange rate regime and the assumptions of incomplete asset markets and local currency pricing are made. We find that the independent policy regime with a managed exchange rate is more resilient than the currency union facing a demand shock that constrains the interest rate to its zero bound.

All these findings are broadly consistent when international financial markets are incomplete and firms set their prices in the currency of destination markets (local currency pricing). The welfare and parameter sensitivity analyses are in general consistent with the results from the impulse response analysis, although the asset market structure and the elasticity of substitution between goods matter for the welfare ranking across regimes.

The remainder of the chapter is organized as follows: Section 3.2 lays out the two-sector two-country general-equilibrium model. Section 3.3 presents the calibration and solution strategy of the model. Section 3.4 analyzes the results for the baseline model in "normal" times and a liquidity trap. Section 3.5 presents the parameter sensitivity analysis using the baseline model and the results for the extended model. Section 3.6 presents the welfare comparison. Section 3.7 concludes and provides some policy implications.

3.2. A two-sector two-country model

The world economy consists of two countries of equal size: Home (H) and Foreign (F). Each economy is populated by a continuum of unit mass households with infinite life, and produces non-tradable goods and tradable goods using sector-specific labour. Monopolistic competition and sticky prices are introduced in order to address the issues of monetary policy.

Firstly, we consider a baseline model with the complete asset market structure at the international level and where the law of one price holds at the export level (producer currency pricing, henceforth PCP), which allows the perfect exchange rate pass-through. Later, we extend the model to allow for the structure of incomplete asset markets and imperfect pass-through of exchange rate (LCP, for local currency pricing). These extensions are justified by some empirical findings in the literature. For example, Rabanal and Tuesta (2010), using data for the United-States and the Eurozone, find that a model with local currency pricing and incomplete markets make a good job in explaining the real exchange rate volatility and well fits the dynamics of domestic variables . The authors point out that the complete market assumption could deliver a similar fit only when the structure of shocks is rich enough. We further introduce a third alternative exchange rate regime in the model.
Since the general setup of the foreign country is similar and symmetrical to that for the home country, this section presents the details of the model from the latter. The full set of equilibrium conditions for the foreign country is presented in Appendix C.1. Variables for the foreign country are denoted by an asterisk.

3.2.1. Households

Households derive utility from consumption (C_t) of tradable and non-tradable goods and disutility from hours worked (N_t). The representative home-household maximizes the following expected discounted sum of utilities:

$$\mho = E_t \sum_{t=0}^{\infty} \beta^t \{U_t(C_t, \varepsilon_t, N_t)\} \tag{3.1}$$

where $\mho$ is household's expected discounted sum of utilities, $U_t(C_t, \varepsilon_t, N_t)$ denotes their utility function, $0 < \beta < 1$ is the intertemporal discount factor and ε_t represents a preference (or demand) shock. A negative ε_t shock implies that agents wish to postpone consumption over time, and will thus increase their desired savings. ε_t follows a first-order autoregressive process : $\log(\varepsilon_t) = \rho_\varepsilon \log(\varepsilon_{t-1}) + e_{\varepsilon,t}, \quad \text{with} \quad e_{\varepsilon,t} \sim i.i.d.(0, \sigma_\varepsilon^2)$.

The final consumption basket is a CES aggregate of non-tradable ($C_{N,t}$) and tradable ($C_{T,t}$) goods with a constant elasticity of substitution $\nu > 0$:

$$C_t = \left[\alpha^{\frac{1}{\nu}} (C_{T,t})^{\frac{\nu-1}{\nu}} + (1-\alpha)^{\frac{1}{\nu}} (C_{N,t})^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}} \tag{3.2}$$

where $\alpha \in [0, 1]$ is the share of tradable goods in the total consumption.

The associated price index is given by:

$$P_t = [\alpha (P_{T,t})^{1-\nu} + (1-\alpha)(P_{N,t})^{1-\nu}]^{\frac{1}{1-\nu}} \tag{3.3}$$

The non-tradable consumption basket is made up of a continuum of differentiated varieties of goods $C_{N,t} \equiv (\int_0^1 C_{N,t}(j)^{\frac{\epsilon-1}{\epsilon}} d_j)^{\frac{\epsilon}{\epsilon-1}}$ with the corresponding price $P_{N,t} = (\int_0^1 P_{N,t}(j)^{1-\epsilon} d_j)^{\frac{1}{1-\epsilon}}$ and $\epsilon > 1$, the elasticity of substitution between varieties.

The tradable goods basket is a CES aggregate of home ($C_{H,t}$) and foreign ($C_{F,t}$) tradable goods, with $\kappa > 0$ as the constant elasticity of substitution:

$$C_{T,t} = \left[\omega^{\frac{1}{\kappa}} (C_{H,t})^{\frac{\kappa-1}{\kappa}} + (1-\omega)^{\frac{1}{\kappa}} (C_{F,t})^{\frac{\kappa-1}{\kappa}}\right]^{\frac{\kappa}{\kappa-1}} \tag{3.4}$$

where ω is the share of tradable goods produced in the Home country. The corresponding price index is

$$P_{T,t} = [\omega (P_{H,t})^{1-\kappa} + (1-\omega)(P_{F,t})^{1-\kappa}]^{\frac{1}{1-\kappa}} \tag{3.5}$$

where ($P_{F,t}$) is the price of foreign tradable goods and ($P_{H,t}$) denotes the price of domestic tradable goods.

The baskets of home ($C_{H,t}$) and foreign ($C_{F,t}$) tradable goods and their associated prices ($P_{H,t}$ and $P_{F,t}$) are defined in the similar manner as for the case of the non-tradable goods baskets by aggregating differentiated varieties. Therefore, the elasticity of substitution between varieties, ϵ, is identical across sectors. From the expenditure minimization problem, the following optimal demands for different goods yield:

$$C_{N,t} = (1-\alpha)\left(\frac{P_{N,t}}{P_t}\right)^{-\nu} C_t \tag{3.6}$$

$$C_{T,t} = \alpha\left(\frac{P_{T,t}}{P_t}\right)^{-\nu} C_t \tag{3.7}$$

$$C_{H,t} = \omega\left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\kappa} C_{T,t} \tag{3.8}$$

$$C_{F,t} = (1-\omega)\left(\frac{P_{F,t}}{P_{T,t}}\right)^{-\kappa} C_{T,t} \tag{3.9}$$

The representative household faces the following period-by-period budget constraint:

$$P_t C_t + E_t D_{t+1} B_{t+1} = W_t N_t + B_t + \Delta_t \tag{3.10}$$

where W_t denotes the household's nominal wage, Δ_t corresponds to profits rebated equally to the households by firms, B_{t+1} is a portfolio of state-contingent securities ensuring complete financial markets, as in Chari et al. (2002), with D_{t+1} the corresponding stochastic discount factor between dates t and *t+1*. Traditionally, the complete market environment ensures that agents have access to state contingent securities that allow them to optimally share risk across countries.

The solution to the representative household problem implies the following optimality conditions:

$$\frac{-U_{N,t}(C_t, \varepsilon_t, N_t)}{U_{C,t}(C_t, \varepsilon_t, N_t)} = \frac{W_t}{P_t} \tag{3.11}$$

$$U_{C,t}(C_t, \varepsilon_t, N_t) = E_t\left\{\beta(1+i_t)\frac{P_t}{P_{t+1}} U_{C,t+1}(C_{t+1}, \varepsilon_{t+1}, N_{t+1})\right\} \tag{3.12}$$

where $(1+i_t)^{-1} = E_t(D_{t+1})$ is the price of the portofolio.
Under complete markets, the optimal risk sharing implies:

$$\frac{U^*_{C,t}(C^*_t, \varepsilon^*_t, N^*_t)}{U_{C,t}(C_t, \varepsilon_t, N_t)} = \frac{S_t P^*_t}{P_t} \tag{3.13}$$

S_t is the nominal exchange rate expressed as units of domestic currency per one unit of foreign currency and $\frac{S_t P^*_t}{P_t} \equiv RR_t$ is the real exchange rate. The relation (3.13) states that the relative

consumption across countries is proportional to the real exchange rate and predicts a positive high cross-correlation between the latter and the relative consumption. The combination of equations (3.12) and (3.13) provides the uncovered interest rate parity relation under the prefect capital mobility assumption.
Foreign household preferences and choices can be defined symmetrically.

3.2.2. Open economy expressions

Let us define the terms of trade (T_t) and the relative price of traded goods (Q_t) as, respectively: $T_t = \frac{P_{F,t}}{P_{H,t}}$ and $Q_t = \frac{P_{T,t}}{P_{N,t}}$.
Given the definition for the terms of trade, the relative price of traded goods, (3.3) and (3.5), the following equation holds:

$$\frac{P_{T,t}}{P_{H,t}} = \left[\omega + (1-\omega)(T_t)^{1-\kappa}\right]^{\frac{1}{1-\kappa}} \equiv f(T_t) \tag{3.14}$$

$$\frac{P_t}{P_{N,t}} = [\alpha(Q_t)^{1-\nu} + (1-\alpha)]^{\frac{1}{1-\nu}} \equiv f(Q_t) \tag{3.15}$$

Finally, we can relate the real exchange rate to the terms of trade and the relative price of traded goods as follows:

$$RR_t = \frac{f^*(Q_t^*)Q_t f^*(T_t^*)T_t}{Q_t^* f(Q_t) f(T_t)} \tag{3.16}$$

3.2.3. Firms and Price setting

For each country, we assume that the production occurs in two sectors: tradable and non-tradable. In this section, the two production sectors in the domestic economy are indexed by $i \in \{H, N\}$.
In both sectors, a continuum of monopolistically competitive firms of measure unity, indexed by j, produces output $Y_{i,t}(j)$ using the technology:

$$Y_{i,t}(j) = A_{i,t} N_{i,t}(j) \tag{3.17}$$

where $N_{i,t}$ denotes hours worked in sector i, $A_{i,t}$ is a technological shock that is common to all firms and follows a stationary first-order autoregressive process : $\log(A_{i,t}) = \rho_A \log(A_{i,t-1}) + e_{A,t}$

with $e_{A,t} \sim i.i.d.(0, \sigma^2_{e_A})$.
Cost minimization by firms implies that the real marginal cost of production in each sector (i) is:

$$mc_{i,t} = \frac{W_t}{A_{i,t}P_{i,t}} \tag{3.18}$$

Following Calvo (1983), we assume that firms set their nominal prices on a staggered basis: at each period, a fraction $(1-\phi^i)$ of firms are randomly selected to set new prices $(P^n_{i,t}(j))$, while the remaining fraction $\phi^i \in [0,1]$ of firms keep their prices unchanged.
The optimal price setting problem for a firm (j) of sector (i) that is able to reset its price at time t is:

$$\max_{P^n_{i,t}(j)} E_t \left\{ \sum_{s=0}^{\infty} (\phi^i)^s \Lambda_{t,t+s} \left[\frac{P^n_{i,t}(j)}{P_{i,t+s}} \left(\frac{P^n_{i,t}(j)}{P_{i,t+s}} \right)^{-\epsilon} Y_{i,t+s} - mc_{i,t+s} \left(\frac{P^n_{i,t}(j)}{P_{i,t+s}} \right)^{-\epsilon} Y_{i,t+s} \right] \right\} \tag{3.19}$$

where $\Lambda_{t,t+s} = \beta^s \frac{U_{C,t+s}(C_{t+s}, \varepsilon_{t+s}, N_{t+s})}{U_{C,t}(C_t, \varepsilon_t, N_t)}$ is the discount factor for future real profits.
The first order condition implies:

$$P^n_{i,t}(j) = \frac{\epsilon}{\epsilon - 1} \frac{\sum_{s=0}^{\infty} (\beta\phi^i)^s U_{C,t+1}(C_{t+s}, \varepsilon_{t+s}, N_{t+s}) Y_{i,t+s} P^{\epsilon}_{i,t+s} mc_{i,t+s}}{\sum_{s=0}^{\infty} (\beta\phi^i)^s U_{C,t+1}(C_{t+s}, \varepsilon_{t+s}, N_{t+s}) Y_{i,t+s} P^{\epsilon-1}_{i,t+s}} \tag{3.20}$$

Given the Calvo-type setup, the aggregate domestic sectorial price index evolves according to the following law of motion,

$$P^{1-\epsilon}_{i,t} = (1-\phi^i)(P^n_{i,t})^{1-\epsilon} + \phi^i P^{1-\epsilon}_{i,t-1} \tag{3.21}$$

The foreign economy has an analogous price setting mechanism.

Since the assumption that prices are set in the producer currency for exports and the international law of one price holds for tradable goods in this baseline model, prices of home goods sold abroad and those of foreign goods sold in home country are given, respectively, by: $P^*_{H,t} = \frac{P_{H,t}}{S_t}$ and $P_{F,t} = S_t P^*_{F,t}$.

3.2.4. Monetary policies

The monetary authority sets the short term nominal interest rate in reaction to endogenous variables (active monetary policy), except when the zero bound constraint is active. Following Monacelli (2004), Faia (2010), Cook and Devereux (2014) and Born et al. (2013), each exchange rate regime will be identified with a differentiated specification of the monetary policy rule. We present here the policy rules under the zero bound constraint. The policy rule in "normal" times is a non-truncated Taylor-type rule.

3.2.4.1. Independent Floating

Under this regime with separate currencies, the monetary authority of each country sets its own interest rate, which follows a Taylor rule truncated at zero,

$$i_t = \max(Z_t, 0) \tag{3.22}$$

$$\text{where} \quad Z_t = \frac{1}{\beta}\left(\frac{\Pi_t}{\Pi}\right)^{\varphi_1} - 1 \tag{3.23}$$

with φ_1, the reaction coefficient to the domestic gross inflation $\Pi_t = P_t/P_{t-1}$ and Π is the steady-state value of Π_t.

3.2.4.2. Monetary union

Under this regime with a single currency, the common central bank sets the nominal interest rate according to the following Taylor-type interest rate rule truncated at zero,

$$i_t^{cu} = \max(Z_t^{cu}, 0) \tag{3.24}$$

$$\text{where} \quad Z_t^{cu} = \frac{1}{\beta}\left(\frac{\Pi_t^{cu}}{\Pi^{cu}}\right)^{\varphi_1} - 1 \tag{3.25}$$

with $\Pi_t^{cu} = (\Pi_t)^{0.5}(\Pi_t^*)^{0.5}$, the gross inflation rate in the currency union, Π^{cu} is its steady state's value. φ_1 is the reaction coefficient to the union gross inflation and Π_t (Π_t^*) is defined such as $\Pi_t = P_t/P_{t-1}$ ($\Pi_t^* = P_t^*/P_{t-1}^*$).

3.2.5. Market Clearing

The aggregate goods market clearing in the tradable and non-tradable sectors satisfies,

$$Y_{H,t} = C_{H,t} + C^*_{H,t} \tag{3.26}$$

$$Y_{N,t} = C_{N,t} \tag{3.27}$$

where $C^*_{H,t} = \alpha(1-\omega)\left(\frac{P^*_{H,t}}{P^*_{T,t}}\right)^{-\kappa}\left(\frac{P^*_{T,t}}{P^*_t}\right)^{-\nu} C^*_t$ denotes total exports to foreign country.
The aggregate labour market clearing requires,

$$N_t = N_{H,t} + N_{N,t} \tag{3.28}$$

The foreign market clearing conditions are symmetrical.

3.3. Calibration

The benchmark calibration of the model is summarized in Table 3.1 below. We use the piecewise-linear method developed by Guerrieri and Iacoviello (2015) to solve the model with the ZLB constraint [2]. We calibrate the two countries in a symmetric manner, except for preference shocks that hit only the home country. The preference shock is calibrated sufficiently large in order to generate the liquidity trap and in an asymmetric way among domestic and foreign countries. This asymmetry allows us to focus only on the analysis of the effects of the shock on the domestic economy, which move relatively to the foreign economy's dynamic (country-specific shock) [3]. Following Monacelli (2004), Eggertsson et al. (2014), we employ the following utility function:

$$U_t(C_t, \varepsilon_t, N_t) = \varepsilon_t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\eta}}{1+\eta}\right) \tag{3.29}$$

where σ is the household's risk aversion parameter (the inverse of the intertemporal elasticity of substitution) and η denotes the inverse of Frisch labour supply elasticity.

2. All optimal conditions of the model derived previously as well as the steady-state equations are summarized in Appendix C.
3. In a robustness perspective, we have submitted both countries to asymmetric preference shocks. The results remain qualitatively unchanged.

Table 3.1 – Calibration

Description	**Parameter**	**Value**
Subjective discount factor	β	0.99
Inverse of Frisch elasticity of labour supply	η	2
Inverse of intertemporal elasticity of substitution in consumption	σ	2
Share of home-traded goods	ω	0.57
Share of non-traded goods	$1-\alpha$	0.62
Elasticity of substitution between traded and non-traded goods	ν	0.74
Elasticity of substitution between home and foreign-traded goods	κ	0.8
Calvo Probability	ϕ^i	0.75
Elasticity of substitution among differentiated goods in each sector	ϵ	10
Smoothing coefficient in the monetary rule	ρ_r	0.8
Inflation stabilizing coefficient in the monetary rule	φ_1	1.5
Autocorrelation of preference shock	ρ_ε	0.8
Autocorrelation of technology shock in each sector	ρ_A	0.8
Standard deviation of the preference shock in country H	σ_ε	0.25

Our baseline calibration of parameters follows the “New Keynesian” literature [4]. Time is measured in quarters. The discount factor, β, is set to 0.99, implying an annualized real interest rate of about 4% in the steady state. The inverse of the intertemporal elasticity of substitution in consumption, σ, is set to 2, following Stockman and Tesar (1995). The inverse of the Frisch elasticity of labour supply, η, is assumed to be equal to 2, a value commonly used in the literature (Eggertsson et al. (2014), Erceg and Lindé (2012)). Consequently, it is assumed that $\sigma = \eta$ as in Chari et al. (2002). In line with Eggertsson et al. (2014), the home bias ($\omega = 0.57$) and the weight of non-traded goods in the consumption basket ($1 - \alpha = 0.62$) are chosen such that steady-state values of imports and manufacturing output are 15% and 38%, respectively (corresponding to eurozone data). The elasticity of substitution between tradable and non-traded goods in consumption, ν, is set to 0.74 following Mendoza (1991)'s estimate for industrialized countries. In this benchmark calibration, the elasticity of substitution between home and for-

4. We further make the sensitivity analysis in order to assess the effects of changes in main parameters on the results.

eign traded goods, κ, is equal to 0.8, which is within the range of estimates provided in Corsetti et al. (2008), Rabanal and Tuesta (2010) and Heathcote and Perri (2002). We choose the calvo probability of not resetting the price in any given quarter, $\phi^i = 0.75$, such that the frequency of price adjustment is 4 quarters. The elasticity of substitution between varieties of a typical good, ϵ, is set to 10 (a representative value in the literature), which implies a value of the steady-state markup of 1.11, consistent with the empirical work of Basu and Fernald (1997). In specifying monetary policy, we set the parameter φ_1 to 2.5 as in Cook and Devereux (2014). In order to allow the comparison between monetary regimes, we assume that this parameter is the same under the floating regime and the monetary union [5]. The steady-state levels of inflation are assumed to be zero (such as $\Pi = 1$ and Π^{cu}). The persistence of technology shocks for each sector is set to 0.8, which is close to the average of the real business cycle literature. As in Cook and Devereux (2014), we assume that the persistence of preference shocks is 0.8. To allow the regime comparison at ZLB, the standard deviation of the asymmetric preference shock is chosen ($\sigma_\varepsilon = 0.25$) so that the zero bound binds when both countries form a currency area, reflecting the magnitude of the shock. In this case, the zero bound will obviously bind when countries have their own independent monetary policy and faced this same shock. Apart from the ZLB (i.e. in "tranquil" times), the shock magnitude is chosen to ensure that interest rates, by stabilizing the economy, remain above their zero floors.

3.4. Results for the baseline model

In this section, we present the dynamics of our baseline model with complete markets and producer currency pricing in reaction to an asymmetric preference shock under both the monetary union and the floating regime. We compare the two policy regimes in an environment away from the ZLB constraint and when the ZLB is binding.

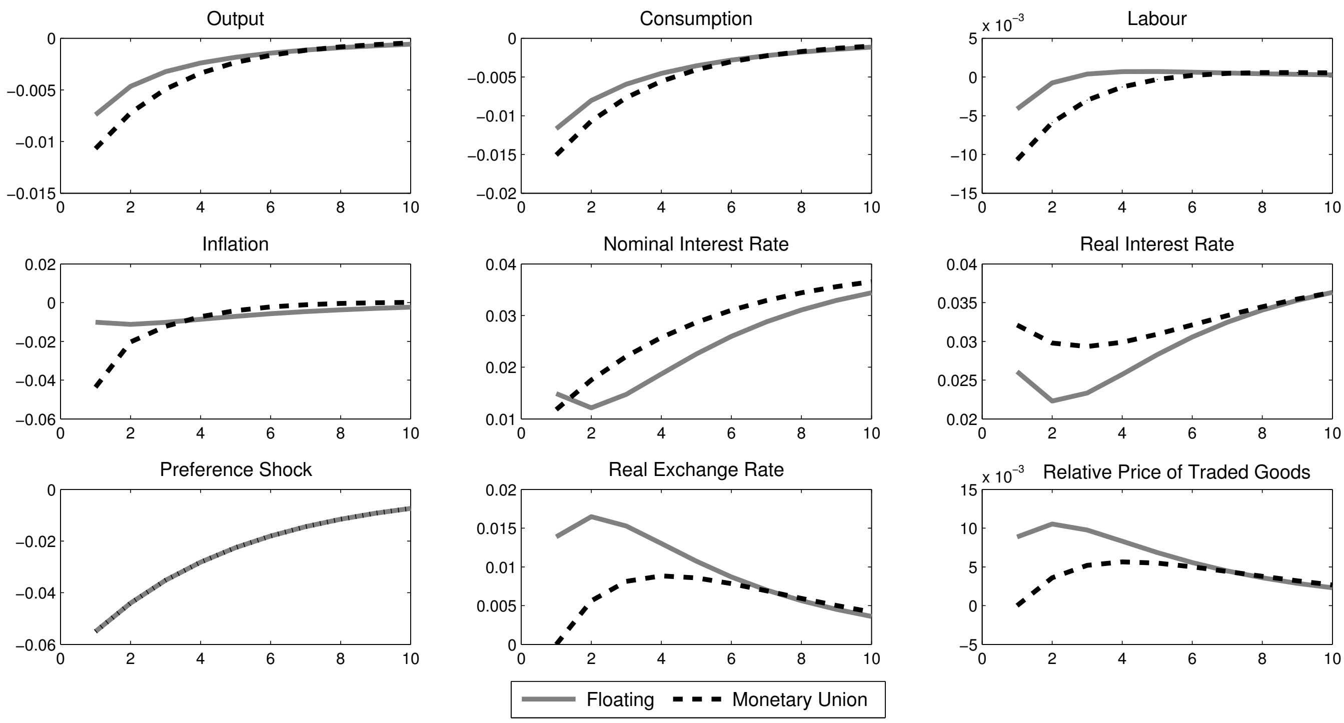
3.4.1. Exchange rate regimes in "tranquil" times

Figure 3.3 displays the dynamics of main domestic variables in response to a negative asymmetric demand shock under the two monetary regimes (monetary union and independent floating), when the zero lower bound constraint is not active. This shock induces a decrease in both inflation and output. Under the two regimes, the central bank revises downwards the nominal interest rate in order to stabilize the inflation rate. As a consequence, the nominal exchange

5. Our results are not modified even we give up this assumption.

rate depreciates under independent floating regime and this leads to the real exchange rate depreciation. But under the monetary union, there is no nominal exchange rate and the real exchange rate depreciation only comes from the relative (gradual) drop in domestic prices which are sticky. Finally, the difference between the two regimes comes from the nominal exchange rate depreciation that relatively dampens the adverse effects of the shock under the independent floating regime. This latter regime has a stabilizing power superior to that of the monetary union facing country-specific shocks in "normal" times. The traditional ranking between the two regimes works well here.

Figure 3.3 – Effects of a negative demand shock in "tranquil" times (away from ZLB)



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in log deviations from steady state, except inflation, the nominal interest rate and the real interest rate which are measured in annualized levels with 0%, 4% and 4% their respective steady-state levels.

3.4.2. Exchange rate regimes at the zero lower bound

Now, consider that the zero lower bound constraint is active and the shock is large enough to stuck the home country interest rate (under the independent floating policy) or currency area policy rate at zero. The shock is asymmetric in the sense that it only hits the home country

(country-specific shock), but sufficiently large that it constrains the policy rate at its zero floor when the two countries form a monetary union. The dynamics of domestic variables in response to a negative drop in home preferences under the two monetary regimes are depicted in Figure 3.4.

The mechanisms are as follow: the negative preference (demand) shock is characterized by a reduction of households' consumption. As a consequence, inflation falls. Since the nominal interest rate is bounded at zero, falling inflation means a higher real interest rate. This higher real interest rate generally works to choke off demand, reducing output and hours worked. In each exchange rate regime, the magnitude of the shock effects on the economy depends on the real exchange rate dynamic. In fact, the standard ranking between the two exchange rate regimes is reversed because of the real exchange rate appreciation under the independent floating regime, in contrast to the currency depreciation that occurs under the monetary union.
In the independent policy case, the real exchange rate depends negatively on changes in relative price levels and positively on the nominal exchange rate evolution. This latter positively depends on current relative price levels and expected relative inflation rates and negatively on expected future path of relative policy rates. In other words, the current real exchange rate dynamic is explained by the relative ex ante long-term real interest rate [6]. Indeed, home private agents anticipate that, in the long-term, the liquidity trap will be expired and the home monetary rule must revert to the standard Taylor-type rule, which responds aggressively to inflation (more than one-for-one according to the Taylor principle, which is respected by our calibration). This means that inflation expectations are persistently low due to expectations of the positive future nominal rate, and hence the long-term real interest rate goes up, particularly in line with the increase in expected future policy rate. Consequently, the current relative consumption declines so that the home currency appreciates via the risk sharing condition (from equation (3.13)) [7].
However, under the monetary union, the nominal exchange rate lacks and does not matter for the bilateral real exchange rate, which depends positively on gradual movements in relative expected future inflation (thus, relative expected price levels). Although the fall in domes-

6. By iterating forward $(\frac{1}{RR_t}) = (\frac{1}{RR_{t+1}})\left(\frac{(1+i_t)}{\Pi_{t+1}}\right)\left(\frac{\Pi^*_{t+1}}{(1+i^*_t)}\right)$, which comes from the combination of equations (3.12) and (3.13), it is straightforward to obtain the relation between the current real exchange rate and accumulated expected future real interest rates.

7. Notice that the foreign policy rate and foreign inflation are given for domestic agents.

tic inflation in short-term, price levels (and inflation) must revert to the steady state the in long-term (tracking the purchasing power parity), regardless of the area-wide nominal interest rate. This implies a rise in home long-term expected inflation, and as a result, the current real exchange rate depreciates [8]. The union acts in this sense as an instrument of commitment for a high level of future inflation.

Importantly, the higher negative effects of the liquidity trap on the main domestic variables (output, consumption and labour) under the independent floating regime, compared to those occur in a monetary union, reflect two factors:
(*i*) the rise in the relative ex ante long-term real interest rate under the independent regime while it substantially decreases under the currency union;
(*ii*) the real currency appreciation essentially caused by the "perverse" nominal appreciation, which follows the rise in relative expected future real interest rate under the independent floating; by contrast, the real exchange rate depreciates in the monetary union due to the increase in the relative expected future inflation and the lack of the nominal exchange rate adjustment that insulates the economy from more adverse effects of the liquidity trap.
These results contribute to explain why the duration of the zero lower bound is more prolonged under the independent floating than under the monetary union.

The endogenous duration of the ZLB is influenced by the endogenous path of the exchange rate in our model. Indeed, since the liquidity trap occurs when the natural (potential) interest rate is negative, the liquidity trap duration depends on how long this natural rate remains significantly below zero ($i_t = 0$ over this period) [9]. The level of the natural interest rate is determined by price levels (inflation), which track the impact of the preference shock on consumption. Thus, the only way to help the natural rate to rebound is the increase in the expected future path of inflation. The high expected level of inflation, by increasing the natural interest rate and reducing the ex ante long-term real interest rate, allows the economy to escape from the ZLB constraint. Obviously, the exchange rate depreciation serves to create the

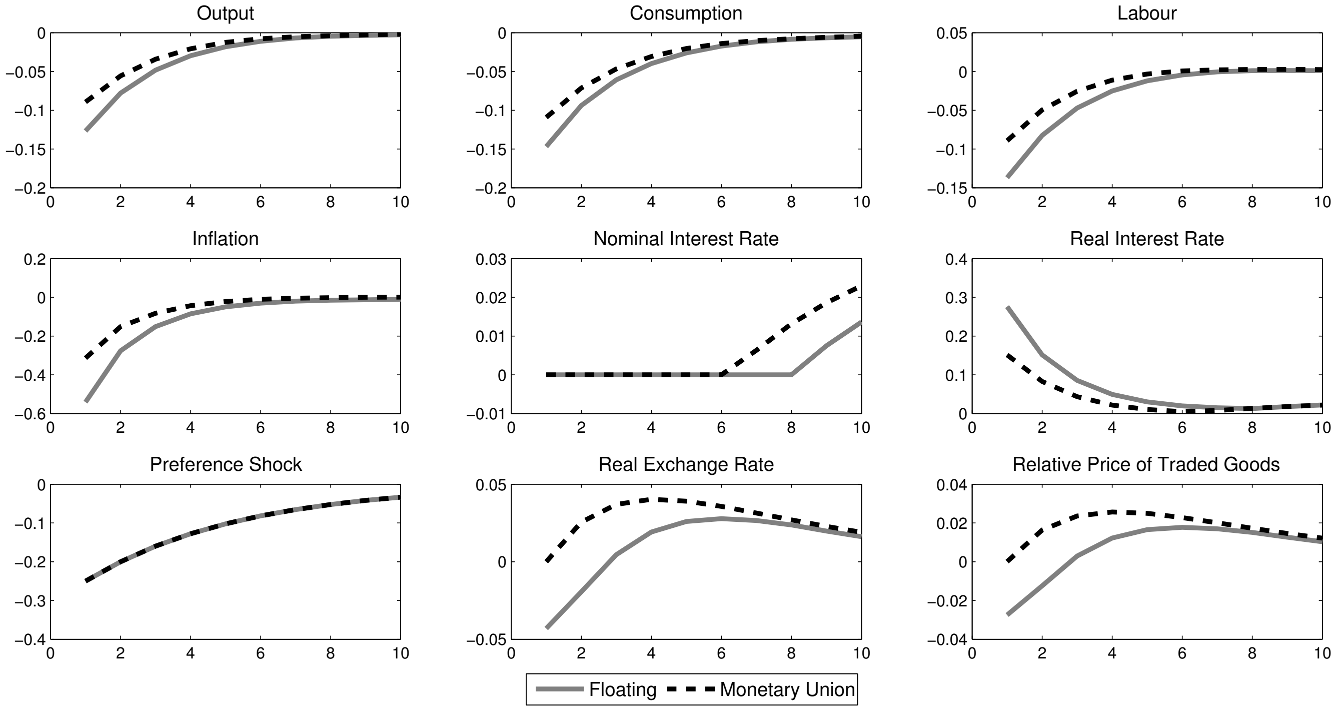
8. Solving forward the following equation $(\frac{1}{RR_t}) = (\frac{1}{RR_{t+1}})(\frac{\Pi^*_{t+1}}{\Pi_{t+1}})$ provides an expression of current real exchange rate as a function of accumulated expected future inflation rates.

