

**Three essays on monetary and international
economics**

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Abstract

This thesis comprises three essays on monetary and international economics. The first essay studies two issues of countries' exchange rate regime (ERR) choices: why countries peg and, if they peg, how they choose their anchor currency. Using spatial analysis, I found that countries are likely to follow the ERR of "neighbouring" countries, and countries' ERR are jointly determined by network effects and country-specific factors. The findings indicate that countries may achieve higher welfare by jointly choosing their ERRs with their major partners through cooperation and negotiation. In the second essay, I am trying to answer the question why countries target the particular variables they target by studying the determinants of countries' monetary policy regimes (MPRs). The study focuses on original OECD member countries, and I develop a chronology of countries' de jure MPRs for early OECD member countries for the post-Bretton Woods period. I also study the determinants of countries' monetary policy arrangements based on de facto analysis with Cobham's (2015) classification as the cross-reference. The results suggest that economic size, trade openness, financial development and political environment all have a role in determining the MPR. The third essay studies two main by-products of financial integration: contagion and risk sharing. I set up a Huggett (1993) type heterogeneous agent model with different types of countries, and try to fill the gap in the literature by exploring the impact of financial integration on consumers with different wealth status. The main findings indicate that lenders and borrowers in countries with current account surpluses and deficits respond to the financial crisis asymmetrically. Moreover, the relationship between financial integration and consumption smoothing is not monotonic, indicating that there is a trade-off between the benefits of international risk sharing and the costs of financial contagion induced by unexpected negative shocks as observed in recent history.

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CHAPTER 1 – INTRODUCTION

Monetary economics has long been an important branch of economics. There were disputes about the importance of monetary policies led by Keynes and Friedman. Keynes and policy makers in his time thought that money does not matter except for keeping interest rates low, but the high inflation caused by a long period of low interest rates cast doubts on that idea. Then economists began to assign much more value to monetary policy, and to think the general goal of monetary policy includes maintaining a low unemployment rate and a high growth rate as well as a stable price level. Friedman's ideas are mostly in line with those economists, but recognize the limitations of monetary policy in the long run. Neither interest rates nor unemployment rates can be pegged for long. Over time, a considerable degree of consensus among economists and policy makers is reached: money can influence demand and unemployment in the short run, but is neutral in the long run.

With the recognition of the importance of money, studies on monetary economics have grown. Arestis and Mihailov (2011) classify recent literature on monetary economics into three fundamental fields and list six “innovative” extensions. The fundamental fields include monetary theory, monetary policy and public finance. The first two essays of the thesis are concerned with monetary policy. The conduct of monetary policy is sophisticated. The primary goal of monetary policy is to maintain price stability and for some countries, to maintain output stability at the same time, though Tinbergen's rule challenges the notion of monetary policy with multiple objectives. The policy tool of monetary policy is restricted, to either monetary base or interest rates. Quantitative easing is a relatively new tool and is still the subject of a fair amount of disputes. The choice of intermediate target is relatively open, ranging from inflation, exchange rates, monetary base to discretionary framework. The operation of monetary policy was unstructured before the 1980s. Since then there has been a wide endorsement of inflation targeting and the Taylor-rule type of policy strategies. We would like to believe the conduct of monetary policy is more scientific nowadays. In addition, though monetary policy is widely deemed as a domestic policy except for monetary union members, it is largely influenced by other countries and world environments. The study of monetary economics under the assumption of a closed economy is impracticable. Policy makers need to adopt a feasible monetary policy regime for their countries and also consider the arrangements of exchange rate policy. A strand of studies such as Edwards (1996), Edwards (1998), Poirson (2001), Juhn and Mauro (2002), Levy Yeyati et al. (2010), Carare and Stone (2006) has tried to figure out why countries choose particular monetary policy arrangements, and the first two essays fit in this subset of monetary policy studies. The third essay is closer to international than monetary economics. It

studies the trade-off between the benefits of international risk sharing and the cost of financial contagion. The topic is under a cross-field of monetary and international economics, financial integration, that Arestis and Mihailov (2011)'s survey and the Handbook of Monetary Economics (1990, 2010) do not cover. This strand of literature consists of topics on international capital flows, risk sharing, financial contagion, capital controls, exchange rate theories, and countries' balance sheets.

The first essay of the thesis studies two old issues of countries' exchange rate regime (ERR) choices: why countries peg and, if they peg, how they choose their anchor currency. Previous studies focused on the use of country-specific factors to explain countries' exchange rate regime choices. However, though some papers found strong correlation between idiosyncratic factors and ERR choices, these factors cannot fully explain the contemporary movement of the choices. It is possible that large swings in regime choices are caused by network effects: a few countries change their ERRs and other countries follow. Meissner and Oomes (2009) is the first paper to explicitly study the role of network effects on countries' ERR choices. Network externalities are actually implicit in the Optimum Currency Area (OCA) view. Since transaction costs between two countries depend on their bilateral exchange rate volatility, one country's optimal ERR choice is reasonably a function of the other country's choice. This network externality may lead to multiple equilibria, which may cause path dependence and coordination failure (Arthur (1989)). As outlined in a two-player game theory model in Meissner and Oomes (2009), though two countries' optimal ERR choice is pegging to the USD (dollar-dollar choice), they may end up with pegging to the euro (euro-euro choice) to avoid the dollar-euro or euro-dollar situation if they start from the euro-euro position. If this snowball effect is true for countries' decisions, we should be able to observe spatial autocorrelations among countries' ERR choices. Using spatial analysis, I found that countries are likely to follow the ERR of other countries, and countries' ERRs are jointly determined by network effects and country-specific factors. The findings indicate that countries may achieve higher welfare by jointly choosing their ERRs with their major partners through cooperation and negotiation.

In the second essay, I am trying to answer the question why countries target the particular variables they target by studying the determinants of countries' monetary policy regimes (MPRs). For most developed countries nowadays, the primary goal of monetary policy is to maintain price stability, which means ensuring low inflation. In the aftermath of the end of the Bretton Woods system, many countries are not exclusively concerned with inflation. Some countries have targeted inflation directly and some have targeted other factors such as exchange rates to control it. The study focuses on original OECD member countries, and in order to find the determinants,

I develop a chronology of countries' de jure MPRs for early OECD member countries for the post-Bretton Woods period. The classification is based on a variety of sources and will be discussed in detail. The chronology of countries' MPRs is presented in section 3.2. I also study the determinants of countries' monetary policy arrangements based on de facto analysis with Cobham's (2015) classification as the cross-reference. The results suggest that economic size, trade openness, financial development and political environment all have a role in determining the MPR.

The third essay studies two main by-products of financial integration: contagion and risk sharing. I set up a Huggett (1993) type heterogeneous agent model with different types of countries, and try to fill the gap in the literature by exploring the impact of financial integration on consumers with different wealth status. We formalise two types of countries: Type I countries have a high domestic equilibrium interest rate and run a current account deficit; Type II countries have a low domestic equilibrium interest rate and a current account surplus. The main findings indicate that lenders and borrowers in countries with current account surpluses and deficits respond to financial crisis asymmetrically. Moreover, the relationship between financial integration and consumption smoothing is not monotonic, indicating that there is a trade-off between the benefits of international risk sharing and the costs of financial contagion induced by unexpected negative shocks as observed in recent history.

There are topics that are important in monetary and international economics but not covered in this thesis. Money supply and money demand are the basis of monetary economics and even today remain puzzling in some aspects. Interest rates and simple policy rules have been under discussion since the 2008 financial crisis. Economists are debating whether policy rules should take asset price or exchange rates into account. The transmission mechanism of money is complicated, and there are growing spill-over effects from other countries to complicate the conduct of domestic policy. Forward guidance is explicit guidance for the future conduct of monetary policy to the public. It is an additional tool to anchor private expectations of inflation and interest rates. Central bank design is closely linked with the credibility of policy makers and largely influence the conduct of monetary policy. There is a trend to make central banks more independent and transparent. Policy evaluation is an important branch of economics. Though this thesis proposes several policy implications, it does not include the evaluation of monetary policies. The dynamics of inflation and inflation expectations are the core of monetary economics. However this thesis does not study this area directly. There are several cross-fields between monetary and other areas of macroeconomics such as fiscal policies, financial markets and asset pricing. This thesis discusses some aspects of

financial markets but not other areas. Many subsets of microeconomics including policy games, information, learning, contracts and mechanism design are interesting extensions of monetary economics. This thesis points out several potential ways to incorporate microeconomics with international monetary economics but does not cover this area massively.

This thesis comprises three studies on monetary and international economics. The structure of the thesis is as follows. The first chapter is an introduction to the research area and key ideas of the thesis. The second and third chapters present empirical studies on countries' exchange rate regime and monetary policy regime choices respectively. The fourth chapter is a theoretical study on the trade-off between the two by-products of financial integration, international risk sharing and financial contagion. The fifth chapter summarises the key results from the thesis and their policy implications.

CHAPTER 2 – NETWORK EFFECTS OF COUNTRIES’ EXCHANGE RATE REGIME CHOICES: A SPATIAL ANALYSIS

2.1 Introduction

”No regime is likely to serve all countries at all times” (Ghosh, 1996, p. 12). There are pros and cons of fixed exchange rates. Countries which peg compromise their monetary autonomy and face the challenges of real shocks while significantly reducing their exchange rate volatility and transaction costs. This paper studies two old issues about countries’ exchange rate regime (ERR) choices - why countries peg and, if they peg, how they choose an anchor currency - with some novel methodologies and ideas in exchange rate policy research.

Figure 2.1 shows countries’ ERR in the year 2004. It suggests that the choices of ERR are clustered in the space: countries are likely to adopt the same ERR as countries near them. In figure 2.2, the graph shows not only ERR but also anchor currency choice of countries with fixed exchange rates. Countries’ anchor choices show the similar pattern of space dependence.

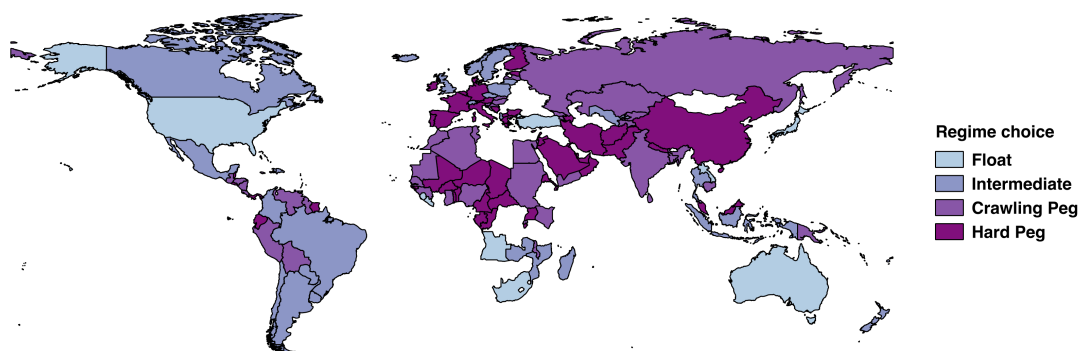


Figure 2.1: Countries’ ERR choices in the year 2004

I use de facto ERR based on the coarse classification of Reinhart and Rogoff (2004). Hard peg includes fine classification 1 to 4. Crawling peg includes fine classification 5 to 9. Intermediate includes fine grid 10 to 12 and float includes fine grid 13.

The cluster between countries’ ERR choices might be attributed to country-specific factors such as political institutions: Asian countries generally have weak political institutions and are more likely to adopt pegs or crawling pegs; North American countries mostly have good political institutions and prefer floating ERR. Figure 2.3 consists of two cartogram maps of countries’ ERRs. A cartogram map combines

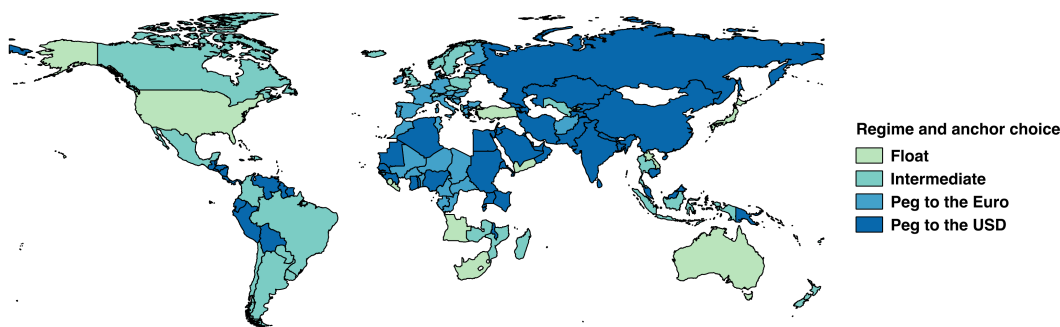


Figure 2.2: Countries' ERR and anchor currency choices in the year 2004

I use de facto ERR based on the coarse classification of Reinhart and Rogoff (2004). Intermediate includes fine grid classification 10 to 12 and float includes fine grid 13. For crawling peg and hard pegs (with fine grid 1 to 8), I classify countries' ERR based on the anchor currency instead of the degree of peg.

statistical information with geographical information. Different from conventional maps, the values of certain variables substitutes for the area of the units. Here the colour represents the choice of ERR and the size represents trade openness in the left-hand map and veto points ¹ in the right-hand map. Cartograms are different from standard box or bar plots since they keep the geographical location of the units in the graph. We can see the space cluster of the ERR choices more clearly from the circles in the Cartograms. If countries with lower (high) trade openness are more likely to float instead of pegging to an anchor currency, we should observe that the large (small) circles on the left figure are mostly light blue. Similarly, If countries with lower (high) veto points are more likely to float instead of pegging to an anchor currency, we should observe that the large (small) circles on the right figure are mostly light blue. However, the size and colour of countries are not systematically associated in both sub-figures, which means that trade openness and veto points fail to explain countries' ERR choices.

Similarly, if it is country-specific factors that determine countries' anchor currency and ERR choice, then we should observe a systematic association between colour and size in figure 2.4, in which the size of each circle represents the degree of trade openness on the left and veto points on the right while the colour represents countries' choice of anchor currency and ERR. However no systematic association between size (idiosyncratic factors) and colour (anchor currency and ERR choices) is found.

¹Veto points measure the extent of institutionalised constraints on the decision-making powers of chief executives. The veto points index in Henisz Polcon Database(2005) directly measures the difficulties or steps required by the executive of a legislature to push his or her agenda. Nations with no legislature nor effective veto points are assigned the highest score. The index can be seen as a proxy for political weakness.

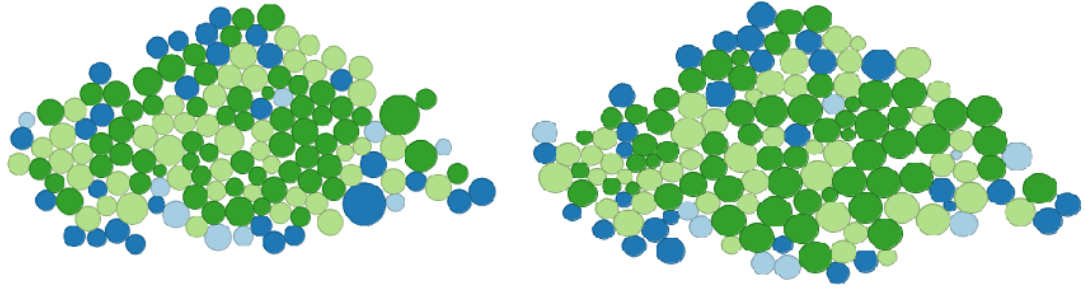


Figure 2.3: Cartogram map of countries' ERR choices

The colour of each country represent the choice of ERR (Light blue: Free floats; Dark blue: Intermediate; Light green: Crawling pegs; Dark green: Hard pegs). The size of each country represents trade openness (left) and veto points (right) instead of area. The data source of veto points and trade openness is listed in table 2.3.

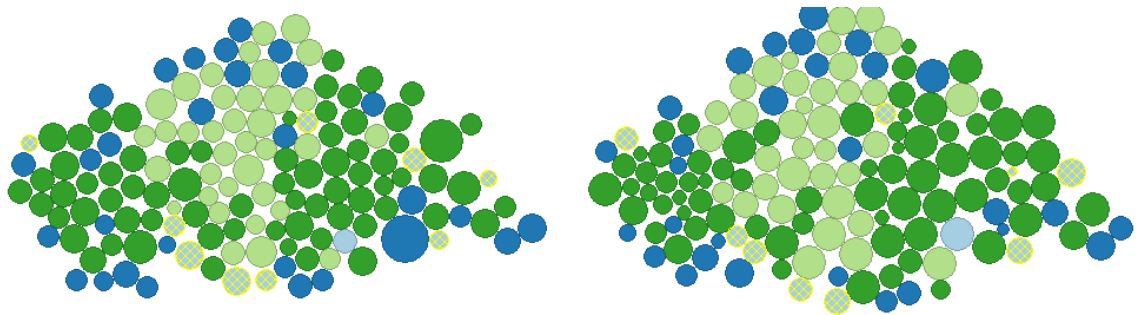


Figure 2.4: Cartogram map of countries' anchor currency and ERR choices

The colour of each country represent the choice of ERR (Light blue: Free floats; Dark blue: Intermediate; Light green: Peg to the euro; Dark green: Peg to the USD). The size of each country represents trade openness (left) and veto points (right) instead of area. The data source of veto points and trade openness is listed in table 2.3.

Meissner and Oomes (2009) is the first paper to explicitly study the role of network effects on countries' ERR choices. Network externalities are actually implicit in the Optimum Currency Area (OCA) view. Since transaction costs between two countries depend on their bilateral exchange rate volatility, one country's optimal ERR choice is reasonably a function of the other country's choice. This network externality may lead to multiple equilibria, which may cause path dependence and coordination failure (Arthur (1989)). As outlined in a two-player game theory model in Meissner and Oomes (2009), though two countries' optimal ERR choice is pegging to the USD (dollar-dollar choice), they may end up with pegging to the euro (euro-euro choice) to avoid the dollar-euro or euro-dollar situation if they start from the euro-euro position. The paper uses the trade-weighted number of trade partners who peg to the same anchor currency as a measure of trade externalities and concludes that currency network effects exist, given that the coefficient on trade externalities is significantly

positive. Similarly, Bleaney and Tian (2012) find that the benefits of fixed exchange rates work largely through currency networks. Bilateral exchange rate volatility is lower if both currencies are pegging to the same anchor. This research aims to study the network effects of countries' ERR choices using spatial analysis. This method of studying the network effects is intuitive and able to provide a clearer way to incorporate the transmission channel. There have been debates on whether the heterogeneity of countries plays a significant role in deciding countries' ERR. This model will examine the significance level of idiosyncratic determinants proposed by early studies as well. If spatial autocorrelation is significant after controlling for idiosyncratic factors, there are network effects in countries' ERR choices: countries are likely to follow the ER policy of their neighbours.

The next section reviews several critical papers on the determinants of ERRs and some literature on the network effects of exchange rate policies. Levy Yeyati et al. (2010) find that many determinants of ERR identified by theoretical studies are significant, while Juhn and Mauro (2002) reject the relevance of nearly all determinants. The ideas, methodology, data selection and model specification of these papers will be discussed in detail. There is only a limited literature on currency networks.

The third section introduces the methodology used in spatial analysis. The spatial econometrics helps to identify the influence of neighbours' decisions on one country explicitly: $y = \rho W y + X\beta + \epsilon$, where y is the vector of discrete variables (0 for hard pegs, 1 for crawling pegs, 2 for intermediate exchange rates and 3 for free floats), ρ is the spatial parameter to capture the spatial autocorrelations, W is the weighting matrix and X is the vector of the idiosyncratic determinants of countries' choices. The strength of the impacts of neighbour's choices on a country is jointly decided by ρ and W . The intuition of spatial econometrics is not complicated but it requires heavy computational intensity. The Bayesian MCMC estimator will be used to estimate spatial autoregressive multinomial probit (SAR MNP) model.