9. If a country faces a large contractionary disturbance, the central bank has to cut the nominal interest rate in order to stabilize the economy. The required policy rate level for stabilizing should be below zero (potential interest rate) following the inflation rate. Because of the zero bound constraint, the monetary authority will not be able to cut the nominal rate by the required amount. This implies that the nominal interest rate at zero is superior to its natural level, and consequently the real interest rate is higher than its natural level in a recession period.

expected future inflation (as in Svensson (2001)). Accordingly, the duration of the liquidity trap is shorter under the monetary union compared to the independent floating regime.

Finally, these results suggest that a monetary union, by committing for high expected future inflation and achieving a risk sharing among countries, mitigates the recessionary impacts of the liquidity trap on the economy better than an independent floating regime [10].

Figure 3.4 – Effects of a negative demand shock in a liquidity trap



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in log deviations from steady state, except inflation, the nominal interest rate and the real interest rate which are measured in annualized levels with 0%, 4% and 4% their respective steady-state levels.

3.5. Robustness and extensions

So far, we have presented our analysis with respect to the two monetary regimes under the assumptions of complete financial markets and producer currency pricing (PCP). We first check the robustness of this baseline model by varying some key parameter values in order to underscore their potential role in explaining our results. Second, we explore the framework to

10. A commitment for a high future inflation provides support for the foolproof way to escape from a liquidity trap according to Svensson (2001). Unlike in Svensson (2001), the view expressed in our study should not be seen as a strategy to escape from a liquidity trap, but as a way of insulating from a prolonged and deep liquidity trap.

which our results are sensitive to an alternative structure of financial markets and alternative pricing method of firms, using a model with the incomplete market assumption and another model with the local currency pricing assumption (LCP). We further augment the range of the regime comparison by introducing an alternative independent monetary policy (independent managed floating regime) in view of finding a robust ranking between a single currency regime and independent monetary regimes (floating and managed floating).

3.5.1. Parameter modification in the baseline model

To understand the determinants of our results, we conduct a sensitivity analysis on some key parameters, which interact with exchange rate dynamics (important in this study) and for values of which there is uncertainty in the literature [11]. We perform this exercise with the baseline model, unless otherwise specified.

Figure 3.5 presents the effects of varying κ, **the elasticity of substitution between home and foreign-produced traded goods** (i.e. cross-country substitutability parameter) under different policies. This parameter is crucial in the model for international relative price dynamics (the terms of trade and the real exchange rate). Indeed, it captures the sensitivity of the households' consumption allocation between domestic and foreign tradable goods with respect to their relative price (terms of trade) [12]. Therefore, κ, through the international risk sharing, influences the real exchange rate. Although most of the recent literature tends to consider this cross-country elasticity of substitution above unit [13], there is a considerable uncertainty regarding estimated values of this parameter in the literature. For example, using Bayesian techniques and data from Euro area and U.S., Rabanal and Tuesta (2010) found estimates of this parameter within the range of 0.16 and 0.94, while Lubik and Schorfheide (2006) found a value of 0.43. Heathcote and Peri (2002) estimate a value of 0.9. Furthermore, Whalley (1985) estimates a value of 1.5 for the U.S., whereas Hooper et al. (1998) estimate trade elasticity for G7 countries and report elasticities for the U.S. between 0.3 and 1.5. Consistently, we set $\kappa = 0.8$ in our benchmark calibration. We further experiment the model simulation

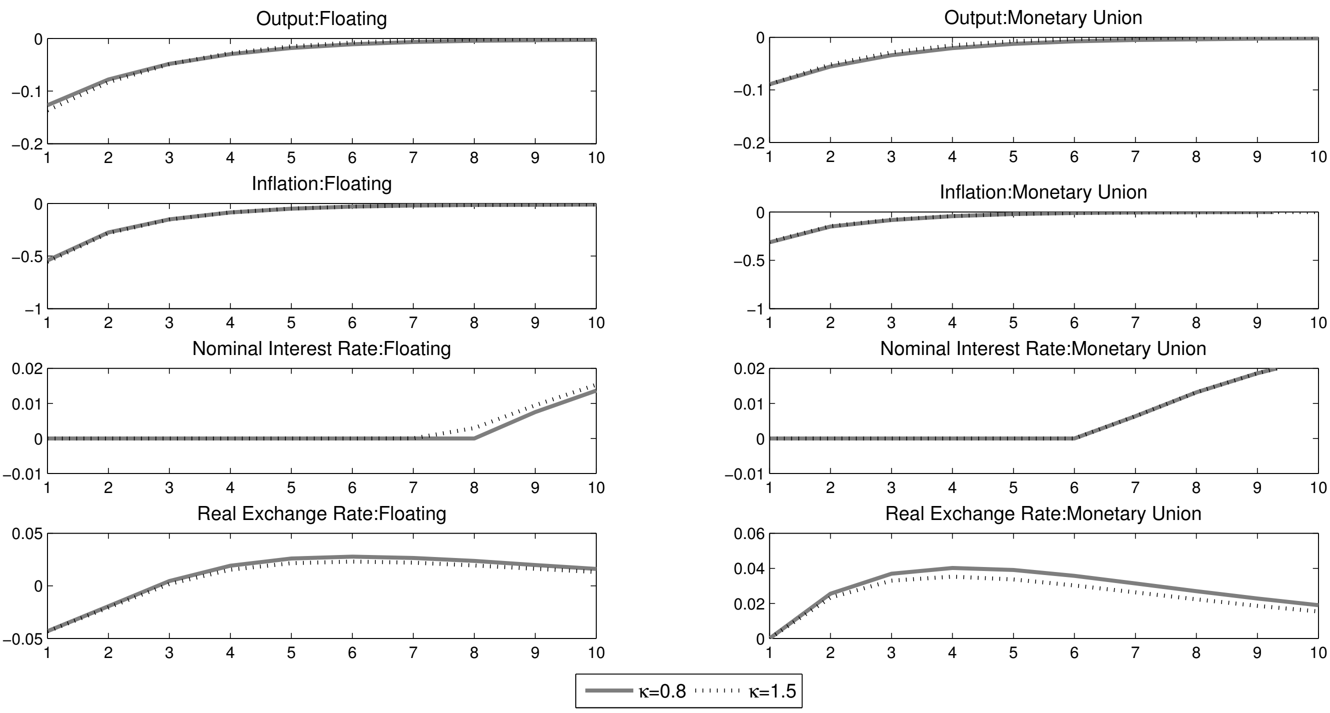
11. Of course, our consumption-based real exchange rate is influenced by the home bias and the share of traded goods in consumption (ω and α, respectively), but since there is not an uncertainty about these two parameters (coming from Euro area data) in our calibration, we voluntarily exclude them from the sensitivity analysis.

12. This parameter has been shown to play a crucial role in key business cycle properties of open economy models (see Corsetti et al. (2008)).

13. Bakus et al. (1994), Eggertsson et al. (2014), Chari et al. (2002), among others, set the elasticity of substitution between home and foreign goods equal to 1.5.

for $\kappa = 1.5$. From the quantitative perspective, the result shows that the model is slightly sensitive to the change in κ. Indeed, when $\kappa = 0.8 < 1$ (home and foreign produced goods are complements) the domestic reaction to relative price changes is smaller, so that the depreciation of the real exchange rate in the medium term is more pronounced. The opposite dynamic occurs when $\kappa = 1.5 > 1$ (home and foreign produced goods are substitutes). However, for the levels we choose within the range of the literature, the effect of changing in κ on the real exchange rate is not enough to translate into a noticeable difference in terms of output variation due to the high share of non-traded goods in our model calibration. Qualitatively, as shown on Figure 3.5, the superiority of the monetary union is maintained regardless of the value of the cross-country substitutability parameter.

Figure 3.5 – Sensitivity analysis with respect to the cross-country elasticity of substitution



The household's **risk aversion parameter**, σ, affects the degree of international risk sharing. This parameter governs how intensely relative demand responds to the adjustments in relative real interest rates, and thus determines how intensely the relative demand influences the real exchange rate behaviour. The values of σ vary in the "New Keynesian" literature from 0.5 in Hansen and Singleton (1983) to 2 in Stockman and Tesar (1995). Figure 3.6 displays the effects of changing in values of σ. It appears that a smaller risk aversion parameter (i.e. the higher elasticity of intertemporal substitution) implies a higher negative effect of the recessionary shock on the economy variables (except the real exchange rate which follows the relative change in CPI-inflation under the monetary union regime). In addition to the capacity of the monetary union to better dampen the adverse effects of a recessionary shock, the difference between the monetary union and the independent floating regime is more pronounced when the elasticity of intertemporal substitution is higher ($\sigma = 0.5$). The reason is the higher relative initial sensitivity of variables under the floating regime to changes in real interest rate compared to the monetary union in the period of the liquidity trap (without the effect of σ).

Figure 3.6 – Sensitivity analysis with respect to the risk aversion

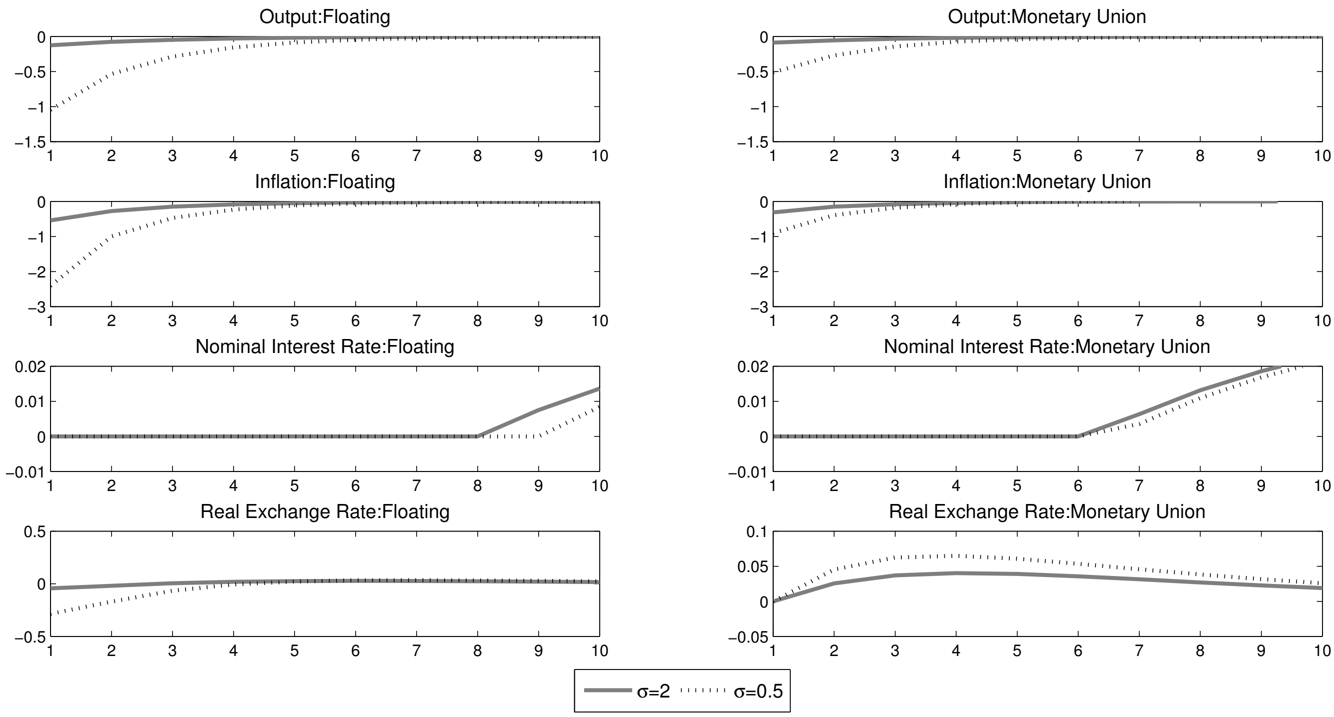
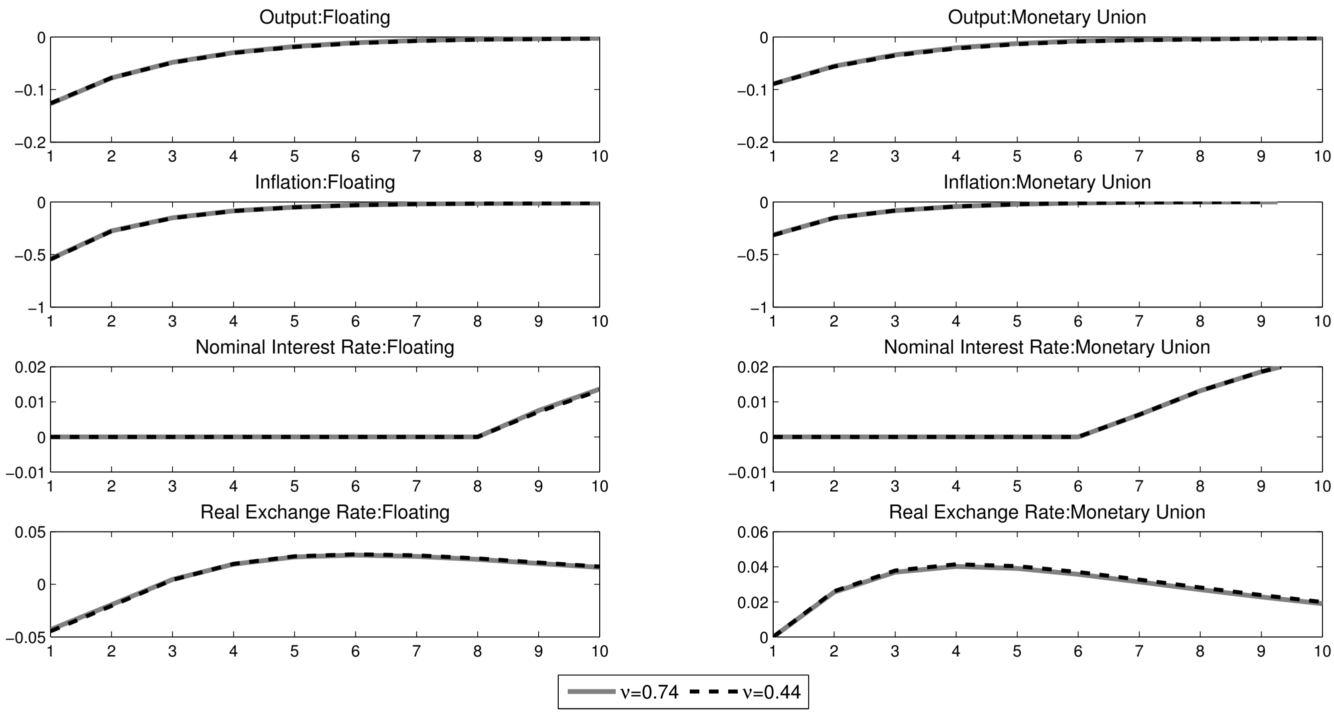


Figure 3.7 below analyses the effects of varying ν, the elasticity of substitution between traded and non-traded goods. Evidence on this parameter suggests a value below unity. Mendoza (1991)'s estimate for industrialized countries is $\nu = 0.74$, whereas Stockman and Tesar (1995)' estimate provides 0.44. The results suggest that for values of ν in this range, there is no difference in the dynamic of the model .

Figure 3.7 – Sensitivity analysis with respect to the elasticity of substitution between traded and non-traded goods



3.5.2. Incomplete market

The uncomfortable implications of the assumption of international complete markets (perfect international mobility of capital) and the empirical evidences (which clearly show the lack of perfect consumption risk sharing across countries) force us to introduce the international incomplete market structure [14]. We opt for a simple and tractable way. We assume that the home households can trade two nominal risk-less bonds denominated in the domestic and foreign currencies. The bonds are issued by households in both countries in order to finance their consumption. Following Benigno and Thoenissen (2008), it is assumed that home currency-denominated bonds are only traded domestically, such as foreign households allocate their wealth only in bonds denominated in the foreign currency [15]. Home households face a cost (i.e. transaction cost or risk premium) of undertaking positions in the foreign bonds market. This cost is proportional to the net foreign asset (NFA for short) position of the home economy as

14. See for example Rabanal and Tuesta (2010).
15. This asymmetry in the financial market structure is made for simplicity. The results would not change if we allow home bonds to be traded internationally. We just would need to add an additional arbitrage condition.

in Benigno (2009). Accordingly, the home household's budget constraint can be written as:

$$P_tC_t + \frac{B_t}{(1+i_t)} + \frac{S_tB_t^*}{(1+i_t^*)\Gamma_t\left(\frac{S_tB_t^*}{P_t}\right)} = W_tN_t + S_tB_{t-1} + B_{t-1}^* + \Delta_t \tag{3.30}$$

where W_t denotes the household's nominal wage and Δ_t are profits rebated equally to households by firms. B_t and B_t^* are the individual's holdings of domestic and foreign nominal risk-less bonds denominated in the issuing currency, i_t and i_t^* are the corresponding interest rates, S_t denotes the nominal exchange rate defined as before. The function $\Gamma_t\left(\frac{S_tB_t^*}{P_t}\right)$ captures the cost of international borrowings. This spread is increasing in the aggregate level of foreign debt $(\Gamma_t\left(\frac{S_tB_t^*}{P_t}\right) \equiv \exp\left(-\gamma(\frac{S_tB_t^*}{P_t})\right)$ with $\Gamma_t'(\cdot) < 0)$ and is equal to zero when the NFA position is at its steady state level $(\Gamma_t(0) = 1)$ [16]. The temporary deviation from uncovered interest rate parity (UIP) is introduced by this cost. γ is the sensitivity of the international borrowing cost with respect to the NFA position and, by following Rabanal and Tuesta (2006), it is set to 0.007 for our baseline calibration.

Given this market structure, the following optimal risk sharing condition holds:

$$E_t\left(\frac{U_{C,t+1}^*(C_{t+1}^*, \varepsilon_{t+1}^*, N_{t+1}^*)}{U_{C,t}^*(C_t^*, \varepsilon_t^*, N_t^*)}\frac{P_t^*}{P_{t+1}^*}\right) = E_t\left(\frac{U_{C,t+1}(C_{t+1}, \varepsilon_{t+1}, N_{t+1})}{U_{C,t}(C_t, \varepsilon_t, N_t)}\frac{P_t}{P_{t+1}}\frac{S_{t+1}}{S_t}\Gamma_t(\frac{S_tB_t^*}{P_t})\right) \tag{3.31}$$

This relation is the equivalent of (3.13) and is the basis of the real exchange rate determination under incomplete markets. Now, the risk sharing condition holds in expected variation terms and is affected by the NFA position because of the bond-holding cost. This borrowing cost acts by reducing the degree of sharing risk between countries. Equation (3.31) is simply a version of UIP with international imperfect mobility of capital. Consequently, under incomplete markets the dynamic of the real exchange rate depends, among other things, on the NFA position (surplus or deficit of the current account).

Combining the home household's budget constraint and goods market equilibrium conditions [17], yields the following law of motion of the internationally traded bonds (NFA), which

16. As discussed in Schmitt-Grohé and Uribe (2003), introducing the transaction cost $\Gamma_t(\cdot)$ has a technical advantage to deal with a non stationarity problem in the open economy models.

17. Since households in the domestic economy are identical, the domestic bond market is in zero net supply.

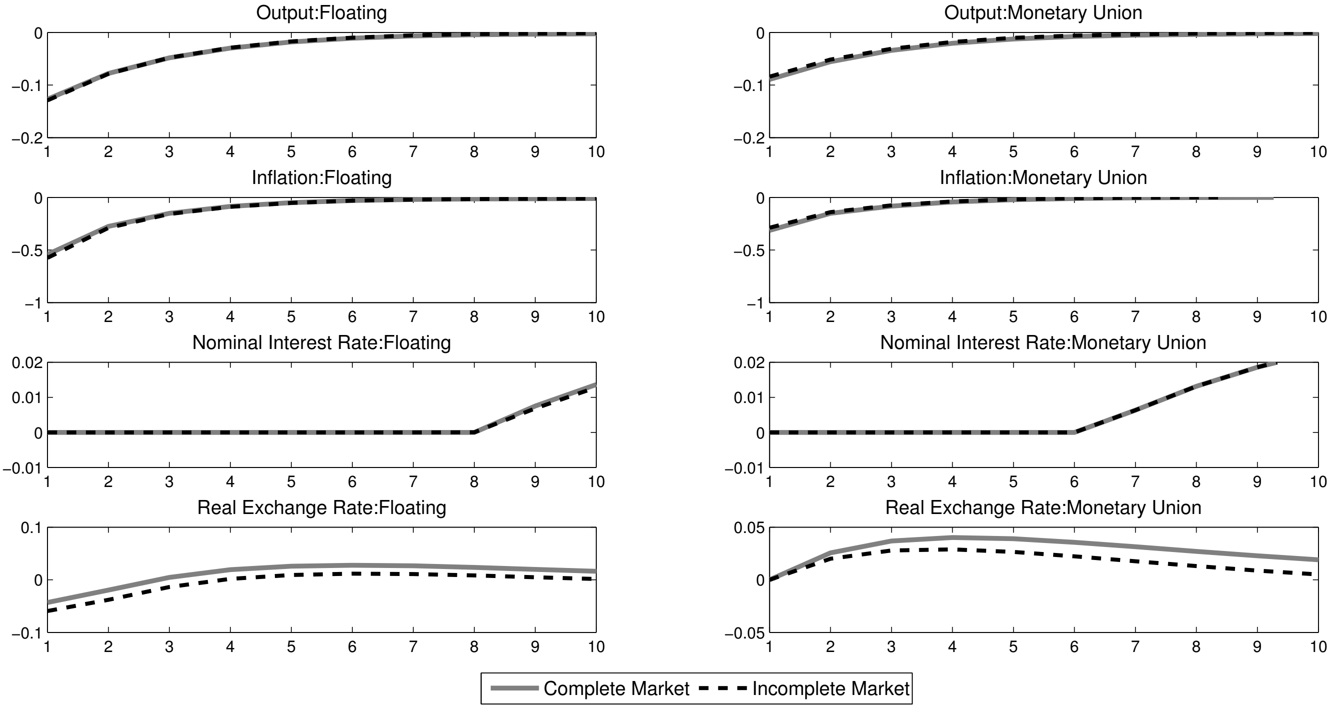
states that the flow of external debt must equate net exports:

$$\frac{S_t B_t^*}{(1+i_t^*)\Gamma_t\left(\frac{S_t B_t^*}{P_t}\right)P_t} = \frac{S_t B_{t-1}^*}{P_t} + \frac{P_{H,t}^*}{P_t}C_{H,t}^* - \frac{P_{F,t}}{P_t}C_{F,t} \tag{3.32}$$

Figure 8 contrasts, when ZLB is active, the results for complete markets with those obtained under the incomplete markets. As before the two considered regimes are: the independent floating and the monetary union. The results are qualitatively similar in the two market structures: the real exchange rate appreciates under the floating regime, whereas it depreciates under the currency union. On the quantitative side, the real exchange rate levels are lower under incomplete markets than under complete markets, corresponding to the different dynamics of long-term real interest rates. In particular, if risk is not shared completely, one does not need higher changes in terms of trade or exchange rate [18]. However, quantitative differences in the responses of output, inflation, consumption and interest rate are negligible [19].

18. See Benigno and Thoenissen (2008) for more details.
19. This result is consistent with the literature without the ZLB constraint, which shows that the allocation under incomplete financial markets is quite close to the allocation under complete markets, unless the trade price elasticity is substantially different from one on either side and, for the case of a high elasticity, shocks are persistent or follow a diffusion process (Corsetti et al. 2008).

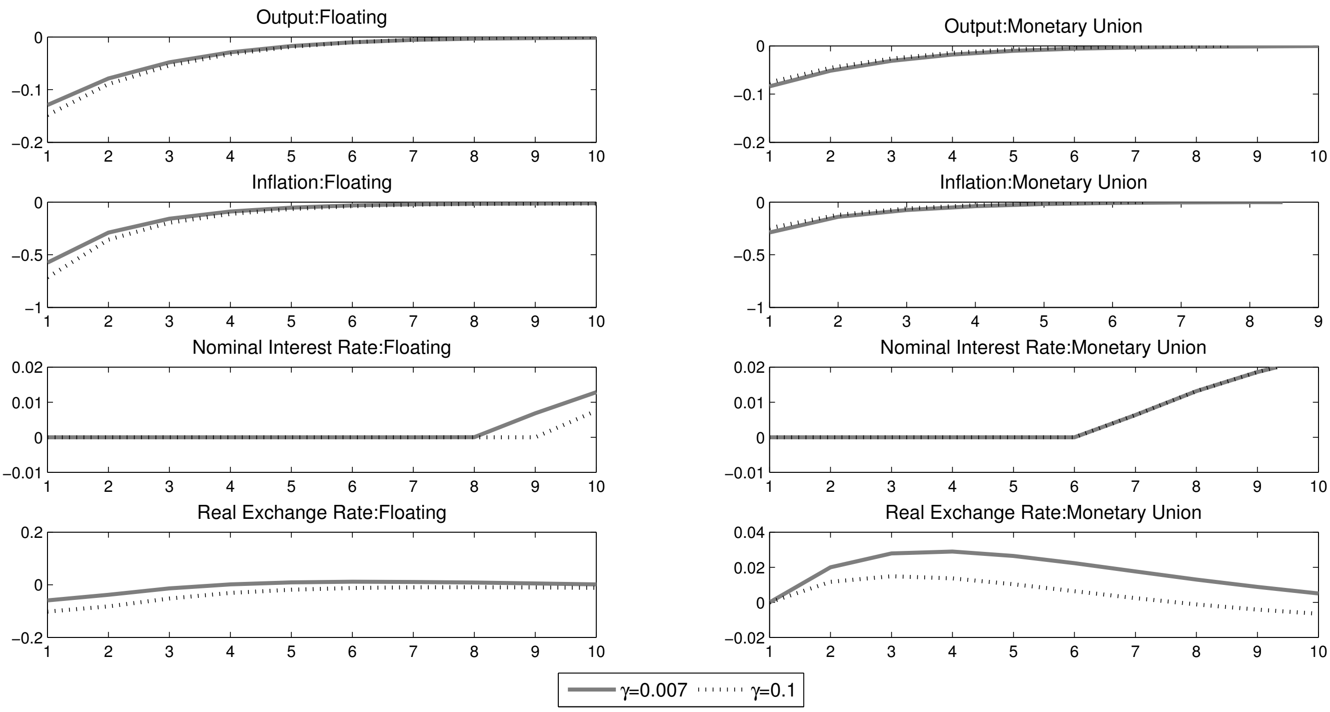
Figure 3.8 – Effects of a negative demand shock under Complete and Incomplete Markets



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in log deviations from steady state, except the nominal interest rate and inflation which are measured in annualized levels with 4% and 0% their respective steady-state levels.

Changing the elasticity of the borrowing cost: Figure 3.9 shows the model sensitivity with respect to γ, the parameter that measures **the elasticity of risk premium relatively to the NFA position**. This parameter is used only in the model with incomplete markets and acts to reduce cross-correlation between the real exchange rate and relative consumption. Its values widely vary in the literature. For instance, Rabanal and Tuesta (2006, 2010) estimates, using data from Euro area and U.S., are respectively 0.007 (in a model with PCP) and 0.015 (in a model with LCP), while Bergin (2006) obtained an estimated value of 0.0038, using data from the G7 countries. We vary the value of this parameter from the low value ($\gamma = 0.007$) of our benchmark calibration to a very high value ($\gamma = 0.1$). Our robustness analysis suggests that, without to be by a large amount like we did here, changing in the reasonable value of the risk premium elasticity does not affect our model in a meaningful way. However, Figure 3.9 shows that raising γ diminishes the levels of real exchange rate, output and inflation, since the smaller the international borrowing cost, the more the model is close to that under a complete market world, which generates a superior adjustment of the real exchange rate compared to incomplete markets as mentioned before [20]. In Figure 3.9, one can compare the independent floating regime and the monetary union with regard to changes in the value of γ. The aforementioned qualitative difference between the two regimes is not sensitive to varying the value of the elasticity of the international borrowing cost with respect to the NFA position.

Figure 3.9 – Sensitivity analysis with respect to the elasticity of risk premium relatively to NFA



3.5.3. Local currency pricing

In the previous sections, we assumed the complete exchange rate pass-through to import prices (PCP). This assumption is inconsistent with several empirical evidences that underscore a rather low degree of pass-through from exchange rates to import prices [21]. Now, we take into account this possibility, by supposing that each producer of traded good price-discriminates between home and foreign markets [22]. The firms are assumed to be monopolistically competitive

20. There is one minor exception concerning output and inflation, which remain broadly unchanged from varying values of γ under the monetary union.

21. For example, Engel (1993) supports empirically that the volatility of the price of a good relative to a similar good within a country is lower than the volatility of the price of a good relative to the price of the same good in a different country. Engel and Rogers (1996) show that the “border effect” introduces significant variation in the price of a good sold in different countries. See also Betts and Devereux (2000) for more details.

22. The price setting for non-tradable goods remains described by relations (3.19), (3.20) and (3.21).

and set their price in the destination market currency rather than in their own currency (Price-to-Market). This assumption allows to generate deviations from the law of one price (such as $P_{H,t} \neq S_t P^*_{H,t}$ and $P_{F,t} \neq S_t P^*_{F,t}$) and therefore the low degree of exchange rate pass-through. $P_{H,t}$ and $P^*_{H,t}$ denote the prices charged for home produced traded goods by firms in home market (in domestic currency) and foreign market (in foreign currency), respectively. As before, a given domestic firm may optimally reset its prices with probability $(1-\phi^i)$ each period. When the firm (j) resets its price, it will be able to reset its prices for sales in both markets and so to solve the following problem:

$$\max_{P^n_{H,t}(j),P^{*n}_{H,t}(j)} E_t\{\sum_{s=0}^{\infty}(\phi^i)^s\Lambda_{t,t+s}[\frac{P^n_{H,t}(j)}{P_{H,t+s}}C_{H,t+s}(j)+\frac{S_tP^{*n}_{H,t}(j)}{P_{H,t+s}}C^*_{H,t+s}(j)$$
$$-mc_{H,t+s}C_{H,t+s}(j)-S_tmc^*_{H,t+s}C^*_{H,t+s}(j)]\} \quad (3.33)$$

where $\Lambda_{t,t+s}=\beta^s\frac{U_{C,t+s}(C_{t+s},\varepsilon_{t+s},N_{t+s})}{U_{C,t}(C_t,\varepsilon_t,N_t)}$ is the discount factor for future real profits,
$C_{H,t+s}(j)=\left(\frac{P^n_{H,t}(j)}{P_{H,t+s}}\right)^{-\epsilon}C_{H,t+s}$ denotes the demand coming from domestic market,
$C^*_{H,t+s}(j)=\left(\frac{P^{*n}_{H,t}(j)}{P_{H,t+s}}\right)^{-\epsilon}C^*_{H,t+s}$ is the export demand and $mc^*_{H,t+s}=\frac{W_t}{A_{H,t}S_tP^*_{H,t}}$ represents the real marginal cost of exports, priced in the local currency [23].
The optimal price setting conditions for domestic consumers and foreign consumers (in foreign currency) are given, respectively:

$$P^n_{H,t}(j)=\frac{\epsilon}{\epsilon-1}\frac{\sum_{s=0}^{\infty}(\beta\phi^i)^sU_{C,t+1}(C_{t+s},\varepsilon_{t+s},N_{t+s})C_{H,t+s}P^{\epsilon}_{H,t+s}mc_{H,t+s}}{\sum_{s=0}^{\infty}(\beta\phi^i)^sU_{C,t+1}(C_{t+s},\varepsilon_{t+s},N_{t+s})C_{H,t+s}P^{\epsilon-1}_{H,t+s}} \quad (3.34)$$
$$P^{*n}_{H,t}(j)=\frac{\epsilon}{\epsilon-1}\frac{\sum_{s=0}^{\infty}(\beta\phi^i)^sU_{C,t+1}(C_{t+s},\varepsilon_{t+s},N_{t+s})C^*_{H,t+s}P^{*\epsilon}_{H,t+s}mc^*_{H,t+s}}{\sum_{s=0}^{\infty}(\beta\phi^i)^sU_{C,t+1}(C_{t+s},\varepsilon_{t+s},N_{t+s})C^*_{H,t+s}P^{*\epsilon-1}_{H,t+s}} \quad (3.35)$$

Finally, the evolutions of corresponding aggregate prices are, respectively:

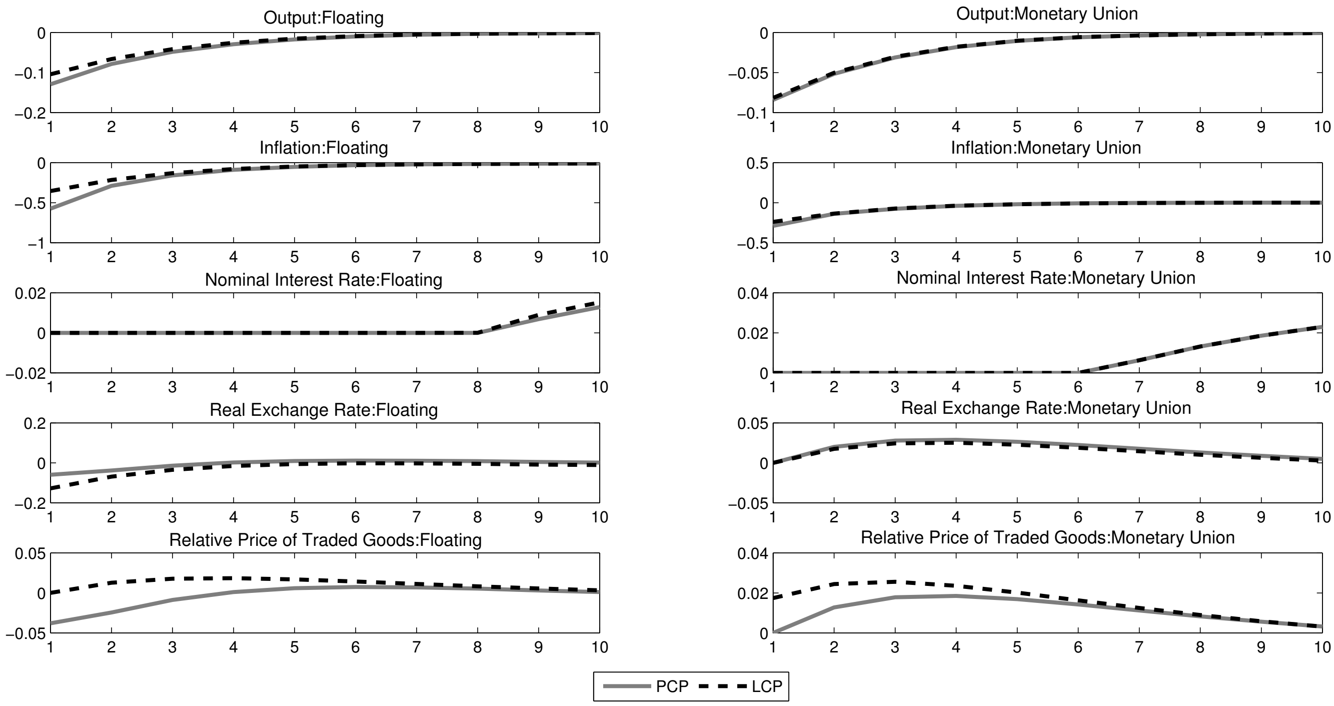
$$P^{1-\epsilon}_{H,t}=(1-\phi^i)(P^n_{H,t})^{1-\epsilon}+\phi^iP^{1-\epsilon}_{H,t-1} \quad (3.36)$$
$$P^{*1-\epsilon}_{H,t}=(1-\phi^i)(P^{*n}_{H,t})^{1-\epsilon}+\phi^iP^{*1-\epsilon}_{H,t-1} \quad (3.37)$$

The similar expressions are usable for the foreign country.

23. Let define $lopg_t \equiv S_tP^*_{H,t}/P_{H,t}$, we can therefore rewrite the real marginal cost of exports as a function of the home real marginal cost, so that $mc^*_{H,t}=mc_{H,t}/lopg_t$. The similar transformation works for the foreign country.

Figure 3.10 shows the results under PCP and LCP assumptions in both the monetary union and the independent floating regime. The exercise is experienced by assuming that markets are incomplete [24]. The findings appear broadly qualitatively unchanged after introducing the LCP assumption: there still is a real depreciation in the monetary union and a real appreciation in the floating regime. Furthermore, quantitative differences in the response of others variables are modest, unless the relative price of traded goods that depreciates more under LCP than under PCP (under which, it appreciates for the floating regime). The reason of this latter dynamic is straightforward: following the relative decline in demand when the shock occurs, the imported goods prices (thus, traded goods prices and consumption prices) decrease less under LCP than under PCP due to effects of price-discriminating behaviour of foreign producers. Consequently, with identical prices of non-traded goods for the two pricing methods, the relative price of traded goods remains superior under LCP compared to PCP [25].

Figure 3.10 – Effects of a negative demand shock under PCP and LCP



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in log deviations from steady state, except the nominal interest rate and inflation which are measured in annualized levels with 4% and 0% their respective steady-state levels.

24. The experience with complete markets has been conducted. The results are similar to those obtained under the incomplete market assumption.
25. The effect of the rise in real interest rate on output outweighs that of the competitiveness, explaining why output under LCP remains superior to that under PCP.

3.5.4. Alternative independent monetary regime

In this subsection, we extend the scope of our comparison of monetary regimes by incorporating an additional model into our analysis, in which the monetary regime consists of an independent managed floating that differs from the above-mentioned independent floating. This extension is justified by the need to know whether the adverse adjustment of the real exchange rate under independent floating regime could be limited using an alternative independent monetary policy [26]. The independent managed floating regime is identified by introducing the level of the nominal exchange rate in the monetary rule, such that:

$$i_t = \max(Z_t, 0) \tag{3.38}$$

where $$Z_t = \frac{1}{\beta}\left(\frac{\Pi_t}{\Pi}\right)^{\varphi_1}\left(\frac{S_t}{S}\right)^{\varphi_2} - 1 \tag{3.39}$$

with $\varphi_1 > 1$ and $\varphi_2 > 0$, the reaction coefficients to the domestic gross inflation ($\Pi_t = P_t/P_{t-1}$) and nominal exchange rate, respectively. Π and S are the steady-state values of Π_t and S_t.

Figure 3.11 below compares the effects of a negative home preference shock on domestic variables under three alternative monetary regimes: independent floating, independent managed floating and currency union.

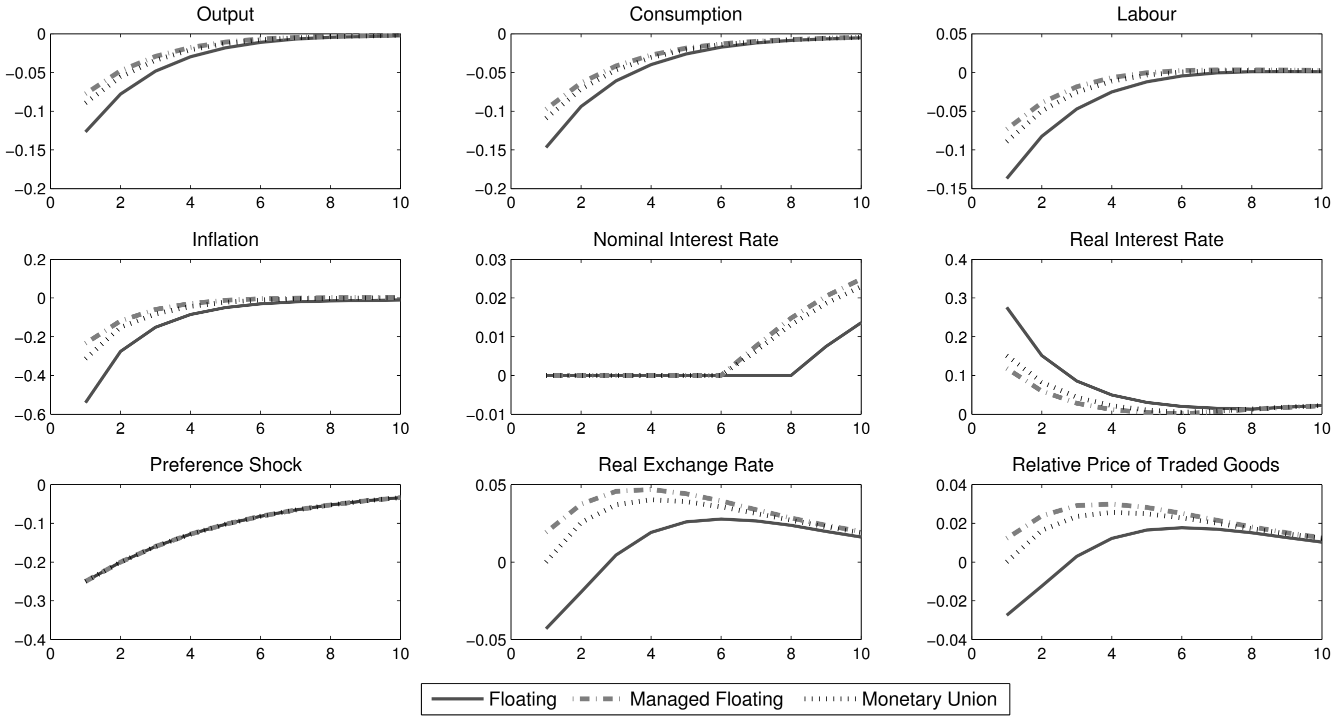
Like before, the shock is enough large to cause a liquidity trap and is calibrated in the similar way. φ_1 and φ_2 are assumed to be equal to 2.5 (as before) and 0.76 (as in Monacelli (2004)), respectively. Remarkably, the results suggest that the independent managed floating, by leading a sharp temporary currency depreciation in nominal and real terms, is very beneficial in insulating the economy from adverse effects of an asymmetric deflationary shock. In other words, the potential pressures that can occur in a liquidity trap are more dampened when the usual monetary regime is the independent managed floating rather than the independent floating. How to explain this finding? It is fundamentally based on the dynamic of the exchange rate. Indeed, taking usually into account the nominal exchange rate level in the monetary rule implies that the current nominal exchange rate depends negatively on expectations of future exchange rate levels, since this latter will reflect the policy rule when the liquidity trap lasts

26. In order to allow the comparison among regimes with simplicity, we present the results by assuming that asset markets are complete and firms set their prices in the producer currency. Otherwise, the results do not change.

(See the forward-iterated UIP condition). Precisely, the expectations of the future interest rate, following the gradual return of price levels to equilibrium, are positive and this translates into expectations of future nominal and real appreciation. The only way for the currency to be appreciated in the future is a sharp current depreciation, since including the nominal exchange rate in the policy rule leads to a negative relation between the current and expected future nominal exchange rate. And, when the interest rate is stuck on its zero lower bound, using the nominal exchange rate as a policy instrument means that the central bank is committed to the expected future price level.

Finally, because of the stronger nominal depreciation (hence real depreciation) under the independent managed floating compared to the monetary union and the independent floating, the former regime is better suited for stabilizing the economy facing deflationary effects of a liquidity trap than the floating regime. Although our approach must be viewed as a way of avoiding worst and prolonged effects of a recessionary shock that causes a liquidity trap instead of a way of escaping from the liquidity trap environment. This result is somewhat in line with the proposals of McCallum (2000) and Svenson (2001, 2009), which consist in targeting the nominal exchange rate and combining with other central bank actions (for instance foreign-exchange market interventions) as an exit strategy from the liquidity trap.

Figure 3.11 – Effects of a negative demand shock under three alternative regimes at ZLB



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in log deviations from steady state, except inflation, the nominal interest rate and the real interest rate, which are measured in annualized levels with 0%, 4% and 4% their respective steady-state levels.

3.6. Welfare analysis

In this section, we conduct monetary regime evaluations by computing the welfare costs (gains) of alternative regimes faced to a large asymmetric shock that leads to a deep recession relative to the world without fluctuations (deterministic world). Following Lucas (1987), we use a measure of the welfare costs in terms of business cycles given by the fraction of steady-state consumption that households would need in the deterministic world (at the steady state) to yield the same welfare as would be achieved in the stochastic world (under the effect of the shock).

Formally, the conditional welfare metric is u that solves:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \varepsilon_t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\eta}}{1+\eta} \right] \right\} = \frac{1}{1-\beta} \left[\frac{1}{1-\sigma} \left((1+\frac{u}{100})C \right)^{1-\sigma} - \frac{N^{1+\eta}}{1+\eta} \right] \tag{3.40}$$

where variables without subscript t are steady-state variables [27].

A positive value for u means that households prefer the stochastic allocation compared to that of the steady state. Indeed, when $u > 0$, consumption in the steady state must be raised in order to yield the same utility as under the shock (welfare gain). In contrast, a negative value of u means that households prefer the non-stochastic allocation and willing to give up a percentage of consumption to get the same utility as under the shock (welfare cost). The welfare cost (gain) in each policy regime is reported in Table 3.2. Since our welfare measure is only quantitatively sensitive to values of preference parameters, we present the welfare cost (gain) by keeping these parameter values at the level of benchmark calibration ($\sigma = 2; \eta = 2$) and varying the values of parameters that qualitatively affect the regimes' ranking under different models [28]. The results in Table 3.2 suggest that, depending on the financial market structure, the cross-country substitutability parameter matters for the comparison among policy regimes based on the welfare criterion. Indeed, in a complete market world and with complementary domestic and foreign goods ($\kappa = 0.8$), households prefer the monetary union (and the independent managed floating) to the independent floating regime in the face of negative effects of a liquidity trap (with a relative gain associated to monetary union about 0.0047% (=-0.2185-(-0.2232)) of steady-state consumption); By contrast, this ranking is reversed when domestic and foreign goods are substitutes ($\kappa = 1.5$), and the welfare cost of the currency union relative to the independent floating regime is -0.018% of steady-state consumption. However, under incomplete markets, when domestic and foreign goods are complements in the utility from consumption the monetary union costs -0.0018% of steady-state consumption relative to the independent floating regime, whilst the latter regime becomes the less preferred one (about -0.03% of steady-state consumption) when goods are substitutes.

The main intuition behind these results comes from the behaviour of the real exchange rate (terms of trade) that depreciates under the currency union and the managed floating while it appreciates under the independent floating in medium term. Since the cross-country elasticity of substitution and the financial markets structure determine to what extent the world demand can be channelized toward domestic goods following term of trade movements, the effect of the term of trade depreciation/appreciation on the welfare, well known in the literature, depends

27. Further details on the calculation of u is in Appendix C.3.

28. The sign of the value of u depend on values of preference parameters and the time on which it has been calculated, among others. We calculate this welfare cost (gain) on the infinity and not on the displayed period of impulse responses in previous sections.

on these factors [29].

In particular, when the elasticity of substitution is high (substitute goods), a relative real exchange rate appreciation can be welfare enhancing under a complete market structure by decreasing on average the disutility of producing at home without an exact equivalent reduction in the utility of consumption, whereas the opposite is true under incomplete markets (an appreciation can be welfare detrimental). More precisely, the high degree of substitutability between home and foreign goods implies high output sensitivity to real exchange rate movements and, consequently, the income effect of the relative appreciation on consumption is higher. Furthermore, depending on the financial market structure, a relatively appreciated domestic exchange rate allows transferring the purchasing power from foreign to home agents. Under complete markets, the sharing of risk across countries is complete and the purchasing power completely transferred. Hence, the positive welfare effect from the improvement in the purchasing power is larger than the negative impact of the income effect on the welfare, and overall, the welfare becomes higher under the policy regime in which the real exchange rate is more appreciated. In incomplete markets, the positive effect of the purchasing power on the welfare is reduced because the risk is not shared completely and the real exchange rate does not transfer as much purchasing power from foreign to home agents. Therefore, the net effect of the currency appreciation on the welfare is negative and, thus the monetary union outperforms the independent floating regime.

On the other hand, for a low elasticity of substitution among goods the income effect of the relative appreciation on consumption - thus on the welfare - is smaller. Under complete markets a relatively more depreciated real exchange rate on average increases welfare by leading a high consumption utility relative to labour disutility. In other words, the negative impact of the real appreciation on the welfare from income effect outweighs the positive welfare effect from purchasing power. Hence, in this case, the monetary union and the managed floating are preferred to the floating. In contrast, in an incomplete market world the positive effect of the purchasing power on the welfare outweighs the negative income effect following an appreciation of the real exchange rate.

Finally, as we have seen above, the relative welfare performance of the currency union (and the managed floating) when asset markets are complete and the elasticity of substitution is

29. See De Paoli (2009) and Rabitsch (2012) for more details.

low or when asset markets are incomplete and this elasticity is high, is justified by the real exchange rate depreciation compared to the real exchange rate appreciation that occurs under an independent policy regime. The only possible exception from these results, showing that the asset market structure and the degree of the elasticity of substitution do not matter for the welfare ranking among regimes, is the case of model simulation in which the discount factor is slightly low ($\beta = 0.98$), all else equal. Indeed, when $\beta = 0.98$ the monetary union is welfare-superior to the independent regimes in the face of a large deflationary shock, irrespective of the degree of risk sharing and the value of cross-country substitutability parameter [30].
In addition, when we give a little attention to the most realistic model with LCP and incomplete market assumptions Table 3.2 shows that the aforementioned results remain consistent.

Table 3.2 – Welfare costs (in percentage of steady-state consumption) across different monetary regimes

Models assumption	Monetary regimes	Welfare costs at ZLB			
		β= 0.99, $\kappa = 0.8$	β= 0.99, $\kappa = 1.5$	β= 0.98, $\kappa = 0.8$	β= 0.98, $\kappa = 1.5$
Complete Markets with PCP	Independent floating	-0.2232	-0.2386	-0.5051	-0.4770
	Monetary union	-0.2185	-0.2566	-0.1738	-0.2126
	Ind. managed floating	-0.2190	-0.2638	-0.2034	-0.2560
Incomplete Markets with PCP	Independent floating	0.0032	-0.0577	-0.2201	-0.1877
	Monetary union	0.0014	-0.0277	0.1190	0.0703
	Ind. managed floating	0.0013	-0.0214	0.0917	0.0641
Incomplete Markets with LCP	Independent floating	0.0043	-0.0366	0.0413	0.0527
	Monetary union	-0.0041	-0.0277	0.1181	0.0762
	Ind. managed floating	-0.00013	-0.0220	0.0891	0.0603

30. Kim et al. (2003) emphasize that the welfare characterization of the asset market structure is highly sensitive to the value of the discount factor.

3.7. Conclusions and policy implications

Traditionally, the theory of optimum currency areas argues in favour of the independent flexible exchange rate since the latter is able to deal with country-specific shocks through the currency depreciation. The focus of this work has been on the quantitative analysis of this recommendation in a context where the economy is in a liquidity trap, using a two-sector two-country model. The large preference shock is chosen to generate the liquidity trap environment.

We experiment our comparison among regimes under several model assumptions and the results are broadly consistent. Our findings suggest that the exchange rate policy regime which allows anchoring of high future inflation expectations outweighs the other ones in dealing with adverse effects of the liquidity trap. Precisely, we remarkably find that the traditional ranking between the independent flexible exchange rate regime and the monetary union is reversed when the nominal interest rate is constrained at the zero bound. Indeed, the monetary union outperforms the independent floating regime under a binding zero bound, reflecting the real exchange rate depreciation - from high expected future inflation - that occurs under the former regime while the latter faces an appreciation of exchange rate. Our results show also that the duration of the liquidity trap, being determined endogenously, is shorter in the monetary union than in the floating regime.

There is some empirical evidence to support the theoretical contribution in this work. Indeed, the exchange rate appreciation under the independent policy regime, which is the main underlying strength of described mechanisms, has been observed during Swiss and Japanese experiences of the ultra-low interest rate. Swiss currency has been sharply appreciated (relative to currencies of trading partners) during two of the three episodes of the liquidity trap (in 1970 and 2008) experienced by this country since the early 1970s, when it has adopted the flexible exchange rate. During the episode from 2003 to 2004, the Swiss franc did not appreciate much (see Bäurle and Kaufmann (2014)). Under both episodes of the zero-interest rate environment with the currency appreciation, the Swiss National Bank's policy has been effectively to introduce a minimum exchange rate against the German mark (in the 1970 episode) and the Euro (in the 2008 episode)[31]. In addition, the Japanese experiences with the zero interest rate in the second half of the 1990s and in recent years has been associated with an appreciation

31. See Bernholz (2007) and SNB (2011).

of the Yen, in particular, relative to the US dollar. This forces the Bank of Japan to make foreign-exchange operations in order to invert the path of exchange rate.

The actions undertaken by the central banks in the two cases of the currency appreciation in the face of a binding zero bound impairs the long term credibility of the monetary policy and causes somewhat a conflict with other policy objectives. In addition, the studies of McCallum (2000), Svenson (2001, 2009) and Orphanides and Wieland (2000), proposing the monetary policy as an exit strategy, focus on the intentional depreciation of exchange rate when the interest rate is stuck at the zero bound (i.e. an ex post intervention). The propositions of these authors may also suffer from the central bank's credibility and require intervening in the foreign-exchange markets.

We argue in this work that an effective policy can be undertaken beforehand in order to dampen the negative impacts of deflationary shocks. Indeed, by showing that the severity of the ZLB constraint is endogenous to the monetary policy regime, this work recommends central banks to prefer an ex ante policy regime that translates into a commitment for a high expected future inflation when the liquidity trap lasts. In this purpose, the currency union as a choice of monetary regime should be preferred to the independent floating regime. Furthermore, if a country decides to keep its own currency instead to be in a currency union, the effective policy to avoid more pronounced and prolonged effects of deflationary and recessionary shocks is to move from flexible regime to the managed floating, which outperforms the monetary union in short-term. This occurs since the managed floating, by depreciating the nominal exchange rate, anchors agents' expectations for high inflation in the end of the ZLB period.

Instead of considering the ex post exit strategy, our view is the endogenous preventive strategy in the face of the liquidity trap. Contrary to the common belief during the Euro crisis, to be a member of the monetary union protects a country against worst and prolonged effects of the liquidity trap, all else equal. Targeting the exchange rate as a usual monetary policy has a more protecting power against adverse effects of the liquidity trap compared to the inflation targeting alone for countries which evolve with their own currencies.

Our welfare analysis supports these results conditionally to the assumption on the asset market structure and the degree of substitution between domestic and foreign goods. In fact, we show that the currency union, as well as the managed floating, welfare-dominate the independent floating regime when asset markets are complete and the elasticity of substitution is low or when asset markets are incomplete and this elasticity is high.

Appendix C

C.1. Equilibrium conditions

Here we list the equilibrium condtions of all model versions for domestic and foreign countries. The foreign variables are marked with asterisk (*).