The results will be presented in section four. Currency network effects are strong: countries tend to follow the choices of their neighbours. However, for country-specific determinants, the models come to different conclusions. Section five will discuss the implications and drawbacks of the results.

2.2 Literature Review

Juhn and Mauro (2002) survey previous studies and find that there is no conclusive evidence showing how countries choose their ERRs. The literature surveyed is from

the 1970s (e.g. Heller (1978)) to the 2000s (e.g. Poirson (2001)), from cross-sectional to panel studies, and from de jure to de facto classifications, and the methods adopted in the studies vary from probit to multinomial logit. The determinants considered by the early studies are numerous, including the size of an economy, financial integration, and political stability.

The determinants of exchange rate regimes can be grouped into two categories: OCA variables and others. The OCA theory was first brought up by Mundell (1961). The paper proposes that a region in which economic efficiency is maximized by having a single currency is an OCA. The criteria for forming an OCA are outlined by the theory. Overall there is a trade-off between reduced transaction costs among regions and maintenance costs for operating the single currency, such as the inability to freely conduct monetary policy. The main variables relevant to the formation of an OCA are trade openness, economic development, capital and labour mobility. The modern OCA theory has evolved over time and now focuses on three widely available and testable variables: size of economy, trade openness and terms of trade volatility. Theoretically, a lower level of real shocks, smaller economy size and higher trade openness are associated with fixed exchange rates. At the same time, risk exposure hypothesis suggests that countries with high trade openness are exposed to terms of trade shocks and thus may prefer a flexible regime.

Other determinants are mostly financial or political factors. Scholars long ago linked financial factors to the ERR choice. Savvides (1990), Edwards (1996, 1998) and Rizzo (1998) find financial determinants like real exchange rate volatility, current account and external debt significant. The formal idea about the financial view emerged when Obstfeld and Taylor (2003) brought together the impossible trinity hypothesis and exchange rate arrangements. Countries cannot manage free capital flows, independent monetary policy and fixed exchange rates at the same time and thus a trade-off between the three should be observed in countries' ERR choices. Assuming that countries conducting non-hard pegs are targeting variables other than exchange rates with their monetary policy regimes, I predict that higher level of capital account openness is correlated with non-ERT (hard pegs) regimes. If I treat the foreign debt to GDP ratio as a de facto measure of capital account openness, I expect an association between high level of foreign debt to GDP ratio and free ERR. However, Calvo and Reinhart (2002)'s fear of floating hypothesis links concern over balance sheet and regime choice together. The currency mismatch hypothesis suggests that countries with high liability dollarization are afraid of sudden balance sheet deteriorations caused by depreciation and are more likely to adopt fixed ERR.

Early studies such as Poirson (2001), Berger et al. (2000) and Edwards (1996, 1998) demonstrate that foreign reserves are a significant determinant of ERR but the direc-

tion of effects is ambiguous. However, there is no theoretical foundation to support the association between the ERR choice and the level of reserves. The significant correlation in previous literature is likely due to simultaneity, that countries operate a fixed ERR require a high level of reserve. I omit the reserve level from determinants due to the concern of simultaneity and lack of theoretical support. Given that the level of foreign reserves is unlikely to be correlated with other explanatory variables, I do not need to worry about the endogeneity issue caused by omitting foreign reserve level.

Frieden et al. (2000) and Poirson (2001) find political elements strongly relevant to ERR choice. It is anticipated that political factors would shape policymakers' decisions including those on monetary policy. However, it is difficult to interpret the link. The credibility view proposes that fixed exchange rates can be a policy crutch for weak governments and helps to tame inflation. Thus we should observe a positive correlation between political institutions and fixed exchange rates along with a negative correlation between high inflation and fixed ERR. The consistency view suggests that weak governments have difficulties in maintaining fixed rates as well as low inflation and would let their exchange rates float. In both groups, political institutions and inflation conditions matter, but the expected signs on the variables are opposite.

Cobham (2010) suggests that the development of financial markets is vital for countries' MRP choices. Only when the transmission channel of monetary policy – the institutional and market infrastructure – is well developed are central banks able to conduct policies solely through interest rates and operate under frameworks like inflation targeting. The paper provides three categories for countries' financial and banking system: basic, intermediate and modern. I expect that the basic type of financial architecture is associated with exchange rate targeting regime. Hence a high level of financial development is expected to be associated flexible exchange rates. Table 2.1 summarises theoretical predictions of the impacts of country-specific variables.

	OCA	Risk exposure	Impossible trinity	Currency mismatch	Credibility view	Consistency view	Financial development
Economic size	+						
Trade openness	-	+					
Terms of trade shocks	+						
Capital account openness			+				
Foreign debt asset			+	-			
High inflation					+	-	-
Political institutions					-	+	
Financial development							+

The signs shows the association between variables and flexible ERR.

Table 2.1: Theoretical predictions of the impacts of country-specific variables

Juhn and Mauro (2002) test two groups of variables jointly. They choose cross-sectional data on the grounds that some variables vary little over time and variables changing sufficiently over time are more endogenous in a time series context than in a cross section context. Both de jure (IMF) and de facto classifications (Levy-Yeyati and Sturzenegger (2005)) are adopted in the study. The sample for the baseline model includes 130 countries for the IMF classification and 75 for the LYS classification. Only countries that did not change their regime over the period from 1990 and 2000 are selected, as the authors' focus of interest is to find long-term determinants. The usual latent variable tests probit and multinomial logit are employed and there are no robustly significant determinants found.

Contrary to Juhn and Mauro (2002), Levy Yeyati et al. (2010) find OCA, financial and political factors identified by previous researchers to be significant in subgroups and jointly. Multinomial logits are run for an unbalanced panel data set of 183 countries over the post-Bretton Woods period from 1974 to 2004. The dependent variables is 1 for floats, 2 for intermediates and 3 for pegs. The regime classifications adopted are IMF, Levy-Yeyati and Sturzenegger (2005) and Reinhart and Rogoff (2004). The paper deals with the endogeneity issue raised by Juhn and Mauro (2002) by lagging the possible endogenous variables by one period, assuming that past values are not directly affected by current unobservable factors. Some researchers are sceptical about this method of dealing with endogeneity (Ball and Mazumder (2011)). Levy Yeyati et al. (2010) find that changes in ERR choices and global trends in ERR choices are endogenous and driven by the variations of the fundamental determinants, and those determinants are long-run determinants given that thirty years is a long period in monetary policy studies. Though studying similar issues, Juhn and Mauro (2002) and Levy Yeyati et al. (2010) with different econometric methodologies come to conflicting results.

Meissner and Oomes (2009) do not simply study the determinants of ERR: the categories for their latent dependent variable are peg to the USD, peg to the Franc, peg to the Mark, float and freely fall, based on the de facto classification of Reinhart and Rogoff (2004). The multinomial logit panel model is used. For explanatory variables, the authors control for factors that affect countries' anchor currency and ERR choice simultaneously. Idiosyncratic determinants of anchor currency choice are trade network externalities, which are measured by the trade-weighted number of trade partners that peg to the same anchor, output co-movement and the currency denomination of liabilities normalized by nominal GDP. Country-specific determinants of ERR choice chosen in the paper match the earlier literature which contained OCA and financial factors. However, political factors, other than inflation history, which might be seen as a proxy for the central bank's strength, are not considered in

their main regressions. In addition, the lag of choice of regime is included as an independent variable to capture policy persistence. The baseline model uses a sample including data from 1990 to 1998. The paper finds that within-bloc trade is crucial and the coefficient on it is significantly positive. According to a counter-factual analysis, the effect of network externalities is strong, and thus countries could be locked in suboptimal anchor choices. However, other determinants of anchor and regime choice, including OCA and other factors, are only significant in some cases. In robustness checks, a cross-sectional data of 1998 is tested as well. The results from the panel and cross-sectional studies do not differ notably. Political factors are also added in robustness checks and turn out to be insignificant. Basically, Meissner and Oomes (2009)'s results are in accordance with Juhn and Mauro (2002)'s findings but raise the importance of network effects in exchange rate policy studies. There are other papers which include trade factors such as trade concentration in the explanatory variables of ERR studies and authors find them significant (Dreyer (1978); Rizzo (1998)). However, trade concentration usually measures the volume or percentage of one country's trade with its major trade partners, which is different from trade within the anchor bloc, and thus cannot help to identify currency network effects. Table 2.2 presents the results from the three main studies considered above.

	Juhn and Mauro (2002)	Levy Yeyati et. al (2010)	Meissner and Oomes (2009)
Dataset	Cross-sectional 2000	Panel 1974-2004	Panel 1990-1998
Methodology	Multinomial Logit	Multinomial Logit	Multinomial Logit
ERR Classification	De jure and LYS (1999)	LYS (1999), RR (2004)	RR (2004)
OCA	-	***	-
Financial	-	**	-
Political	-	***	-
Network Effects	/	/	***

*Note: - insignificant, / not relevant, * significant at 10% level, ** significant at 5% level, *** significant at 1% level.*

Table 2.2: Comparison of studies on the determinants of ERR

There is only a limited literature on currency network effects. Some research has been done on the dollarization ratio and network externalities. Peiers and Wrase (1997) build a model to explain the network effects of countries' dollarization ratios. They propose that experiences with transactions in dollars reduce the marginal cost of dollar-denominated borrowing and transacting. Uribe (1997) creates a sim-

ilar model independently and also assumes that experiences in dollar-denominated transactions affect future transactions in dollars. An earlier work by Kiyotaki and Wright (1989) implicitly proposed the idea of network externalities by suggesting a dominant currency as a medium of exchange. Oomes (2003) develops a theoretical model with empirical estimation based on similar ideas and shows that network effects are indeed relevant to exchange rate policy.

Yehoue (2004) builds a theoretical model to examine the impacts of trade network externalities on currency bloc formation. The paper proposes a dynamic game with 3 players (countries), and suggests that once the benefits of cost reduction outweigh the cost of adopting a single currency (such as forgoing monetary autonomy), countries are likely to form a currency bloc. And this mechanism helps to explain the slow expansion of currency blocs: a country is willing to join a bloc if and only if the trade volume between the country and the existing bloc is high enough. The theoretical model highlights the role of network externalities in ER policy and mimics the creation and expansion of currency blocs in history, such as the gold standard, the CFA zone and the EMU.

As for more explicit studies on currency networks, Bleaney and Tian (2012) suggest that the peg effect operates mostly through currency networks. They find lower bilateral volatility among countries choosing the same anchor currency and argue that these currency network effects help to offset the disadvantages coming with monetary dependence. Similarly Devereux et al. (2003) compare the cases of the euro and the USD, suggesting that currency union, an ultimate version of hard pegs, helps the participating countries decrease exchange-rate pass-through and improve resistance to exchange rate shocks. Matesanz and Ortega (2014) find there is interdependence between countries' exchange rate policies but they focus on ER movements and believe this interdependence is the reason for financial crisis contagion. This research is a combination of above approaches, focusing on both network effects and country-specific determinants of ERR using spatial analysis.

2.3 Methodology and Data

In the 1960s more or less all countries pegged to the USD within the Bretton Woods international monetary system; after the system broke down in the early 1970s most 'advanced' economies started to float, while most developing countries continued to peg. In the 1980s and 1990s, emerging market countries started to operate managed floats but developing countries mostly continued to peg. After the 1997 financial crisis, some emerging economies, especially Asian countries, abandoned intermediate

regimes and moved to fixed or flexible regimes. Levy Yeyati et al. (2010) suggest that this trend is endogenous but some research has countered this finding. It is possible that large swings in regime choices are caused by network effects: a few countries change their ERR and other countries follow. If this snowball effect is true for countries' decisions, we should be able to observe spatial autocorrelations among countries' ERR choices.

2.3.1 Methodology

It is common to criticise economists for relying too much on fancy econometrics which is complex and hard to interpret. Spatial econometrics, although looking fancy with its complicated algorithms and estimation strategy, has a straightforward intuition: it is simply trying to examine the influence of neighbouring countries. The model I want to estimate is

$$y = \rho W y + X \beta + \epsilon \quad (2.1)$$

where y is choice of countries, ρ is the spatial autoregressive parameter, W is the weighting matrix which reflects the channel of spacial impacts, β is a vector of coefficients for country-specific factors, X is the matrix of country-specific factors, and ϵ is the error term. The impact of neighbours is determined by $\rho W y$. Neighbours here can be those with geographical proximity, economic closeness or institutional similarity. This is a natural tool to analyse the network effects caused by interdependence among countries' decisions.

Time dependence is a key motivation for adopting spatial analysis (LeSage and Pace (2008)). If countries observe and make decisions based on other countries' past decisions, then the decisions of countries will show spatial dependence in cross-sectional data. The data generating process will be $y_t = \rho W y_{(t-1)} + X_t \beta + \epsilon_t$, with y_t being the decision outcome and ϵ_t being the error term at time t . The model has a space-time lagged representation.

$$y_t = \rho W y_{t-1} + X_t \beta + \epsilon_t \quad (2.2)$$

$$y_t = \rho W (X_{t-1} \beta + \rho W y_{t-2} + \epsilon_{t-1}) + X \beta + \epsilon_t \quad (2.3)$$

$$y_t = (I_n X + \rho W X_{t-1}) \beta + \rho^2 W^2 (\rho W y_{t-3} + X_{t-2} \beta + \epsilon_{t-2}) + \epsilon_t + \rho W \epsilon_{t-1} \quad (2.4)$$

$$y_t = (I_n X + \rho W X_{t-1} + \rho^2 W^2 X_{t-2}) \beta + \rho^3 W^3 (\rho W y_{t-4} + X_{t-3} \beta + \epsilon_{t-3}) \\ + \epsilon_t + \rho W \epsilon_{t-1} + \rho^2 W^2 \epsilon_{t-2} \quad (2.5)$$

.....

$$y_t = (I_n X + \rho W X_{t-1} + \rho^2 W^2 X_{t-2} + \dots + \rho^{q-1} W^{q-1} X_{t-q+1}) \beta + \rho^q W^q y_{t-q} + u_t \quad (2.6)$$

$$\text{where } u_t = \epsilon_t + \rho W \epsilon_{t-1} + \rho^2 W^2 \epsilon_{t-2} + \dots + \rho^{q-1} W^{q-1} \epsilon_{t-q+1}$$

Country-specific factors such as economic size, the degree of trade openness, political institutions and financial infrastructure do not change drastically every year. Thus I assume that X_t is relatively fixed over a period of time, and suppress the time denote of X in the equation. In this case, equation 2.6 can be written as equation 2.7, which can be further arranged as 2.8.

$$y_t = (I_n X + \rho W X + \rho^2 W^2 X + \dots + \rho^{q-1} W^{q-1} X) \beta + \rho^q W^q y_{t-q} + u_t \quad (2.7)$$

$$y_t = (I_n + \rho W + \rho^2 W^2 + \dots + \rho^{q-1} W^{q-1}) X \beta + \rho^q W^q y_{t-q} + u_t \quad (2.8)$$

$$(2.9)$$

The error term is assumed to have a normal distribution $\epsilon_t \sim N(0, \sigma_\epsilon^2)$. Thus $E(\epsilon_t) = 0$. I use normalised version of weighting matrix, which means that the sum of row elements equal to 1 if not all elements are zero. If all elements in a row are equal to zero, these elements remain zero, so $W \leq I_W$. In addition, I assume $|\rho| < 1$. The assumptions on ρ and W also make sure that $I - \rho W$ is positive definite and invertible. As q becomes larger, $\rho^q W^q$ becomes smaller, and the expectation of y is asymptotically equal to

$$\lim_{q \rightarrow \infty} E(y) = (I_n - \rho W)^{-1} X \beta \quad (2.10)$$

With some iterations, I show how time dependence of decisions (space-time-lagged

model) can have a spacial autoregressive (space-lagged) representation in the cross-sectional setting. Hence the data generating process indicated by equation 2.10 can be arranged as equation 2.1.

In this chapter, y is the choice of countries ERR, which is a categorical variable. It raises further complications to the problem. The choice of ERR y reflects unobserved utility y^* associated with the choice. LeSage and Pace (2009) proposes an estimation strategy of SAR MNP model based on Bayesian MCMC and a Gibbs sampling scheme. Let j denotes alternatives choice of ERR and number of covariates $J = 3$ with $j = 0$ being the default category. The model to estimate can be written as

$$y_j^* = \rho W y_{j0}^* + X\beta_j + u_j \quad \forall j = 1, 2, 3 \quad (2.11)$$

Similar to models with continuous dependent variables, ρ is the spatial autoregressive parameter, and the impact of other countries is determined by $\rho W y_{j0}^*$.

We need to find posterior distributions of y_j^* , ρ , β and cross-alternative covariates matrix. Following LeSage and Pace (2008) and Wang et al. (2014), I draw parameters with the following strategies. The latent dependent variable y^* with spatial autocorrelations follows a truncated multivariate normal distribution (TMVN): $y^* \sim TMVN(\mu, \Omega)$. From the iteration, I can find that the mean $\mu = (I_n - \rho W)^{-1} X\beta$ and variance-covariance matrix is Ω . They adopt Geweke (1991)'s method to create samples for y^* . Sample size has always been a concern in cross-sectional studies, as I have only around 150 observations to create thousands of draws. Using the m-step Gibbs sampler for drawing y^* can mitigate the problem by creating more draws effectively. As proposed by Koop (2003), the 10-step Gibbs sampler is standard and should be adequate. I draw y_i^* from y^* conditional on all other y_j^* s where $j=1,2,n$ but $j \neq i$ and y_s are drawn from a TMVN distribution. As in basic spatial autoregressive (SAR) models, β s are drawn from normal distributions and ρ is sampled using the Metropolis-Hastings algorithm. The matrix Ω measures cross-alternative covariates, and the spatial parameter is drawn from a multivariate normal and Wishart distribution. The algorithm and code to estimate the SAR MNP model are provided by the authors of Wang et al. (2014).

In summary, the spatial multinomial model follows the DGP: $y^* = (I_n - \rho W)^{-1} X\beta + (I_n - \rho W)^{-1} \epsilon$ and $\epsilon \sim N(0, I_n)$. Thus in order for the disturbance term to be normally distributed, country-specific independent variables must be controlled for and included in X . Previous studies in this area, as mentioned in the literature review, provide guidelines for necessary controls, which will be discussed in the next subsection. It has been shown that the magnitude and significance level of the parameters would be notably biased when spatial autocorrelations exist but are

being neglected (Gelman et al. (2014)). This paper will provide further evidence for the debate about whether ERR choices are endogenous.

Fleming (2004) survey several methods to estimate spatial discrete models: Bayesian MCMC sampling, heteroskedastic estimator, feasible generalised least squares estimator, and GMM estimators. Wang and Kockelman (2009), Chakir and Parent (2009), Wang et al. (2014) and this chapter adopt Bayesian MCMC approach. Comparing to MCMC algorithms, other methods are advantageous in terms of showing the consistency of estimators. However, Bayesian methods are with the medium level of computational intensity and applicable to multinomial cases as well as relatively small sample sizes. This chapter is also different from the mentioned papers as I use a combination of frequentist and Bayesian estimation to deal with endogeneity issues. I adopt a 2-step estimation strategy. First, I use ordinary least squares (OLS) to regress endogenous variables including weighting matrix on instruments variables. Second, I estimate the SAR MNP model with exogenous variables obtained from the first step with Bayesian methods. This two-step method is an intuitively appealing empirical strategy. However, the statistical properties of such estimators are unknown and should be the subject of future work.

Beron and Vijverberg (2004) show that using maximum likelihood (ML) to estimate a spatial probit model involves substantial difficulty and takes an unnecessarily long time. However, Smirnov (2010) presents a persuade ML method to estimate the spatial discrete choice model. The new method is consistent and easy to compute and maintains analytical tractability of the concept of random utility theory. The persuade ML estimator is equivalent to a standard ML estimator for an auxiliary model. In the auxiliary model, individuals are fully account for the spatial effect in the observed variables, but account only for private effects of spatial interdependencies in the unobserved shocks in random utilities. The assumption of homogeneity of spatial effects on random utilities across alternatives indicates that spatial effects of shocks in random utilities of others have no impact on conditional choice probabilities. Pinkse and Slade (1998) uses GMM to estimate a binary probit model with spatial error correlation. Pinkse et al. (2006) proposes an one step GMM estimator or continuous updating estimator of Hansen et al. (1996) to estimate dynamic spatial discrete choice models. The estimator is proved to be consistent, asymptotically normal and efficient. But so far these methods are applicable to binary choice models.

There is growing literature combining copula with spatial analysis. Using copula, it is able to generate stochastic dependence relationship among variables given pre-specified marginal distributions. Hence copula offers a new way to model spatial dependence. Bhat and Sener (2009) and Bhat et al. (2010) use copula-based dis-

crete models for accommodating spatial correlation across observational units. Sener and Bhat (2012) extend the copula approach to spatial multinomial data. Kazianka (2013) further develop the method to estimate count data model with spatial dependencies. It will be interesting to explore the alternative method to estimate the spatial multinomial model as robustness checks.

The weighting matrix reflects the impact of spatial interdependence and thus the selection of weighting matrix is of great importance. Without an appropriate weighting matrix, the spatial autocorrelation would not be significant even if it exists, or the spatial parameter might be seriously biased. In this study, I consider four alternative weighting matrices to examine the existence and possible channel of spatial autocorrelation. The first choice is the geographical distance between the capitals of countries, which is commonly used as a weighting matrix.

In economic policy studies, especially exchange rate policy, I believe that economic distance is more relevant. Trade closeness has always been an important measure of economic distance and is also selected as the weighting matrix. Moreover, Meissner and Oomes (2009) find the trade volume matters for network effects. Thus, based on the early studies, the ratio of trade volume (inflow and outflow) between countries i, j over the total trade volume of country i is chosen to be the measure of distance from country j to i . Similarly, the distance from country i to j will be the import and export between i and j divided by the total trade volume of country j . Though the numerator will be the same for the weighting elements of country i to j and j to i , the denominator will be larger in the country with more trade. Thus the weighting matrix is asymmetric, so the influence of a small economy on a large economy will be smaller than the impacts of a large economy on a small one, which fits the reality. If W with economic distances identifies the spatial autocorrelation, then the bilateral or multilateral trade between regions will be the main cause of network effects.

Some studies argues that trade flow is endogenously affected by a country's exchange rate policy (McKenzie (1999); Baldwin (2005)). Hence I use instrumented trade flows instead of original ones. The predicted values of trade data are from author's websites of Melitz and Toubal (2014). The instrument variables used are common languages, distance, post-colonial relationships, common legal systems and religions as well as dummy variables for years at war. Thus the estimations with trade weighting matrix adopt a two-step mixed strategy method. The first step is done with frequentist method (OLS) and the second step is Bayesian MCMC method.

There are other methods to deal with endogenous weighting matrix. Kelejian and Piras (2014) uses two stage least square (2SLS) estimation to deal with endogenous weighting matrix. The 2SLS estimator shows consistency and asymptotical

normality with endogenous weighting matrix. However, the method also imposes several high level assumptions. Qu et al. (2017) develop a Quasi maximum likelihood estimator to estimate the model with endogenous weighting matrix in one step. Kuersteiner and Prucha (2015) develop a class of GMM estimators based on linear and quadratic moment conditions and forward difference data, and the estimators allow for endogenous spatial weight matrices and other effects. Bhattacharjee et al. (2016)'s method based on functional data analysis can account for endogenous weighting matrix as well. The estimation method involves partitioning the spatial domain, constructing functional average surface and estimating functional principal components estimator. There are increasing literature² estimating spatial models with unknown weighting matrix. It would be interesting to examine what kind of information unknown weighting matrices can reveal in future studies.

I will also explore weighting matrices constructed on the basis of institutional relationships. The choice of anchor currency is linked deeply with histories and institutions. Two proxies are used as there is no direct measure of the institutional closeness between countries. An institutional weighting matrix, which is constructed on the basis of the past colonial experience of countries, is tested. I use a dummy variable: if two countries were colonised by the same country in the past, I put 1 in their relationship, and 0 otherwise. The linguistic factor is a reasonable proxy as well. Countries with the same spoken, official or native languages are likely to have similar histories and institutions, and their culture and political environment usually share similarities. Linguistic proximity between countries will impact the ease of communication and doing business with each other. Melitz and Toubal (2014) create an index of language closeness taking account of the linguistic factors mentioned above. And I will use this index as another proxy for institutional closeness. The normalised versions of the matrices are used. The best fitting weighting matrix is also the most likely transmission channel of network effects. It is reasonable to assume that modern ERR arrangements do not influence past colonial relationships or languages, and hence we can treat the weighting matrices with institutional relationships as exogenous.

2.3.2 Data

Following previous studies, OCA, financial and political factors are included in the explanatory variable matrix X . I am more concerned with de facto exchange rates, thus Reinhart and Rogoff (2004), in which anchor currency choices are also identified, is used as the source for the dependent variables. The variables and their sources

²For examples: Bailey et al. (2013), Bhattacharjee and Holly (2013), Gupta and Robinson (2015), Ahrens and Bhattacharjee (2015), Bhattacharjee and Holly (2015), Sun (2016), etc...

are summarised in table 2.3. There are no direct measures of countries' capital account openness, financial development or political institutions. Thus I use index measure constructed in previous literature for these variables. KAopen measures the degree of capital account openness: the higher the value, the higher the degree of openness. The polity index shows the strength of political institutions. Financial development is a relatively new index, providing a unified measure of the depth, access and efficiency of countries' financial institutions and financial markets.

Variable Name	Measure	Calculation	Source
Logsize	Economic size	Log of GDP	IFS
Openness	Trade openness	(import+export)/GDP	IFS
ToTshocks	Real shocks	Standard deviation of the logarithm of terms of trade	WDI series
KAopen	Capital account openness	Index measure of capital openness	Chinn and Ito (2008)
Liability	Foreign liability	Foreign debt assets as percentage of GDP	Lane and Milesi-Ferretti (2007)
Vetopoints	Political weakness	Extent of institutionalized constraints on the decision-making powers of chief executives	Polcon_2005
HighInflation	Inflation history	Dummy variable for countries with inflation greater than 10% in the past year	IFS
FD	Financial development	Index measure of financial development	Svirydzenka (2016)
W_trade	Instrumented bilateral trade volume	$W_{ij} = \frac{(exports_{ij} + export_{ij})}{(export_j + import_j)}$	Melitz and Toubal (2014)
W_dist	Geographical distance		CEPII Database
W_common colonizer	Colonial Experience	Dummy variable for countries sharing a common colonizer in the history	Melitz and Toubal (2014)
Dependent Variable	ERR	De facto regime	Reinhart and Rogoff (2004)

Table 2.3: Data Description and Source

If countries choose their ERRs based on other countries' decisions over a period, countries' ERRs will present spatial autocorrelation in a cross-sectional setting, and thus cross-sectional data will suffice in this study. The year 2004 is chosen. 2004 is near the end of the Great Moderation and a few years before the crisis. The large swing of ERR choices among emerging markets after 1997 and the switch to the euro for countries which used to peg to the mark or the franc have been completed. In addition, data availability is superior to that for earlier periods: 156 countries are in the sample.

Tavlas et al. (2008) provide a survey of the classification and performance of alternative exchange rate systems. The survey suggests that studies on the link between particular regimes and macroeconomic variables are conflicting. This raises the concern of simultaneity in the model. Thus economic size, capital account openness and the debt to GDP ratio are instrumented using legal tradition factors, following Carare and Stone (2006). The measures of legal traditions include the index of law and order (The International Country Risk Guide), the property rights index (The Heritage Foundation) and the dummy variables indicating countries' legal origins (La Porta et al. (1998)). The first step estimation with instruments variable is done with OLS. In the second stage, I replace unobservable components in the main regression by the residuals of the first equation and run Bayesian estimation. The first stage estimation I use is similar to the two-stage instrumental variable method in Qu and Lee (2015). In Kelejian and Piras (2014), first stage estimation is only run on non-zero elements in the weighting matrix. In Qu and Lee (2015) and my chapter, first stage IV estimation is done with all non-diagonal elements in the weighting matrix.

The treatment of the eurozone countries is tricky. Although I could see a currency union as countries pegging to the same currency, the euro is floating freely. There are several possible ways to deal with it: treating these countries as free floaters, fixers or as a single floating unit. It is countries' behaviour that I am interested in, not the currency as such, so treating the eurozone as a unit is not optimal for the study. If countries are free floaters, as we can observe, they do give up their monetary autonomy when joining the eurozone. Thus in this study, I follow Reinhart and Rogoff (2004) and treat the eurozone countries as exchange rate fixers in the baseline model. I will show the result of treating the eurozone as a single floating unit in robustness check.

2.4 Results

The empirical results are presented in this section. Basically all models confirm the statistical significance of the spatial autoregressive coefficient, which validates the use of spatial analysis. Bayesian estimations do not naturally have a standard error for coefficients, and hence I use numerical standard error which calculates the square root of estimated variance divided by the number of observations to examine the statistical significance of the parameters.

2.4.1 ERR choices

I categorise countries' ERRs based on the coarse classification of R&R. There are four categories: hard pegs, crawling pegs, intermediates (which include managed floats) and free floats. Since I exclude countries without essential economic data (output, import and export) in 2004, I only have 2 cases of free falls which do not suffice to provide inferences and thus free fall countries are excluded from the sample.

(1)	W_Trade			W_Dist			W_Common colonizer		
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Crawling pegs	Intermediates	Free floats	Crawling pegs	intermediates	Free floats	Crawling pegs	intermediates	Free floats
Log of GDP	0.473 (0.390)	-0.428 (0.353)	0.943** (0.449)	-1.115* (0.598)	-2.201*** (0.709)	-10.806*** (1.423)	-0.004 (0.295)	-0.686** (0.321)	-1.471 (1.050)
Trade openness	0.003 (0.004)	-0.002 (0.004)	-0.018*** (0.005)	-0.002 (0.007)	-0.009 (0.008)	-0.075*** (0.015)	0.005 (0.003)	0.002 (0.003)	-0.026** (0.013)
Terms of trade shocks	-0.024 (0.029)	-0.041 (0.035)	-0.153*** (0.050)	-0.187*** (0.064)	-0.204*** (0.073)	-1.007*** (0.144)	-0.014 (0.022)	0.003 (0.030)	-0.115 (0.089)
Capital account openness	-1.840** (0.900)	-0.606 (0.895)	-6.934*** (1.244)	-3.396** (1.699)	-1.658 (1.751)	-1.841 (3.514)	-0.479 (0.681)	1.125 (0.752)	-1.566 (1.816)
Debt to GDP ratio	0.008 (0.007)	0.015* (0.009)	0.041*** (0.009)	0.067*** (0.017)	0.070*** (0.019)	0.239*** (0.031)	0.007 (0.005)	0.003 (0.006)	0.053*** (0.019)
High inflation	0.367 (0.457)	1.621*** (0.483)	5.887*** (1.052)	2.386** (0.955)	3.851*** (1.087)	12.372*** (2.057)	-0.231 (0.334)	0.706* (0.373)	2.339** (1.075)
Polity index	0.017** (0.008)	0.025*** (0.010)	0.016 (0.011)	0.058*** (0.015)	0.068*** (0.015)	0.014 (0.017)	0.009* (0.005)	0.022** (0.010)	-0.016 (0.017)
Financial development	-0.327 (1.214)	3.871*** (1.320)	17.726*** (2.758)	-0.693 (1.858)	4.699** (2.207)	24.524*** (3.181)	-2.598** (1.053)	0.616 (1.102)	7.098* (3.755)
ρ	0.529*** (0.128)			0.687*** (0.066)			0.415** (0.194)		
Log likelihood	-591.949			-615.566			-2201.115		
No. of Draws	8,000								
No. of burn-ins	4,000								
No. of observations	156								

Note: The base category is hard pegs. The numerical standard error are reported in the brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.4: Determinants of ERR choices

Table 2.4 presents the results of using the SAR MNP model to estimate countries' ERR choices. The second to fourth columns displays results with the trade weighting matrix. The spatial autoregressive coefficient is 0.529 with a standard deviation of 0.128. The spatial parameter is significant both statistically and economically. Several country-specific factors also play a significant role in determining countries' ERR. With hard pegs as the base category, countries with a lower level of capital account openness and a higher level of the polity index are more likely to adopt crawling pegs. Country-specific factors provide little information as to why countries adopt crawling pegs instead of hard ones. Countries with a high level of the debt to GDP ratio, inflation, level of the polity index and financial development are more likely to adopt intermediate ERR. Economic size, the debt to GDP ratio, high inflation and financial development are positively and significantly correlated with operating free floats, while trade openness, terms of trade shocks and capital account openness are negatively and significantly correlated with free floats.

The results partially meet the predictions from the OCA theories: large economies and countries with high trade openness are more likely to operate free floats. The

signs on ToT shocks are inconsistent with the OCA prediction. The signs on trade openness are in accordance with the predictions from the OCA theory rather than the risk exposure hypothesis. The impossible trinity hypothesis is rejected given that with hard pegs as the default category, parameters on capital account openness are positive for crawling peg and intermediate ERR. Though the sign on capital account openness for free floats is negative as predicted, the parameter is insignificant. The signs on the coefficients of debt to GDP ratio are negative, though only significant for crawling pegs, which suggests that the parameters support the currency mismatch rather than impossible trinity hypothesis. Countries with a high level of the foreign debt to GDP ratio are more likely to adopt hard pegs to avoid sudden deterioration of their balance sheets caused by sharp currency depreciation. The signs on high inflation and the polity index for crawling pegs support the consistency view. Weak governments have difficulty in maintaining low inflation and operating a fixed ER at the same time, and thus would let their exchange rates float. The signs on high inflation and the polity index for free floats are opposite to the signs for crawling pegs, and support the credibility view. Countries with weak political institutions are more likely to use fixed ERR as a ‘crutch’ to tame inflation. The signs on these two variables for intermediate ERR support neither the credibility nor the consistency view. The signs on financial development meet my prediction that although exchange rate targeting can be done with a basic financial architecture, other arrangements require more sophisticated financial development.

The columns five, six and seven in table 2.4 shows the results with the weighting matrix constructed with geographical distance. The spatial autoregressive coefficient is statistically and economically significant. The coefficients on control variables are with same signs and similar level of significance expect for economic size. Contrary to the previous results and the OCA theory, countries with large economic size are more likely to adopt a fixed ERR instead of other arrangements.

The last three columns of table 2.4 displays results with the past colonial relationships as the weighting matrix. The spatial autoregressive coefficient is 0.415 and significant, suggesting that countries tend to follow the ERR choice of another country if they share a common coloniser in history. The high significance of the weighting matrix constructed with the past colonial relationships is a strong evidence indicating that countries’ ERR choices could be path dependent. Several parameters on idiosyncratic factors are different from results with trade or geographical weighting matrix. However, those variables, though with opposite signs, are insignificant.

The spatial autoregressive coefficient is insignificant if I use the weighting matrix constructed with linguistic factors. Moreover, all parameters on country-specific factors are insignificant. Thus the model with linguistic weighting matrix is mis-

specified and results with the linguistic weighting matrix are not reported.

The results with the trade weighting matrix are the one with the lowest log likelihood, suggesting that it better reflects the transmission channel of network effects. Countries are likely to follow the ERR choice of their major trade partners. In terms of country-specific factors, the predictions from theories are only partially met.

2.4.2 Anchor currency choice

In this section, instead of classifying countries with fixed exchange rates based on the degree of peg (hard or crawling), I categorise these countries according to the anchor currency they choose. Hence the dependent variable is 0 for pegging to the USD, 1 for pegging to the euro, 2 for intermediates and 3 for free floats.

(1)	W_Trade			W_dist			W_common colonizer		
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Pegging to the euro	Intermediates	Free floats	Crawling pegs	Intermediates	Free floats	Pegging to the euro	Intermediates	Free floats
Log of GDP	-0.097 (0.342)	-0.823** (0.328)	-0.089 (0.644)	-0.335 (1.085)	-1.762 (1.193)	-9.481* (4.975)	-0.122 (0.369)	-0.840** (0.337)	-1.491** (0.639)
Trade openness	-0.009** (0.004)	-0.007** (0.004)	-0.017*** (0.005)	-0.014 (0.011)	-0.010 (0.009)	-0.065** (0.032)	0.001 (0.004)	0.001 (0.003)	-0.020** (0.010)
Terms of trade shocks	0.009 (0.025)	-0.021 (0.028)	-0.119** (0.058)	0.057 (0.057)	0.058 (0.069)	-0.637** (0.272)	0.065** (0.030)	0.023 (0.029)	-0.068 (0.067)
Capital account openness	1.216* (0.737)	1.546** (0.769)	-2.009 (2.740)	5.114 (3.457)	5.475 (3.464)	2.069 (3.622)	2.618*** (0.938)	2.279*** (0.832)	0.549 (1.275)
Debt to GDP ratio	-0.014* (0.008)	-0.001 (0.006)	0.015 (0.012)	-0.074** (0.036)	-0.042 (0.032)	0.133** (0.058)	-0.020*** (0.007)	-0.003 (0.006)	0.034** (0.014)
High inflation	-0.794* (0.436)	1.009** (0.400)	2.828 (1.908)	-2.579 (1.761)	1.286 (0.817)	8.119*** (2.496)	-1.482** (0.598)	0.419 (0.364)	0.661 (0.691)
Polity index	0.003 (0.005)	0.011** (0.005)	0.003 (0.009)	0.017 (0.018)	0.055 (0.038)	-0.005 (0.016)	-0.005 (0.007)	0.013* (0.008)	-0.014 (0.012)
Financial development	3.866*** (1.388)	5.811*** (1.273)	11.999*** (4.549)	9.349 (7.732)	12.032 (8.040)	34.663*** (12.441)	-0.608 (1.145)	0.864 (1.095)	2.549 (2.792)
ρ	0.303 (0.215)			0.527* (0.279)			0.655*** (0.075)		
Log likelihood		-824.163		-677.666			-408.494		
No. of Draws	8,000								
No. of burn-ins	4,000								
No. of observations	156								

Note: The base category is pegging to the USD. The numerical standard error are reported in the brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.5: Determinants of ERR and anchor currency choices

In table 2.5, three groups of results with different weighting matrices (trade volume, geographical distance, and past colonial relationships) are presented. The spatial autocorrelation here suggests not only that countries' choice of the regime is affected by the neighbours, but so is their choice of anchor. Thus countries would seem to follow their neighbours' choice of the anchor, whether it's their geographical or their colonial neighbours.

Columns two to four display the results with the trade weighting matrix. The spatial autoregressive coefficient is insignificant and thus the model is misspecified. Hence I do not discuss these results in detail.

Meissner and Oomes (2009) suggests that trade reflect the network effects of coun-

tries' ERR. It is unexpected that trade weighting matrix is of less importance in table 2.5. I stress that I use instrumented trade data to construct trade weighting matrix, and assuming that trade relationship influence countries' ERR choices through instruments only, which are common languages, distance, post-colonial relationships, common legal systems and religions as well as dummy variables for years at war. Hence the prevalent correlations between trade and ERR might be due to reverse causality or channels different from instruments I mentioned. Given that instrumental variables cover many institutional channels of influence, I think the reverse causality is a more important reason for high correlation between trade and ERR and anchor currency choices in previous studies.