— Demand for goods

$$C_{N,t} = (1-\alpha)\left(\frac{1}{f(Q_t)}\right)^{-\nu} C_t, \qquad C^*_{N,t} = (1-\alpha)\left(\frac{1}{f^*(Q^*_t)}\right)^{-\nu} C^*_t \tag{C.1.1}$$

$$C_{H,t} = \alpha\omega\left(\frac{1}{f(T_t)}\right)^{-\kappa}\left(\frac{Q_t}{f(Q_t)}\right)^{-\nu} C_t, \qquad C^*_{F,t} = \alpha\omega\left(\frac{1}{f^*(T^*_t)}\right)^{-\kappa}\left(\frac{Q^*_t}{f^*(Q^*_t)}\right)^{-\kappa} C^*_t \tag{C.1.2}$$

$$C_{F,t} = \alpha(1-\omega)\left(\frac{T_t}{f(T_t)}\right)^{-k}\left(\frac{f(Q_t)}{Q_t}\right)^{\nu} C_t, \quad C^*_{H,t} = \alpha(1-\omega)\left(\frac{T^*_t}{f^*(T^*_t)}\right)^{-\kappa}\left(\frac{f^*(Q^*_t)}{Q^*_t}\right)^{\nu} c^*_t \tag{C.1.3}$$

— Real wages

$$\frac{N_t^{\eta}}{C_t^{-\sigma}} = \frac{W_t}{P_t} = w_t, \qquad \frac{N_t^{*\eta}}{C_t^{*-\sigma}} = \frac{W^*_t}{P^*_t} = w^*_t \tag{C.1.4}$$

— Euler equation for Consumption

$$\beta E_t\left[\frac{(1+i_t)}{\Pi_{t+1}}\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\frac{\varepsilon_{t+1}}{\varepsilon_t}\right] = 1, \qquad \beta E_t\left[\frac{(1+i^*_t)}{\Pi^*_{t+1}}\left(\frac{C^*_{t+1}}{C^*_t}\right)^{-\sigma}\frac{\varepsilon^*_{t+1}}{\varepsilon^*_t}\right] = 1 \tag{C.1.5}$$

— Risk sharing condition (Complete asset markets)

$$RR_t = \frac{C_t^{*-\sigma}\varepsilon^*_t}{C_t^{-\sigma}\varepsilon_t}, \tag{C.1.6}$$

— Real marginal costs

$$mc_{H,t} = \frac{w_{T,t}}{A_{H,t}}\frac{f(Q_t)f(T_t)}{Q_t}, \qquad mc^*_{F,t} = \frac{w^*_T}{A^*_{F,t}}\frac{f^*(Q^*_t)f^*(T^*_t)}{Q^*_t} \tag{C.1.7}$$

$$mc_{N,t} = \frac{w_N}{A_{N,t}}f(Q_t), \qquad mc_{N,t} = \frac{w^*_T}{A^*_{N,t}}f^*(Q^*_t) \tag{C.1.8}$$

— Production functions

$$Y_{H,t} = A_{H,t}A_{H,t}, \qquad Y^*_{F,t} = A^*_{F,t}N^*_{F,t} \tag{C.1.9}$$

$$Y_{N,t} = A_{N,t}N_{N,t}, \qquad Y^*_{N,t} = A^*_{N,t}N^*_{N,t} \tag{C.1.10}$$

— Resource constraints and market clearing conditions

$$Y_{H,t} = C_{H,t} + C^*_{H,t}, \qquad Y^*_{F,t} = C^*_{F,t} + C_{F,t} \tag{C.1.11}$$

$$Y_{N,t} = C_{N,t}, \qquad Y^*_{N,t} = C^*_{N,t} \tag{C.1.12}$$

$$N_t = N_{H,t} + N_{N,t}, \qquad N^*_t = N^*_{H,t} + N^*_{N,t} \tag{C.1.13}$$

$$Y_t = Y_{H,t} + Y_{N,t}, \qquad Y^*_t = Y^*_{H,t} + Y^*_{N,t} \tag{C.1.14}$$

— Phillips curve for tradable goods

$$A1_t = C_t^{-\sigma}\varepsilon_t Y_{H,t} mc_{H,t} + \beta\phi^T E_t \Pi^{\epsilon}_{H,t+1} A1_{t+1} \tag{C.1.15}$$

$$A2_t = C_t^{-\sigma}\varepsilon_t Y_{H,t} + \beta\phi^T E_t \Pi^{\epsilon-1}_{H,t+1} A2_{t+1} \tag{C.1.16}$$

$$\Pi^n_{H,t} = \Pi_{H,t}\frac{\epsilon}{\epsilon-1}\frac{A1_t}{A2_t} \tag{C.1.17}$$

$$\Pi_{H,t} = \left[(1-\phi^T)(\Pi^n_{H,t})^{1-\epsilon} + \phi^T\right]^{\frac{1}{1-\epsilon}} \tag{C.1.18}$$

$$A1^*_t = C_t^{*-\sigma}\varepsilon^*_t Y^*_{F,t} mc^*_{F,t} + \beta\phi^T E_t \Pi^{*\epsilon}_{F,t+1} A1^*_{t+1} \tag{C.1.19}$$

$$A2^*_t = C_t^{*-\sigma}\varepsilon^*_t Y^*_{F,t} + \beta\phi^T E_t \Pi^{*\epsilon-1}_{F,t+1} A2^*_{t+1} \tag{C.1.20}$$

$$\Pi^{*n}_{F,t} = \Pi^*_{F,t}\frac{\epsilon}{\epsilon-1}\frac{A1^*_t}{A2^*_t} \tag{C.1.21}$$

$$\Pi^*_{F,t} = \left[(1-\phi^T)(\Pi^{*n}_{F,t})^{1-\epsilon} + \phi^T\right]^{\frac{1}{1-\epsilon}} \tag{C.1.22}$$

— Evolution of the tradable price dispersion

$$v_{H,t} = (1-\phi^T)\left(\frac{\Pi_{H,t}}{\Pi^n_{H,t}}\right)^{\epsilon} + \phi^T\Pi^{\epsilon}_{H,t}v_{H,t-1} \tag{C.1.23}$$

$$v^*_{F,t} = (1-\phi^T)\left(\frac{\Pi^*_{F,t}}{\Pi^{*n}_{F,t}}\right)^{\epsilon} + \phi^T\Pi^{*\epsilon}_{F,t}v^*_{H,t-1} \tag{C.1.24}$$

— Phillips Curves for non-tradable goods

$$X1_t = C_t^{-\sigma}\varepsilon_t Y_{N,t} mc_{N,t} + \beta\phi^N E_t \Pi_{N,t+1}^{\epsilon} X1_{t+1} \tag{C.1.25}$$

$$X2_t = C_t^{-\sigma}\varepsilon_t Y_{N,t} + \beta\phi^N E_t \Pi_{N,t+1}^{\epsilon-1} X2_{t+1} \tag{C.1.26}$$

$$\Pi_{N,t}^n = \Pi_{N,t}\frac{\epsilon}{\epsilon-1}\frac{X1_t}{X2_t} \tag{C.1.27}$$

$$\Pi_{N,t} = \left[(1-\phi^N)(\Pi_{N,t}^n)^{1-\epsilon} + \phi^N\right]^{\frac{1}{1-\epsilon}} \tag{C.1.28}$$

$$X1_t^* = C_t^{*-\sigma}\varepsilon_t^* Y_{N,t}^* mc_{N,t} + \beta\phi^N E_t \Pi_{N,t+1}^{*\varepsilon} X1_{t+1}^* \tag{C.1.29}$$

$$X2_t^* = C_t^{*-\sigma}\varepsilon_t^* Y_{N,t}^* + \beta\phi^N E_t \Pi_{N,t+1}^{*\epsilon-1} X2_{t+1}^* \tag{C.1.30}$$

$$\Pi_{N,t}^n = \Pi_{N,t}^*\frac{\epsilon}{\epsilon-1}\frac{X1_t^*}{X2_t^*} \tag{C.1.31}$$

$$\Pi_{N,t}^* = \left[(1-\phi^N)(\Pi_{N,t}^{*n})^{1-\epsilon} + \phi^N\right]^{\frac{1}{1-\epsilon}} \tag{C.1.32}$$

— Evolution of the non-tradable price dispersion

$$v_{N,t} = (1-\phi^N)\left(\frac{\Pi_{N,t}}{\Pi_{N,t}^n}\right)^{\epsilon} + \phi^N \Pi_{N,t}^{\epsilon} v_{N,t-1} \tag{C.1.33}$$

$$v_{N,t}^* = (1-\phi^N)\left(\frac{\Pi_{N,t}}{\Pi_{N,t}^n}\right)^{\epsilon} + \phi^N \Pi_{N,t}^{\epsilon} v_{N,t-1}^* \tag{C.1.34}$$

— Open economy relations

$$\frac{P_{T,t}}{P_{H,t}} = \left[\omega + (1-\omega)(T_t)^{1-\kappa}\right]^{\frac{1}{1-\kappa}} \equiv f(T_t), \qquad \frac{P_{T,t}^*}{P_{F,t}^*} = \left[\omega + (1-\omega)(T_t^*)^{1-\kappa}\right]^{\frac{1}{1-\kappa}} \equiv f^*(T_t^*) \tag{C.1.35}$$

$$\frac{P_t}{P_{N,t}} = \left[\alpha(Q_t)^{1-\nu} + (1-\alpha)\right]^{\frac{1}{1-\nu}} \equiv f(Q_t), \qquad \frac{P_t^*}{P_{N,t}^*} = \left[\alpha(Q_t^*)^{1-\nu} + (1-\alpha)\right]^{\frac{1}{1-\nu}} \equiv f^*(Q_t^*) \tag{C.1.36}$$

$$\frac{\Pi_{T,t}}{\Pi_{H,t}} = \frac{f(T_t)}{f(T_{t-1})}, \qquad \frac{\Pi_{T,t}^*}{\Pi_{F,t}^*} = \frac{f^*(T_t^*)}{f^*(T_{t-1}^*)} \tag{C.1.37}$$

$$\frac{Q_t}{Q_{t-1}} = \frac{\Pi_{T,t}}{\Pi_{N,t}}, \qquad \frac{Q_t^*}{Q_{t-1}^*} = \frac{\Pi_{T,t}^*}{\Pi_{N,t}^*} \tag{C.1.38}$$

$$\frac{f(Q_t)}{f(Q_{t-1})} = \frac{\Pi_t}{\Pi_{N,t}}, \qquad \frac{f^*(Q_t^*)}{f^*(Q_{t-1}^*)} = \frac{\Pi_t^*}{\Pi_{N,t}^*} \tag{C.1.39}$$

$$RR_t = \frac{f^*(Q_t^*)Q_t f^*(T_t^*)T_t}{Q_t^* f(Q_t) f(T_t)}, \qquad RR_t^* = \frac{1}{RR_t} \tag{C.1.40}$$

— Relations from PCP

$$\frac{T_t}{T_{t-1}} = \frac{S_t}{S_{t-1}} \frac{\Pi^*_{F,t}}{\Pi_{H,t}}, \qquad T^*_t = \frac{1}{T_t} \tag{C.1.41}$$

— Monetary regimes

- Independent Floating

$$i_t = \max(Z_t, 0), \qquad i^*_t = \max(Z^*_t, 0) \tag{C.1.42}$$

$$Z_t = \frac{1}{\beta}\left(\frac{\Pi_t}{\Pi}\right)^{\varphi_1} - 1, \qquad Z^*_t = \frac{1}{\beta}\left(\frac{\Pi^*_t}{\Pi^*}\right)^{\varphi_1} - 1 \tag{C.1.43}$$

- Monetary Union

$$i^{cu}_t = \max(Z^{cu}_t, 0) \tag{C.1.44}$$

$$Z^{cu}_t = \frac{1}{\beta}\left(\frac{\Pi^{cu}_t}{\Pi^{cu}}\right)^{\varphi_1} - 1 \tag{C.1.45}$$

— Exogenous shocks

$$\log(\varepsilon_t) = \rho_\varepsilon \log(\varepsilon_{t-1}) + e_{\varepsilon,t}, \qquad \log(\varepsilon^*_t) = \rho_\varepsilon \log(\varepsilon^*_{t-1}) + e^*_{\varepsilon,t} \tag{C.1.46}$$

$$\log(A_{H,t}) = \rho_A \log(A_{H,t-1}) + e_{A,t}, \qquad \log(A^*_{F,t}) = \rho_A \log(A^*_{F,t-1}) + e^*_{A,t} \tag{C.1.47}$$

$$\log(A_{N,t}) = \rho_A \log(A_{N,t-1}) + e_{A,t}, \qquad \log(A^*_{N,t}) = \rho_A \log(A^*_{N,t-1}) + e^*_{A,t} \tag{C.1.48}$$

— Risk sharing condition (Incomplete asset markets)

$$\frac{\varepsilon^*_{t+1} C^{*-\sigma}_{t+1}}{\varepsilon^*_t C^{*-\sigma}_t} = \frac{\varepsilon_{t+1} C^{-\sigma}_{t+1}}{\varepsilon_t C^{-\sigma}_t} \frac{RR_{t+1}}{RR_t} \Gamma_t(\cdot\,) \tag{C.1.49}$$

$$\Gamma_t(\cdot\,) = \exp[-\gamma(\frac{S_t B^*_t}{P_t})] \tag{C.1.50}$$

— Net Foreign Asset position (Incomplete finacial markets)

$$\frac{S_t B^*_t}{(1+i^*_t)\Gamma_t\left(\frac{S_t B^*_t}{P_t}\right) P_t} = \frac{S_t B^*_{t-1}}{P_t} + \frac{1}{f(T_t)} \frac{Q_t}{f(Q_t)} C^*_{H,t} - \frac{T_t}{f(T_t)} \frac{Q_t}{f(Q_t)} C_{F,t} \tag{C.1.51}$$

— Definitions

$$\Pi_t = \frac{P_t}{P_{t-1}}, \qquad \Pi_t^* = \frac{P_t^*}{P_{t-1}^*} \tag{C.1.52}$$

$$\Pi_{H,t} = \frac{P_{H,t}}{P_{H,t-1}}, \qquad \Pi_{F,t}^* = \frac{P_F^*}{P_{F,t-1}^*} \tag{C.1.53}$$

$$\Pi_{T,t} = \frac{P_{T,t}}{P_{T,t-1}}, \qquad \Pi_{T,t}^* = \frac{P_{T,t}^*}{P_{T,t-1}^*} \tag{C.1.54}$$

$$\Pi_{N,t} = \frac{P_{N,t}}{P_{N,t-1}}, \qquad \Pi_{N,t}^* = \frac{P_{N,t}^*}{P_{N,t-1}^*} \tag{C.1.55}$$

$$P_{H,t} = S_t P_{H,t}^* \qquad P_{F,t} = S_t P_{F,t}^* \tag{C.1.56}$$

$$T_t = \frac{P_{F,t}}{P_{H,t}} \qquad T_t^* = \frac{P_{H,t}^*}{P_{F,t}^*} \tag{C.1.57}$$

$$Q_t = \frac{P_{T,t}}{P_{N,t}} \qquad Q_t^* = \frac{P_{T,t}^*}{P_{N,t}^*} \tag{C.1.58}$$

— LCP implications

Under the LCP assumption some equilibrium conditions are modified and additional relations of interest are required.

$$P_{H,t} \neq S_t P_{H,t}^* \qquad P_{F,t} \neq S_t P_{F,t}^* \tag{C.1.59}$$

$$lopg_t \equiv \frac{S_t P_{H,t}^*}{P_{H,t}} \qquad lopg_t^* \equiv \frac{S_t P_{F,t}^*}{P_{F,t}} \tag{C.1.60}$$

$$lopg_t = T_t \times T_t^* \times lopg_t^* \tag{C.1.61}$$

- Phillips Curves

$$Z1^*_t = C_t^{-\sigma}\varepsilon_t C^*_{H,t} mc^*_{H,t} + \beta\phi^T E_t \Pi^{*\epsilon}_{H,t+1} Z1^*_{t+1} \tag{C.1.62}$$

$$Z2^*_t = C_t^{-\sigma}\varepsilon_t C^*_{H,t} + \beta\phi^T E_t \Pi^{*\epsilon-1}_{H,t+1} Z2^*_{t+1} \tag{C.1.63}$$

$$\Pi^{*n}_{H,t} = \Pi^*_{H,t}\frac{\epsilon}{\epsilon-1}\frac{Z1^*_t}{A2^*_t} \tag{C.1.64}$$

$$\Pi^*_{H,t} = \left[(1-\phi^T)(\Pi^{*n}_{H,t})^{1-\epsilon} + \phi^T\right]^{\frac{1}{1-\epsilon}} \tag{C.1.65}$$

$$Z1_t = C_t^{*-\sigma}\varepsilon^*_t C_{F,t} mc_{F,t} + \beta\phi^T E_t \Pi^{\epsilon}_{F,t+1} Z1_{t+1} \tag{C.1.66}$$

$$Z2_t = C_t^{*-\sigma}\varepsilon^*_t C_{F,t} + \beta\phi^T E_t \Pi^{\epsilon-1}_{F,t+1} Z2_{t+1} \tag{C.1.67}$$

$$\Pi^n_{F,t} = \Pi_{F,t}\frac{\epsilon}{\epsilon-1}\frac{A1_t}{A2_t} \tag{C.1.68}$$

$$\Pi_{F,t} = \left[(1-\phi^T)(\Pi^n_{F,t})^{1-\epsilon} + \phi^T\right]^{\frac{1}{1-\epsilon}} \tag{C.1.69}$$

$$mc^*_{H,t} = \frac{mc_{H,t}}{lopg_t} \tag{C.1.70}$$

$$mc_{F,t} = mc^*_{F,t} lopg^*_t \tag{C.1.71}$$

- Evolution of the tradable price dispersion

$$v^*_{H,t} = (1-\phi^T)\left(\frac{\Pi^*_{H,t}}{\Pi^{*n}_{H,t}}\right)^{\epsilon} + \phi^T \Pi^{*\epsilon}_{H,t} v^*_{H,t-1} \tag{C.1.72}$$

$$v_{F,t} = (1-\phi^T)\left(\frac{\Pi_{F,t}}{\Pi^n_{F,t}}\right)^{\epsilon} + \phi^T \Pi^{\epsilon}_{H,t} v_{F,t-1} \tag{C.1.73}$$

- Net Foreign Asset position under LCP

$$\frac{S_t B^*_t}{(1+i^*_t)\Gamma_t\left(\frac{S_t B^*_t}{P_t}\right)P_t} = \frac{S_t B^*_{t-1}}{P_t} + \frac{lopg_t}{f(T_t)}\frac{Q_t}{f(Q_t)}C^*_{H,t} - \frac{T_t}{f(T_t)}\frac{Q_t}{f(Q_t)}C_{F,t} \tag{C.1.74}$$

C.2. Steady state

The steady state is symmetric as follow:

$$P = P_H = P_T = P_N = P^* = P_F^* = P_T^* = P_N^* \tag{C.2.75}$$

$$Q = Q^* = RR = RR^* = T = T^* = f(Q) = f(T) = f^*(T^*) = f^* = (Q^*) = 1 \tag{C.2.76}$$

$$Y_H = C_H + C_H^* \tag{C.2.77}$$

$$Y_N = C_N \tag{C.2.78}$$

$$Y = Y_H + Y_N \tag{C.2.79}$$

$$C_H = \alpha\omega C \tag{C.2.80}$$

$$C_H* = \alpha(1-\omega)C^* \tag{C.2.81}$$

$$C_N = (1-\alpha)C \tag{C.2.82}$$

$$C = C^* \tag{C.2.83}$$

$$Y = Y^* \tag{C.2.84}$$

$$Y_H = \alpha\omega C + \alpha(1-\omega)C = \alpha C \tag{C.2.85}$$

$$Y_N = (1-\alpha)C \tag{C.2.86}$$

$$Y = Y_H + Y_N = \alpha C + (1-\alpha)C = C \tag{C.2.87}$$

$$\frac{Y_H}{Y} = \alpha \tag{C.2.88}$$

$$\frac{Y_N}{Y} = 1-\alpha \tag{C.2.89}$$

$$Y_H = N_H \tag{C.2.90}$$

$$Y_N = N_N \tag{C.2.91}$$

$$Y = N \tag{C.2.92}$$

$$N = N_H + N_N \tag{C.2.93}$$

$$\frac{N^\eta}{C^{-\sigma}} = w \tag{C.2.94}$$

$$R = \frac{1}{\beta} \tag{C.2.95}$$

$$\Pi = 1 = \Pi^* \tag{C.2.96}$$

$$mc_H = w \tag{C.2.97}$$

$$mc_N = w \tag{C.2.98}$$

$$mc_H = \frac{\epsilon - 1}{\epsilon} \tag{C.2.99}$$

$$mc_N = \frac{\epsilon - 1}{\epsilon} \tag{C.2.100}$$

$$Y = N = C \tag{C.2.101}$$

$$\frac{C^{\eta}}{C^{-\sigma}} = w = \frac{\epsilon - 1}{\epsilon} \tag{C.2.102}$$

$$v_H = v_N = v_H^* = v_F^* = v_N^* = v_F = 1 \tag{C.2.103}$$

C.3. Welfare calculation

The welfare metric u solves:

$$E_t \sum_{t=0}^{\infty} \beta^t \left\{ \varepsilon_t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\eta}}{1+\eta} \right] \right\} = \frac{1}{1-\beta} \left[\frac{1}{1-\sigma} \left((1 + \frac{u}{100}) C \right)^{1-\sigma} - \frac{N^{1+\eta}}{1+\eta} \right] \tag{C.3.104}$$

Let,

$$\mho_t(\varepsilon_t, C_t, N_t) = E_t \sum_{t=0}^{\infty} \beta^t \left\{ \varepsilon_t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\eta}}{1+\eta} \right] \right\} \tag{C.3.105}$$

be the expected utility function.

We can define two auxiliary value functions such that:

$$\mho_t(\varepsilon_t, C_t, N_t) = V_t^C(\tilde{C}_t) + V_t^N(\tilde{N}_t) \tag{C.3.106}$$

$$V_t^C(\tilde{C}_t) = E_t \sum_{t=0}^{\infty} \beta^t \frac{\tilde{C}_t^{1-\sigma}}{1-\sigma} \tag{C.3.107}$$

$$V_t^C(\tilde{N}_t) = -E_t \sum_{t=0}^{\infty} \beta^t \frac{\tilde{N}_t^{1+\eta}}{1+\eta} \tag{C.3.108}$$

where $\tilde{C}_t$ and $\tilde{N}_t$ are consumption and labor allocations under the effect of the shock ε_t. The equivalent expressions in steady state are, respectively:

$$\mho(C, N) = V^C(C) + V^N(N) \tag{C.3.109}$$

$$V^C(C) = \frac{1}{(1-\beta)} \frac{C^{1-\sigma}}{1-\sigma} \tag{C.3.110}$$

$$V^C(N) = -\frac{1}{(1-\beta)} \frac{N^{1+\eta}}{1+\eta} \tag{C.3.111}$$

The relation (C.4.105) becomes:

$$\mho_t(\varepsilon_t, C_t, N_t) = \frac{1}{1-\beta}\left[\frac{1}{1-\sigma}\left((1+\frac{u}{100})C\right)^{1-\sigma} - \frac{N^{1+\eta}}{1+\eta}\right] \tag{C.3.112}$$

$$\Rightarrow \left(\mho_t + \frac{1}{(1-\beta)}\frac{N^{1+\eta}}{1+\eta}\right) = \frac{1}{(1-\beta)}\frac{C^{1-\sigma}}{1-\sigma}\left(1+\frac{u}{100}\right)^{1-\sigma} \tag{C.3.113}$$

$$\Rightarrow \left(\frac{\mho_t - V^N(N)}{V^C(C)}\right) = \left(1+\frac{u}{100}\right)^{1-\sigma} \tag{C.3.114}$$

$$\Rightarrow u = 100 \times \left[\left(\frac{\mho_t - V^N}{V^C}\right)^{\frac{1}{1-\sigma}} - 1\right] \tag{C.3.115}$$

Chapter 4

Currency misalignments, exchange rate regimes and liquidity trap

CHAPTER 4 - CURRENCY MISALIGNMENTS, EXCHANGE RATE REGIMES AND LIQUIDITY TRAP

4.1. Introduction

There is currency misalignment when the observed exchange rate deviates from its long-run path. This is generally interpreted as a currency overvaluation or undervaluation. The recent years have been marked by a resurgence of the interest of the policy makers and academicians in the study of currency misalignments for both developed and developing countries. Indeed, the links between currency misalignments and some main macroeconomic variables have been recognised in the literature over the years: (i) economic growth could be strongly affected by currency misalignment which remains a cyclical instrument through its effects on trade and competitiveness (Rodrik (2008), Couharde and Sallenave (2013), Haussman et al.(2005)), and on allocation of resources across goods and sectors (see Corsetti and Pesenti (2005), Engel (2011), among others). In particular, many emerging countries deliberately use their currency level in order to boost their economic growth (for instance, the recent Chinese devaluation of the Yuan for dealing with the economic downturn is illustrative); (ii) currency misalignment may be viewed as an indicator for future realignments from which currency crises can emerge (Holtemöller and Mallick (2013), Bussière and Fratzscher (2006), Bukart and Coudert (2002), Kaminsky and Reinhart (1999)); (iii) a persistent misalignment plays a role in creating and eliminating current account imbalances (Kaminsky et al. (1998), Feldstein (2011), Saadaoui (2015)); (iv) finally and above all, currency misalignment is commonly associated with the choice of exchange rate regimes and viewed to some extent as an indicator of monetary integration. From this perspective, using a sample of developed and developing countries Dubas (2009) shows that misalignment is more pronounced in the floating regime than in other regimes. By contrast, Coudert and Couharde (2009) and Holtemöller and Mallick (2013) found that a fixed exchange rate regime leads to more misalignment than the floating one. A sample of emerging and developing countries was used by the first authors while the second ones have used a sample of developed and developing countries. Coudert et al. (2013) point out the rise in misalignment on average within the Euro area since the beginning of monetary union. Couharde et al. (2013) using a currency misalignment index show that the CFA zone is a sustainable currency area while Hoffmann (2007) argues that the flexible exchange rate regime facilitates a smooth adjustment process and stabilise macroeconomic variables in developing economies in the face of external shocks compared with the fixed exchange rate regime. Furthermore, in relation to countries that plan to join a monetary union, currency misalignment is a determinant of the correct entry rate for the nominal exchange rate and the timing for adopting the single currency.

However, besides the fact that they are all empirical, the effects of a monetary policy context such as the liquidity trap on the link between currency misalignment and the choice of exchange rate regime have been neglected in the studies cited above. Thus, in the light of the recent episodes of the very low interest rate experienced in many developed countries and some emerging countries [1], it is questionable whether this policy context, commonly called the "Zero Lower Bound" (henceforth ZLB) or liquidity trap environment, particularly affects the levels of currency misalignments in these countries and whether the monetary regime matters for its potential effects. This chapter aims to explore the impacts of the liquidity trap on the currency misalignment and investigates the implications of such effects in terms of the choice of currency regimes and of monetary integration.

It should be noted that the literature on the ZLB constraint, which is essentially theoretical, has until now focused on the issue of exiting from the liquidity trap. This work is in our knowledge one of the first studies addressing the effects of the liquidity trap on the interaction between currency misalignment and the monetary regime. We perform our analysis by considering two monetary regimes: the currency union (henceforth CU) and the independent monetary policy or floating regime (henceforth IMP).

The contribution of this chapter is both empirical and theoretical.

4.1.1. Empirical contribution

Our major empirical contribution is to show that there is a difference among levels of currency misalignments in "normal" and liquidity trap times, and that monetary regimes matter for this difference. Indeed, we show that the currency union reduces misalignments when the ZLB constraint is binding compared with the independent floating regime. For our analysis, using quarterly data for 21 countries (splited in CU members and IMP countries or floaters)

1. Some emerging countries like Bulgaria, Israel, Singapore and Kingdom of Bahrain have recently implemented a near zero interest rate policy.

that have experienced the episodes of very low interest rates over the period 1999Q1-2014Q4, we first estimate the long-run relation between observed real exchange rates and their long-run determinants. Second, we calculate currency misalignments as the difference between observed real exchange rates and estimated long-run exchange rates. We finally relate currency misalignments to the ZLB constraint, defined as a dummy variable, through both an econometric regression that account for their correlation and the mean comparison tests among levels of misalignments under different monetary regimes when the ZLB constraint binds.

Our first finding is that misalignments are generally higher in the period without the ZLB constraint compared with the ZLB period under the CU regime, whereas this difference does not exist under the IMP regime. In addition, we remarkably find that, during the liquidity trap, the currency misalignment is larger under the IMP regime than under the CU, suggesting that the CU insulates countries from potential large misalignments arising with the independent policy in the liquidity trap. These empirical results are novel in the abovementioned literature on currency misalignments.

We further interpret and rationalize these findings using an analytical "New Keynesian" model.

4.1.2. Theoretical contribution

On the theoretical side, our contribution is to derive analytically the currency misalignment relative to the long-term (and efficient) allocation and simulate it under the ZLB constraint in order to interpret the empirical findings. In this respect, we develop a two-sector two-country dynamic stochastic general equilibrium model in which the currency misalignment is defined as the gap between the actual real exchange rate and its value that prevails when prices are flexible and the net exports are zero (corresponding to the efficient allocation). Therefore, our theoretical concept of the long-run exchange rate is distinct from the few existing studies and goes beyond these. Indeed, in a two-sector small open economy Edwards (1988) simply refers to the long-run sustainable equilibrium attained when the non-tradable goods market and the external sector (current account and balance of payments) are simultaneously in equilibrium. Whereas, Engel (2011)'s model contains only one good sector and defines the currency misalignment as the average deviation of consumer prices across two countries.

Furthermore, our supplementary theoretical and not the least contribution is to make endogenous the duration of the liquidity trap.

As a common practice in the ZLB literature, we assume that the liquidity trap is caused by an adverse taste (or demand) shock sufficiently large to constrain the interest rate at its zero floor. We compare currency misalignments among monetary regimes during "tranquil" and liquidity trap times.

Without the liquidity trap (i.e. in "tranquil" times), we find that the levels of currency misalignments are higher under the monetary union than the independent policy. This result is reversed during the liquidity trap. Indeed, in line with the empirical results, we find that currency misalignments in the liquidity trap are larger under the IMP regime than under the CU due to the perverse appreciation of exchange rate occurring in the former regime. By contrast, in times without the ZLB constraint the IMP regime outperforms the CU regime in terms of the size of the currency misalignment.

Overall our theoretical and empirical results suggest that the currency union tends to reduce currency misalignments during the liquidity trap compared with the IMP regime, and that the liquidity trap increases the convergence speed of the real exchange rate towards its long-run level irrespective of the nature of monetary regimes. These findings have economic policy implications in terms of timing to join a currency union, the decision of opting for the currency union or the flexible exchange rate and ultimately in terms of monetary integration.

The remainder of the chapter is organized as follows: Section 4.2 lays out the empirical investigation including the data description, panel unit root and cointegration tests, the long-run exchange rate estimation, the misalignment calculation, the estimation and tests on the relation between currency misalignments and the ZLB constraint. Section 4.3 presents the two-sector two-country model, calibration and solution strategy of the model, the model simulation in and outside the liquidity trap and the result analysis. Section 4.4 concludes and provides some policy implications.

4.2. Empirical investigation

The aim of our empirical analysis is to know whether or not the ZLB constraint affects both real exchange rate misalignments and short-term dynamics, and additionally to what extent this effect differs among exchange rate regimes. To do this, we adopt the following empirical methodology. First, we estimate the long-run relationship between real exchange rates and fundamentals, which are the long-run determinants. Then, we derive currency misalignments as the gap between the observed real exchange rate and the estimated long-run real exchange rate. Finally, we assess the links between the ZLB constraint and both the exchange rate misalignment and short-term dynamic.

4.2.1. Determination of long-run exchange rates

Although it is difficult, if not impossible, to predict the exchange rate in the short run, the views from many authors converge on the fact that the real exchange rate behaviour in the medium and long terms can be explained, to some extent, by the change in a set of economic fundamentals (Couharde and Sallenave (2013), Edwards (1988), Engel et al. (2007), Faruqee (1994), Obstfeld and Rogoff (1995), among others). There are different approaches in the empirical literature to determine the long-run exchange rate: the purchasing power parity (PPP) introduced by Cassel (1918), the natural rate of exchange rate (NATREX) proposed by Stein (1994) and the behavioural equilibrium exchange rate (BEER) developed by Clark and MacDonald (1998) [2].