Columns five to seven display the results with the weighting matrix constructed with geographic distance. With both anchor currency and ERR choice as dependent variables, the spatial autoregressive coefficient is 0.527 and significant, suggesting that countries are likely to follow the anchor currency choice of their geographical neighbours. Not many country-specific variables are significant. Countries with a lower level of foreign debt to GDP ratio are more likely to peg to the euro instead of the USD. The idiosyncratic variables provide no information why countries choose intermediate ERR instead of pegging to the USD. The parameter on idiosyncratic variables for free floats have the same signs and similar significance level with results in table 2.4. Contrary to the OCA predictions, small economies with low real shocks are likely to choose free floats. The signs on trade openness fits the expectation. The impossible trinity hypothesis is contradicted though the coefficient is insignificant. The parameters on debt to GDP ratio, high inflation, the polity index and financial development fit the currency mismatch hypothesis, credibility view and financial development view. However, the sign on the polity index is insignificant.

The last three columns of table 2.5 show the results with the past colonial relations as the weighting matrix. The spatial coefficient is 0.655 and significant. The signs of the parameters on control variables are basically the same as the results with distance as the weighting matrix, but significance level of the parameter are different. Countries with high real shocks, high level of capital account openness, low level of foreign debt to GDP ratio and low inflation are more likely to peg to the euro instead of the USD. Countries with small economic size, high level of capital account openness and high level of the polity index have a higher likelihood to operate intermediate ERR. The signs of parameters for free floats are the same as using distance as weighting matrix, but coefficients on ToT shocks, capital account openness, high inflation and financial development are insignificant.

The model with the past colonial relationships as the weighting matrix is the one with the lowest log likelihood, suggesting that countries' anchor currency and ERR

choice are more likely to be path dependent. There are countries that are not geographically nor economically close to Europe (US) pegging to the euro (USD) for historical reasons.

By running SAR MNL model, it is assumed that countries make the choice of ERR and anchor currency simultaneously. However, it is possible that countries' ERR and anchor currency is a two-step choice. If it is true, then a multilevel model, estimating why countries peg or float first and then estimate why countries with fixed ERR choose a particular anchor currency, will be more appropriate. Since this study estimates SAR model in a cross sectional setting with country level data, a multilevel model would further restrain the sample size in the second step. This study does not provide a multilevel analysis given the restriction, but it will be interesting to see how this influences results in further researches.

As in the study of countries' ERR choices, the spatial autoregressive coefficients and the parameters on idiosyncratic factors are insignificant if the linguistic weighting matrix is used, and hence results are not reported. Though common language and language proximity play a role in countries' political culture and policy-making, countries do not seem to follow the anchor currency or ERR choice of countries that they share similar or common languages with. However, language proximity is expected to be influenced by the past colonial relationships. It is interesting that the weighting matrix with language factors is insignificant, while the weighting matrix with past colonial relationship is. It is worth noting that I use if countries share a common coloniser in the past in the matrix instead of all colonial relationships. Hence the impacts between coloniser and the colonised are neglected. Seeing that many coloniser's languages are now official or common language in colonial countries, the language weighting matrix indicates that colonisers' ERR choices have impacts on colonial countries and colonial countries' ERR influence colonisers' as well. The assumptions imposed by language weighting matrix are too many and too strong. For instance, Hong Kong, Bahrain and the Bahamas share a common coloniser in the past, and are now pegging to the Dollar. Hence unlike the weighting matrix constructed with data if countries share a common coloniser in the past, language weighting matrix does not seem to reflect the influence of ERR choices.

2.4.3 Robustness and treatment of the eurozone

The dollar-euro exchange rate is the most influential exchange rate in the market. Both currencies are freely floating. In this section, the eurozone is treated as one unit with a floating exchange rate regime as a robustness check. Since I believe that currency network effects are key determinants of exchange rate regimes, treating the

eurozone as one single unit should not change the significance level of the spatial autoregressive coefficient. However, the parameters for country-specific determinants might be different.

As a robustness check, I use the weighting matrix that has the lowest log likelihood in the main results. The results are presented in table 2.6, with columns two to four displaying results with countries' ERR as dependent variable and the trade weighting matrix, and columns five to seven showing results with countries' anchor currency choice and ERR as dependent variables and the past colonial relationships as the weighting matrix. As predicted, the spatial autocorrelation between countries' choices remains significant but some parameters on the explanatory variables are different from previous models.

(1)	ERR choices			ERR and anchor currency choices		
	(2)	(3)	(4)	(5)	(6)	(7)
	Crawling Pegs	Intermediates	Free floats	Peg to the Euro	Intermediates	Free floats
Log of GDP	0.170 (0.296)	-0.506 (0.379)	1.131** (0.535)	-0.293 (0.396)	-0.775** (0.327)	-0.050 (0.353)
Trade openness	-0.000 (0.003)	-0.007* (0.003)	-0.015*** (0.006)	0.003 (0.005)	0.001 (0.003)	-0.012 (0.008)
Terms of trade shocks	-0.024 (0.022)	-0.021 (0.028)	-0.094** (0.041)	0.084*** (0.032)	0.025 (0.030)	-0.047 (0.055)
Capital account openness	-0.839 (0.656)	0.891 (0.842)	-3.349*** (1.222)	2.998*** (1.019)	2.224*** (0.855)	-1.428 (1.281)
Debt to GDP ratio	0.004 (0.005)	-0.003 (0.007)	0.007 (0.008)	-0.011 (0.008)	-0.005 (0.006)	0.019* (0.011)
High inflation	-0.114 (0.321)	1.069*** (0.382)	1.409** (0.564)	-1.215** (0.558)	0.409 (0.359)	0.509 (0.646)
Polity index	0.011** (0.005)	0.018*** (0.007)	-0.000 (0.009)	-0.006 (0.007)	0.012 (0.008)	-0.014 (0.011)
Financial development	0.519 (1.178)	5.989*** (1.365)	7.938*** (1.869)	-4.580** (1.810)	1.340 (1.206)	2.413 (2.521)
ρ		0.096* (0.057)		0.655*** (0.103)		
Log likelihood		-315.667		-803.824		
No. of Draws		8,000				
No. of burn-ins		4,000				
No. of observations		146				

*Note: The base category is hard pegs and pegging to the USD for the left and right regression respectively. The numerical standard error are reported in the brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

Table 2.6: The eurozone

The spatial autoregressive coefficient for the ERR choice study with trade weighting matrix is statistically significant at the 90% level but with little economic significance given that the value is small. It suggests that if I treat the eurozone as a single floating unit, the likelihood that countries follow the ERR choice of their major trade partners is small. However, several country-specific factors remain significant. There are few differences between the main results and robustness check. The signs

of the parameters are mostly in accordance with the main results. The signs of the coefficients on trade openness for crawling pegs and on financial development for crawling pegs and free floats are different, but insignificant in the main results and robustness test. The coefficients on capital account openness for crawling pegs and on debt to GDP ratio for free floats are insignificant in the robustness check. Trade openness is significant in the robustness test.

In the robustness check, with pegging to the USD as the base category, country-specific factors in addition to network effects determine countries' anchor currency and ERR choices. The spatial autoregressive coefficients remain statistically and economically significant. There are several differences in the parameters on idiosyncratic factors. Economic size is negatively and insignificantly correlated with operating free floats in the robustness test, but it is significant in the main regression. Given that now I categorise the eurozone as one unit with floating ERR, the negative association between economic size and free floats should not be significant. Similarly, if I treat the eurozone as one single floating unit, the negative correlation between trade openness and free floats is no longer significant. The sign of the coefficient on capital account openness for free floats is positive in the main regression and negative in the robustness test, but the coefficients are insignificant in both cases. The coefficients on the polity index for intermediates are positive in the main models and robustness test, but insignificant in robustness test. The significance level and signs of other coefficients are the same in the main models and robustness test.

2.4.4 Summary of results

The spatial autocorrelation coefficients in the above models vary between 0.096 and 0.687 and are mostly significant at the 99% level, suggesting that the spatial dependence is positive and strong. Compared to other channels, trade better reflects the impact of spatial interdependence for countries' ERR choices and past colonial relationships better reflect the network effects for countries' ERR and anchor currency choices.

(1)	(2)	ERR choices			ERR and anchor currency choices		
		(3)	(4)	(5)	(6)	(7)	(8)
		Crawling pegs	Intermediate	Free floats	Peg to the euro	Intermediate	Free floats
OCA	Log of GDP		-		-	-	-
	Trade openness			-**			-
	Terms of trade shocks	-			+		-
Financial	Capital account openness	-		-	+	+	
	Debt to GDP ratio	+		+	-*	-	+
	Financial development		+	+		+	+
Political	High inflation		+	+	-	+	+
	Polity index	+	+			+	

The least significant results among different groups are reported, and inconsistent results are not reported. The default category is hard pegs for ERR choices, and peg to the USD for ERR and anchor currency choices. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.7: Summary of results for idiosyncratic factors

Table 2.7 summarises the association between idiosyncratic factors and ERR choice. For clarity, only consistent results are reported. The coefficients of country-specific factors are sensitive to changes in model specification and weighting matrix selection. Few coefficients are consistently robust for all model specifications. Overall the signs of the parameters support the OCA theory in terms of trade openness, the currency mismatch hypothesis in terms of the foreign debt to GDP ratio, and Cobham (2010)'s theory in terms of financial development. Country-specific factors provide more information for countries' ERR choices than for countries' ERR and anchor currency choices seeing that fewer control variables are consistently significant in column 6 to 8 of table 2.7.

2.5 Conclusion

The main conclusion of this paper is twofold. First, it shows that currency network effects are strong: countries are likely to follow the ERR choices of their major trade partners; and countries are likely to follow the anchor currency and ERR choices of other countries if they have had a common coloniser in the past. Second, I re-examine the country-specific determinants proposed by earlier studies and find some of them significant, suggesting that the country's choice of ERR is made under the influences of both other countries and idiosyncratic factors.

From this research I can also see how sensitive the results are to methodology and data selection in ERR studies. It is similar to the findings in the previous studies that fail to come up with conclusive evidence which would allow us to be sure about the positive determinants of countries' ERR. In addition, the results of this study are still limited by data availability so I cannot include more countries in the sample.

As currency network effects are strong, countries would face multiple equilibria which

may lead to path dependence along with coordination failure, and thus are highly likely to be locked in suboptimal equilibria as demonstrated in Meissner and Oomes (2009)'s game theory model. In most multi-equilibria games, players may end up in a bad equilibrium but could improve their utilities by all moving to a good equilibrium together. Countries might be better off switching to a different anchor simultaneously, but no country has an incentive to switch on its own. This might explain some of the facts described in Quah and Crowley (2012) and Stockman (1999). Most east Asian countries peg to the USD, though they do not necessarily trade more with the USA. The intra-east-Asia trade is of higher importance, but a large volume of intra-Asia trade is denominated in the USD. Their study suggests that the Renminbi and the Yen should have played a larger role in southeast Asian countries. For the future, the study implies that the Renminbi could be a more suitable anchor for east Asian countries in the light of the expanding economic influence of China, but they found no trend of switching. At the same time, with economic development and political reforms, many southeast Asian countries have better political institutions and financial infrastructure, making them ready to pursue free exchange rates and independent monetary policy in the future. However, if any country switches to free floats on its own, it will face disadvantages in global markets. Overall the findings on currency network effects indicate that countries, especially small open economies and emerging markets that fix their exchange rates, can achieve higher welfare by escaping the suboptimal equilibrium and jointly choosing their ERRs with their major partners through cooperation and negotiation.

2.6 Appendix

Albania	Dominica	Kazakhstan	Poland
United Arab Emirates	Denmark	Kenya	Portugal
Argentina	Dominican Republic	Kyrgyzstan	Paraguay
Armenia	Algeria	Cambodia	Qatar
Antigua and Barbuda	Ecuador	Saint Kitts and Nevis	Russian Federation
Australia	Egypt	Republic of Korea	Rwanda
Austria	Eritrea	Kuwait	Saudi Arabia
Azerbaijan	Spain	Lebanon	Sudan
Burundi	Estonia	Liberia	Senegal
Benin	Finland	Saint Lucia	Singapore
Burkina Faso	Fiji	Sri Lanka	Solomon Islands
Bangladesh	France	Lithuania	Sierra Leone
Bulgaria	Micronesia	Latvia	El Salvador
Bahrain	Gabon	Morocco	Sao Tome and Principe
The Bahamas	United Kingdom	Republic of Moldova	Suriname
Bosnia and Herzegovina	Georgia	Madagascar	Slovakia
Belarus	Ghana	Mexico	Slovenia
Belgium and Luxembourg	Guinea	Marshall Islands	Sweden
Belize	The Gambia	Mali	Seychelles
Bolivia	Guinea-Bissau	Malta	Chad
Brazil	Greece	Mozambique	Togo
Barbados	Grenada	Mauritania	Thailand
Brunei Darussalam	Guatemala	Mauritius	Tajikistan
Central African Republic	Guyana	Malawi	Tonga
Canada	Hong Kong	Malaysia	Trinidad and Tobago
Switzerland	Honduras	Niger	Tunisia
Chile	Croatia	Nigeria	Turkey
China	Haiti	Nicaragua	Uganda
Cte d'Ivoire	Hungary	Netherlands	Ukraine
Cameroon	Indonesia	Norway	Uruguay
Congo	India	Nepal	United States of America
Colombia	Ireland	New Zealand	Uzbekistan
Comoros	Iran	Oman	St. Vincent and the Grenadines
Cabe Verde	Iceland	Pakistan	Venezuela
Costa Rica	Israel	Panama	Viet Nam
Cyprus	Italy	Peru	Vanuatu
Czech Republic	Jamaica	Philippines	Yemen
Germany	Jordan	Palau	South Africa
Djibouti	Japan	Papua New Guinea	Zambia

Table 2.8: List of countries of Chapter 2

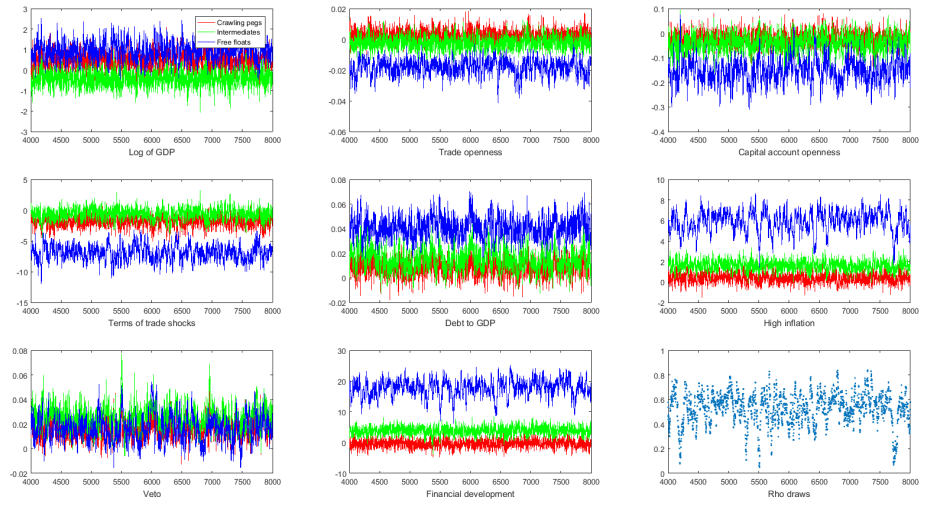


Figure 2.5: Trace plot of Parameters in SAR MNP Model with trade weighting matrix and hard pegs as the the base category for countries' ERR choices

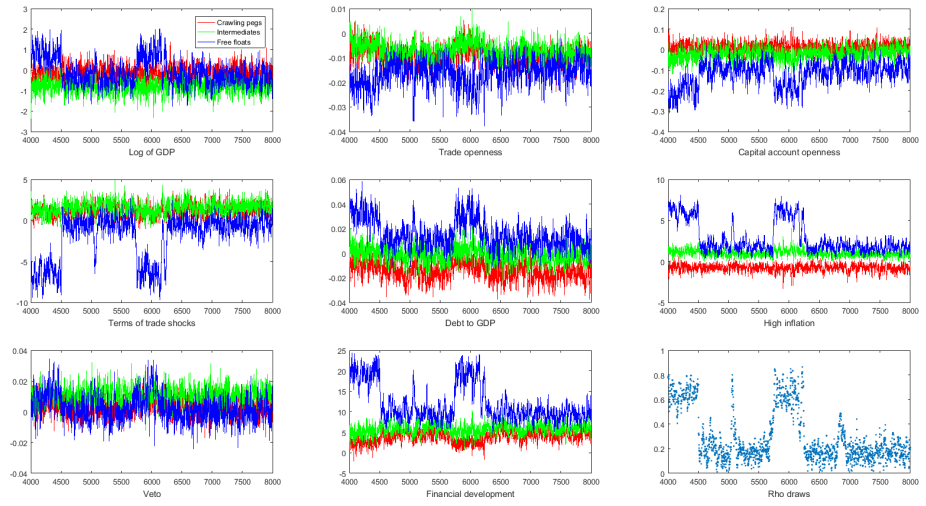


Figure 2.6: Trace plot of Parameters in SAR MNP Model with trade weighting matrix and peg to the USD as the base category for countries' ERR and anchor currency choices

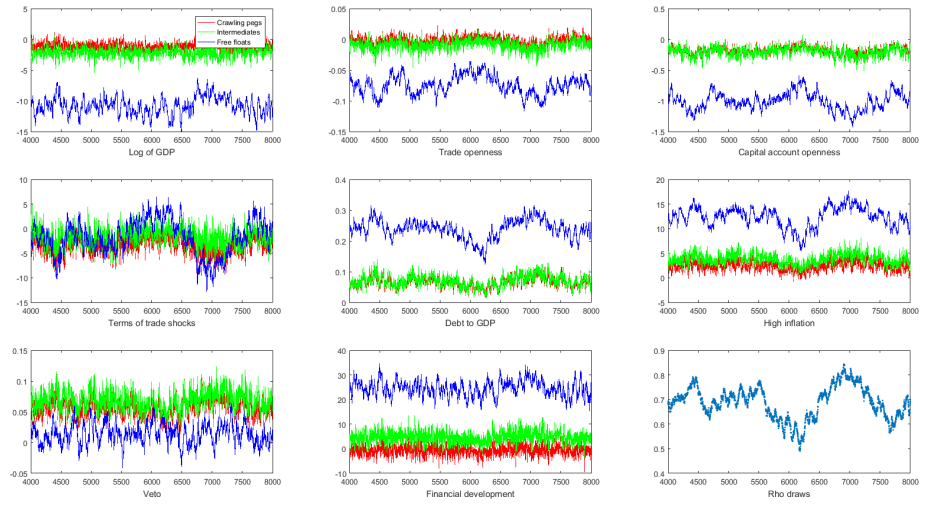


Figure 2.7: Trace plot of Parameters in SAR MNP Model with geographical weighting matrix and hard pegs as the the base category for countries' ERR choices

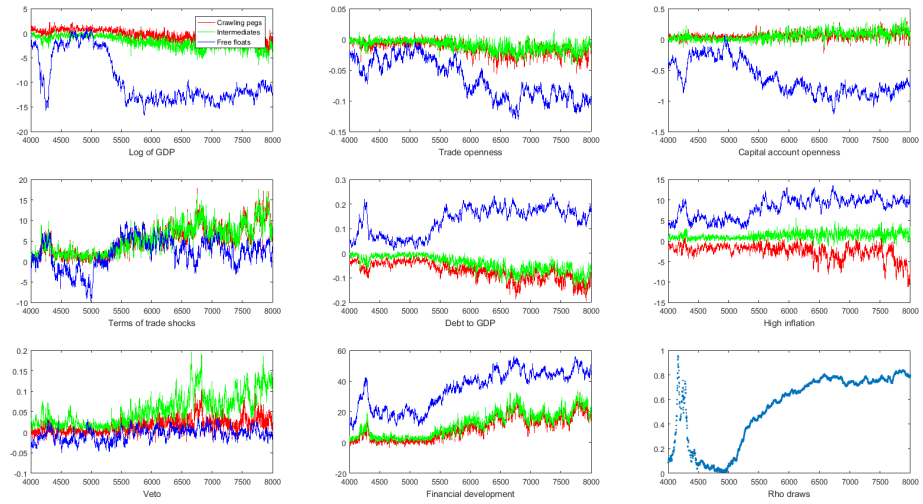


Figure 2.8: Trace plot of Parameters in SAR MNP Model with geographical weighting matrix and peg to the USD as the base category for countries' ERR and anchor currency choices

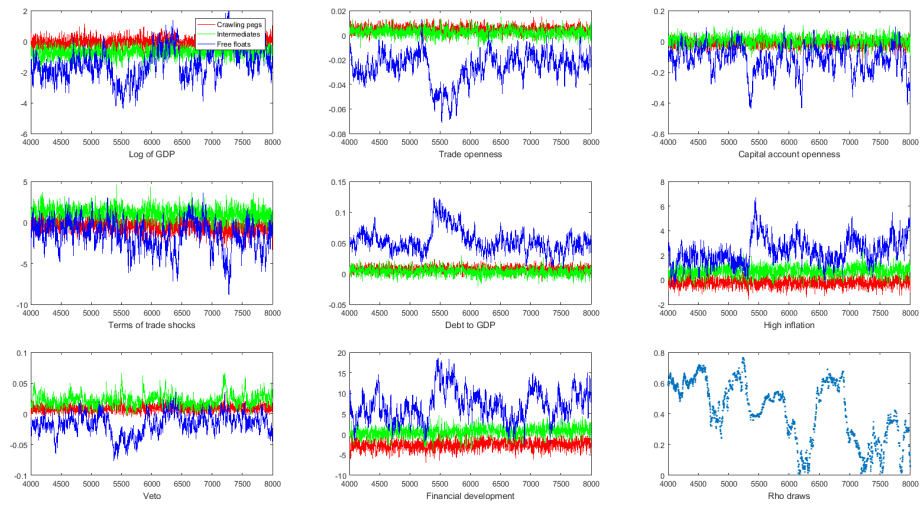


Figure 2.9: Trace plot of Parameters in SAR MNP Model with colonial experience as the weighting matrix and hard pegs as the the base category for countries' ERR choices

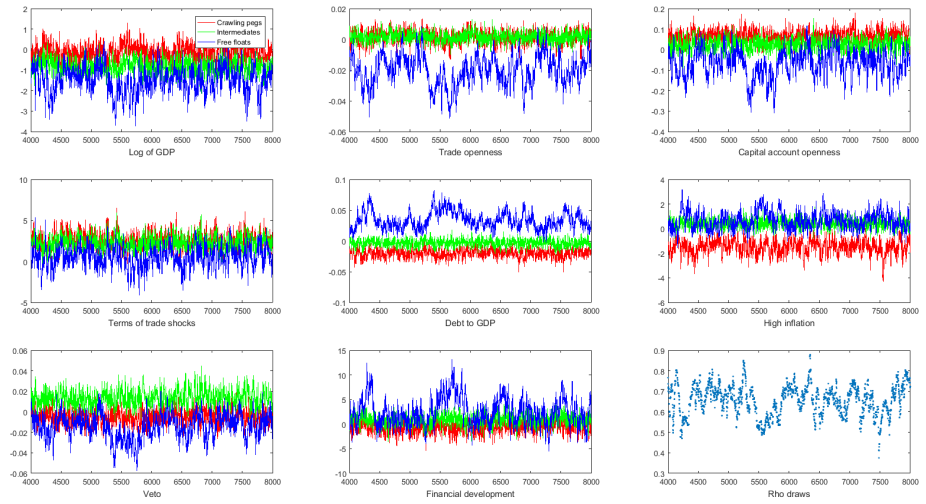


Figure 2.10: Trace plot of Parameters in SAR MNP Model with colonial experience as the weighting matrix and peg to the USD as the base category for countries' ERR and anchor currency choices

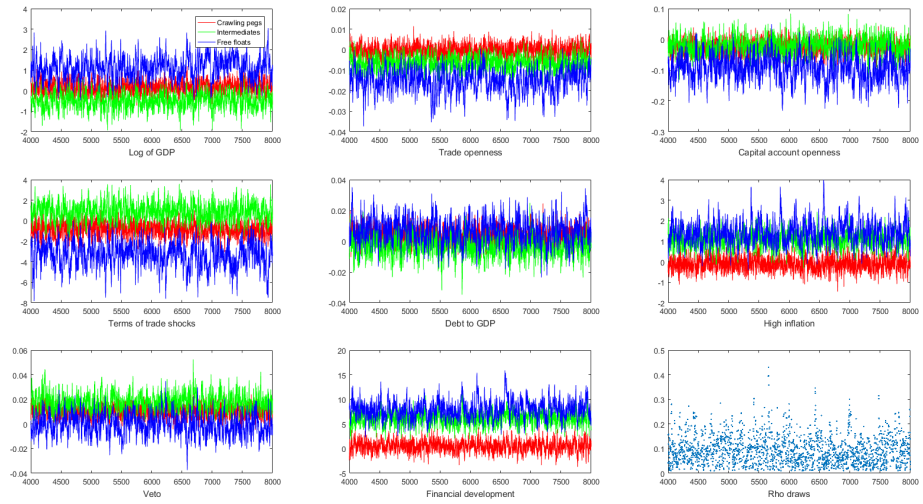


Figure 2.11: Trace plot of Parameters in SAR MNP Model with trade weighting matrix and hard pegs as the the base category for countries' ERR choices - Treating eurozone countries as one economy with floating ERR

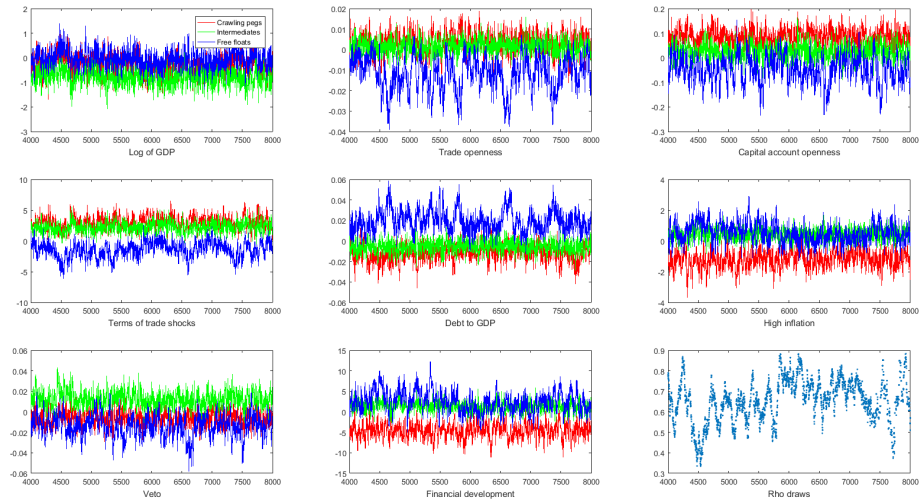


Figure 2.12: Trace plot of Parameters in SAR MNP Model with colonial experience as the weighting matrix and peg to the USD as the base category for countries' ERR and anchor currency choices - Treating eurozone countries as one economy with floating ERR

CHAPTER 3 – DETERMINANTS OF COUNTRIES’ MONETARY POLICY REGIME CHOICES: EVIDENCE FROM ORIGINAL OECD MEMBER COUNTRIES

3.1 Introduction

The world entered a “brave new world” after Bretton Woods where countries could choose their monetary policy regime (MPR) freely. As stated by the central banks, for most countries, the ultimate goal of monetary policy is now to maintain price stability, which means ensuring low inflation.

The Bank’s monetary policy objective is to deliver price stability – low inflation – and, subject to that, to support the Government’s economic objectives including those for growth and employment. Price stability is defined by the Government’s inflation target of 2%. – Bank of England 2014

The Congress established the statutory objectives for monetary policy – maximum employment, stable prices, and moderate long-term interest rates – in the Federal Reserve Act. The FOMC noted in its statement that the Committee judges that inflation at the rate of 2 percent (as measured by the annual change in the price index for personal consumption expenditures, or PCE) is most consistent over the longer run with the Federal Reserve’s statutory mandate. – Federal Reserve 2014

One of the main objectives of Denmark’s Nationalbank is to ensure stable prices, i.e. low inflation. This is achieved through the monetary and exchange rate policy. Since the early 1980s, monetary policy has been aimed at keeping the exchange rate of the krone stable, initially against the German D-mark and then against the euro. As the monetary policy target of the euro area is to keep inflation below, but close to 2 percent in the medium term, the fixed-exchange-rate policy provides a framework for low inflation in Denmark. – Denmark’s Nationalbank 2014

Some countries target inflation directly and some target other factors to control it. There are three formal MPRs since Bretton Woods: exchange rate targeting (ERT),

monetary targeting (MT) and inflation targeting (IT). If a countries' monetary policy framework does not have an explicit target, I categorise them as discretionary framework. Why do countries target the particular variables they target? This paper aims to answer this question by studying the determinants of countries' MPR choices. Examining the determinants of advanced economies may provide further guidelines for other countries when choosing an MPR.

As far as I know, this paper is the first paper explicitly studying the determinants of countries MPR' choices. Previous studies mainly focus on the determinants of exchange rate regime (EER) and find conflicting results for the determinants, however, most studies find the OCA factors and financial development relevant for the choice. Carare and Stone (2006) study the determinants of adopting an inflation targeting regime and find that per capita GDP and stock market capitalisation are significant determinants in a cross-sectional setting. The results do not contradict their findings and suggest that economic size, trade openness, historical inflation, financial development and political environment all have a role in determining the MPR.

The chronology of countries' MPRs and model specifications are presented in section 3.2. In section 3.3, I examine the potential determinants outlined in the literature from a theoretical perspective and list the hypothesis as well as data sources. I will present the empirical results and robustness tests in section 3.4 followed by concluding remarks.

3.2 Model and classification of MPRs

3.2.1 Econometric model

I study the determinants of countries' MPR in the post-Bretton Woods period (1980 to 2012). Countries that are already OECD members are included in the sample and I call them original OECD member countries. I want to estimate

$$y_{it} = x'_{it}\beta + \epsilon_{it}. \quad (3.1)$$

Here y is countries' MPR regime choices which could be ERT, MT, IT and D. ERT and D are only categories that exist in the whole sample period, however D in the 1980s is different from D in 2000s. Thus I set default/base category as ERT. Given the discrete nature of countries' MPR, the equation 3.1 can not be estimated directly.

From random utility model, the choice of countries' MPR y reflects the unobservable utility y^* associated with the choice. I adopt multinomial logit model (MNL) for estimation. The MNL model imposes the independence of irrelevant alternatives property. There are methods such as multinomial probit, generalised extreme value and heteroscedastic extreme value relax this restriction and might be explored in future studies.

With MNL model, it is assumed that log-odds of each MPR choice follow a linear model

$$y_{it}^* = \log \frac{\pi_{jit}}{\pi_{0it}} + x_{it}\beta_j \quad (3.2)$$

with $t = 1980, 1981 \dots 2012$, $i \in \{\text{early OECD member countries}\}$, x are potential determinants, β are coefficients associated with determinants and $y \in \{\text{ERT, MT, IT, D}\}$ is the country's MPR choice. Subscript j denotes alternatives of discrete choices. One of the MPR choice will be the default category 0, and $j \in \{0, 1 \dots J\}$ with $J = 3$. π_{jit} is the conditional probability of country i at time t to choose alternative j and π_{0it} is the probability of choosing the default category. Thus

$$\pi_{jit} = \frac{\exp(x'_{it}\beta_j)}{\sum_{k=1}^J \exp(x'_{it}\beta_k) + 1}. \quad (3.3)$$

Let N be the total number of observations. The corresponding log likelihood function for maximum likelihood estimation is

$$\log(L) = \sum_{it=1}^N \sum_{j=0}^J \frac{\exp(x'_{it}\beta_j)}{\sum_{k=1}^J \exp(x'_{it}\beta_k) + 1}. \quad (3.4)$$

The MNL model finds coefficients that maximise the log likelihood. However, coefficients here do not directly reflect how variables change the marginal probability of adopting a certain regime. To obtain the marginal effects of MNL model, we need predictions from a fit model at fixed values of some covariates and integrating over the remaining covariates. The marginal effects of the explanatory variable l for j -th alternative can be calculated from 3.5.

$$\frac{d\pi_{jit}}{dx_{lit}} = \pi_{jit}(\beta_{jl} - \sum_q (\pi_{qit}\beta_{qj})) \quad (3.5)$$

where q represents all explanatory variables except for l . I use two methods to show the economic significance of the idiosyncratic factors. First I estimate the marginal effects for each observation and reports the average marginal effects. It is also possible to calculate the standard errors of the marginal effects. Alternatively, I plot predictive margins at each value of explanatory variables instead of averaging them. Both methods give a similar conclusion about the economic significance of

explanatory variables.

3.2.2 Classification of early OECD member countries' MPR

I am interested in the de jure choice and thus countries' own classification of their regime choice is the main source of this study. The Bank of England sent a survey to central banks, and one question asks whether they have adopted explicit targets. Ninety-three central banks responded to the survey and a majority of the countries in the sample responded. It is hard to track down the words of central banks in the 1970s or 1980s. Thus this survey provides valuable data for this study. Subsequently, for accuracy, my definition of the categories follows the BoE survey closely.

The definition of formal IT is straightforward: a central bank announces an explicit target for inflation rates, usually for the medium term. Some central banks have point targets, and some have a range target. Money targeting includes all targets on money aggregates and credit. If a country is categorised as exchange rate (ER) targeter by themselves or by IMF's "Annual Report on Exchange Arrangements and Exchange" on that year, then their MPRs are categorised as ERT. IMF classification would have sent strong messages to the public that they are targeting exchange rates. For ERT countries, which adopt no separate legal tender, are in a monetary union, have pre-announced pegs and have de facto pegs according to IMF are all included. Some central banks were operating without an explicit target during some period in their history, and those countries have discretionary monetary policy framework.

There are periods when some central banks have dual targets. Though in theory countries have trade-offs between capital account openness, fixed exchange rates and monetary autonomy, Italy, France, Finland and Spain did have two explicit goals in certain periods: Italy and France were targeting both money and exchange rates in certain periods from the 1980s until 1998; Finland and Spain were conducting IT and ERT at the same time during the mid-1990s. In the time of dual targets, they were in the European Monetary System (EMS) and thus were required to watch over their exchange rates and stay within the band against the ECU. I assume that the Tinbergen rule holds, and thus central banks can only target one variable at a time. I use Ilzetzki et al. (2011) as additional reference, categorising countries as ERT if they have a de facto peg and MT or IT if not. Though this procedure contradicts my aim to classify countries' MPRs based on de jure announcements, it is a necessary treatment if I want to identify one intermediate target for each period.

In addition, I include the MPR choice of the eurozone. Thus I have an unbalanced panel given that the eurozone was created in 1999. Eurozone countries are considered

individually as ERT after 1999 and the eurozone itself as D in the main regression.

OECD economic surveys of countries were the main source for countries that did not reply to the Bank of England survey. Presentations and studies on individual countries such as Andolfatto and Gomme (2003), Mishkin (2001), Gumundsson and Kristinsson (1997), Berg and Gröttheim (1997), Sullivan (2013) and Nascimento (2005) are referred to when there are conflicts in the main sources. The detailed list of countries' MPRs is in the appendix with the sources of data.

Basically the principle and source of classification can be summarised as:

- If a country claims to have a target in the BoE survey or the OECD economic survey, then the country is a formal targeter of that instrument.
- If the IMF classifies a country as an exchange rates targeter and the country does not claim to have any other explicit target, then the country is classified as an ERTer.
- If a country have two targets at the same time and ER is one of the targets, then I use the R&R de facto ERR classification as an additional references. If a country is a de facto ER targeter in R&R, then I classify that country as ER targeter, and if not I classify it as the targeter of the other instrument.

The next subsection goes through countries' MPRs in turn, and a detailed list is in the appendix with the data sources.

The classification of countries' MPRs on the early part of the period is difficult since the conduct of monetary policy was more opaque and it is hard to track down the words of governments in the 1970s and 1980s. However, by combining multiple sources, I provide a chronology of MPRs for early OECD member countries in the appendix.

Figure 3.1 shows the transition in the MPRs of early OECD countries. IT starts from 1989: the first IT country was New Zealand. In 1999, Germany joined the eurozone and ended the last case of MT. Among early OECD members, the most prevalent MPR choices are ERT and D, and the regimes that exit throughout the period are ERT and D. Since discretionary framework in early part of the period is different from it in late part, I use ERT as the default category in the regression.

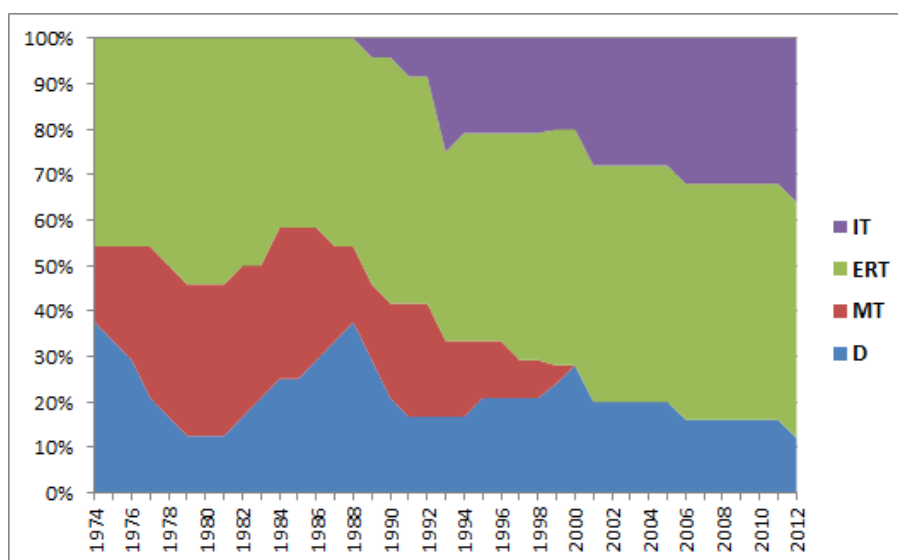


Figure 3.1: MPR of Early OECD members

Australia and New Zealand

After Bretton Woods, Australia had discretionary monetary policies until 1975. From 1976 to 1985, Australia conducted monetary policy based on ‘conditional projections’ for the M3 growth rate, and is thus categorised as MT. In the meanwhile New Zealand pegged to the Australian dollar. Australia adopted a discretionary framework from 1986 due to the turbulent economic circumstances. New Zealand gave up pegging to the Australian dollar in 1985 and chose an discretionary framework as well. In 1989, New Zealand became the first country to adopt IT, and Australia followed in 1993.

United States and Canada

The patterns of MPR choice for the United States and Canada are similar: they adopted MT soon after Bretton Woods, switched to discretionary frameworks in the early 1980s and then became inflation targeters.