Since the PPP approach imposes a strong assumption on the long-run exchange rate (which should be constant) and the NATREX approach considers both the medium and long runs, we adopt the Behavioural Equilibrium Exchange Rate (BEER) approach which allows the real exchange rate to evolve around a time-varying equilibrium value (i.e. the long-run exchange rate) and considers only the long-run horizon. According to this empirical approach, the equilibrium exchange rate is related to a set of fundamentals (terms of trade, productivity differential, degree of openness, net foreign asset position and government spending) which varies from one study to another [3].

In order to be in line with our subsequent theoretical framework, we retain two fundamentals in our empirical evidence [4]: the terms of trade and the productivity differential. Therefore, the specification of the long-run real exchange rate in relation with its fundamentals is given by

2. The fundamental equilibrium exchange rate (FEER) developed by Williamson (1994) is also used to calculate the equilibrium exchange rate, but it considers the medium term. For more complete taxonomies of equilibrium exchange rates, see MacDonald (2000) and Driver and Westaway (2005).

3. For instance, Couharde and Sallenave (2013) and Coudert et al. (2013) retain the net foreign asset position and the productivity differential, while Couharde et al. (2013) take into account the net foreign asset position, the productivity differential and the terms of trade in explaining the long-run real exchange rate behaviour. Coulibaly and Gnimassoun (2013) choose the terms of trade, the net foreign asset position, the productivity differential and the government spending as determinants of equilibrium exchange rates.

4. We have performed our empirical investigation with additional fundamentals such as the current account and trade openness. Our results presented later were unchanged.

the following equation:

$$\log RER_{i,t} = \alpha_i + \gamma_1 \log PROD_{i,t} + \gamma_2 \log TOT_{i,t} + \varepsilon_{i,t} \tag{4.1}$$

where $i = 1, 2, ..., N$ denotes countries and $t = 1, 2, ..., T$ time periods. RER is country's real effective exchange rate, $PROD$ its relative sectorial productivity and TOT measures its terms of trade. γ_1 and γ_1 are coefficients associated with productivity differentials and terms of trade, respectively. α_i accounts for country-specific fixed effects and $\varepsilon_{i,t}$ is an error term. "log" represents the natural logarithm. All variables are defined in the subsection below.

We expect a negative long-run relation between the real exchange rate and its two determinants in (4.1) [5] . Indeed, the productivity differential refers to the Balassa-Samuelson effect, which means that an increase in productivity in the traded goods sector relative to the non-traded goods sector raises the real wage in both sectors, and as consequence the relative price and cost increase in the non-traded goods sector. As a result, the real exchange rate appreciates [6]. Concerning the terms of trade, its augmentation tends to appreciate the real exchange rate. In particular, an increase in terms of trade, meaning that it improves, augments the income by increasing output in the tradable goods sector and improving trade balance. This leads to a real exchange rate appreciation. Before estimating the long-run relation in (4.1), we have to present our variables and data. Furthermore, we need to apply unit root and cointegration tests to our data in order to avoid a spurious or biased regression.

4.2.1.1. Data, Panel unit root and Cointegration Tests

We consider quarterly data over the period 1999Q1-2014Q4 for two samples of countries that have experienced the episodes of very low interest rates (the ZLB constraint) during the last two decades: a sample of countries which belong to a currency union (henceforth CU countries) and a sample of countries which have their own currencies (called as independent monetary policy (IMP) countries or floaters). The panel of the monetary union includes 12 founding countries of the Eurozone: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. The panel of 9 IMP countries contains: Canada, Czech Republic, Denmark, Israel, Japan, Sweden, Switzerland, United Kingdom and United

5. The real effective exchange rate is defined such as its reduction corresponds to an appreciation.

6. The assumption behind this mechanism is the labour mobility and wage equalization across sectors (perfect competition).

States.

The real effective exchange rate for each country is defined as a weighted average of real bilateral exchange rates against its ten main trading partners over the whole of our study period. We compute the real effective exchange rate as follows:

$$RER_{i,t} = \prod_{j=1}^{K} \left(\frac{S_{ij,t} P_{j,t}}{P_{i,t}} \right)^{\omega_{j,t}} \tag{4.2}$$

where $RER_{i,t}$ denotes the country i's real effective exchange rate at time t, $j = 1, 2, ..., K = 10$ is the number of trading partners of country i, $S_{ij,t}$ is country i's bilateral nominal exchange rate against its partner j (defined as the price of foreign currency in terms of domestic currency). For partners within the monetary union, $S_{ij,t} = 1$. $P_{i,t}$ (respectively $P_{j,t}$) defines country i (respectively j)'s consumer price index.

$\omega_{j,t}$ are time-varying trade weights of each partner j in the total trade of country i over the whole period of the study [7]. They are calculated as total of trade between countries i and j divided by total of trade of country i:

$$\omega_{j,t} = \frac{(X + M)_{ij,t}}{(X + M)_{i,t}} \tag{4.3}$$

where $\sum_{j=1}^{K} \omega_{j,t} = 1$ for each country i, and X and M being respectively the exports and imports.

Following the literature, the productivity differential of each country i ($PROD_{i,t}$) is defined by a proxy, GDP per capita relative to its ten main trading partners, using the same weights as for the real effective exchange rate calculation [8]:

$$PROD_{i,t} = \frac{(GDP/capita)_{i,t}}{\prod_{j=1}^{K} (GDP/capita)_{j,t}^{\omega j,t}} \tag{4.4}$$

where GDP is the gross domestic product and capita corresponds to the population in line with the World Bank's measure of GDP per capita.

The terms of trade variable ($TOT_{i,t}$) is calculated as the ratio between the price of imports and

7. We choose time-varying trade weights instead of constant weights in order to take into account trade dynamics and the changes in trade profiles of countries over the period.

8. GDP per capita is generally correlated to the productivity level. This proxy is also used by Coudert et al. (2013), Couharde et al. (2013) and Galstyan and Lane (2009).

exports of the country i. We use the price deflators of imports and exports, respectively, as proxies for the price of imports and the price of exports.

All data sources are given in Appendix D.1. We have to conduct now the panel unit root test in order to determine the order of integration of each variable and test the existence of a cointegrating relationship between the real effective exchange rate and its economic fundamentals. To this end, we undertake the first and second generation panel unit root tests: Maddala and Wu (1999) test is the one of the first generation that imposes the cross-sectional independence and allows for heterogeneity in the unit root process. We further use Pesaran (2007)'s second generation panel unit test, which allows the cross-sectional dependence. Both tests have as the null hypothesis that all panels contain unit roots. The statistic results of tests for our two groups of countries are presented in Table 4.1. According to these tests, we do not reject the null hypothesis of unit root for all series of our two samples at the conventional significance level [9]. Therefore, our series are non-stationary and integrated.

Table 4.1 – Unit root tests for CU countries and IMP countries

Variables	**CU Countries**				**IMP Countries**			
	Maddala and Wu test		Pessaran test		Maddala and Wu test		Pessaran test	
	With Constant	With Constant and Trend	With Constant	With Constant and Trend	With Constant	With Constant and Trend	With Constant	With Constant and Trend
$log(RER)$	26.739	18.893	-2.381***	-1.511**	13.292	4.963	1.125	3.204
$log(PROD)$	26.681	20.499	-0.870	-2.090**	16.710	10.977	-0.100	2.365
$log(TOT)$	42.832***	45.806***	-0.419	0.372	19.925	19.597	-0.672	-0.925

Notes: ***, ** and * indicate the rejection of the null hypothesis of non-stationarity at the 1%, 5% and 10% significance levels respectively. The optimal lags are chosen by considering the Akaike information criterion.

We now proceed to panel cointegration tests. We implement two types of tests in order to get a robust decision concerning the cointegration relation among the variables: the recent error-correction based test proposed by Westerlund (2007) and Pedroni (1999, 2004)'s panel cointegration tests. These tests are based on the null hypothesis of no cointegration among

9. The decision of the null hypothesis rejection for each variable is conditional to both tests and data generating models. For example, the real exchange rate in CU countries does not contain a unit root according to Pesaran (2007)'s test with the model containing a constant but the same variable contains a unit root according to Maddala and Wu (1999)'s test with the model including a constant. As a precaution, we reasonably conclude that this variable contains a unit root.

series. Westerlund's tests provide four test statistics depending on the assumption of homogeneity (G_t and G_a) or heterogeneity (P_t and P_a) of the error-correction coefficients among cross-sections. Moreover, the decisions of Pedroni's tests are based on seven test statistics: four rely on the assumption of common unit root processes across countries and three others statistics assume different unit root processes for individual countries. Table 4.2 displays all statistics and results of both Westerlund and Pedroni tests, showing that we can reasonably reject the null hypothesis of no cointegration between the three considered variables [10]. There exists in that case a stable long-run relationship between real effective exchange rates and their fundamentals for the two samples of countries. The cointegration relation among variables being established, we now conduct the estimation of the long-run relationship before deriving the corresponding misalignments.

4.2.1.2. Estimation of equilibrium exchange rates

Since the considered variables are non-stationary and cointegrated, we focus on the panel dynamic OLS (DOLS) [11] procedure, proposed by Mark and Sul (2003), in order to estimate the long-run relation between the fundamentals and the real effective exchange rate. More robust than the standard OLS estimator, the DOLS approach consists in augmenting the cointegration relationship by leads and lags of the first differences of fundamental variables in order to correct the potential endogenous feedback effect. In particular, our empirical DOLS is generally specified as follows:

$$\log(RER)_{i,t} = \alpha_i + \gamma' X_{i,t} + \sum_{q=-p_1}^{p_2} \delta'_{i,q} \Delta X_{i,t-q} + \epsilon_{i,t} \tag{4.5}$$

where $X_{i,t}$ is the set of explanatory variables, γ the coefficients in equation (4.1) capturing the long-run impact of changes in economic fundamentals on the (log) RER and α_i denotes country-fixed effects. The ($p_1 = 2$) leads and ($p_2 = 2$) lags are chosen according to the time dimension of series [12]. The results are presented in Table 4.3. The estimated coefficients associated with

10. In particular, let us discuss about the cointegration tests concerning the sample of the monetary union countries. Indeed, Westerlund (2007)'s tests do not reject the null hypothesis of no cointegration if the differentiated dependent variable is assumed to be generated with constant in the error-correction model ; while they reject the same hypothesis when the dependent variable is generated with both constant and trend. Additionally, Pedroni (1999, 2004)'s tests in between dimension (group-mean tests) reject the null hypothesis for the monetary union panel when it is assumed that the data generating process has only a constant. For these reasons, to be pragmatic we conclude that series are cointegrated for the sample of monetary union countries.

11. OLS for Ordinary Least Squares.

12. The results are robust when the numbers of lags and leads are inferior to those chosen here.

Table 4.2 – Cointegration tests between log(RER), log(PROD) and log(TOT) for CU countries and IMP countries

Statistics	CU Countries				IMP Countries			
	With Constant		With Constant and Trend		With Constant		With Constant and Trend	
	Value	P-value	Value	P-value	Value	P-value	Value	P-value
Westerlund tests								
Gt	-1.691	0.902	-3.193	0.003	-3.001	0.001	-3.986	0.000
Ga	-5.871	0.964	-16.286	0.105	-13.782	0.013	-28.207	0.000
Pt	5.649	0.609	-9.683	0.026	-10.845	0.000	-10.983	0.000
Pa	-5.335	0.629	-14.688	0.016	-16.167	0.000	-19.528	0.000
Pedroni tests								
Panel-v	-0.964	0.832	1.906	0.028	2.893	0.001	2.129	0.016
Pane-rho	-0.26	0.397	-3.673	0.000	-6.43	0.000	-6.259	0.000
Panel-PP	-1.026	0.152	-4.545	0.000	-5.83	0.000	-7.06	0.000
Panel-ADF	-1.35	0.088	-4.603	0.000	-4.821	0.000	-5.309	0.000
Group-rho	-2.139	0.016	-3.247	0.000	-8.639	0.000	-9.095	0.000
Grou-PP	-2.223	0.013	-5.104	0.000	-8.755	0.000	-10.829	0.000
Group-ADF	-2.617	0.004	-5.417	0.000	-5.121	0.000	-6.001	0.000

Notes: Akaike Notes: Akaike information criterion is used to choose optimal lag and lead lengths for each series and the Bartlett kernel window width is set according to $4(T/100)^{2/9} \approx 3$.

productivity differentials and terms of trade are statistically significant and correctly signed for our two groups of countries. Indeed, a 1% increase in productivity differentials (resp. terms of trade) is associated with a 0.65% (resp. 1.47%) appreciation in the real effective exchange rate under the regime of the monetary union, while the same increase in productivity differentials (resp. terms of trade) leads to 0.67% (resp. 0.36%) real exchange rate appreciation for IMP countries. Consequently, the long-run effects of productivity differentials on the real exchange rates are more pronounced in the IMP case than those in the currency union. The inverse is valid for the terms of trade effects on the real exchange rates. Our next goal is the misalignment calculation.

Table 4.3 – Long-run estimation

Variables	CU Countries		IMP Countries	
	coefficients	t-stat	coefficients	t-stat
$log(PROD)$	-0.655***	-11.296	-0.675***	-14.615
$log(TOT)$	-1.474***	-6.161	-0.365***	-4.802
Observations	768		576	
R^2	0.96		0.98	

Note: *** indicates that the coefficient is significant at 1% level. The individual country-fixed effects are presented in Appendix D.2.

4.2.2. Currency misalignment, exchange rate dynamics and the ZLB across monetary regimes

In this subsection, based upon the exchange rate regimes we assess whether or not the ZLB constraint influences misalignments and short-run dynamics of the real exchange rate. From the estimated long-run elasticities, we derive currency misalignment ($mis_{i,t}$) for each country of the two groups as follows:

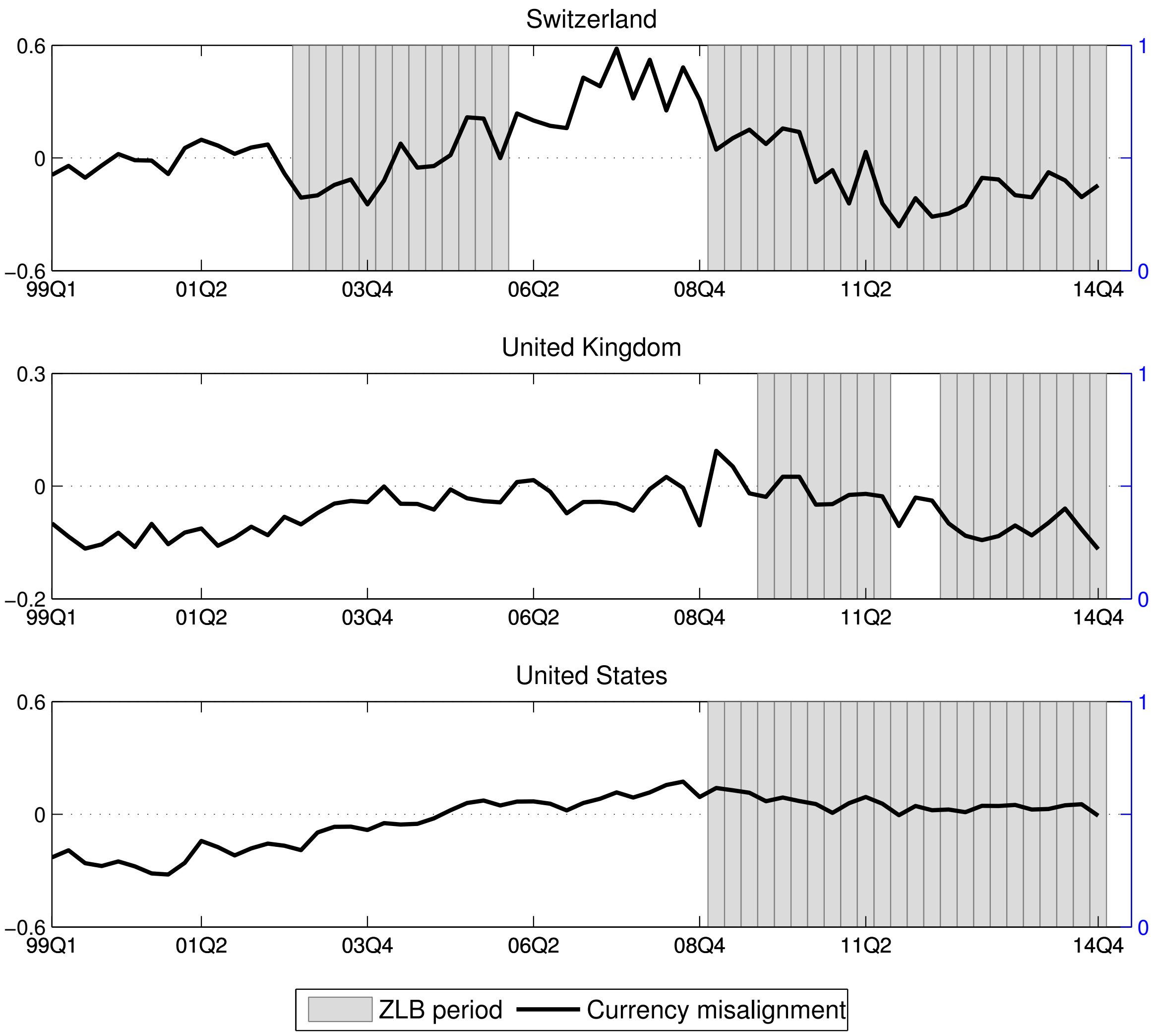
$$mis_{i,t} = \log(RER)_{i,t} - (\alpha_i + \hat{\gamma_1}\log(PROD)_{i,t} + \hat{\gamma_2}\log(TOT)_{i,t}) \tag{4.6}$$

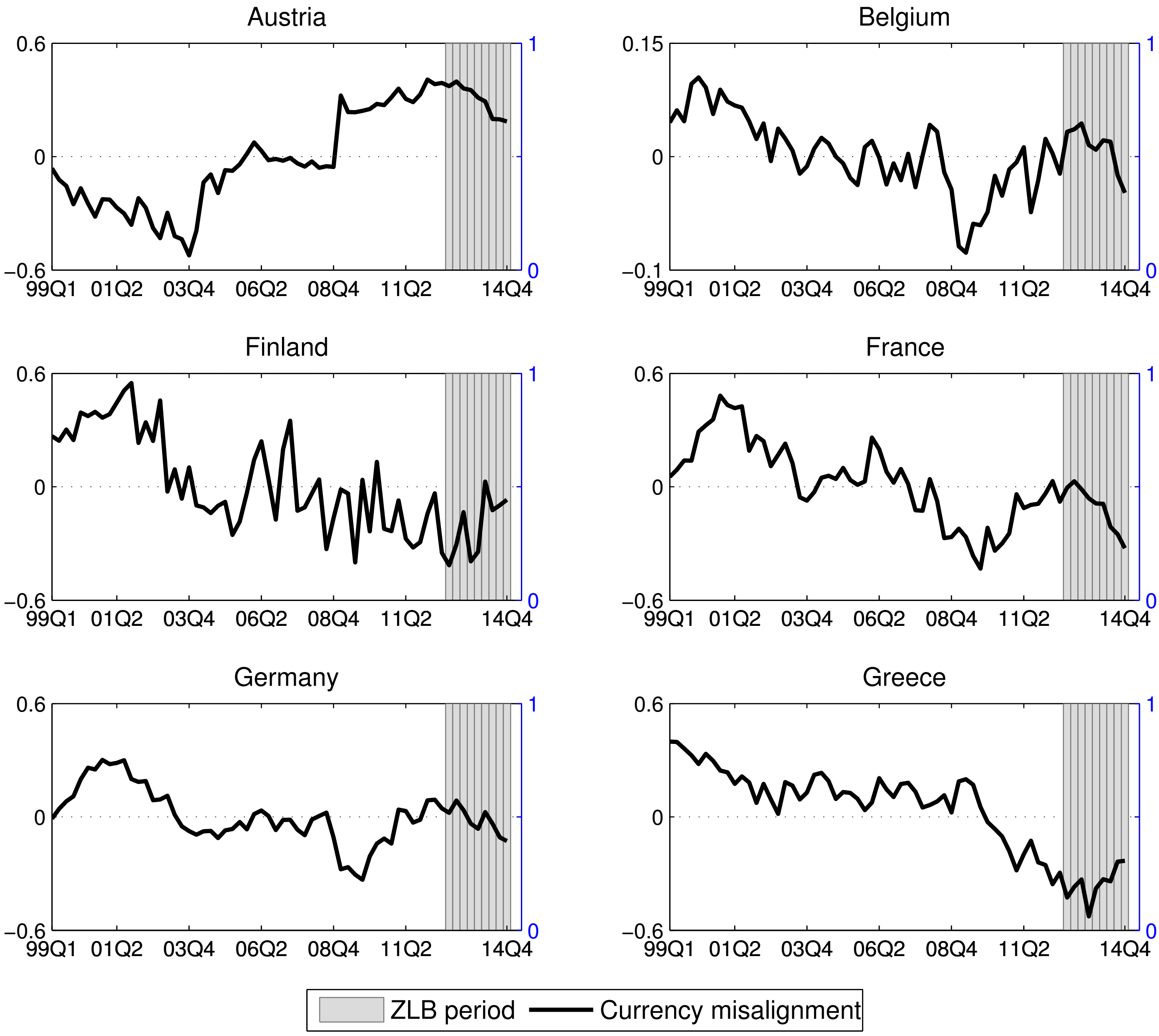
From (4.6), currency misalignments are the gap between observed real exchange rates and their equilibrium values, which are estimated according to the DOLS procedure. A positive misalignment corresponds to an undervaluation whereas a negative value of misalignment means a currency overvaluation compared to its fundamentals. Figure 4.1 displays currency misalignments and the ZLB episodes for selected countries in each sample. Misalignments for others countries are reported in Appendix D.3. Graphically, the results suggest that the ZLB episodes are generally characterised by an overvaluation (negative misalignment) of real exchange rates within the currency union (nine out of twelve countries) when the same periods coincide in general with a mixed behaviour of exchange rates in countries evolving under the floating regime [13]. For instance, we see that currencies of United States, Sweden and Czech Republic

13. The special case of Japan is an exception since its policy rate has been constrained at the zero floor during almost the whole time dimension of the sample.

are undervalued while those of United Kingdom, Canada and Israel are overvalued when the ZLB occurs.

Figure 4.1 – Misalignments under ZLB periods for selected countries




Austria
Belgium
Finland
France
Germany
Greece
0.6
0.15
0
−0.6
−0.1
1
0
99Q1 01Q2 03Q4 06Q2 08Q4 11Q2 14Q4
ZLB period
Currency misalignment

In order to support this observation, we now explore whether or not there is a correlation between the ZLB constraint and exchange rate misalignments. Indeed, we regress misalignments on a dummy variable ($dumZLB$) which accounts for the ZLB constraint. The dummy variable is defined in such a way that it takes the value of 1 in the ZLB periods and 0 elsewhere. We assume that the ZLB periods correspond to those under which the nominal interest rates are inferior to 1% [14]. In order to take into account the persistence in currency misalignments, we specify the equation to be estimated as:

$$mis_{i,t} = \vartheta_1 mis_{i,t-1} + \vartheta_2 dumZLB_{i,t} + \mu_{i,t} \tag{4.7}$$

where ϑ_1 and ϑ_2 are respectively the misalignment persistence and the coefficient measuring the link between the ZLB constraint and misalignments. $\mu_{i,t}$ is an error term. The Generalized Method of Moment (GMM) is used to estimate the equation (4.7). This method provides a consistent estimator in such a context of dynamic panel data models. Table 4.4 summarizes the estimation results for both the CU sample and the IMP sample. All coefficients are statistically significant, except for that of the dummy variable under the IMP regime. We find that misalignments are broadly persistent in the same magnitude for IMP countries (0.868) and CU countries (0.86). Despite the low levels of estimated coefficients associated with the ZLB effects, we find that the ZLB constraint negatively influences misalignments (currency overvaluation) in both the floating regime and the currency union. The effect of the ZLB constraint in the floating countries is not statistically significant. Before tracking the mechanism behind this finding in the theoretical model, we rely on the following intuition. By construction, an increase in overvaluation comes from the observed real exchange rate appreciation or the depreciation of equilibrium exchange rates. The appreciation in observed real exchange rates is due to the nominal exchange rate appreciation and a higher level of inflation in home country relative to all partners. The equilibrium exchange rate depreciates because of the decrease in productivity differentials and (or) terms of trade. The opposite explanation holds for the undervaluation of currencies. Since a great recession characterised by the ZLB constraint depresses output (productivity differentials), price levels (thus, terms of trade) and affects the nominal exchange rate movements via the interest rates and price level expectations, one can support that the constrained interest rate at zero is accompanied by movements in both observed and equilib-

14. The interest rate data source is indicated in Appendix D.1.

rium real exchange rates. Consequently, currency misalignments are affected through these channels and this should happen differently according to the considered monetary regimes.

Table 4.4 – Estimation of the relation between misalignment and ZLB

Variables	CU Countries		IMP Countries	
	coefficients	t-stat	coefficients	t-stat
mis_{t-1}	0.86***	48.086	0.868***	45.825
$DumZLB$	-0.007*	-1.791	-0.003	-1.308
Observations	768		576	
R^2	0.76		0.78	

Note: ***and * indicate that the coefficients are respectively significant at 1% and 10% levels.

Furthermore, we compare the levels of currency misalignments among "normal" and ZLB times, as well as between monetary regimes under the ZLB constraint. Let's begin with comparing the averages of misalignments in and outside the ZLB period under each monetary regime. Afterwards, we compare the misalignment averages during the ZLB period across different monetary regimes. To this end, we perform mean-comparison tests in order to check whether or not the means of misalignments are significantly different between the subperiods with and without the ZLB constraint in each regime, and among the subsamples with the ZLB constraint under the two regimes. The null hypothesis of the first test is that the mean misalignment in the ZLB subperiod is equal to that of the non-ZLB subperiod. The null hypothesis of the second test supposes that the mean misalignment in the ZLB subperiod under the currency union is equal to that under the IMP regime. The tests are T-test with unequal variances since subsamples have different lengths:

$$t_1 = \frac{(\overline{mis}_{wzlb,r} - \overline{mis}_{zlb,r})}{\sqrt{\frac{V^2_{wzlb,r}}{N_{wzlb,r}} + \frac{V^2_{zlb,r}}{N_{zlb,r}}}} \quad \text{and} \quad t_2 = \frac{(\overline{mis}_{zlb,cu} - \overline{mis}_{zlb,imp})}{\sqrt{\frac{V^2_{zlb,cu}}{N_{zlb,cu}} + \frac{V^2_{zlb,imp}}{N_{zlb,imp}}}}$$

where $\overline{mis}_{zlb,r}$ and $\overline{mis}_{wzlb,r}$ are empirical means of misalignments in and outside the ZLB period, respectively, under the regime $r = \{cu, imp\}$. $V^2_{zlb,r}$ and $V^2_{wzlb,r}$, are the corresponding empirical variances. $N_{zlb,r}$ and $N_{wzlb,r}$ are the sizes of subsamples of ZLB and non-ZLB periods, respectively.

The results of the two tests are displayed in Table 4.5. Based on the test statistics, we have strong evidence against the null hypothesis of the equality of misalignment means in and outside the ZLB period under the currency union regime, while we fail to reject the same hypothesis under the IMP regime. The null hypothesis of the equality of misalignment means with the ZLB constraint among the two monetary regimes is also strongly rejected. These results suggest that there is a difference in means between currency misalignments in and outside the ZLB period under the regime of the currency union. In particular, currency misalignments without the ZLB constraint are larger on average than those with the ZLB constraint under the monetary union (as shown on the right-hand side of Table 4.5). However, under the IMP regime, we find that the means of misalignments are not different between the ZLB period and the non-ZLB period. These findings are in line with those highlighted by the estimates of regression (4.7). Additionally, Table 4.5 suggests that when countries are subject to the ZLB constraint, the means of currency misalignments are different between the monetary union and the IMP regime. Specially, misalignments under the currency union regime are smaller on average than those under the IMP regime when the ZLB occurs.

Table 4.5 – Tests of the mean comparison

	ZLB versus **non-ZLB**		
	t_1	P-value	P-value of the significant altrenative hypothesis
CU	6.387***	0.000	Ha: $(\overline{mis}_{wzlb,r} - \overline{mis}_{zlb,r}) > 0$; P-value=0.000
IMP	0.413	0.679	

	CU versus **IMP**		
	t_2	P-value	P-value of the significant altrenative hypothesis
ZLB period	-3.778***	0.000	Ha: $(\overline{mis}_{zlb,cu} - \overline{mis}_{zlb,imp}) < 0$; P-value=0.000

Note: *** indicates that the null hypothesis is significantly rejected at 1% level.

In order to strengthen our analyses, we focus on the analysis of short-run real exchange rate dynamics by estimating the panel Vector Error Correction Models (VECM) which is specified as follows:

$$\Delta \log(RER)_{i,t} = \theta mis_{i,t-1} + \psi_1 dumZLB_{i,t} + \sum_{q=1}^{2} \psi_{2,q} \Delta X_{i,t} + \zeta_{i,t} \tag{4.8}$$

where θ is the speed of adjustment which is expected to be negative and less than one in absolute value; The negative sign indicates that the real exchange rate adjusts at each period in such a manner that to reduce the previous misalignment; $dumZLB_{i,t}$ denotes the dummy variable taking into account the ZLB episodes; $X_{i,t}$ is the set of ($q = 2$) explanatory variables (productivity differentials and terms of trade) and $\zeta_{i,t}$ the error term; ψ_1 and $\psi_{2,q}$ are the short-run coefficients. Δ stands for the first difference symbol.