Canada in order to control its inflation problem started a monetary gradualism programme in 1975. During the programme, the target range of MT growth rate was reduced gradually. However, the programme was abandoned in 1982 due to the uncertainty about M1. After that, Canada followed a discretionary monetary framework with intermediate exchange rates. In 1991, IT was officially adopted as the MPR in Canada. Canada did not recognise the monetary gradualism period as official MT regime in the BoE survey, but I categorise this period as MT since the

target was set and announced even though not rigidly followed.

The United States kept to MT for a longer period, from 1974 to 1987. In response to the concern that monetary aggregates would no longer be a useful guide for monetary policy, the Fed abandoned its M1 target in 1987. For a very long period, from 1988 to 2011, the United States followed a "learning by doing" strategy without an explicit intermediate target (Garrison (2009)). I categorise this period as a discretionary framework rather than IT since no clear target was announced for inflation rates. The Federal Reserve did not take an official position on attempts to make price stability the sole objective of monetary policy until 2012.

Economic and Monetary Union

Among 23 early OECD countries, 11 of them joined the European Economic and Monetary Union (EMU) in 1999 and Greece became the twelfth eurozone country in 2001. The European Central Bank (ECB), is responsible for making monetary policy instead of the central banks of participating countries.

Most countries now in EMU were ERT in their earlier years. Austria, Belgium, Luxembourg and Netherlands pegged to the Deutsche Mark (DM) after Bretton Woods and joined the euro in 1999. Ireland pegged to the Pound before 1979, and pegged to the DM and joined the euro in 1999. Germany targeted money from 1974 to 1998: it is the longest and one of the most successful MTers (Mishkin (2001)) in history. Greece targeted money until 1994 and changed to ERT before joining the eurozone.

Spain did not have an explicit target before 1989, adopted an ERT in 1989 and then an IT in 1994 without forgoing its ERT. In 1999, Spain joined the eurozone. Finland targeted exchange rates before entering the eurozone, but from 1993 to 1998 it had an inflation target as well. Rose (2007) suggests that inflation targeting is a stable regime: countries are unlikely to be forced out of this regime. Since the birth of IT, in nearly two decades, only Finland, Spain and Slovakia have quit the regime, but they only exited IT to join the EMU which is D.

France, Italy and Portugal had discretionary policy frameworks in the mid-1970s. Portugal adopted an ERT in 1978 and kept it until 1999, however in 1991 and 1992 it targeted money to help control inflation and to avoid overshooting capital inflows (OECD Economic Survey 1992). France began an MT after 1977 though it also had an ERT in the 1980s. Italy began targeting money in 1979. It was targeting both money and exchange rates from 1984 to 1998 except for the the period that Italy

was out of the European Exchange Rate Mechanism (ERM). Italy dropped out of the ERM temporarily at the end of 1992 and moved back in late 1996. France, Italy and Portugal joined the eurozone in 1999.

Other European countries

Denmark has had an explicit target – an ERT – since 1972 and has kept that policy until today. Norway had similar arrangements before 1994. After the oil price shock in the early 1990s, Norway gave up its ERT seeing it a too costly for the government to directly intervene in the exchange market. In 2001, Norway formally adopted the IT regime. Sweden had an ERT and then switched to an IT in 1993 after the Swedish recession.

Switzerland targeted money from 1974 but had a structural change in monetary policy in 2000 and abandoned MT. This reform followed a period when the demand for base money had become unstable. The new policy framework focuses on medium-term inflation projections, but is not classified here as an IT regime as inflation rates were not identified as the sole objective of monetary policy.

Iceland did not have an intermediate target from the 1970s to the 1990s. It maintained a managed float but experienced hyperinflation at times. It began to explicitly target inflation in 2001, trying to mitigate conflicting pressures relating to the interest rate, inflation and exchange rates.

The United Kingdom adopted MTs from 1977 to 1986. From October 1990 to September 1992, it targeted exchange rates by joining the European Monetary System (EMS). The UK became an official inflation targeter in 1993 after being forced out of the fixed exchange rates arrangement and remains an ITer until today. I classify the time in between these explicit regimes as discretionary frameworks.

Turkey and Japan

Turkey continued pegging to the USD from 1974 until 1981, operated for a few years without explicit targets and then adopted MT in 1990 but gave it up in 1992. The adoption of MT was part of the plan for trying to reduce the hyperinflation which accelerated in 1987 and to accumulate foreign reserves. From 1993, the Central Bank of Turkey conducted its policies without an explicit target, but it linked its policy with the balance sheet of the government, trying to supply the large and growing government financing requirement during the 1991 crisis. Turkey formally

adopted IT in 2006.

Japan is the only developed country in the survey that has never adopted an explicit target during the sample period. From 1998, monetary policy in Japan was “exceptionally accommodating” (OECD Economic Survey: Japan, 1997) during and even after the Asian financial crisis and still without an explicit target. In 2013, Japan adopted an IT framework as a part of Abenomics.

3.3 Selection of determinants

I explore the potential determinants of countries’ MPRs in this section. Most theoretical studies in this area focus on the choice between fixed exchange rates and monetary autonomy. Shambaugh (2004) suggests that there is a trade-off between fixed exchange rates and monetary autonomy according to the empirical evidence. Thus only countries with flexible exchange rates are able to pursue other targets such as money or inflation. For example, Von Hagen et al. (1989) shows that persistent net intervention in foreign exchange markets has impacts on money supply.

There are abundant literature on the determinants of countries’ ERR choices. The optimum currency area (OCA) theory predicts small economic size, higher trade openness and low real shocks will be associated with ERT (Mundell (1961)). The formal idea about the financial view on exchange rate policy arrangements emerged when Obstfeld and Taylor (2003) brought together the impossible trinity hypothesis and exchange rate arrangements. Countries cannot manage free capital flows, independent monetary policy and fixed exchange rates at the same time and thus a trade-off between the three should be observed. Frieden et al. (2000) and Poirson (2001) suggest that political factors play a role as well.

Kuttner and Posen (2001) with a large dataset of nearly 200 distinct frameworks spanning three decades show that hard pegs provide a low exchange rate volatility and inflation environment for countries. However, Bouakez and Rebei (2008) suggest that the exchange rate pass-through has declined in recent years among industrialised countries, indicating the impact of exchange rate movements on the domestic price level has decreased. They attribute this decline largely to the fact that many countries have switched from ERT to IT.

Though many researchers have included inflation persistence in their models as it does exist in the post-WWII data, Furthermore, Capistrán and Ramos-Francia (2010) find that an inflation targeting framework helps to decrease the dispersion of long run inflation. However, Carare (2002) discussed the initial conditions necessary

for IT, arguing that some of them could also be determinants of the adoption of IT. The paper suggests that macroeconomic stability, which includes inflation, is required for adoption of IT and thus the association between inflation and IT should be negative. SamarIna and De Haan (2011) study the determinants of IT adoption with probit analysis. In this approach, the determinants are assumed to have the same effects on the adoption of MT, ERT and discretionary framework compared to IT, which is problematic.

The importance of explicit targets is stressed in the literature. Ruge-Murcia (1995) supports the importance of credibility from the econometrics perspective as well: the uncertainty about government policy explains a major part of inflation volatility. In addition, Bailliu et al. (2003) show that countries with an explicit exchange rate policy, no matter if it is fixed, intermediate or floating, have better performance in terms of growth. Clarida et al. (1999) propose a framework to study the effectiveness of monetary policy, and several policy rules are discussed. Overall, a forward looking policy with binding constraint and commitment has better performance, though many problems may emerge during the practice of monetary policy. Estrella and Mishkin (1997) suggests that monetary aggregates fall considerable short as information variables. On the other hand, Benati (2008) demonstrates that under inflation targeting, inflation is purely forward-looking and shows no or little persistence. The study focuses on evidence from many advanced economies and the results are analogous in all sample countries. This finding makes inflation targeting appealing to countries with a history of high inflation. McCallum (1995) argues that central banks can avoid the time-inconsistency problem by admitting that expansionary monetary policy is preferred given that wage- and price-setting process are forward looking. But a nominal anchor may restrain overly expansionary policies.

Based on the literature stressing the importance of using an explicit target to anchor the inflation expectations of agents, good political institutions and low inflation are expected to be associated with the use of explicit targets. Hence it suggests a negative coefficient on the polity index, which measures the strength of political institutions, for D, and a positive coefficient on historical inflation for D. Historical inflation measures the average inflation rate during the previous MPR, and I use the average inflation of the previous decade for the initial period in the sample. However, governments with high credibility may be able to pursue multiple objectives at a low cost in terms of inflation bias. If that is the case, the opposite results will be expected. The relationship between political institutions and ERT is complicated. The sustainability view suggests that countries with good political arrangements have the credibility and ability to maintain fixed exchange rates. However, the policy crutch view indicates that administrations with low quality of institutions are

more likely to adopt fixed exchange rates rather than more sophisticated monetary policy arrangements. Furthermore, the adoption of IT was sometimes accompanied by a structural change in monetary policy to tackle high inflation or hyperinflation. Therefore I predict a positive sign for the coefficient on historical inflation for IT.

Collins and Siklos (2004) use an empirical study to show that the US has similar monetary behaviour to Canada, Australia and New Zealand in the 1990s. It is hard to differentiate formal IT from disciplined discretionary policy. However Carare and Stone (2006) find economic size, inflation history, broad money, stock market capital to GDP ratio and government debt (fiscal dominance) relevant for the choice between conventional inflation targeting and discretionary inflation targeting in a cross-sectional setting.

The transmission of monetary policy is not always speedy or complete (Liu et al. (2008)). Thus the development of financial markets is vital for countries' MRP choices. Cobham (2010) suggests that only when the transmission channel of monetary policy – the institutional and market infrastructure – is well developed are central banks able to conduct policies solely through interest rates and operate under frameworks like inflation targeting. The paper provides three categories for countries' financial and banking system: basic, intermediate and modern. I expect that the modern type of financial architecture is associated with an IT framework, intermediate with MT or discretionary and the basic type with ERT. Mishkin (1999) also indicates that ERT may promote financial fragility and thus is potentially dangerous without institutional reforms.

Broda (2004) suggests that the dynamic of terms of trade is different for oil exporters. Countries with a high volume of oil export are vulnerable to shocks in oil prices and thus are more likely to adopt flexible exchange rates to offset ToT shocks.

I summarise the theories and hypotheses mentioned in table 3.1. For variables for which I cannot deduce their correlation with specific MPRs from theories, I expect to observe insignificant coefficients. The default category is ERT, and thus all signs show the relative likelihood to adopt a certain regime comparing to the ERT.

Variable Name	D	MT	IT	Theoretical or empirical support
Economic size	+	+	+	Mundell (1961)
Trade openness	-	-	-	Mundell (1961)
Real shocks	+	+	+	Mundell (1961)
Capital account openness	+	+	+	Obstfeld and Taylor (2003)
Financial development	?	+	+	Cobham (2010)
Political institutions	+/-	?	?	Edwards (1996), Von Hagen (1999)
Historical inflation	+/-	?	+	Benati (2008)
Oil export	+	+	+	Broda (2004)

Note: The base category is ERT. + positive association, - negative association, ? ambiguous direction of association.

Table 3.1: Expectations of the results

The determinants such as economic size, trade openness, if the country has a high inflation and if the country is an oil exporter can be directly measured. Following Levy Yeyati et al. (2010), I use the standard deviation of the logarithm of terms of trade to proximate real shocks in the economies. I adopt index measures from Chinn and Ito (2008), Svirydzenka (2016) and Jagers and Marshall (2009) to examine the impacts of capital account openness, financial development and political institutions respectively. Svirydzenka (2016) provides a new index to financial development. It measures depth, access and efficiency of financial institutes (FIs) and markets (FMs). FIs include banks, insurance companies, mutual funds, and pension funds. FMs include stock and bond markets.

In table 3.2, the description and sources of the explanatory variables are presented.

Variable Name	Measure	Calculation	Source
Loggdp	Economic size	Log of GDP	OECD
Openness	Trade openness	(import+export)/GDP	OECD
ToTshocks	Real shocks	Standard deviation of the logarithm of terms of trade	WDI series
CAopen	Financial development	Measure of capital openness	Chinn and Ito (2008)
FI	Financial institutions	Development of financial institutions	Svirydzenka (2016)
FM	Financial markets	Development of financial markets	Svirydzenka (2016)
PolityIndex	Political Institution	Annual Polity scores	Jagers and Marshall (2009)
Inflation	Historical inflation	Average inflation rate during the previous MPR	OECD
Oilexport	Oil exporter	Dummy variable: 1 for oil exporter	OECD

Table 3.2: Data Description and Source

Policymakers take past economic conditions in addition to the current situation into account when setting monetary policies. Thus I use the average value of the proceeding five years for the explanatory variables that vary considerably between years. Those variables include economic size, trade openness, polity index. The procedure also helps us to tackle endogeneity issues. Terms of trade shocks are measured with the standard deviations of the logarithm of terms of trade for the preceding five years, and I use the highest value of a country's ToT shocks to fill up the missing values. Financial development and being an oil exporter do not change over a short period of time, and thus contemporary data is used. For the explanatory variables of the eurozone, I use the average value of eurozone member countries in the sample except for the log of GDP. The log of the sum of the GDP of eurozone member countries in the sample is used to measure the economic size of the eurozone.

3.4 Empirical Results

I present three groups of results: one with OCA factors, one with OCA plus polity index and capital account openness, and one with all factors I identified in section 3.3. Historical inflation and being an oil exporter are included in all regressions as control variables. In this way, I can examine the consistency of results.

3.4.1 Main results

Table 3.3 shows main results. In terms of the signs of the parameters, the three models report similar results except for terms of trade shocks and oil exporter in model 1. It is possible that financial development influence both countries' MPR choices and macro performances, so model 1 may suffer from endogeneity bias. Hence I focus on the results from models 2 and 3. The log likelihood decreases and pseudo r squared increases when I include more variables, which justifies the inclusion of the financial and political factors.

(1)	Model 1			Model 2			Model 3		
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	D	MT	IT	D	MT	IT	D	MT	IT
Log of GDP	0.579*** (0.0975)	0.720*** (0.135)	-0.374** (0.119)	1.020*** (0.131)	1.102*** (0.193)	-0.575*** (0.155)	0.965*** (0.141)	1.049*** (0.199)	-1.414*** (0.242)
Trade openness	-2.700*** (0.616)	-1.844* (0.928)	-5.614*** (0.882)	-2.838*** (0.697)	-2.872* (1.291)	-6.652*** (1.022)	-2.455*** (0.711)	-2.822* (1.287)	-9.943*** (1.394)
Terms of trade shocks	1.332 (3.071)	-8.326* (3.838)	-1.517 (3.342)	4.861 (3.682)	-9.977* (4.258)	3.040 (3.688)	5.007 (3.921)	-11.50* (4.515)	4.350 (4.232)
Historical inflation	0.112*** (0.0191)	0.0804*** (0.0244)	0.0499* (0.0204)	0.0856*** (0.0181)	0.0436 (0.0229)	0.0116 (0.0254)	0.127*** (0.0259)	0.108*** (0.0311)	0.0660* (0.0285)
Oil exporter	1.493*** (0.431)	-0.577 (0.679)	3.330*** (0.449)	1.944*** (0.520)	0.535 (0.700)	3.472*** (0.486)	1.908*** (0.525)	0.584 (0.757)	3.968*** (0.561)
Capital account openness				0.763*** (0.211)	-0.411* (0.195)	0.850*** (0.240)	0.706** (0.226)	-0.227 (0.221)	1.561*** (0.309)
Polity index				-0.152 (0.105)	0.00599 (0.122)	-0.873* (0.426)	-0.164 (0.106)	0.0195 (0.123)	-1.508** (0.503)
Financial markets							5.526*** (1.200)	1.065 (1.450)	9.381*** (1.408)
Financial institutions							1.124 (1.432)	3.076* (1.280)	1.197 (1.211)
No. of observations			806			713			713
Pseudo R2			0.352			0.408			0.452
Log likelihood			-647.4			-512.4			-473.8
Constant			Yes			Yes			Yes
Constant			Yes			Yes			Yes
Year dummies			Yes			Yes			Yes

Note: *, ** and *** represent p value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.

Table 3.3: Determinants of countries' MPR

In model 3, economic size is positively associated with D and MT frameworks, but negatively associated with IT. High terms of trade shocks increase the countries' likelihood of choosing D and IT but decrease the likelihood to adopt MT. The OCA theory predicts that economic size and real shocks are negatively correlated with ERT. Thus I expect that the signs of those two variables should be positive for D, MT and IT. However, the results contradict my expectation for large economies are less likely to do IT rather than ERT, and countries with high real shocks are more likely to adopt ERT rather than MT. The signs on the coefficients of trade openness are negative and significant. It fits the hypothesis that countries with high trade openness are more likely to adopt ERT.

Countries with a high level of historical inflation are more likely to do D, MT and IT. At the same time, countries with good political institutions are less likely to choose D and IT, but more likely to do MT. However, the coefficients are insignificant for D and MT. The coefficients on historical inflation together with polity index support the sustainability view that countries with good political institutions and reasonable inflation rate are able to operate a credible ERT.

As expected, the coefficients on oil exporter are positive for D, MT and IT. Oil exporting countries are less likely to choose ERT to control the influence of fluctuations

in oil prices.

A high degree of capital account openness is associated with D and IT, but insignificantly linked to MT. The results are sensible considering that it is costly to target ERT and MT directly if the country has a high level of financial openness.

The results show that financial development matters to the choice of MPR. A high level of financial market development is positively and significantly associated with the adoption of D and IT, and insignificantly correlated with MT. The coefficients on financial institutions for D, MT and IT are positive, but insignificant for D and IT. The results are mostly in line with my predication's expect for D. It is possible that countries such as the US and eurozone choose D instead of ERT because of the superiority of their financial infrastructure. The US and eurozone are able to pursue multiple objectives without compromising their price stability and thus they choose discretionary frameworks instead of IT. This case of D is different from discretionary policy in the 1970s and 1980s. Thus in the next subsection, I will categorise countries with implicit policy and good price stability as IT instead of D as a robustness check. Overall the results suggest that idiosyncratic factors are relevant for countries' MPR choices.

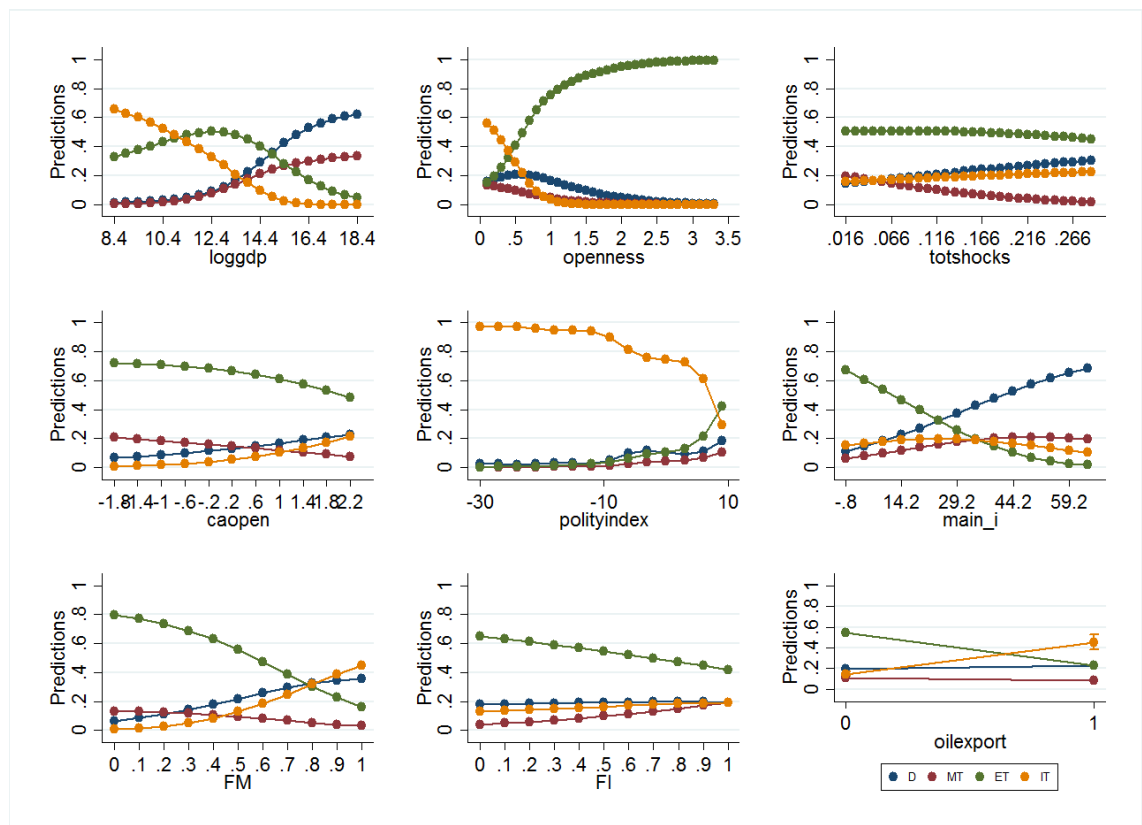


Figure 3.2: Predictive margins. Determinants of countries' MPRs

The coefficients can only tell us the sign and the statistical significance level of the

impacts. However, it is possible for a determinant to have small and significant impacts on the likelihood of countries' MPR choices. The predictive margin of variables can tell us the magnitude and economic significance of the impacts for each variable. Figure 3.2 shows the predictive margin of the model. Taking the first graph as example, the predictive margin shows that, keeping other variables constant at their mean values, for all countries with a loggdp value equal to a particular point (on the x-axis), the proportion of countries to choose D (MT, ERT or IT depending on the line) would be equal to the corresponding value on the y-axis. And the sum of the probabilities of choosing a certain MPR given the particular value of the loggdp is equal to 1. Thus it suggests that economic size has positive impacts on the choice of MT and negative impacts on IT, and the magnitudes of the effects are significant (from 0% to 38% and from 70% to 0% respectively). And interestingly, countries' probability to adopt ERT increases with economic size until a certain point and then decreases. Countries' likelihood to adopt D is increasing with economic size. Economic size turns out to be vital determinants of countries' MPRs, given that the probability to do a certain regime changes significantly with changes in the value of the log of GDP.

The variables that cause big movements along the y-axis are ones with high economic relevance. I scale the y-axis from 0 to 1, so it is easy to identify the major determinants. Except for economic size, trade openness, the polity index, historical inflation and FM appear to be major determinants of the MPR choices.

Keeping other variables constant at their mean values, countries with high trade openness are likely to adopt ERT with probability equal to 1, while economies with low trade openness are more likely to adopt IT. Economies with low political institutions are likely to do IT with a high probability. The reason behind it could be that, among original OECD member countries, after Greece joined the eurozone, the only case of ERT is Denmark which has the highest level of the polity index. It seems that, though worldwide it is countries with good political environments that are more likely to conduct IT, it is not the same among advanced economies. The likelihood of countries choosing IT decreases with increases in the polity index. Arising historical inflation from its minimum value of -0.8% to its maximum (59.2%) would increase the probability that countries do D (MT) from 10% (5%) to 70% (20%), and decrease the likelihood that countries choose ERT from 70% to 0. The probability for countries to do IT increases with historical inflation and then decreases with it. Carare (2002) suggests that relatively stable macroeconomic conditions are required to adopt IT. Thus I observe that countries are likely to adopt IT to tackle inflation, but the initial inflation cannot be too high when the central bank announces the adoption. Countries' propensity to do ERT decreases from 0.8 to 0.2 with increasing in financial

market development, while the probability to do IT and D increases from 0 to 0.42 and 0.38 respectively. Financial market development has a negative but insignificant influence on countries' likelihood to adopt MT. Being an oil exporter increases the probability that countries adopt IT from 20% to nearly 60%, while decrease the likelihood of doing ERT from 58% to 20%. Other variables, though statistically significant, have less determinant power on the choice of countries' MPR.

	ERT	D	MT	IT
Log of GDP	-0.0192 (0.0139)	0.0998*** (0.0110)	0.0442*** (0.00997)	-0.125*** (0.0133)
Trade openness	0.762*** (0.0811)	0.0369 (0.0667)	-0.152* (0.0743)	-0.647*** (0.0849)
Terms of trade shocks	-0.0555 (0.417)	0.614 (0.329)	-0.642** (0.241)	0.0827 (0.334)
Historical inflation	-0.0143*** (0.00274)	0.00615*** (0.00172)	0.00187 (0.00148)	0.00629*** (0.00167)
Oil exporter	-0.331*** (0.0562)	0.0686 (0.0396)	-0.00158 (0.0420)	0.264*** (0.0322)
Capital account openness	-0.104*** (0.0225)	0.0337 (0.0197)	-0.0329** (0.0123)	0.103*** (0.0214)
Polity index	0.0201 (0.0169)	-0.0153* (0.00742)	0.00530 (0.00726)	-0.0101 (0.00943)
Financial markets	-0.714*** (0.115)	0.258** (0.0978)	-0.182* (0.0799)	0.638*** (0.0909)
Financial institutions	-0.146 (0.119)	-0.00731 (0.127)	0.0968 (0.0707)	0.0562 (0.102)

*Note: Average marginal effects of determinants reported. *, ** and *** represent p value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.*

Table 3.4: Average marginal effects of determinants of countries' MPR

Table 3.4 presents the average marginal effects of explanatory variables. The values show how changes in variables impact the probability of choosing a certain regime. The conclusion we draw from marginal effects is similar to the plots of predictive margins, that economic size, trade openness, historical inflation, being an oil exporter, capital account openness and financial markets are both economically and statistically significant. The importance of capital account openness is less obvious in the graph. However, simply averaging the marginal effects may neglect important relationship between idiosyncratic factors and regime choices. The impact of economic size on ERT is insignificant in the table, but the plot of predictive margins shows that countries' probability of doing ERT increases with ERT and then decrease with it. This non-monotonic relationship will be neglected if we only look at the average. The prediction of OCA theory on economic size is partially met.

3.4.2 Robustness checks

In this section, I conduct three robustness checks. First I separate disciplined and undisciplined discretion. The discretionary framework with an average inflation rate over the preceding five years around 2% (1% to 3%) for a consecutive number of years is defined as disciplined D. The discretionary framework that does not fit this criterion is defined as undisciplined D. In a robustness check, I treat disciplined D as informal IT. Hence D includes undisciplined discretion only and I combine IT and informal IT. The countries operate disciplined discretion are Japan from 1985 to 1995, Norway from 1995 to 2000, and the US from 1996 to 2007 and from 2009 to 2011.

(1)	Model 1			Model 2			Model 3		
	(2) D	(3) MT	(4) IT	(5) D	(6) MT	(7) IT	(8) D	(9) MT	(10) IT
Log of GDP	-0.094 (0.127)	0.587*** (0.130)	0.163 (0.085)	0.127 (0.161)	0.927*** (0.180)	-0.575*** (0.155)	-0.204 (0.196)	0.849*** (0.187)	0.299** (0.114)
Trade openness	-7.853*** (1.302)	-2.394* (0.946)	-3.510*** (0.549)	-8.490*** (1.451)	-3.469** (1.297)	-6.652*** (1.022)	-10.310*** (1.657)	-3.671** (1.294)	-3.971*** (0.624)
Terms of trade shocks	-2.654 (3.139)	-9.320* (3.832)	2.284 (2.991)	1.755 (3.779)	-11.11** (4.272)	3.040 (3.688)	-0.455 (4.136)	-14.830** (4.650)	1.881 (3.590)
Historical inflation	0.090*** (0.018)	0.073*** (0.022)	0.049** (0.018)	0.078*** (0.018)	0.049* (0.022)	0.012 (0.025)	0.146*** (0.027)	0.130*** (0.030)	0.104*** (0.025)
Oil exporter	1.573** (0.525)	-0.597 (0.680)	2.839*** (0.418)	1.876** (0.630)	0.598 (0.703)	3.472*** (0.486)	1.700* (0.710)	0.628 (0.802)	2.931*** (0.482)
Capital account openness				0.978*** (0.210)	-0.360 (0.189)	0.850*** (0.240)	1.072*** (0.235)	-0.0921 (0.218)	1.121*** (0.239)
Polity index				-0.219 (0.162)	-0.0440 (0.166)	-0.873* (0.426)	-0.266 (0.194)	-0.0538 (0.190)	0.768 (0.427)
Financial markets							5.853*** (1.277)	0.684 (1.425)	5.370*** (1.007)
Financial institutions							4.226** (1.518)	4.460** (1.363)	-2.590* (1.072)
No. of observations			806			713			713
Pseudo R2			0.335			0.408			0.408
Log likelihood			-660.0			-512.4			-505.9
Constant			Yes			Yes			Yes
Year dummies			Yes			Yes			Yes

Note: *, ** and *** represent p-value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.

Table 3.5: Treating constrained discretion as inflation targeting

The results in table 3.5 are mostly close to the results in table 3.3, but there are several differences in the parameters for D and IT. The sign of the parameter on economic size for D is negative and insignificant in the robustness check, and is significantly positive in the main regression. The parameter on economic size for IT is significantly positive in the robustness test, and is significantly negative in the main regression. The reason behind the reverse of the signs on economic size for D and IT might be that I classify disciplined D as IT in table 3.5. And hence large economies such as the US and eurozone are doing IT instead of D. The parameter

of terms of trade shocks for D is negative in the robustness check and positive in the main regression, however, these results are statistically insignificant in both cases. The signs of parameter of polity index on MT and IT are different in the main regression and the robustness check. Countries with good political environment are more likely to adopt IT instead of ERT, and more likely to do ERT instead of D and MT. But these results on polity index are insignificant in the robustness check. The signs on the coefficients of FI are different for IT, but insignificant in the main regression and significant in the second regression. Again the change might be due to that economies with good FI development are able to conduct D with low cost in terms of inflation bias. Hence when I reclassify disciplined D, the parameter on FI changes accordingly. The magnitudes of the parameters differ, but the magnitude of the coefficients is hard to interpret in limited dependent variable models. Thus I will focus on the predictive margins in figure 4.3.

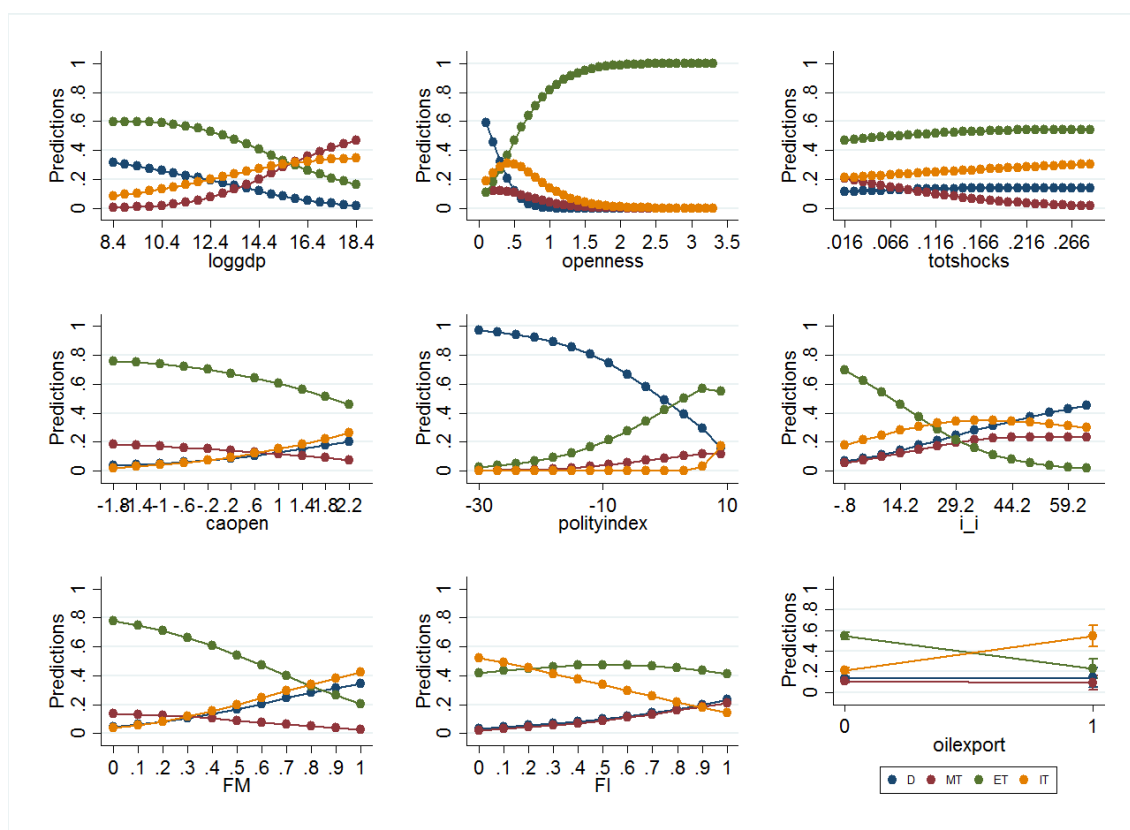


Figure 3.3: Predictive margins - Treating constrained discretion as inflation targeting

The conclusions I draw from the predictive margins in the robustness check is similar: economic size, trade openness, capital account openness, the polity index, historical inflation, being an oil exporter and financial market development are major determinants. However, countries with large economic size are more likely to do IT when I treat disciplined D as informal IT. Countries' likelihood to do D decreases with

increasing in the polity index. Other factors are relatively less important determinants, with less power to alter the probability of choices. Table 3.6 give basically identical conclusion about the economic significance of the determinants.

	ERT	D	MT	IT
Log of GDP	-0.0498*** (0.0139)	-0.0380** (0.0143)	0.0525*** (0.0104)	0.0352** (0.0136)
Trade openness	0.763*** (0.0815)	-0.612*** (0.120)	-0.0373 (0.0766)	-0.114 (0.0772)
Terms of trade shocks	0.425 (0.425)	0.125 (0.281)	-0.920*** (0.262)	0.369 (0.394)
Historical inflation	-0.0175*** (0.00295)	0.00595*** (0.00164)	0.00490** (0.00156)	0.00668* (0.00265)
Oil exporter	-0.307*** (0.0640)	0.0274 (0.0466)	-0.0122 (0.0444)	0.292*** (0.0466)
Capital account openness	-0.118*** (0.0238)	0.0479** (0.0165)	-0.0313* (0.0123)	0.101*** (0.0266)
Polity index	-0.0510 (0.0378)	-0.0444* (0.0173)	-0.00601 (0.00990)	0.101* (0.0502)
Financial markets	-0.628*** (0.116)	0.268** (0.0879)	-0.0918 (0.0811)	0.451*** (0.108)
Financial institutions	-0.0898 (0.120)	0.343** (0.112)	0.233** (0.0787)	-0.486*** (0.128)

*Note: Average marginal effects of determinants reported. *,** and *** represent p value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.*

Table 3.6: Average marginal effects - treating constrained discretion as inflation targeting

Next, I delete all eurozone countries from the sample after 1999 (2001 for Greece) and only treat the eurozone countries as a single unit. Table 3.7 shows the results for the second robustness check. There are several differences between these results and those for the main regression. The coefficients on terms of trade shocks for D and IT are insignificant in both models, but positive in table 3.3 and negative in table 3.7. Historical inflation is significantly and positively associated with D, MT and IT in the main regression. In the robustness check, the coefficient on historical inflation is insignificant for IT. The parameter of capital account openness on MT is statistically insignificant in the main regression and when I only include the eurozone as one single unit, but the sign on it are opposite. The parameters of financial institutions development on D and MT are positive and insignificant in the main regression. But these parameters are negative in this robustness check, and significant for IT. Countries with good FI development are more likely to do MT rather than ERT, and less likely to choose D and IT comparing to ERT.

(1)	Model 1			Model 2			Model 3		
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	D	MT	IT	D	MT	IT	D	MT	IT
Log of GDP	0.488*** (0.117)	0.842*** (0.150)	-0.269 (0.156)	0.769*** (0.146)	1.053*** (0.199)	-0.854*** (0.243)	0.809*** (0.152)	1.051*** (0.206)	-1.182*** (0.314)
Trade openness	-7.077*** (1.181)	-1.956 (1.172)	-9.857*** (1.439)	-9.726*** (1.566)	-5.383** (1.780)	-15.26*** (2.114)	-10.55*** (1.690)	-5.715** (1.904)	-18.31*** (2.407)
Terms of trade shocks	-6.801 (3.934)	-11.71** (4.179)	-9.733* (4.683)	-2.250 (5.094)	-13.39** (4.774)	-3.930 (5.470)	-4.123 (5.410)	-16.41** (5.126)	-6.957 (5.880)
Historical inflation	0.150*** (0.0243)	0.114*** (0.0277)	0.0987*** (0.0259)	0.0881** (0.0307)	0.0478 (0.0320)	0.00159 (0.0402)	0.126** (0.0465)	0.132** (0.0472)	0.0373 (0.0496)
Oil exporter	1.711*** (0.485)	-0.710 (0.686)	3.413*** (0.543)	2.609*** (0.695)	0.765 (0.751)	4.466*** (0.727)	2.410*** (0.668)	0.366 (0.859)	4.573*** (0.752)
Capital account openness				1.127*** (0.245)	-0.138 (0.207)	1.756*** (0.358)	1.017*** (0.271)	0.0365 (0.235)	2.212*** (0.430)
Polity index				-0.295 (0.223)	-0.0991 (0.215)	-1.956** (0.657)	-0.283 (0.207)	-0.0413 (0.200)	-2.248** (0.702)
Financial markets							7.241*** (1.629)	2.200 (1.678)	9.980*** (1.973)
Financial institutions							-1.250 (1.626)	3.308* (1.371)	-3.505* (1.634)
No. of observations			622			543			543
Pseudo R2			0.408			0.507			0.540
Log likelihood			-498.2			-357.8			-333.9
Constant			Yes			Yes			Yes
Year dummies			Yes			Yes			Yes

Note: *, ** and *** represent p-value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.

Table 3.7: Treating eurozone countries as a single unit

Figure 3.4 shows the predictive margins for the second robustness check. The results are similar to the main regression. The impacts of economic size and the polity index on countries' MPR choices are in accordance with the main regression instead of the previous robustness check.