Our VECM model allows for the ZLB dummy variable ($dumZLB_{i,t}$) and changes in fundamentals $X_{i,t}$ influence the short-run dynamics of the $RER_{i,t}$.

In order to assess the impact of the ZLB on the convergence process toward equilibrium, we estimate two VECM models: a model which does not include the ZLB dummy variable (VECM1) and another which takes into account the ZLB variable (VECM2). In particular, by assuming that the ZLB constraint has only an impact on the short-run adjustment process of the real exchange rate, we introduce the ZLB dummy variable into the (VECM2) model as an exogenous non-fundamental variable.

To estimate equation (4.8) in both the versions without and with the ZLB dummy, we use the GMM approach which provides consistent estimation of the coefficients. Results are summarized in Table 4.6.

Table 4.6 – Estimation of the panel Vector Error Correction Models (VECM)

Variables	CU countries		IMP countries	
	coefficients	t-stat	**coefficients**	t-stat
Model VECM1				
mis_{t-1}	-0.102***	-7.528	-0.129***	-6.823
$\Delta log(PROD)$	-0.483***	-16.368	-0.655***	-15.259
$\Delta log(TOT)$	-0.102	-1.605	-0.279***	-3.800
R^2	0.30		0.34	
Model VECM2				
mis_{t-1}	-0.105***	-7.493	-0.130***	-6.878
$\Delta log(PROD)$	-0.484***	-16.377	-0.658***	-15.317
$\Delta log(TOT)$	-0.105*	-1.649	-0.276***	-3.7662
dumZLB	-0.002	-0.743	-0.003	-1.320
R^2	0.31		0.34	
Observation	768		576	

Note: ***and * indicate that the coefficients are respectively significant at 1% and 10% levels.

The results are in line with those previously found. As expected, the speed of adjustment is significantly negative in both the Eurozone and Floaters groups. The convergence speed of real exchange rate toward equilibrium is higher for IMP countries (13% in the VECM2) than for Eurozone group (10.5% in the VECM2). This means that the real exchange rate moves each quarter in order to reduce 13% of past misalignment in floating countries while 10.5% of past misalignment is reduced in currency union. This result further implies that misalignments are more persistent in CU countries than in IMP countries. This seems to be reasonable since the real exchange rate cannot adjust quickly under a regime of the currency union due to short-term price rigidity. By comparing the models without and with the ZLB dummy, we can observe that the ZLB constraint slightly increases the convergence speed of the real exchange rate toward its equilibrium level under the two regimes.

Findings in Table 4.6 also indicate that contemporaneous changes in fundamentals influence significantly the real exchange rate in the expected direction. Additionally, we find that the effects of the ZLB constraint on the short-term dynamics of the real exchange rate are non-significantly negative in both the monetary union and the IMP regime. This seems to indicate that the ZLB effects on currency misalignments could come from equilibrium values of exchange rates via the channels of productivity differentials and terms of trade, which are impacted by the large deflation generating the ZLB constraint.

Summary of the empirical results

The goal of this empirical exercise was to assess the impacts of the ZLB on currency misalignments depending on monetary regimes. In this perspective, we find that the ZLB constraint negatively impacts misalignments in the sense of a currency overvaluation in both the currency union and the floating regime, even though its effect is non-significant under the latter regime. When countries are belonging to the currency union there exists a difference in level between misalignments in the ZLB period and those in the "tranquil" period, while this difference does not exist for the independent floating countries. In particular, the ZLB constraint has acted by reducing currency misalignments in the monetary union countries. Consequently, despite the fact that currency misalignments are more persistent in the currency union compared to the IMP regime, they are larger on average in the latter regime than in the former when economies are hit by a large shock that stuck the interest rate at zero. Additionally, the ZLB constraint generally increases the speed of convergence of the real exchange rates towards their long-run values irrespective of the currency regimes. In this respect, by showing that a ZLB environment decreases currency misalignments within a currency union, our results tend to balance those of Coudert et al. (2013) who found that currency misalignments have increased on average for all Euro area countries since the monetary union, and that they became more persistent.
We now investigate whether theses empirical findings could be rationalised by a theoretical model. This is the purpose of the next section.

4.3. The model

In this section, we develop a dynamic stochastic general equilibrium (DSGE) model in which currency misalignments are derived from the gap between the actual real exchange rate and its potential (natural) level that prevails under the flexible price equilibrium. The purposes of the model are to investigate the effects of the ZLB constraint on currency misalignments, and then theoretically supporting the previous empirical investigation. Our approach allows exit from the ZLB to be determined endogenously, rather than fixed arbitrarily. We consider two countries of equal size: Home (H) and Foreign (F), two-sectors: tradable and non-tradable sectors. Each economy is populated by a continuum of unit mass households with infinite life, and produces non-tradable and tradable goods using sector-specific labour. Monopolistic competition and sticky prices are introduced in order to address the issues of monetary policy. Since the general setup of the foreign country is similar and symmetrical to that for the home country, this section presents the details of the model from the latter. Variables for the foreign country are denoted by an asterisk and the details of the foreign part of the model are presented in Appendix D.5.

4.3.1. Households

The representative home-household maximizes her following expected value of her lifetime:

$$\mho = E_t \sum_{t=0}^{\infty} \beta^t \{U_t(C_t, \varepsilon_t, N_t)\} \tag{4.9}$$

where C_t denotes consumption and N_t hours worked ; $\mho$ is household's expected discounted sum of utilities, $U_t(C_t, \varepsilon_t, N_t)$ denotes their utility function, $0 < \beta < 1$ is the intertemporal discount factor and ε_t represents a shock to preferences or a demand shock. A negative ε_t shock implies that agents wish to postpone consumption over time, and will thus increase their desired savings. ε_t follows a first-order autoregressive process : $\log(\varepsilon_t) = \rho_\varepsilon \log(\varepsilon_{t-1}) + e_{\varepsilon,t}$, with $e_{\varepsilon,t} \sim i.i.d.(0, \sigma_\varepsilon^2)$.

The final consumption basket is a CES aggregate of non-tradable ($C_{N,t}$) and tradable ($C_{T,t}$) goods with a constant elasticity of substitution $\nu > 0$:

$$C_t = \left[\alpha^{\frac{1}{\nu}} (C_{T,t})^{\frac{\nu-1}{\nu}} + (1-\alpha)^{\frac{1}{\nu}} (C_{N,t})^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}} \tag{4.10}$$

where $\alpha \in [0,1]$ is the share of tradable goods in total consumption.
The associated price index is given by:

$$P_t = [\alpha(P_{T,t})^{1-\nu} + (1-\alpha)(P_{N,t})^{1-\nu}]^{\frac{1}{1-\nu}} \tag{4.11}$$

The non-tradable consumption basket is made up of a continuum of differentiated varieties of goods $C_{N,t} \equiv (\int_0^1 C_{N,t}(j)^{\frac{\epsilon-1}{\epsilon}} d_j)^{\frac{\epsilon}{\epsilon-1}}$ with the corresponding price $P_{N,t} = (\int_0^1 P_{N,t}(j)^{1-\epsilon} d_j)^{\frac{1}{1-\epsilon}}$ and $\epsilon > 1$, the elasticity of substitution between varieties.
The tradable goods basket is a composite of home ($C_{H,t}$) and foreign ($C_{F,t}$) tradable goods, with $\kappa > 0$ as the constant elasticity of substitution:

$$C_{T,t} = \left[\omega^{\frac{1}{\kappa}} (C_{H,t})^{\frac{\kappa-1}{\kappa}} + (1-\omega)^{\frac{1}{\kappa}} (C_{F,t})^{\frac{\kappa-1}{\kappa}}\right]^{\frac{\kappa}{\kappa-1}} \tag{4.12}$$

where ω is the share of tradable goods produced in the home country. The corresponding price index is

$$P_{T,t} = [\omega(P_{H,t})^{1-\kappa} + (1-\omega)(P_{F,t})^{1-\kappa}]^{\frac{1}{1-\kappa}} \tag{4.13}$$

where ($P_{F,t}$) is the price of the foreign tradable consumption goods and ($P_{H,t}$) denotes the price of the domestic tradable goods.
The baskets of home ($C_{H,t}$) and foreign ($C_{F,t}$) tradable goods and their associated prices ($P_{H,t}$ and $P_{F,t}$) are defined from the similar manner of the differentiated variety aggregation that for the case of the non-tradable basket. Therefore, the elasticity of substitution between varieties, ϵ, is identical across sectors.
By the expenditure minimization problem, the following optimal demands for different goods

yield:

$$C_{N,t} = (1-\alpha)\left(\frac{P_{N,t}}{P_t}\right)^{-\nu} C_t \tag{4.14}$$

$$C_{T,t} = \alpha\left(\frac{P_{T,t}}{P_t}\right)^{-\nu} C_t \tag{4.15}$$

$$C_{H,t} = \omega\left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\kappa} C_{T,t} \tag{4.16}$$

$$C_{F,t} = (1-\omega)\left(\frac{P_{F,t}}{P_{T,t}}\right)^{-\kappa} C_{T,t} \tag{4.17}$$

The household faces the following period-by-period budget constraint:

$$P_tC_t + B_t + S_tB_t^* = W_tN_t + (1+i_{t-1})B_{t-1} + (1+i_{t-1}^*)\Gamma_{t-1}(\cdot)S_tB_{t-1}^* + \Delta_t \tag{4.18}$$

where W_t denotes household's nominal wage and Δ_t are profits rebated equally to the households by firms. B_t and B_t^* are the individual's holdings of domestic and foreign nominal risk-less bonds denominated in the issuing currency, i_t and i_t^* are the corresponding interest rates, S_t denotes the nominal exchange rate defined as units of domestic currency per one unit of foreign currency. The function $\Gamma_t\left(\frac{S_tB_t^*}{YP_t}\right)$ captures the cost of international borrowings. This spread is increasing in the aggregate level of foreign debt ($\Gamma_t\left(\frac{S_tB_t^*}{YP_t}\right) \equiv \exp\left(-\gamma(\frac{S_tB_t^*}{YP_t})\right)$ with $\Gamma_t'(\cdot) < 0$) and is equal to zero when the NFA position is at its steady state level ($\Gamma_t(0) = 1$)[15]. The temporary deviation from uncovered interest rate parity (UIP) is introduced by this cost. γ is the sensitivity of the international borrowing cost with respect to NFA position. Following Benigno and Thoenissen (2008), we have assumed that home currency-denominated bonds are only traded domestically, such as foreign households allocate their wealth only in bonds denominated in the foreign currency[16].

15. As discussed in Schmitt-Grohé and Uribe (2003), introducing the transaction cost $\Gamma_t(\cdot)$ has a technical advantage to deal with a non stationarity problem in the open economy models.

16. This asymmetry in the financial market structure is made for simplicity. The results would not change if we allowed home bonds to be traded internationally. We would just need to add an additional arbitrage condition.

The solution to the household problem implies the following optimality conditions:

$$\frac{-U_{N,t}(C_t, \varepsilon_t, N_t)}{U_{C,t}(C_t, \varepsilon_t, N_t)} = \frac{W_t}{P_t} \tag{4.19}$$

$$U_{C,t}(C_t, \varepsilon_t, N_t) = E_t \left\{ \beta(1+i_t)\frac{P_t}{P_{t+1}} U_{C,t+1}(C_{t+1}, \varepsilon_{t+1}, N_{t+1}) \right\} \tag{4.20}$$

and the the following optimal risk sharing condition holds:

$$E_t \left(\frac{U^*_{C,t+1}(C^*_{t+1}, \varepsilon^*_{t+1}, N^*_{t+1})}{U^*_{C,t}(C^*_t, \varepsilon^*_t, N^*_t)} \frac{P^*_t}{P^*_{t+1}} \right) = E_t \left(\frac{U_{C,t+1}(C_{t+1}, \varepsilon_{t+1}, N_{t+1})}{U_{C,t}(C_t, \varepsilon_t, N_t)} \frac{P_t}{P_{t+1}} \frac{S_{t+1}}{S_t} \Gamma_t(\frac{S_t B^*_t}{Y P_t}) \right) \tag{4.21}$$

Foreign household preferences and choices can be defined symmetrically.

4.3.2. Open economy expressions

Let us define the terms of trade (TOT_t), the relative price of traded goods (Q_t) and the real exchange rate (RER_t) as, respectively: $TOT_t = \frac{P_{F,t}}{P_{H,t}}$, $Q_t = \frac{P_{T,t}}{P_{N,t}}$ and $RER_t = \frac{S_t P^*}{P_t}$.
Given the definition for the terms of trade, the relative price of traded goods, (4.3) and (4.5), the following equation holds:

$$\frac{P_{T,t}}{P_{H,t}} = \left[\omega + (1-\omega)(TOT_t)^{1-\kappa}\right]^{\frac{1}{1-\kappa}} \equiv f(TOT_t) \tag{4.22}$$

$$\frac{P_t}{P_{N,t}} = [\alpha(Q_t)^{1-\nu} + (1-\alpha)]^{\frac{1}{1-\nu}} \equiv f(Q_t) \tag{4.23}$$

Finally, we can relate the real exchange rate to the terms of trade and the relative price of traded goods as follows:

$$RER_t = \frac{f^*(Q^*_t) Q_t f^*(TOT^*_t) TOT_t}{Q^*_t f(Q_t) f(TOT_t)} \tag{4.24}$$

4.3.3. Firms and Price Setting

For each country, we assume that the production occurs in two sectors: tradable and non-tradable. In this section, the two production sectors in domestic economy are indexed by $k \in \{H, N\}$.
In both sectors, a continuum of monopolistically competitive firms of measure unity, indexed

by l, produces output $Y_{k,t}(l)$ using the technology:

$$Y_{k,t}(l) = A_{k,t}N_{k,t}(l) \tag{4.25}$$

where $N_{k,t}$ denotes hours worked in sector k, $A_{k,t}$ is a technological shock that is common to all firms and follows a stationary first-order autoregressive process : $\log(A_{k,t}) = \rho_A \log(A_{k,t-1}) + e_{A,t}$ with $e_{A,t} \sim i.i.d.(0, \sigma^2_{e_A})$.
Cost minimization by firms implies that the real marginal cost of production in each sector (k) is:

$$mc_{k,t} = \frac{W_t}{A_{k,t}P_{k,t}} \tag{4.26}$$

Following Calvo (1983), we assume that firms set nominal prices on a staggered basis: at each period, a fraction $(1-\phi^k)$ of firms are randomly selected to set new prices $(P^n_{i,t}(j))$, while the remaining fraction $\phi^k \in [0,1]$ of firms keep their prices unchanged.
The optimal price setting problem for a firm (l) of the sector (k) that is able to reset its price at time t is:

$$\max_{P^n_{k,t}(l)} E_t \left\{ \sum_{s=0}^{\infty} (\phi^k)^s \Lambda_{t,t+s} \left[\frac{P^n_{k,t}(l)}{P_{k,t+s}} \left(\frac{P^n_{k,t}(l)}{P_{k,t+s}} \right)^{-\epsilon} Y_{k,t+s} - mc_{k,t+s} \left(\frac{P^n_{k,t}(j)}{P_{k,t+s}} \right)^{-\epsilon} Y_{k,t+s} \right] \right\} \tag{4.27}$$

where $\Lambda_{t,t+s} = \beta^s \frac{U_{C,t+s}(C_{t+s},\varepsilon_{t+s},N_{t+s})}{U_{C,t}(C_t,\varepsilon_t,N_t)}$ is the discount factor for future real profits.
The first order condition implies:

$$P^n_{k,t}(l) = \frac{\epsilon}{\epsilon-1} \frac{\sum_{s=0}^{\infty}(\beta\phi^k)^s U_{C,t+1}(C_{t+s},\varepsilon_{t+s},N_{t+s}) Y_{k,t+s} P^{\epsilon}_{k,t+s} mc_{k,t+s}}{\sum_{s=0}^{\infty}(\beta\phi^k)^s U_{C,t+1}(C_{t+s},\varepsilon_{t+s},N_{t+s}) Y_{k,t+s} P^{\epsilon-1}_{k,t+s}} \tag{4.28}$$

Given the Calvo-type setup, the aggregate domestic sectorial price index evolves according to the following law of motion,

$$P^{1-\epsilon}_{k,t} = (1-\phi^k)(P^n_{k,t})^{1-\epsilon} + \phi^k P^{1-\epsilon}_{k,t-1} \tag{4.29}$$

The foreign economy has an analogous price setting mechanism.

Since the assumption that prices are set in the producer currency for exports and that the international law of one price holds for the tradable goods in this baseline model, the prices of home goods sold abroad and those of foreign goods sold in home country are given, respectively, by: $P^*_{H,t} = \frac{P_{H,t}}{S_t}$ and $P_{F,t} = S_t P^*_{F,t}$.

4.3.4. Monetary policy rules

The monetary authority sets the short term nominal interest rate by reacting to endogenous variables (active monetary policy), except when the zero bound constraint is active.

Under the regime with separate currencies, the monetary authority of each country sets its own interest rate, which follows a Taylor rule truncated at zero,

$$i_t = \max(0, i + \varphi_1 \pi_t + \varphi_2 x_t) \tag{4.30}$$

where $\varphi_1 > 1$ and $\varphi_1 < 1$ are the central bank's response to the inflation rate (π_t) and output gap (x_t), respectively. i is the steady-state value of the interest rate (i_t).

Under a currency union, the common central bank sets the nominal interest rate according to the following Taylor-type interest rate rule truncated at zero,

$$i^{cu}_t = \max(0, i^{cu} + \varphi_1 \pi^{cu}_t + \varphi_2 x^{cu}_t) \tag{4.31}$$

where $\varphi_1 > 1$ and $\varphi_1 < 1$ are the central bank's responses to the union's inflation rate (π^{cu}_t) and union's output gap (x^{cu}_t), respectively. We define $\pi^{cu}_t = (\pi_t)^{0.5}(\pi^*_t)^{0.5}$ and $x^{cu}_t = (x_t + x^*_t)$. i^{cu} is the steady-state value of the interest rate (i^{cu}_t).

4.3.5. Market Clearing and Net Foreign Asset position

The aggregate goods market clearing in the tradable and non-tradable sectors satisfies,

$$Y_{H,t} = C_{H,t} + C^*_{H,t} \tag{4.32}$$

$$Y_{N,t} = C_{N,t} \tag{4.33}$$

where $C^*_{H,t} = \alpha(1-\omega)\left(\frac{P^*_{H,t}}{P^*_{T,t}}\right)^{-\kappa}\left(\frac{P^*_{T,t}}{P^*_t}\right)^{-\nu} C^*_t$ denotes total exports to foreign country.

The country aggregate resource constraint is then:

$$Y_t = Y_{H,t} + Y_{N,t} \tag{4.34}$$

with Y_t domestic output.

Aggregate labour market clearing requires,

$$N_t = N_{H,t} + N_{N,t} \tag{4.35}$$

The foreign market clearing conditions are analogous.

The countrywide producer price and real marginal are defined as follows:

$$P_{d,t}Y_t = P_{H,t}Y_{H,t} + P_{N,t}Y_{N,t} \tag{4.36}$$

$$mc_tY_t = mc_{H,t}Y_{H,t} + mc_{N,t}Y_{N,t} \tag{4.37}$$

$P_{d,t}$ and mc_t are the producer price index (PPI) and the aggregate real marginal cost in home country, respectively. Combining the market clearing conditions with the households' budget constraint yields the following dynamic of the net foreign assets (NFA) position (i.e. the balance of payments) [17]:

$$S_tB^*_t = (1 + i^*_{t-1})\Gamma_{t-1}(\cdot)S_tB^*_{t-1} + P_{H,t}C^*_{H,t} - P_{F,t}C_{F,t} \tag{4.38}$$

The expression of equation (4.40) in real terms relative to the steady-state output is given by:

$$b^*_t = (1 + i^*_{t-1})\Gamma_{t-1}(\cdot)\frac{S_t}{\pi_tS_{t-1}}b^*_{t-1} + \frac{P_{H,t}C^*_{H,t}}{P_tY} - \frac{P_{F,t}C_{F,t}}{P_tY} \tag{4.39}$$

with $b^*_t = \frac{S_tB^*_t}{YP_t}$.

4.3.6. Equilibrium dynamics

In order to solve the model, we log-linearize its equilibrium conditions around the steady state. The steady state and the log-linearized version of the model are presented in Appendices D.4 and D.5, respectively. A circumflex means the log-deviation of a variable from its steady-state value.

We employ the following utility function:

$$U_t(C_t, \varepsilon_t, N_t) = \varepsilon_t\left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\eta}}{1+\eta}\right) \tag{4.40}$$

17. Since households in domestic economy are identical, the domestic bonds market is in zero net supply.

where σ is the household's risk aversion parameter (the inverse of intertemporal substitution elasticity) and η denotes the inverse of Frisch labour supply elasticity.

Here, we use the log-linearized version of the model in order to derive its "gap" formulation, in which variables are expressed as the difference between their log-linearized levels when price are sticky and fully flexible (i.e. the log-deviation of the current level of the variable from its natural level). We present the "gap" version of the model for only the domestic country, that of the foreign country being summarized in Appendix D.6.

Let's define variables with superscript p as the flexible-price levels of variables. The flexible-price values of the model variables are called their natural or potential values and can be found by imposing the conditions $\widehat{mc}^p_{H,t} = 0$ and $\widehat{mc}^p_{N,t} = 0$ (which imply $\widehat{\Pi}^p_{H,t} = 0$ and $\widehat{\Pi}^p_{N,t} = 0$) since the real marginal costs in both tradable and non-tradable sectors are constant and correspond to the inverse of the constant markup in the flexible-price equilibrium (see the model's steady-state in the appendix). We further assume the zero net foreign asset holdings in the long run ($\widehat{b}^p_t = 0$), implying that the current account is in equilibrium (zero net exports) under flexible prices. This corresponds to the complete market's net asset holdings, and taking together with the flexible price condition leads to the efficient allocation. Therefore, our theoretical concept of the long-run exchange rate coincides with both a sort of the external balance equilibrium notion and the efficient allocation (which arises under the flexible price and complete market condition). Our natural exchange rate is efficient and time-varying.

Before using these conditions in the variable derivation in terms of "gaps", let us make some definitions as:

— Ouput gap: $x_t = \widehat{y}_t - \widehat{y}^p_t$

— Misalignment or real exchange rate gap: $rer^G_t = \widehat{rer}_t - \widehat{rer}^p_t$

— Terms of trade gap: $tot^G_t = \widehat{tot}_t - \widehat{tot}^p_t$

— Gap of the relative price of traded goods: $q^G_t = \widehat{q}_t - \widehat{q}^p_t$

Substituting the log-linearized versions of the equation (4.34) and its foreign counterpart (Appendix D.5.28 and Appendix D.5.53) into the log-linearized expression for the consumption Euler equation (i.e. Appendix D.5.13) yields the following log-linearized IS curve equation:

$$\widehat{y}_t = \widehat{y}_{t+1} - \frac{Z_2}{Z_1}\Delta\widehat{y}^*_{t+1} - Z_2 Z_3\left(\frac{Z_2}{Z_1}+1\right)\Delta\widehat{tot}_{t+1} - Z_2\nu\left(\frac{Z_2}{Z_1}+1\right)\widehat{rer}_{t+1} - \frac{1}{\sigma}\left(\frac{Z_1 - Z_2}{Z_1}\right)(i_t - \widehat{\Pi}_{t+1}) - \frac{1}{\sigma}\left(\frac{Z_1 - Z_2}{Z_1}\right)(\widehat{\varepsilon}_{t+1} - \widehat{\varepsilon}_t) \quad (4.41)$$

with the notations that:

$Z_1 = [\alpha\omega + (1-\alpha)]$, $Z_2 = \alpha(1-\omega)$ and $Z_3 = [2\omega(\kappa - \nu) + \nu]$.

By plugging the log-linearized versions of (4.19), (4.35), (4.34) and foreign counterpart of (4.34) into the two log-linearized equations of (4.26), we obtain the following log-linearized real marginal costs in the two sectors:

$$\widehat{mc}_{H,t} = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right]\widehat{y}_t - \frac{\sigma Z_2}{(Z_1 - Z_2)}\widehat{y}^*_t - \left[\frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)} - \frac{Z_2}{\alpha}\right]\widehat{tot}_t \\ - \frac{\sigma Z_2}{(Z_1 - Z_2)}\nu\widehat{rer}_t - \eta\widehat{a}_t - \widehat{a}_{H,t} - (1-\alpha)\widehat{q}_t \quad (4.42)$$

$$\widehat{mc}_{N,t} = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right]\widehat{y}_t - \frac{\sigma Z_2}{(Z_1 - Z_2)}\widehat{y}^*_t - \frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)}\widehat{tot}_t \\ - \frac{\sigma Z_2}{(Z_1 - Z_2)}\nu\widehat{rer}_t - \eta\widehat{a}_t - \widehat{a}_{N,t} + \alpha\widehat{q}_t \quad (4.43)$$

where $\widehat{a}_t = \frac{Y_H}{Y}\widehat{a}_{H,t} + \frac{Y_N}{Y}\widehat{a}_{N,t}$ is log-linearized countrywide technological shock. Substituting (4.42) and (4.43) into the log-linearized expression of (4.37) gives the log-linearized aggregate real marginal cost as :

$$\widehat{mc}_t = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right]\widehat{y}_t - \frac{\sigma Z_2}{(Z_1 - Z_2)}\widehat{y}^*_t - \left[\frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)} - Z_2\right]\widehat{tot}_t \\ - \frac{\sigma Z_2}{(Z_1 - Z_2)}\nu\widehat{rer}_t - (1+\eta)\widehat{a}_t \quad (4.44)$$

Imposing that $\widehat{mc}^p_t = 0$ (since $\widehat{mc}^p_{H,t} = 0$ and $\widehat{mc}^p_{N,t} = 0$), the solution for potential output can be written,

$$\widehat{y}^p_t = \frac{Z_2\sigma}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{y}^{*p}_t + \frac{Z_2(\sigma Z_3 - Z_1 + Z_2)}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{tot}^p_t + \\ \frac{Z_2\sigma\nu}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{rer}^p_t + \frac{(1+\eta)(Z_1 - Z2)}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{a}_t \quad (4.45)$$

To obtain a tractable solution for the potential real interest rate, we use and rearrange (4.41) such as:

$$\widehat{r}_t^p = \left(\frac{Z_1\sigma}{Z_1 - Z_2}\right)\Delta\widehat{y}_{t+1}^p - \left(\frac{Z_2\sigma}{Z_1 - Z_2}\right)\Delta\widehat{y}_{t+1}^{*p} - \left(\frac{Z_2 Z_3\sigma}{Z_1 - Z_2}\right)\Delta\widehat{tot}_{t+1}^p - \left(\frac{Z_2\sigma v}{Z_1 - Z_2}\right)\Delta\widehat{rer}_{t+1}^p - (\widehat{\varepsilon}_{t+1} - \widehat{\varepsilon}_t) \quad (4.46)$$

Therefore, the IS curve in the "gap" form can be obtained from (4.41) which holds for actual and potential output and using the above definitions, so that :

$$x_t = x_{t+1} - \frac{Z_2}{Z_1}\Delta x_{t+1}^* - \frac{Z_2 Z_3}{Z_1}\Delta tot_{t+1}^G - \frac{Z_2}{Z_1}\nu\Delta rer_{t+1}^G - \frac{1}{\sigma}\left(\frac{Z_1 - Z_2}{Z_1}\right)\left[i_t - \pi_{t+1} - \widehat{r}_t^p\right] \quad (4.47)$$

Using the flexible-price condition, we can rewrite the log-linearized real marginal costs in "gap" form as:

$$mc_{H,t} = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right] x_t - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right) x_t^* - \left[\frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)} - \frac{Z_2}{\alpha}\right] tot_t^G - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right)\nu rer_t^G - (1-\alpha) q_t^G \quad (4.48)$$

$$mc_{N,t} = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right] x_t - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right) x_t^* - \frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)} tot_t^G - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right)\nu rer_t^G + \alpha q_t^G \quad (4.49)$$

$$mc_t = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right] x_t - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right) x_t^* - \left[\frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)} - Z_2\right] tot_t^G - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right)\nu rer_t^G \quad (4.50)$$

By log-linearizing (4.11), (4.13), (4.36) and combining with the log-linearized definition of terms of trade, we get the dynamic of the CPI inflation as :

$$\pi_t = \alpha(1-\omega)\Delta tot_t^G + \alpha\widehat{\Pi}_{H,t} + (1-\alpha)\widehat{\Pi}_{N,t} = \alpha(1-\omega)\Delta tot_t^G + \pi_{d,t} \quad (4.51)$$

where $\widehat{\Pi}_{d,t} = \pi_{d,t}$ represents the PPI inflation. The log-linearization of (4.28) and (4.29) and using the assumption that $\phi^T = \phi^N = \phi$ and $\widehat{\Pi}_{d,t} = \pi_{d,t}$ yields:

$$\pi_{d,t} = \beta\pi_{d,t+1} + \frac{(1-\phi)(1-\beta\phi)}{\phi} mc_t \tag{4.52}$$

Substituting (4.52) and (4.50) into (4.51) provides the Phillips curve. Plugging the log-linearized versions of (4.20) and its foreign analogous into the log-linearized risk sharing condition (4.21) leads to the following Uncovered Interest rate Parity (UIP) condition:

$$\widehat{rer}_t = E_t\widehat{rer}_{t+1} + (i_t^* - \widehat{\Pi}_{t+1}^*) - (i_t - \widehat{\Pi}_{t+1}) - \gamma\widehat{b}_t^* \tag{4.53}$$

The solution for the real interest rate from the IS curve in (4.41), defined as $\widehat{r}_t = (i_t - \widehat{\Pi}_{t+1})$, and its foreign analogous can be substituted into (4.53) such that the dynamic of real exchange rate is:

$$\begin{aligned}\widehat{rer}_t = \widehat{rer}_{t+1} - \frac{\sigma}{[Z_1 + Z_2(2\sigma\nu - 1)]}\Delta\widehat{y}_{t+1} + \frac{\sigma}{[Z_1 + Z_2(2\sigma\nu - 1)]}\Delta\widehat{y}_{t+1}^* + \frac{2Z_2Z_3\sigma}{[Z_1 + Z_2(2\sigma\nu - 1)]}\Delta\widehat{tot}_{t+1} \\ + \frac{(Z_1 - Z_2)}{[Z_1 + Z_2(2\sigma\nu - 1)]}[\Delta\widehat{\varepsilon}_{t+1} - \Delta\widehat{\varepsilon}_{t+1}^*] - \frac{(Z_1 - Z_2)}{[Z_1 + Z_2(2\sigma\nu - 1)]}\gamma b_t^*\end{aligned} \tag{4.54}$$

The equation (4.54) holds for the potential real exchange rate, so that:

$$\begin{aligned}\widehat{rer}_t^p = \frac{\sigma}{[Z_1 + Z_2(2\sigma\nu - 1)]}[\widehat{y}_t^p - \widehat{y}_t^{*p}] - \frac{2Z_2Z_3\sigma}{[Z_1 + Z_2(2\sigma\nu - 1)]}\widehat{tot}_t^p \\ + \frac{(Z_1 - Z_2)}{[Z_1 + Z_2(2\sigma\nu - 1)]}(\widehat{\varepsilon}_t^* - \widehat{\varepsilon}_t)\end{aligned} \tag{4.55}$$

From (4.54) which holds for observed and potential real exchange rate, we obtain the real exchange rate gap or currency misalignment as follows:

$$\begin{aligned}mis_t \equiv rer_t^G = rer_{t+1}^G - \frac{\sigma}{\big[Z_1 + Z_2(2\sigma\nu - 1)\big]}\Delta x_{t+1} + \frac{\sigma}{\big[Z_1 + Z_2(2\sigma\nu - 1)\big]}\Delta x_{t+1}^* \\ + \frac{2Z_2Z_3\sigma}{\big[Z_1 + Z_2(2\sigma\nu - 1)\big]}\Delta tot_{t+1}^G - \frac{(Z_1 - Z_2)}{\big[Z_1 + Z_2(2\sigma\nu - 1)\big]}\gamma b_t^*\end{aligned} \tag{4.56}$$

We log-linearize the balance of Payments in (4.39), to get:

$$\widehat{b}_t^* = \frac{1}{\beta}\widehat{b}_{t-1}^* + \widehat{y}_t - \widehat{c}_t - Z_2\widehat{tot}_t \tag{4.57}$$

Substituting the log-linearized aggregate resource constraint (4.34) into (4.56) gives:

$$\begin{aligned}\widehat{b}_t^* = \frac{1}{\beta}\widehat{b}_{t-1}^* - \Big(\frac{Z_2}{Z_1 - Z_2}\Big)\widehat{y}_t + \Big(\frac{Z_2}{Z_1 - Z_2}\Big)\widehat{y}_t^* \\ + \Big[\frac{Z_2(Z_3 - Z_1 + Z_2)}{Z_1 - Z_2}\Big]\widehat{tot}_t + \Big(\frac{Z_2}{Z_1 - Z_2}\Big)\nu\widehat{rer}_t\end{aligned} \tag{4.58}$$

Using the assumption that $\widehat{b}_t^p = 0$, we easily derive the NFA dynamic in "gap" terms, as:

$$\begin{aligned}b_t^* = \frac{1}{\beta}b_{t-1}^* - \Big(\frac{Z_2}{Z_1 - Z_2}\Big)x_t + \Big(\frac{Z_2}{Z_1 - Z_2}\Big)x_t^* \\ + \Big[\frac{Z_2(Z_3 - Z_1 + Z_2)}{Z_1 - Z_2}\Big]tot_t^G + \Big(\frac{Z_2}{Z_1 - Z_2}\Big)\nu rer_t^G\end{aligned} \tag{4.59}$$

It is straightforward to derive the remaining equations of the model in "gap" form. Consequently, we summarize the full set of reduced equations of the model for domestic country in the Box below [18]. Equation (E1) expresses the "New Keynesian" IS curve for a two-sector open economy model. We can see that the home output gap (x_t) depends inversely on the deviation of the real interest rate ($i_t - \pi_{t+1}$) from its potential rate ($\widehat{r}_t^p$), on the expected currency misalignments, the expected terms of trade gap, the expected changes in the foreign output gap, as well as on the expected home output gap in the following period. The price-setting equation (E2) specifies current CPI inflation to depend positively on expected PPI inflation, the output gap and negatively on the foreign output gap, the terms of trade gap and currency misalignment. Equation (E5) gives the dynamic of currency misalignment as a negative function of the expected home output gap and the NFA position, and a positive function of the expected foreign output gap and the terms of trade gap in the following period. Equation (E6) stands for the dynamic of the NFA position. Equations (E7) and (E8) define the terms of trade gap and the change in the relative price of traded goods, respectively. Equation (E12) and (E14) indicate that the potential real interest rate and potential exchange rate vary directly with the preference shock.

18. The full set of equations describing the foreign country is presented in Appendix D.6.

BOX: Model dynamic for domestic country

$$E1 : x_t = x_{t+1} - \frac{Z_2}{Z_1}\Delta x^*_{t+1} - \frac{Z_2 Z_3}{Z_1}\Delta tot^G_{t+1} - \frac{Z_2}{Z_1}\nu \Delta rer^G_{t+1} - \frac{1}{\sigma}\left(\frac{Z_1 - Z_2}{Z_1}\right)\left[i_t - \pi_{t+1} - \widehat{r}^p_t\right]$$

$$E2 : \pi_t = \alpha(1-\omega)\Delta tot^G_t + \pi_{d,t}$$

$$E3 : \pi_{d,t} = \beta\pi_{d,t+1} + \frac{(1-\phi)(1-\beta\phi)}{\phi} mc_t$$

$$E4 : mc_t = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right] x_t - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right) x^*_t - \left[\frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)} - Z_2\right] tot^G_t - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right)\nu rer^G_t$$

$$E5 : rer^G_t =$$

$$rer^G_{t+1} - \frac{\sigma}{\left[Z_1 + Z_2(2\sigma\nu - 1)\right]}\Delta x_{t+1} + \frac{\sigma}{\left[Z_1 + Z_2(2\sigma\nu - 1)\right]}\Delta x^*_{t+1} + \frac{2Z_2 Z_3 \sigma}{\left[Z_1 + Z_2(2\sigma\nu - 1)\right]}\Delta tot^G_{t+1} - \frac{(Z_1 - Z_2)}{\left[Z_1 + Z_2(2\sigma\nu - 1)\right]}\gamma b^*_t$$

$$E6 : b^*_t = \frac{1}{\beta} b^*_{t-1} - \left(\frac{Z_2}{Z_1 - Z_2}\right) x_t + \left(\frac{Z_2}{Z_1 - Z_2}\right) x^*_t + \left[\frac{Z_2(Z_3 - Z_1 + Z_2)}{Z_1 - Z_2}\right] tot^G_t + \left(\frac{Z_2}{Z_1 - Z_2}\right)\nu rer^G_t$$

$$E7 : tot^G_t = \frac{1}{(2\omega - 1)} rer^G_t - \left(\frac{1-\alpha}{2\omega - 1}\right)\left(q^G_t - q^{G*}_t\right)$$

$$E8 : \Delta q^G_t = (1-\omega)\Delta tot^G_t + \pi_{H,t} - \pi_{N,t}$$

$$E9 : \Delta tot^G_t = \Delta s^G_t + \pi^*_{F,t} - \pi_{N,t}$$

$E10 : i_t = \max(0, i + \varphi_1 \pi_t + \varphi_2 x_t)$, Independent Floating regime

$E11 : i^{cu}_t = \max(0, i^{cu} + \varphi_1 \pi^{cu}_t + \varphi_2 x^{cu}_t)$, Currency Union

$$E12 : \widehat{r}^p_t = \left(\frac{Z_1\sigma}{Z_1 - Z_2}\right)\Delta\widehat{y}^p_{t+1} - \left(\frac{Z_2\sigma}{Z_1 - Z_2}\right)\Delta\widehat{y}^{*p}_{t+1} - \left(\frac{Z_2 Z_3\sigma}{Z_1 - Z_2}\right)\Delta\widehat{tot}^p_{t+1} - \left(\frac{Z_2\sigma\nu}{Z_1 - Z_2}\right)\Delta\widehat{rer}^p_{t+1} - (\widehat{\varepsilon}_{t+1} - \widehat{\varepsilon}_t)$$

$$E13 : \widehat{y}^p_t = \frac{Z_2\sigma}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{y}^{*p}_t + \frac{Z_2(\sigma Z_3 - Z_1 + Z_2)}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{tot}^p_t + \frac{Z_2\sigma\nu}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{rer}^p_t + \frac{(1+\eta)(Z_1 - Z2)}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{a}_t$$

$$E14 : \widehat{rer}^p_t = \frac{\sigma}{[Z_1 + Z_2(2\sigma\nu - 1)]}[\widehat{y}^p_t - \widehat{y}^{*p}_t] - \frac{2Z_2 Z_3\sigma}{[Z_1 + Z_2(2\sigma\nu - 1)]}\widehat{tot}^p_t + \frac{(Z_1 - Z_2)}{[Z_1 + Z_2(2\sigma\nu - 1)]}(\widehat{\varepsilon}^*_t - \widehat{\varepsilon}_t)$$

$$E15 : \widehat{tot}^p_t = \frac{1}{(2\omega - 1)}\widehat{rer}^p_t - \left(\frac{1-\alpha}{2\omega - 1}\right)\left[\widehat{q}^p_t - \widehat{q}^{*p}_t\right]$$

$$E16 : \widehat{q}^p_t = (1-\omega)\widehat{tot}^p_t$$

4.3.7. Calibration

The parameters are calibrated on the basis of the "New Keynesian" literature. The full set of parameters and the sources of their calibration are summarized in Table 4.7. By following the recent literature on the ZLB, we assume that the ZLB constraint is caused by a negative preference shock. The shock is asymmetric, thus, it hits only the domestic country. In order to generate an environment away from the ZLB constraint (i.e. in normal times), we chose the standard deviation of the shock (σ_ε) equals to 0.02, ensuring that interest rates, by stabilizing economies, remain above their zero floors. By contrast, a large standard deviation of the asymmetric preference shock is chosen ($\sigma_\varepsilon = 0.25$) in order to cause the ZLB constraint in both the currency union and the independent policy regime. To allow comparison across regimes, this shock magnitude is the same in the two considered regimes.

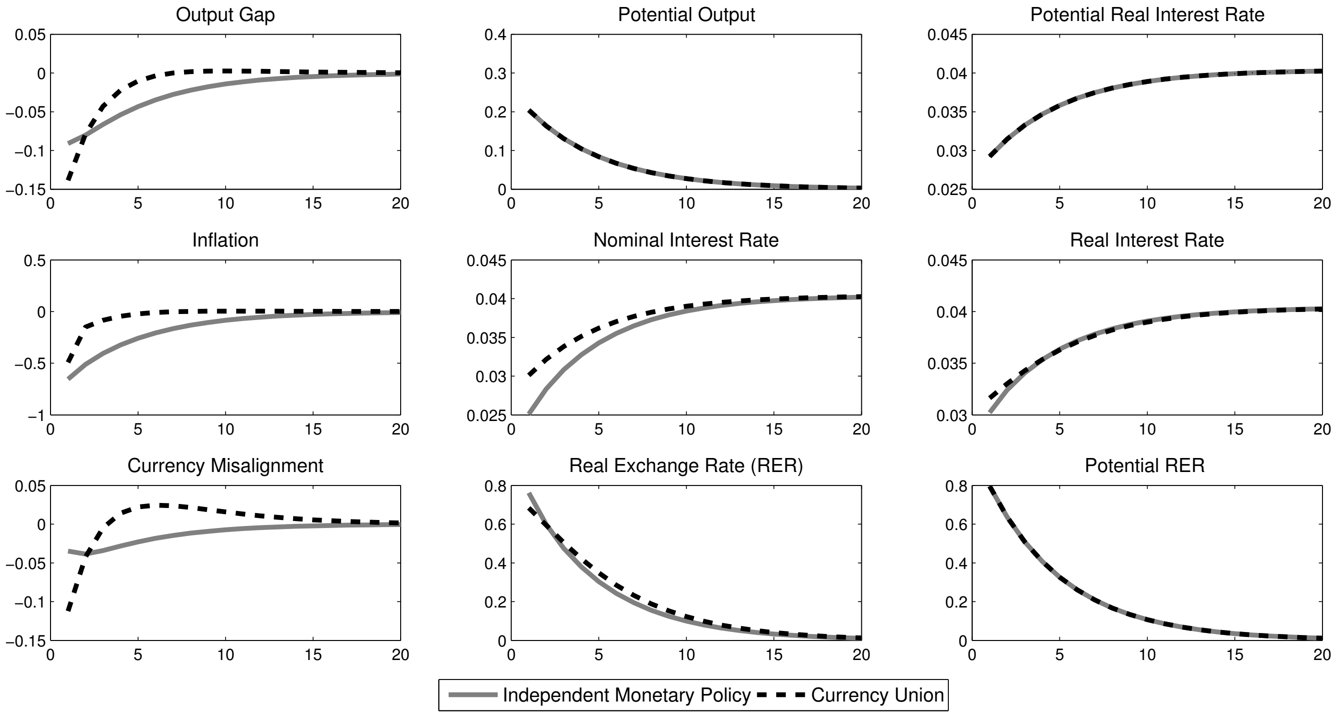
Table 4.7 – Calibration

Description	Parameter	Value	Source
Subjective discount factor	β	0.99	Standard in the literature
Inverse of the Frisch elasticity of labour supply	η	2	Eggertsson and al. (2014)
Inverse of intertemporal elasticity of substitution in consumption	σ	2	Stockman and Tesar (1995)
Share of home-traded goods	ω	0.57	Eggertsson and al. (2014)
Share of Non-traded goods	$1 - \alpha$	0.62	Eggertsson and al. (2014)
Elasticity of substitution between Traded and Non-traded goods	ν	0.74	Mendoza (1991)
Elasticity of substitution between Home and Foreign-traded goods	κ	1.5	Backus and al. (1994)
Calvo probability	ϕ	0.75	Common in the litterature
Elasticity of foreign borrowing cost	γ	0.007	Rabanal and Tuesta (2006,2010)
Inflation stabilizing coefficient in the monetary rule	φ_1	2.2	close to Ahmad and al. (2013)
Output gap stabilizing coefficient in the monetary rule	φ_2	0.25	close to Ahmad and al. (2013)
Autocorrelaion of the preference shock	ρ_ε	0.8	Cook and Devereux (2014)
Autocorrelaion of the technology shock in each sector	ρ_A	0.8	

4.3.8. Currency misalignments and monetary regimes away from the zero bound

In this subsection, we compare the monetary union and the IMP regime on the basis of currency misalignment when a country faces an asymmetric demand shock, which is small enough that the central bank can stabilise inflation and the output gap by the traditional monetary instrument. Figure 4.2 shows the responses of the main domestic variables to a negative preference shock under the monetary union and IMP regimes.
From equation (4.55) and (4.46), this shock causes both the potential real exchange rate to depreciate and the potential real interest rate to decrease, implying an increase in potential output and a decrease in output gap (see also equations 4.45 and 4.47). The potential real exchange rate depreciates because of the relative decline in the marginal utility of consumption, which further causes itself the relative fall in CPI inflation. That fall in inflation is supported by the relative output gap's path. Under the IMP regime, the nominal and real interests would (aggressively) track inflation and the output gap. Consequently, the nominal and real exchange rate depreciate. In the currency union case, the nominal interest rate reflects both the average inflation within the zone and the area-wide output gap, and thus, it decreases less than that in the IMP case. Accordingly, the real exchange rate depreciates more under the IMP regime than under the currency union. Currency misalignment (which may be viewed as an overvaluation) occurs since the initial depreciation of the potential real exchange rate is larger than the actual real exchange rate depreciation. Importantly, currency misalignments are broadly higher under the currency union than under the IMP regime, reflecting the output gap and actual exchange rate dynamics. This is in line with Coudert et al. (2013)'s result suggesting that levels of currency misalignments are larger under the monetary union than under the independent policy in "normal" times.

Figure 4.2 – Dynamics of key variables away from ZLB



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in percent deviations from steady state, except inflation which is in percent annualized level with 0% its steady-state value, the nominal interest rate, the real interest rate and the potential real interest rate which are measured in annualized levels with 4% their respective steady-state levels.

4.3.9. Effects of the ZLB constraint on currency misalignments

Now let's consider the case where the preference shock is large enough to constrain the interest rates at their zero floors in the currency union and the IMP regime. The shock only affects the home country.

Figure 4.3 displays the behaviours of main domestic variables in response to a negative preference shock creating a liquidity trap. As before, this shock tends to depress the potential real interest rate (r_t^p) and depreciate the potential real exchange rate, implying an increase in potential output.

Note that, if the zero bound is not binding, equation (4.47) implies that the actual real interest rate (and thus, the nominal interest rate) simply tracks the potential real interest rate. As a consequence, the duration of the liquidity trap depends solely on how long the potential real interest rate remains below zero. Since the potential real interest rate depends, among others, on the potential real exchange rate from equation (4.46), this latter affects the duration of the

ZLB constraint (i.e. duration of the liquidity trap) which moves endogenously.

Let us return to the key mechanism. When the large taste shock occurs, the central bank has to cut the nominal interest rate in order to stabilize the economy. The required policy rate level for stabilizing should be below zero (potential interest rate) following the inflation rate and the output gap. Because of the zero bound constraint, the monetary authority will not be able to cut the nominal rate by the required amount. This implies that the nominal interest rate at zero is superior to its potential level, and consequently the actual real interest is higher than the natural level in the ZLB period. This leads to the fall in the output gap and inflation. The difference between among regimes in terms of adjustments of the output gap, followed by inflation, the real interest rate and currency misalignment, is explained by the initial appreciation of the actual real exchange rate under the IMP regime and the depreciation occurring in the currency union.

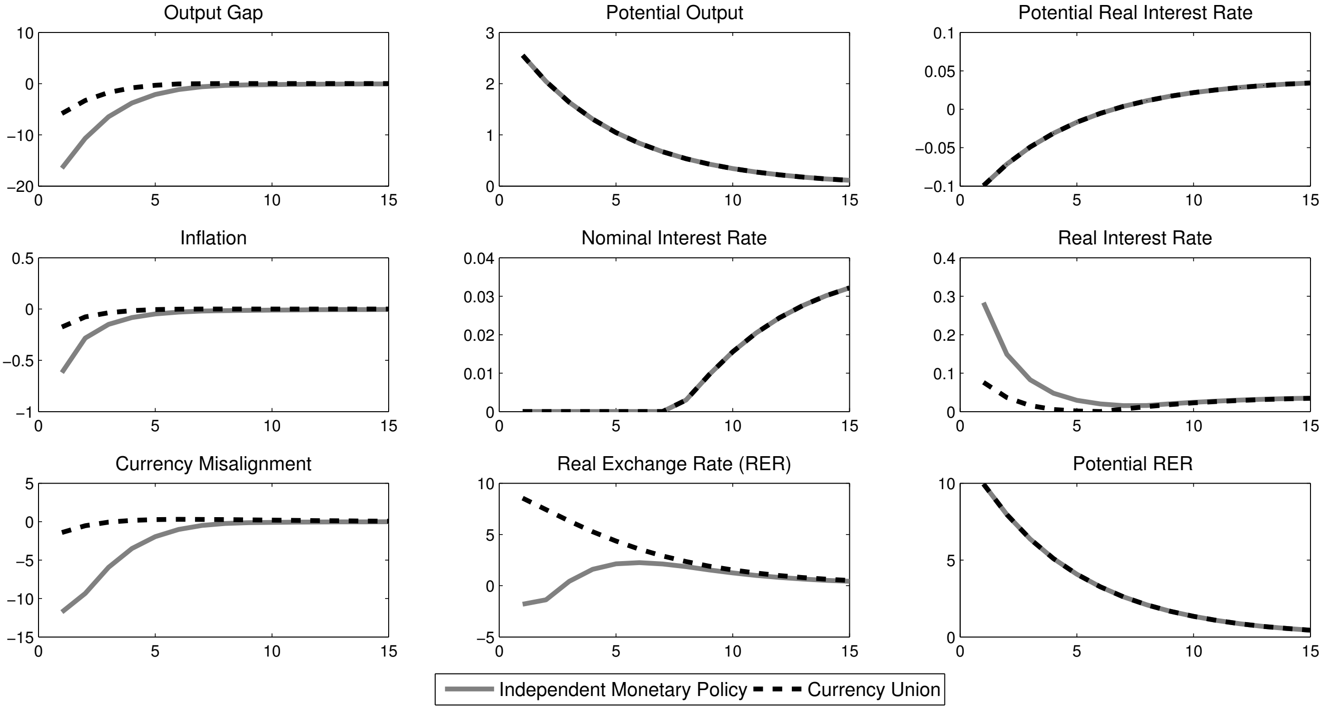
Indeed, as the policy rate under the currency union depend on the average inflation within the region and the sum of the region output gap, the economic agents anticipate a high future inflation in the home country when the liquidity trap lasts, implying a low expected long-term real interest rate. Consequently, there is a deprecation of the real exchange rate which only depends on the home relative inflation.

However, under the IMP regime, agents know that the policy rule (aggressively) responds to both the domestic inflation and output gap. They thus anticipate a low future inflation in home country, and therefore, the ex ante long-run real interest rate substantially rises. Thence, the nominal and real exchange rate appreciate. These mechanisms have already been amply discussed in the previous chapter.

Since the shock leads to the potential real exchange rate depreciation, the actual real depreciation occurring under the currency union tends to reduce the currency overvaluation relative to the IMP regime under which the actual real exchange rate appreciates.

Currency misalignments are finally higher in the IMP regime than in the currency union, reflecting the appreciation and the depreciation of the actual real exchange rate in the former and latter regimes, respectively.

Figure 4.3 – Dynamics of key variables at ZLB



Notes: Time, measured in quarters, is on the horizontal axis. All variables are measured in percent deviations from steady state, except inflation, the nominal interest rate, the real interest rate and the potential real interest rate which are measured in annualized levels with 0%, 4% , 4%, and 4% their respective steady-state levels.

Theoretical summary

There are three main lessons from theory. First, the model suggests that in line with our empirical evidence, when the zero bound constraint is binding, currency misalignments are higher on average in the IMP regime compared with the currency union. Second, this ranking on the misalignment basis among regimes is reversed if the nominal interest rate is not constrained. As in the empirical analysis, these first two points suggest that the liquidity trap tends to reduce currency misalignments within the currency area. The third lesson from the theory is learned by noting that the key driving force that causes the difference in misalignment levels among regimes is the real exchange rate adjustment. Indeed, without the ZLB constraint the actual real exchange rate depreciates in both the monetary union and the IMP regime, but more in the latter regime than in the former. In contrast, if the ZLB constraint binds, the actual real exchange rate depreciates in the monetary union whereas it appreciates under the IMP regime. Irrespective of the monetary regimes and the environment circumscribed by the interest rate (i.e. with or without the ZLB constraint), a negative preference shock generates a currency overvaluation. Consequently, the actual real depreciation occurring under the currency union tends to reduce the currency overvaluation relative to the IMP regime under which the actual real exchange rate appreciates. Finally, currency misalignment reverts to equilibrium more rapidly with the ZLB constraint than without.

4.4. Concluding remarks and policy implications

Despite the vast body of research on currency misalignments in general, there is a paucity of work investigating their size during the liquidity trap. The goals of this chapter were to empirically and theoretically explore the effects of the ZLB constraint on the size of currency misalignments and to compare the magnitude of these effects based on the monetary regimes.

In the first part of the chapter, we have estimated and tested the effect of the liquidity trap on misalignments in a sample, large enough and fully representative of countries that have experienced the ZLB constraint in recent years, using the recent development in non-stationary panel data econometric methods. We find that currency misalignments are remarkably reduced by the liquidity trap under the monetary union compared with the independent monetary policy regime. We further find that the speed of the real exchange rate convergence towards its long-run value increases due to the liquidity trap effect.

In the second part of our study, we have rationalized theses empirical results through a two-sector two-country DSGE model in which the duration of the liquidity trap is endogenous and misalignment is defined as the deviation between the actual real exchange rate and its long-run "efficient" level. The theoretical model proposes a mechanism through which the empirical results hold. In particular, since the preference shock induces a currency overvaluation irrespective of whether or not the country is belonging to the currency union, the sharp appreciation of the actual nominal (and real) exchange rate that occurs in the liquidity trap adversely affects the currency misalignment under the IMP regime. In contrast, the actual real exchange rate depreciates under the currency union during the liquidity trap and therefore reduces the currency overvaluation.

Importantly, our findings have policy implications regarding the decision and timing of opting for the currency union, and more generally regarding the monetary integration. Indeed, by reducing the levels of currency misalignments the ZLB constraint tends to preclude more intra-union imbalances and thus, increases the economic integration within a currency area. In this perspective, our results relativize that of Coudert et al. (2013) by showing that there may be an economic environment within a monetary union (such as the current episode of the ZLB in the Euro area) that could sharply decrease the currency misalignment. Our work suggests that the timing of adopting the single currency for countries that plan to join the European

Monetary Union (EMU) is that of the liquidity trap. During these times, the extent of a potential overvaluation deteriorating the competitiveness of countries entering in the EMU is significantly reduced.

Finally, since the speed of the real exchange rate convergence is increased by the liquidity trap, the latter reinforces the sustainability of the currency union in the sense that the real exchange rate does not deviate persistently from its equilibrium value. For the same reason, the inefficiency caused by the currency misalignment in IMP countries also does not last long as in the period without the ZLB constraint.

Appendix D

D.1. Data sources

- **Bilateral Nominal exchange rates :** from International Financial Statistics (IMF) and Reuters.
- **Consumption Price Index (CPI) (2010=100):** from International Financial Statistics (IMF) and Datastream (Oxford economics) and Directorate General of Budget of Taiwan.
- **Exports and Imports:** from Direction of Trade Statistics (IMF).
- **GDP:** from OECD, IFS (FMI) and Datastream (Oxford economics).
- **Population:** from OECD, datastream (Oxford economics) and World Economic Outlook (IMF).
- **Price deflators of imports and exports:** from Datastream (Oxford economics).
- **Short term interest rate:** from Datastream and central bank databases of countries.

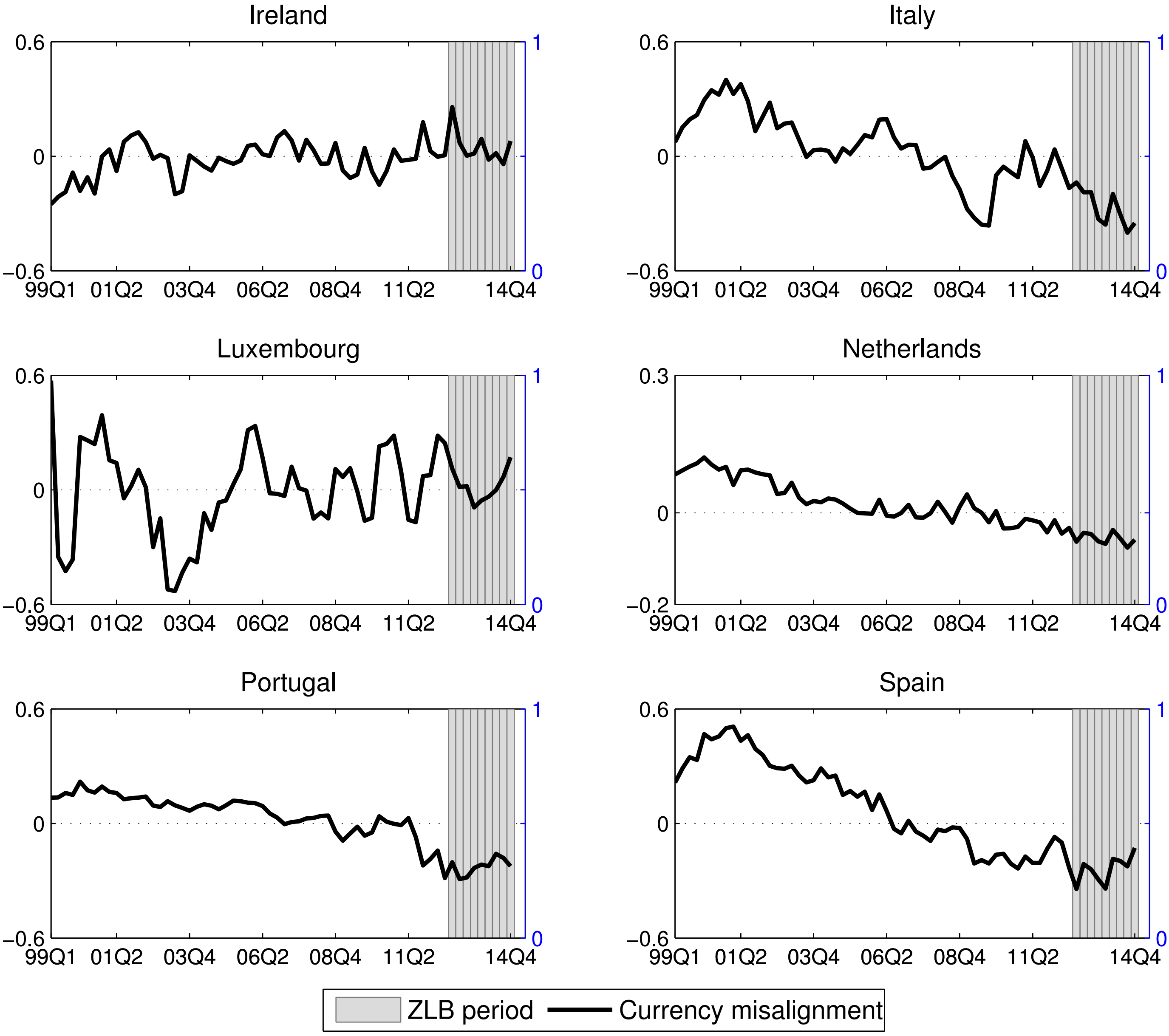
D.2. Equilibrium exchange rate estimation

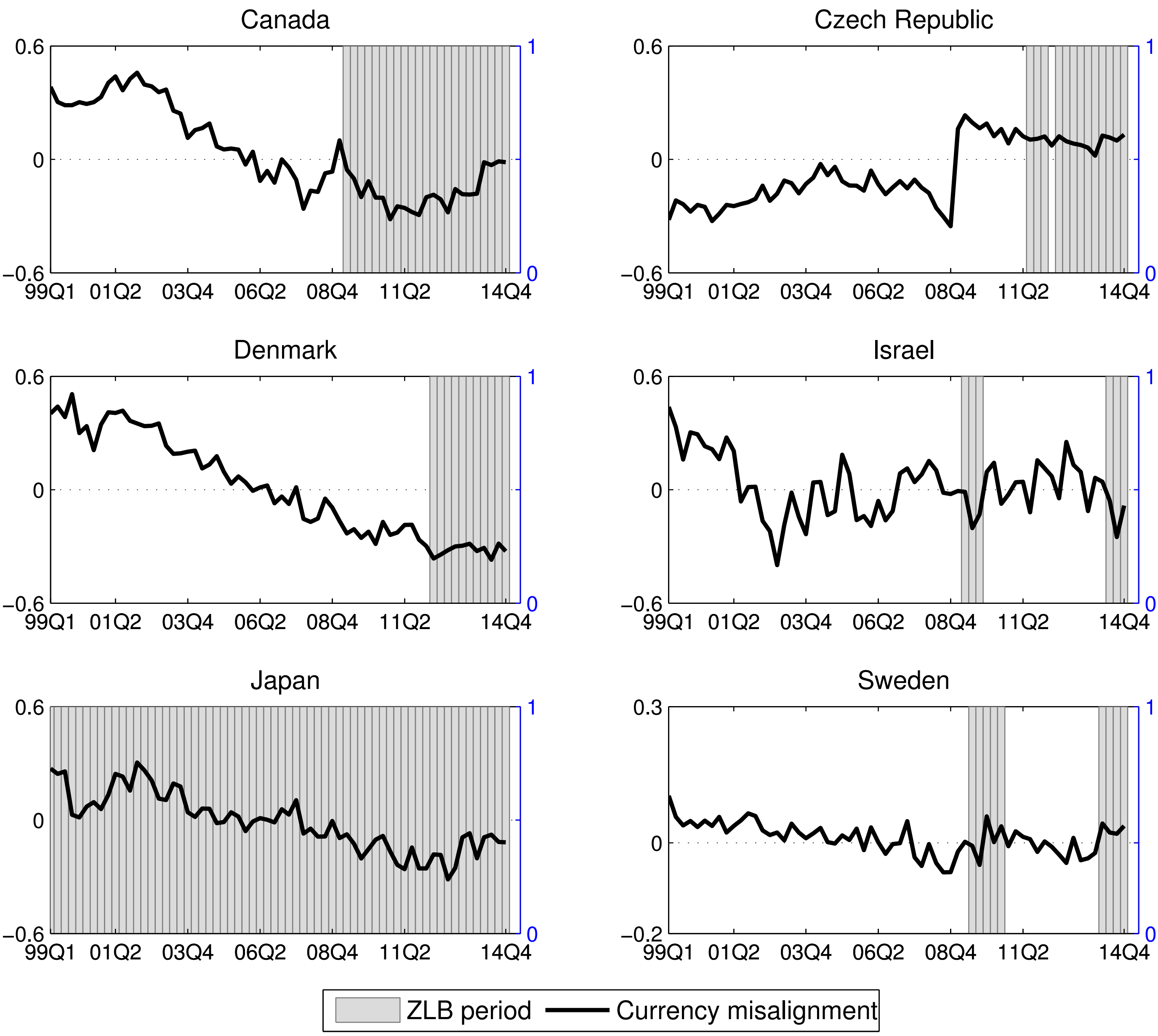
Table D.2.1 – Country-fixed effects

CU countries	α_i
Austria	-0.405
Belgium	0.072
Finland	-1.046
France	-0.120
Germany	-0.151
Greece	-0.436
Ireand	-0.044
Italy	-0.305
Luxembourg	0.4889
Netherland	-0.181
Portugal	-0.461
Spain	-0.223
IMP countries	
Canada	-0.213
Czech Republic	2.448
Denmark	1.586
Israel	0.949
Japan	2.742
Sweden	1.724
Switzerland	0.480
United Kingdom	-0.385
United States	-1.055

D.3. Currency misalignment and ZLB across monetary regimes

Figure D.3.1 – Misalignments under ZLB periods for others countries




Canada
Czech Republic
Denmark
Israel
Japan
Sweden
0.6
0
−0.6
0.3
−0.2
1
0
99Q1 01Q2 03Q4 06Q2 08Q4 11Q2 14Q4
ZLB period
Currency misalignment

D.4. Steady-State equilibrium

$$Y = Y_H + Y_N \qquad Y^* = Y_H^* + Y_N^* \tag{D.4.1}$$

$$Y_H = \alpha C \qquad Y_F^* = \alpha C^* \tag{D.4.2}$$

$$Y_N = (1-\alpha)C \qquad Y_N^* = (1-\alpha)C^* \tag{D.4.3}$$

$$Y = C \qquad Y^* = C^* \tag{D.4.4}$$

$$Y_H = N_H \qquad Y_F^* = N_F^* \tag{D.4.5}$$

$$Y_N = N_N \qquad Y_N^* = N_N^* \tag{D.4.6}$$

$$N = N_H + N_N \qquad N^* = N_H^* + N_N^* \tag{D.4.7}$$

$$R = \frac{1}{\beta} \qquad R^* = \frac{1}{\beta} \tag{D.4.8}$$

$$mc_H = mc_N = \frac{\epsilon - 1}{\epsilon} \qquad mc_F^* = mc_N^* = \frac{\epsilon - 1}{\epsilon} \tag{D.4.9}$$

$$w = \frac{N^\eta}{C^{-\sigma}} = mc_H = mc_N \qquad w^* = \frac{N^{*\eta}}{C^{*-\sigma}} = mc_F^* = mc_N^* \tag{D.4.10}$$

$$\tag{D.4.11}$$

D.5. Log-linearized version of the model

D.5.1. Domestic country

All log-linerized equilibrium conditions for domestic country are:

$$\widehat{w}_t = \sigma \widehat{c}_t + \eta \widehat{n}_t \tag{D.5.12}$$

$$\widehat{c}_t = E_t \widehat{c}_{t+1} - \frac{1}{\sigma} E_t (i_t - \widehat{\Pi}_{t+1}) - \frac{1}{\sigma} E_t (\widehat{\varepsilon}_{t+1} - \widehat{\varepsilon}_t) \tag{D.5.13}$$

$$E_t \widehat{rer}_{t+1} - \widehat{rer}_t = E_t (i_t - \widehat{\Pi}_{t+1}) - E_t (i_t^* - \widehat{\Pi}_{t+1}^*) + \gamma \widehat{b}_t^* \tag{D.5.14}$$

$$\widehat{y}_{H,t} = \widehat{a}_{H,t} + \widehat{n}_{H,t} \tag{D.5.15}$$

$$\widehat{y}_{N,t} = \widehat{a}_{N,t} + \widehat{n}_{N,t} \tag{D.5.16}$$

$$\widehat{mc}_{H,t} = \widehat{w}_t - \widehat{a}_{H,t} + (1-\omega)\widehat{tot}_t - (1-\alpha)\widehat{q}_t \tag{D.5.17}$$

$$\widehat{mc}_{N,t} = \widehat{w}_t - \widehat{a}_{N,t} + \alpha q_t = \widehat{a}_{H,t} - \widehat{a}_{N,t} + \widehat{q}_t - (1-\omega)\widehat{tot}_t + \widehat{mc}_{H,t} \tag{D.5.18}$$

$$\widehat{\Pi}_{H,t} = \beta E_t \widehat{\Pi}_{H,t+1} + \frac{(1-\phi_T)(1-\beta\phi_T)}{\phi_T} \widehat{mc}_{H,t} \tag{D.5.19}$$

$$\widehat{\Pi}_{N,t} = \beta E_t \widehat{\Pi}_{N,t+1} + \frac{(1-\phi_N)(1-\beta\phi_N)}{\phi_N}\widehat{mc}_{N,t} \tag{D.5.20}$$

$$\widehat{y}_t = \frac{Y_H}{Y}\widehat{y}_{H,t} + \frac{Y_N}{Y}\widehat{y}_{N,t} \tag{D.5.21}$$

$$\widehat{a}_t = \frac{Y_H}{Y}\widehat{a}_{H,t} + \frac{Y_N}{Y}\widehat{a}_{N,t} \tag{D.5.22}$$

$$\widehat{n}_t = \frac{N_H}{N}\widehat{n}_{H,t} + \frac{N_N}{N}\widehat{n}_{N,t} \tag{D.5.23}$$

$$\widehat{mc}_t = \frac{Y_H}{Y}\widehat{mc}_{H,t} + \frac{Y_N}{Y}\widehat{mc}_{N,t} \tag{D.5.24}$$

$$b^*_t = \frac{1}{\beta}b^*_{t-1} + \widehat{y}_t - \widehat{c}_t - \alpha(1-\omega)\widehat{tot}_t \tag{D.5.25}$$

$$Y_H\widehat{y}_{H,t} = \alpha\omega C\widehat{c}_t + \alpha(1-\omega)C\widehat{c}^*_t + 2\alpha\omega C\kappa(1-\omega)\widehat{tot}_t - \alpha C\nu(1-\alpha)[\omega\widehat{q}_t + (1-\omega)\widehat{q}^*_t] \tag{D.5.26}$$

$$Y_N\widehat{y}_{N,t} = (1-\alpha)C\nu\alpha\widehat{q}_t + (1-\alpha)C\widehat{c}_t \tag{D.5.27}$$

$$\widehat{y}_t = [\alpha\omega + (1-\alpha)]\widehat{c}_t + \alpha(1-\omega)\widehat{c}^*_t + \alpha(1-\omega)[2\omega(\kappa-\nu)+\nu]\widehat{tot}_t + \alpha(1-\omega)\nu\widehat{rer}_t \tag{D.5.28}$$

$$\widehat{\Pi}_{d,t} = \frac{Y_H}{Y}\widehat{\Pi}_{H,t} + \frac{Y_N}{Y}\widehat{\Pi}_{N,t} \tag{D.5.29}$$

$$\Delta\widehat{tot}_t = \Delta S_t + \widehat{\Pi}^*_{F,t} - \widehat{\Pi}_{H,t} \tag{D.5.30}$$

$$\widehat{\Pi}_t = \alpha(1-\omega)\Delta\widehat{tot}_t + \alpha\widehat{\Pi}_{H,t} + (1-\alpha)\widehat{\Pi}_{N,t} \tag{D.5.31}$$

$$\Delta q_t = (1-\omega)\Delta\widehat{tot}_t + \widehat{\Pi}_{H,t} - \widehat{\Pi}_{N,t} \tag{D.5.32}$$

$$\widehat{rer}_t = (2\omega-1)\widehat{tot}_t + (1-\alpha)(\widehat{q}_t - \widehat{q}^*_t) \tag{D.5.33}$$

$$f(\widehat{tot}_t) = (1-\omega)\widehat{tot}_t \tag{D.5.34}$$

$$f(\widehat{q}_t) = \alpha\widehat{q}_t \tag{D.5.35}$$

$$\widehat{\Pi}_{H,t} = \pi_{H,t} \tag{D.5.36}$$

$$\widehat{\Pi}_{N,t} = \pi_{N,t} \tag{D.5.37}$$

$$\widehat{\Pi}_t = \pi_t \tag{D.5.38}$$

D.5.2. Foreign country

All log-linerized equilibrium conditions for foreign country are:

$$\widehat{w}_t^* = \sigma\widehat{c}_t^* + \eta\widehat{n}_t^* \tag{D.5.39}$$

$$\widehat{c}_t^* = E_t\widehat{c}_{t+1}^* - \frac{1}{\sigma}E_t(i_t^* - \widehat{\Pi}_{t+1}^*) - \frac{1}{\sigma}E_t(\widehat{\varepsilon}_{t+1}^* - \widehat{\varepsilon}_t^*) \tag{D.5.40}$$

$$\widehat{y}_{F,t}^* = \widehat{a}_{F,t}^* + \widehat{n}_{F,t}^* \tag{D.5.41}$$

$$\widehat{y}_{N,t}^* = \widehat{a}_{N,t}^* + \widehat{n}_{N,t}^* \tag{D.5.42}$$

$$\widehat{mc}_{F,t}^* = \widehat{w}_t^* - \widehat{a}_{F,t}^* + (1-\omega)\widehat{tot}_t^* - (1-\alpha)\widehat{q}_t^* \tag{D.5.43}$$

$$\widehat{mc}_{N,t}^* = \widehat{w}_t^* - \widehat{a}_{N,t}^* + \alpha q_t^* = \widehat{a}_{F,t}^* - \widehat{a}_{N,t}^* + \widehat{q}_t^* - (1-\omega)\widehat{tot}_t^* + \widehat{mc}_{F,t}^* \tag{D.5.44}$$

$$\widehat{\Pi}_{F,t}^* = \beta E_t\widehat{\Pi}_{F,t+1}^* + \frac{(1-\phi_T)(1-\beta\phi_T)}{\phi_T}\widehat{mc}_{F,t}^* \tag{D.5.45}$$

$$\widehat{\Pi}_{N,t}^* = \beta E_t\widehat{\Pi}_{N,t+1}^* + \frac{(1-\phi_N)(1-\beta\phi_N)}{\phi_N}\widehat{mc}_{N,t}^* \tag{D.5.46}$$

$$\widehat{y}_t^* = \frac{Y_F^*}{Y^*}\widehat{y}_{F,t}^* + \frac{Y_N^*}{Y^*}\widehat{y}_{N,t}^* \tag{D.5.47}$$

$$\widehat{a}_t^* = \frac{Y_F^*}{Y^*}\widehat{a}_{F,t}^* + \frac{Y_N^*}{Y^*}\widehat{a}_{N,t}^* \tag{D.5.48}$$

$$\widehat{n}_t^* = \frac{N_F^*}{N^*}\widehat{n}_{F,t}^* + \frac{N_N^*}{N^*}\widehat{n}_{N,t}^* \tag{D.5.49}$$

$$\widehat{mc}_t^* = \frac{Y_F^*}{Y^*}\widehat{mc}_{F,t}^* + \frac{Y_N^*}{Y^*}\widehat{mc}_{N,t}^* \tag{D.5.50}$$

$$Y_F^*\widehat{y}_{F,t}^* = \alpha\omega C^*\widehat{c}_t^* + \alpha(1-\omega)C\widehat{c}_t - 2\alpha\omega C\kappa(1-\omega)\widehat{tot}_t - \alpha C\nu(1-\alpha)[\omega\widehat{q}_t^* + (1-\omega)\widehat{q}_t] \tag{D.5.51}$$

$$Y_N^*\widehat{y}_{N,t}^* = (1-\alpha)C^*\nu\alpha\widehat{q}_t^* + (1-\alpha)C^*\widehat{c}_t^* \tag{D.5.52}$$

$$\widehat{y}_t^* = [\alpha\omega + (1-\alpha)]\widehat{c}_t^* + \alpha(1-\omega)\widehat{c}_t - \alpha(1-\omega)[2\omega(\kappa-\nu)+\nu]\widehat{tot}_t - \alpha(1-\omega)\nu\widehat{rer}_t \tag{D.5.53}$$

$$\widehat{\Pi}_{d,t}^* = \frac{Y_F^*}{Y^*}\widehat{\Pi}_{F,t}^* + \frac{Y_N^*}{Y^*}\widehat{\Pi}_{N,t} \tag{D.5.54}$$

$$\widehat{tot}_t^* = -\widehat{tot}_t \tag{D.5.55}$$

$$\widehat{\Pi}_t^* = -\alpha(1-\omega)\Delta\widehat{tot}_t + \alpha\widehat{\Pi}_{F,t}^* + (1-\alpha)\widehat{\Pi}_{N,t}^* \tag{D.5.56}$$

$$\Delta q_t^* = -(1-\omega)\Delta\widehat{tot}_t + \widehat{\Pi}_{F,t}^* - \widehat{\Pi}_{N,t}^* \tag{D.5.57}$$

$$\widehat{rer}_t^* = -\widehat{rer}_t \tag{D.5.58}$$

$$f^*(\widehat{tot}_t^*) = (1-\omega)\widehat{tot}_t^* \tag{D.5.59}$$

$$f^*(\widehat{q}_t^*) = \alpha\widehat{q}_t^* \tag{D.5.60}$$

D.6. Model dynamic for foreign country

$$x_t^* = x_{t+1}^* - \frac{Z_2}{Z_1}\Delta x_{t+1} + \frac{Z_2 Z_3}{Z_1}\Delta tot_{t+1}^G + \frac{Z_2}{Z_1}\nu \Delta rer_{t+1}^G - \frac{1}{\sigma}\left(\frac{Z_1 - Z_2}{Z_1}\right)\left[i_t^* - \pi_{t+1}^* - \widehat{r}_t^{*p}\right] \quad \text{(D.6.61)}$$

$$mc_t^* = \left[\frac{\sigma Z_1}{(Z_1 - Z_2)} + \eta\right] x_t^* - \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right) x_t + \left[\frac{\sigma Z_2 Z_3}{(Z_1 - Z_2)} - Z_2\right] tot_t^G + \left(\frac{\sigma Z_2}{Z_1 - Z_2}\right)\nu rer_t^G \quad \text{(D.6.62)}$$

$$\widehat{r}_t^{*p} = \left(\frac{Z_1\sigma}{Z_1 - Z_2}\right)\Delta \widehat{y}_{t+1}^{*p} - \left(\frac{Z_2\sigma}{Z_1 - Z_2}\right)\Delta \widehat{y}_{t+1}^{p} + \left(\frac{Z_2 Z_3\sigma}{Z_1 - Z_2}\right)\Delta \widehat{tot}_{t+1}^{p} + \left(\frac{Z_2\sigma\nu}{Z_1 - Z_2}\right)\Delta \widehat{rer}_{t+1}^{p} - (\widehat{\varepsilon}_{t+1}^* - \widehat{\varepsilon}_t^*) \quad \text{(D.6.63)}$$

$$\widehat{y}_t^{*p} = \frac{Z_2\sigma}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{y}_t^p - \frac{Z_2(\sigma Z_3 - Z_1 + Z_2)}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{tot}_t^p - \frac{Z_2\sigma\nu}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{rer}_t^p + \frac{(1+\eta)(Z_1 - Z2)}{\left[(\sigma+\eta)Z_1 - \eta Z_2\right]}\widehat{a}_t^* \quad \text{(D.6.64)}$$

$$\pi_t^* = -\alpha(1-\omega)\Delta tot_t^G + \pi_{d,t}^* \tag{D.6.65}$$

$$\pi_{d,t}^* = \beta\pi_{d,t+1}^* + \frac{(1-\phi)(1-\beta\phi)}{\phi}mc_t^* \tag{D.6.66}$$

$$rer_t^{*G} = -rer_t^G \tag{D.6.67}$$

$$tot_t^{*G} = -tot_t^G \tag{D.6.68}$$

$$\Delta q_t^{*G} = -(1-\omega)\Delta tot_t^G + \pi_{F,t}^* - \pi_{N,t}^* \tag{D.6.69}$$

$$i_t^* = \max(0, i^* + \varphi_1\pi_t^* + \varphi_2 x_t^*) \tag{D.6.70}$$

$$\widehat{q}_t^{*p} = -(1-\omega)\widehat{tot}_t^p \tag{D.6.71}$$

$$rer_t^{*p} = -rer_t^p \tag{D.6.72}$$

$$tot_t^{*p} = -tot_t^p \tag{D.6.73}$$

General conclusion

The purpose of this work was to contribute to both the theoretical and the empirical literature on the appropriate choice of exchange rate policies. An additional contribution of our work is to offer economic policy recommendations for and against monetary integration. To this end, we developed four essays which tackled several issues linked to the choice of exchange rate regimes, issues as of yet neglected in the literature.

The first question addressed was whether the main prescription of the Mundell-Fleming framework on the superiority of flexible exchange rates in the face of real shocks holds when economies are indebted in foreign currency and characterized by local currency pricing of imports (LCP). Using data from the Southeast Asia countries and an estimated DSGE model, our first essay shows that the floating regime is the best regime for Southeast Asian countries among the four alternative regimes analyzed (floating, managed floating, fixed exchange rates and target zone). This result can be explained by the high degrees of trade openness of these countries: the expenditure switching effects under the floating regime dominates the potentially destabilizing effects of foreign currency denominated debt, even if the exchange rate pass-through is low.

The second issue tackled in this work is the implications of the nominal effective exchange rate targeting policy for monetary integration in a region where countries have similar components in their trade-weighted currency baskets used to define their effective exchange rates. Based on a multi-country model, the second essay of the thesis showed that the exchange rate targeting policy may lead to a stability of bilateral exchange rates when trade-weighted baskets of currencies are similar. Leading to some sort of fixity of regional bilateral exchange rates, this policy provides an economic resource allocation very close to that of a monetary union in the face of symmetric real shocks. This renders the latter regime uninteresting. This finding cast doubt on the OCA theory and supports the feasibility of a “de facto currency area”.

The third essay of this thesis investigates the validity of the claim to superiority of the flexible exchange rate in a liquidity trap environment. Using several varieties of two-country two-sector DSGE models, we show that, contrary to common belief during the recent Euro crisis and the standard Mundell-Fleming framework, the independent floating regime is less preferable than the currency union when countries are faced with a deflationary shock with interest rates stuck at zero. The rationale behind this finding is the “perverse” adjustment of the real exchange rate under the floating regime in such an economic environment. We also find that the preventive strategy against the adverse effects of the liquidity trap on the real exchange rate, while maintaining an independent monetary policy, is to adopt a managed floating regime.

Finally, the last essay highlights the role of currency misalignments in the choice of exchange rate policies and monetary integration in the context of the zero lower bound (ZLB). The methodology we use is both empirical (panel data econometrics and mean comparison tests) and theoretical (two-countries two-sectors DSGE model). We find that the ZLB reduces the currency misalignment under a monetary union regime, suggesting a reinforcement of the monetary integration in such a regime during the liquidity trap period. We further show that, in a liquidity trap, the size of currency misalignment is larger under the floating regime than the currency union.

This set of findings has implications in terms of economic policy. First, foreign-currency denominated debt and local-currency pricing practices in international trade should not be the only conditions considered by small open economies for giving up the independence of monetary policy. The degree of trade openness is an important parameter which, through the expenditure switching effects, may make the flexible exchange rate more attractive. In particular, flexible exchange rates seem to be the best regime for Southeast Asia countries despite their relatively high degree of foreign-currency indebtedness. Our findings suggest that, in a region where trade-weighted baskets of currencies defining effective exchange rates are similar among economies, targeting a nominal effective exchange rate as an exchange rate policy is quite sufficient to keep monetary independence and be better off compared to a currency union. The Southeast Asia region currently satisfies these conditions. When the central bank lacks its traditional policy instrument (and thus the liquidity trap occurs), it may be preferable for countries to be in currency union rather than keeping the independent floating regime. In addition, that period seems to be the best one to join a currency union, as by reducing currency misalignments it strengthens monetary integration within a currency area. Finally, foreign-exchange market interventions through nominal exchange rate targeting is the best preventive strategy for countries with independent monetary policies to deal with adverse effects of shocks generating a liquidity trap.

This thesis has paved the way for a research agenda centred on the study of the relation between the size of (sectorial) fiscal multipliers and exchange rate regimes in a liquidity trap. Additional works would be the strategic analysis of exchange rate policies in line with the potential global currency war posed by the Chinese aggressive exchange rate policy and the data-based estimation of DSGE models constrained by the zero lower bound in order to assess exchange rate policies.

In this perspective, recent fiscal stimulus in many developed countries against the contraction of economic activity have created a renewed interest in the study of the size of the public spending multiplier, which is supposed to be larger in a liquidity trap than in "normal" times (see Cristiano et al. (2011), Erceg and Lindé (2014), among others). We plan to study the role of the exchange rate regime in explaining the size of (sectorial) fiscal multiplier across economic environments (liquidity trap versus "normal" times) using DSGE and Vector Autoregressive (VAR) models.

Moreover, we intend to borrow from game theory in order to analyze some macroeconomic issues related to a potential risk of global currency war that would occurs when major actors of the world economy are willing to manipulate and keep their currency undervalued in order to boost their exports. We are interested in equilibria that might emerge in such a situation in terms of optimal and world-consistent exchange rate policies. Finally and in direct line with the content of this thesis, we plan to conduct a data-based estimation of some of the DSGE models analyzed here under the ZLB constraint. The challenge in this exercise will be to implement econometrically the inequality constraint. In addition, the use of the optimal monetary regime framework in this thesis is conditional to the assumption of the perfect credibility of the regimes considered. Future researches should look at the imperfect credibility of both fixed and flexible exchange rate regime for instance.

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Colophon

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Title : Essays on exchange rate policies and monetary integration

Abstract :

This thesis investigates the choice of exchange rate regimes in specific economic contexts. The first part of this work (Chapters 1 and 2) considers the case of small open economies with foreign-currency denominated debt and that of a region where there is a similarity among trade-weighted currency baskets of countries. The second part of the thesis (Chapters 3 and 4) focuses on the study of exchange rate regimes and monetary integration in a liquidity trap environment relative to "tranquil" times. Based on dynamic stochastic general equilibrium (DSGE) models and Bayesian and Panel data econometrics, the thesis mainly uses the analyses of impulse responses, welfare and currency misalignments as comparison criteria among alternative currency regimes. The key lessons from this work are summarized as follows. For small open economies heavily indebted in foreign currency, like those of Southeast Asia, the flexible exchange rate is the best regime, followed by intermediate and fixed exchange rate regimes. At the regional level, it is shown that the exchange rate targeting regime leads to a stability of intra-regional bilateral exchange rates, which is a sort of fixity of exchange rates similar to a "de facto currency area". In the context of a liquidity trap, we find that, contrary to common belief during the Euro area crisis, the currency union welfare dominates the independent floating regime. Only a central bank intervention in the form of a managed float policy could allow the independent floating to outperform the monetary union. Through both the empirical and theoretical analyses of the liquidity trap effects on currency misalignments, it is shown that the ZLB constraint tends to reduce currency misalignments compared with the independent floating policy. This suggests a reinforcement of the monetary integration within a monetary union during the liquidity trap.

Keywords : Exchange rate regimes, DSGE, liquidity trap, currency misalignment, monetary union, monetary integration, foreign-currency denominated debt, external shocks, zero lower bound.

JEL classification : E3, E4, E5, F3, F4, F5.

Titre : Essais sur les politiques de change et l'intégration monétaire

Résumé :

Cette thèse étudie le choix des régimes de change dans des contextes économiques particuliers. La première partie (Chapitres 1 et 2) considère le cas des petits pays dont les dettes sont libellées en monnaies étrangères et celui d'une région constituée de tels petits pays lorsqu'il existe une similitude dans la composition des paniers définissant leurs taux de change effectifs. La deuxième partie de la thèse (Chapitres 3 et 4) se penche sur la considération des différents régimes de change dans le contexte monétaire de trappe à liquidité comparativement à un environnement monétaire traditionnel. En se basant sur une modélisation théorique de type DSGE, l'économétrie bayésienne et des données de panel, la thèse utilise principalement l'analyse des fonctions de réponses, de bien-être et de désalignements monétaires comme critères de comparaison de plusieurs régimes monétaires alternatifs. Les principaux enseignements de cette thèse se résument ainsi. Le change flexible semble être le meilleur régime pour des petites économies ouvertes comme ceux de l'Asie du Sud-Est. Au niveau régional, il est montré le ciblage effectif conduit à une stabilité des taux de change bilatéraux de la région, une sorte de fixité des taux de change qui ressemblerait à une zone monétaire de facto. Dans le contexte monétaire de trappe à liquidité, on trouve que, contrairement à la croyance commune lors la crise de la zone euro, l'union monétaire est plus performante que des politiques nationales de change flexible. Seule une intervention sur le taux de change nominal pourrait permettre au régime de change indépendant de dominer l'union monétaire. A travers une analyse théorique et empirique de l'effet de la trappe à liquidité sur l'ampleur des désalignements monétaires, il est aussi montré que la contrainte ZLB tend à réduire le désalignement monétaire dans une union monétaire comparativement aux politiques nationales de flottement. Cela plaide en faveur du renforcement de l'intégration monétaire au sein d'une union durant la période de trappe à liquidité.

Mots clés : Regimes de change, DSGE, trappe à liquidité, désalignement monétaire, union monétaire, intégration monétaire, dette libellée en monnaie étrangères, Chocs extérieurs, taux d'intérêt à zéro.

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