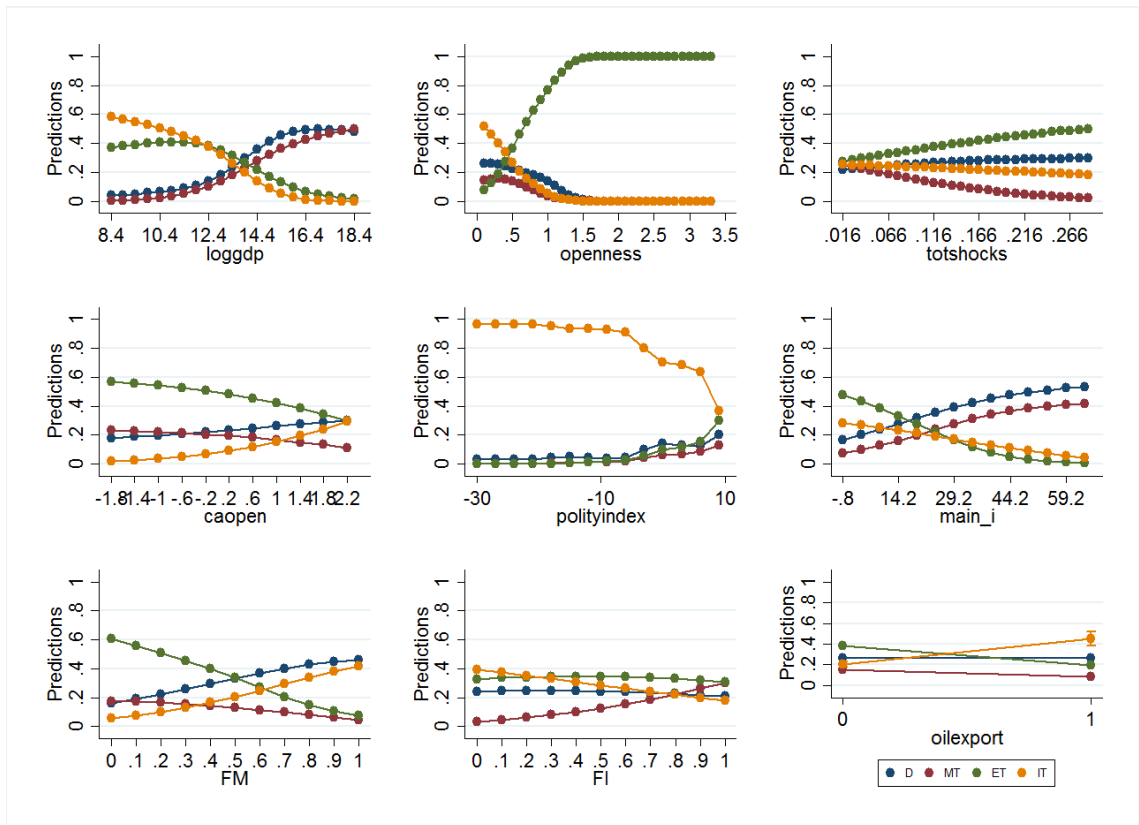


Figure 3.4: Predictive margins - Treating eurozone countries as a single unit

Table 3.8 shows the results for the third robustness check, in which I only include the eurozone countries separately and treat them as ERT. This set of results is similar to the main regression with two differences. The coefficient of economic size on D is significant and negative in the robustness check, but it is significant and positive in the main regression. The difference is likely due to the exclusion of the eurozone as a single unit. The parameter of the polity index on MT is insignificant in both cases, but is negative in this robustness check and positive in the main regression.

(1)	Model 1			Model 2			Model 3		
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	D	MT	IT	D	MT	IT	D	MT	IT
Log of GDP	-0.180 (0.135)	0.527*** (0.140)	-0.573*** (0.125)	0.160 (0.176)	0.973*** (0.209)	-0.678*** (0.159)	-0.459* (0.224)	0.862*** (0.221)	-1.669*** (0.253)
Trade openness	-9.843*** (1.379)	-2.800** (1.040)	-6.802*** (1.027)	-10.14*** (1.592)	-3.519* (1.479)	-7.557*** (1.131)	-13.66*** (1.865)	-3.602* (1.523)	-12.20*** (1.592)
Terms of trade shocks	-2.558 (3.086)	-9.067* (3.877)	-2.187 (3.367)	1.952 (3.723)	-11.02* (4.308)	2.389 (3.716)	0.767 (4.174)	-13.52** (4.633)	4.506 (4.348)
Historical inflation	0.0659*** (0.0167)	0.0536* (0.0225)	0.0189 (0.0183)	0.0722*** (0.0177)	0.0427 (0.0224)	0.0130 (0.0257)	0.122*** (0.0262)	0.117*** (0.0308)	0.0763** (0.0293)
Oil exporter	2.274*** (0.473)	-0.492 (0.678)	3.244*** (0.446)	2.733*** (0.577)	0.695 (0.703)	3.467*** (0.482)	3.081*** (0.604)	0.900 (0.768)	4.053*** (0.560)
Capital account openness				1.002*** (0.213)	-0.386 (0.199)	0.897*** (0.243)	1.112*** (0.253)	-0.185 (0.226)	1.665*** (0.322)
Polity index				-0.204 (0.147)	-0.0331 (0.152)	-0.701 (0.434)	-0.330 (0.207)	-0.0766 (0.197)	-1.208* (0.515)
Financial markets							9.462*** (1.403)	1.725 (1.460)	10.70*** (1.483)
Financial institutions							1.635 (1.474)	3.462** (1.300)	1.334 (1.232)
No. of observations			792			699	3.534		699
Pseudo R2			0.375			0.422			0.488
Log likelihood			-610.2			-486.4			-431.3
Constant			Yes			Yes			Yes
Year dummies			Yes			Yes			Yes

Note: *, ** and *** represent p-value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.

Table 3.8: Treating eurozone countries separately

Figure 3.5 shows the predictive margins of the robustness check that I only include the eurozone countries separately as ERT. The economic significance and direction of impacts are mostly consistent with the main regression. The major difference is that countries' probability of doing D decreases with increases in economic size, but the change in predictive margin is limited.

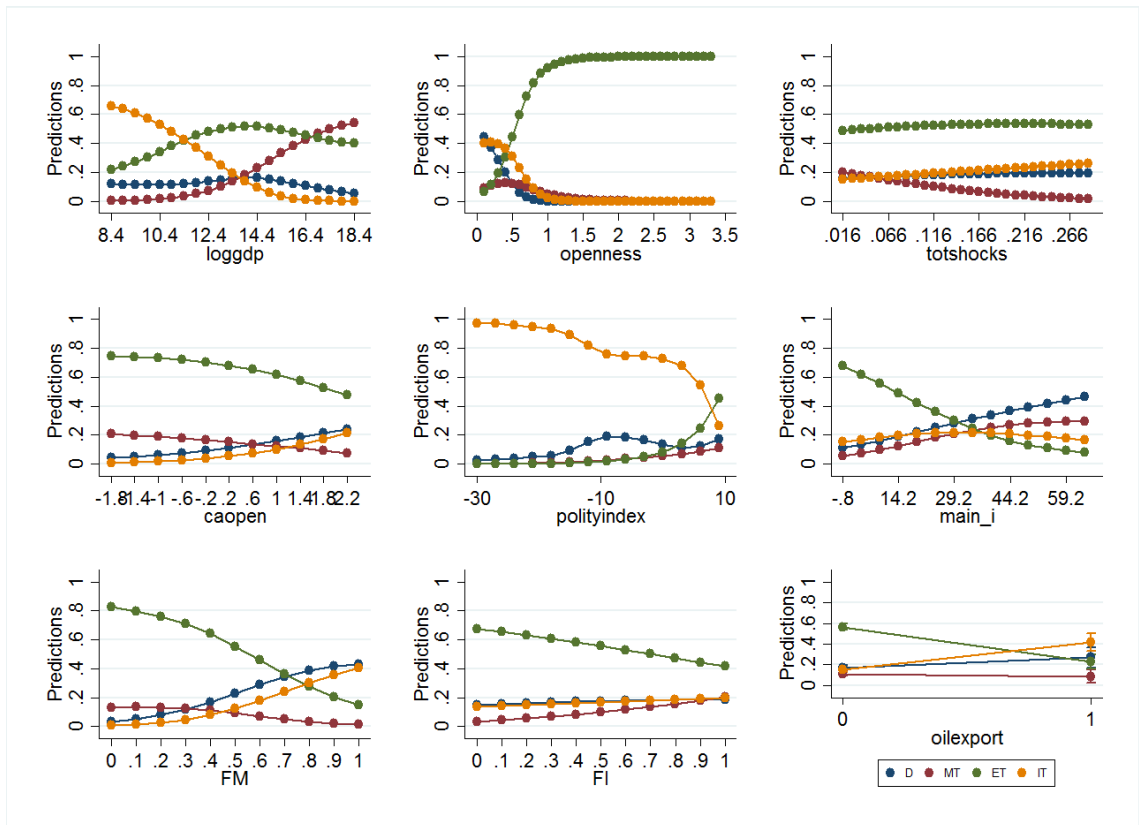


Figure 3.5: Predictive margins - Excluding the eurozone as a single unit

Table 3.9 displays the average marginal effects of alternative treatments of eurozone countries. The indications of the economic importance of determinants are similar by looking at the plots of predictive margins and average marginal effects. The only different is that in the second robustness check of eurozone countries where I include the eurozone countries separately but not as a single unit: from average marginal effects, economic size has positive and significant impacts on the probability of doing ERT, but from figure 3.5, we see that the association is not monotonic.

	Eurozone countries as a single unit				Eurozone countries seperately			
	ERT	D	MT	IT	ERT	D	MT	IT
Log of GDP	-0.0461*** (0.0110)	0.0993*** (0.0130)	0.0569*** (0.0115)	-0.110*** (0.0157)	0.0633*** -0.0171	-0.0082 -0.0147	0.0598*** -0.0123	-0.115*** -0.0143
Trade openness	0.905*** (0.101)	-0.0481 (0.0974)	-0.203* (0.102)	-0.654*** (0.103)	1.262*** -0.106	-0.712*** -0.115	-0.022 -0.0905	-0.529*** -0.093
Terms of trade shocks	0.916* (0.416)	0.441 (0.409)	-0.956** (0.317)	-0.401 (0.373)	0.299 -0.398	0.0826 -0.286	-0.621* -0.249	0.239 -0.335
Historical inflation	-0.0129** (0.00408)	0.00461* (0.00221)	0.00410 (0.00232)	0.00418* (0.00199)	-0.0127*** -0.00253	0.00441** -0.00146	0.00233 -0.00151	0.00600*** -0.00169
Oil exporter	-0.195*** (0.0584)	0.00604 (0.0468)	-0.0254 (0.0569)	0.214*** (0.0375)	-0.358*** -0.0524	0.118** -0.0374	0.00245 -0.0424	0.237*** -0.0333
Capital account openness	-0.0971*** (0.0186)	0.0213 (0.0244)	-0.0390* (0.0158)	0.115*** (0.0247)	-0.115*** -0.0218	0.0422* -0.0169	-0.0346** -0.0128	0.107*** -0.0217
Polity index	0.0200 (0.0210)	-0.0184 (0.00945)	0.00685 (0.0114)	-0.00848 (0.00966)	0.0393 -0.0273	-0.0196* -0.00957	0.00124 -0.0102	-0.0209 -0.0145
Financial markets	-0.608*** (0.118)	0.249* (0.116)	-0.152 (0.106)	0.511*** (0.100)	-0.860*** -0.108	0.426*** -0.0877	-0.208* -0.0814	0.642*** -0.0931
Financial institutions	-0.0386 (0.104)	-0.0437 (0.147)	0.239* (0.0951)	-0.157 (0.123)	-0.192 -0.108	0.0397 -0.108	0.102 -0.0703	0.0509 -0.104

Note: Average marginal effects of determinants reported. *, ** and *** represent p value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.

Table 3.9: Average marginal effects - Treatments of eurozone countries

Overall, results from the three robustness tests are close to results from the main regression. Economic size, trade openness, capital account openness, being an oil exporter, the polity index, historical inflation and financial development are statistically and economically significant to the choice of MPR. I summarise results from the main test and three robustness regressions in table 3.10 and list my expectations. Only consistent results in all three models are reported.

	Expetations			Emprical results		
	D	MT	IT	D	MT	IT
Log of GDP	+	+	+		+ * **	
Trade openness	-	-	-	- * **	-*	- * **
Terms of trade shocks	+	+	+		-*	
Historical inflation	+/-		+	+ * *	+ * *	+
Oil exporter	+	+	+	+*	+	+ * **
Capital account openness	+	+	+	+ * *		+ * **
Polity index	+/-			-		
Financial markets		+	+	+ * **	+	+ * **
Financial institutions		+	+		+	

Note: The least significant results among different groups are reported, and inconsistent results are not reported. *, ** and *** represent p value at 10%, 5% and 1% respectively. The base category is ERT.

Table 3.10: Summary of results for the determinants of de jure MPR choices

As discussed, the results are mostly in line with the predictions from the OCA theory, the sustainability view of fixed exchange rates, Broda (2004), Obstfeld and Taylor (2003) and Cobham (2010). This study is focused on the original OECD members, and hence mostly advanced economies. This explains many of the differences between the results and predictions.

3.4.3 De facto objectives of countries monetary policy

Cobham (2015) provides a statistical analysis on what advanced economies are trying to stabilise with their monetary policy. The de facto objective (objectives) of countries is different from monetary policy regime choices since pre-announced targets and economic consequences associated with the pre-announcement of the regime are not considered. In this section, I study if the potential determinants of de jure classification have any explanatory power for de facto objectives. However, since the classification are different, there is no direct comparability between the two sets of results.

I re-classify Cobham's (2015) classification into five course categories: ERT (single objective of growth of exchange rates and monetary union, 0), MT (single objective of monetary growth, 1), GDPT (single objective of growth of either nominal or real GDP, 2), PT (single objective of growth of price level or multiple objectives subject to a price stability constraint, 3) and D (unconstrained multiple objectives, 4). The reason that I combine the constrained multiple (CM) objectives with PT rather than unconstrained multiple (UM) objectives is that both CM and PT are sophisticated monetary framework arrangements, and I predict that similar country-specific factors are associated with doing CM and PT. Figure 3.7 shows the transition of countries' MPR. Though the composition of countries adopting certain regimes looks different from the de jure MPR one, the trend is similar: over time more countries try to stabilise the price level directly through single objective or constrained multiple objectives, and a group of countries (mainly eurozone countries) continue to stabilise ERT.

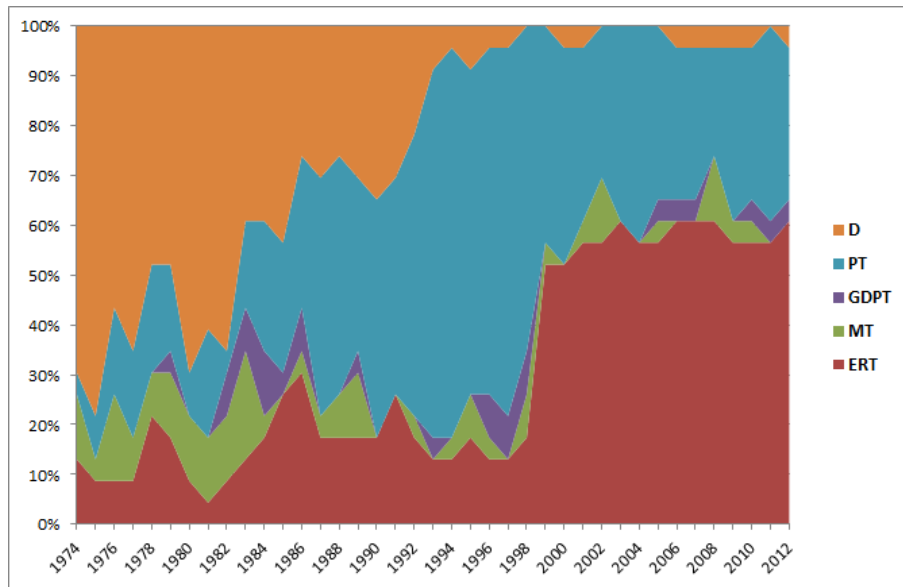


Figure 3.6: De facto classification

Data Source: Cobham (2015).

The results are presented in table 3.11. From model one to model three, the results are similar in terms of the significance levels and the signs of the parameters. Only a few variables are statistically significant. Economic size is positively associated with SM. Trade openness is negatively correlated with all non-ERT choices. Terms of trade shocks are positively associated with all non-ERT choices, though only significant for SM. The results from de facto monetary policy arrangements fit the OCA theory closely.

A high level of historical inflation is positively correlated with SP, MC and MU, and negatively associated with SM. Being an oil exporter is positively and significantly associated with all non-ERT choices. Countries with a high level of capital account openness are more likely to do ERT rather than other arrangements, but only the coefficient on MU is significant. Financial markets and institutions development are both relevant to the choice of countries' monetary policy objectives. Countries with high financial market development are significantly more likely to choose sophisticated arrangements such as single objective of income (nominal and real), price level and constrained multiple objectives. Financial institution development increases countries' propensity to adopt SY. The polity index is significant in the de jure MPR results but is insignificant in de facto tests.

(1)	model 1				model 2				model 3			
	(2) SM	(3) SY	(4) SP+MC	(5) MU	(6) SM	(7) SY	(8) SP+MC	(9) MU	(10) SM	(11) SY	(12) SP+MC	(13) MU
Log of GDP	0.116 (0.212)	0.274 (0.211)	0.0341 (0.0795)	-0.293* (0.125)	0.522* (0.255)	0.630** (0.235)	0.227* (0.100)	0.0298 (0.199)	0.658** (0.249)	0.499 (0.265)	0.109 (0.109)	-0.0538 (0.206)
Trade openness	-5.651*** (1.571)	-4.386** (1.512)	-1.726*** (0.327)	-2.784*** (0.657)	-5.990*** (1.635)	-4.740** (1.509)	-2.317*** (0.473)	-5.044*** (1.517)	-6.086*** (1.534)	-4.527** (1.648)	-2.300*** (0.493)	-4.783** (1.529)
Terms of trade shocks	13.68* (5.496)	8.503 (6.441)	4.995 (3.108)	5.712 (3.956)	8.774 (6.368)	2.160 (6.919)	1.872 (3.608)	0.114 (5.367)	15.41* (6.782)	1.659 (7.288)	3.519 (3.826)	1.145 (5.524)
Historical inflation	-0.202* (0.0875)	0.0148 (0.0578)	0.0443 (0.0331)	0.187*** (0.0352)	-0.252* (0.123)	0.0206 (0.0824)	0.0543 (0.0480)	0.283*** (0.0595)	-0.283* (0.134)	0.137 (0.0930)	0.112* (0.0513)	0.319*** (0.0631)
Oil exporter	3.484*** (0.886)	2.385* (1.065)	2.835*** (0.739)	2.343** (0.841)	4.045*** (0.932)	2.924** (1.089)	3.074*** (0.746)	3.272*** (0.888)	4.072*** (0.947)	2.762* (1.114)	2.858*** (0.752)	3.168*** (0.895)
Capital account openness					-0.412 (0.339)	-0.727* (0.201)	-0.130 (0.238)	-0.695** (0.373)	-0.129 (0.210)	-0.560 (0.210)	-0.0925 (0.210)	-0.607* (0.249)
Polity index					0.0282 (0.0751)	-0.0208 (0.295)	0.0593 (0.129)	0.215 (0.125)	0.0179 (0.0821)	-0.154 (0.327)	0.0157 (0.135)	0.194 (0.126)
Financial markets									-1.781 (2.087)	4.131* (1.809)	4.156*** (1.513)	1.150 (1.513)
Financial institutions									-2.199 (2.125)	5.774* (2.360)	1.447 (1.010)	0.692 (1.473)
No. of observations	806				713				713			
Pseudo R2	0.358				0.417				0.441			
Log likelihood	-688.0				-551.2				-527.9			
Constant	Yes				Yes				Yes			
Year dummies	Yes				Yes				Yes			

Note: *, ** and *** represent p value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.

Table 3.11: Determinants of countries' de facto monetary policy objectives

I plot the predictive margins of each variable in graph 3.7 and examine the impacts of each variable on the proportion of countries to choose a specific arrangement. Similar to the main results trade openness, historical inflation, being an oil exporter and financial market development are vital determinants of countries' MPRs.

Trade openness has a large effect on the probability of countries to choose de facto ERT as well: as trade openness increases, the probability of countries doing ERT increases from 10% to 100%. A high historical inflation rate increases countries' probability to do unconstrained multiple objectives from 0 to 100%. With increasing in historical inflation, countries' likelihood to adopt ERT, MT and PT drops. Both financial market and institution development increase countries' probability of doing SP and MC. Financial development factors decrease the chance of countries doing primitive monetary arrangements like ERT and MT. Similar to the results of de jure analyses, FM development plays a larger role in determining countries' de facto monetary policy arrangements comparing to FI development.

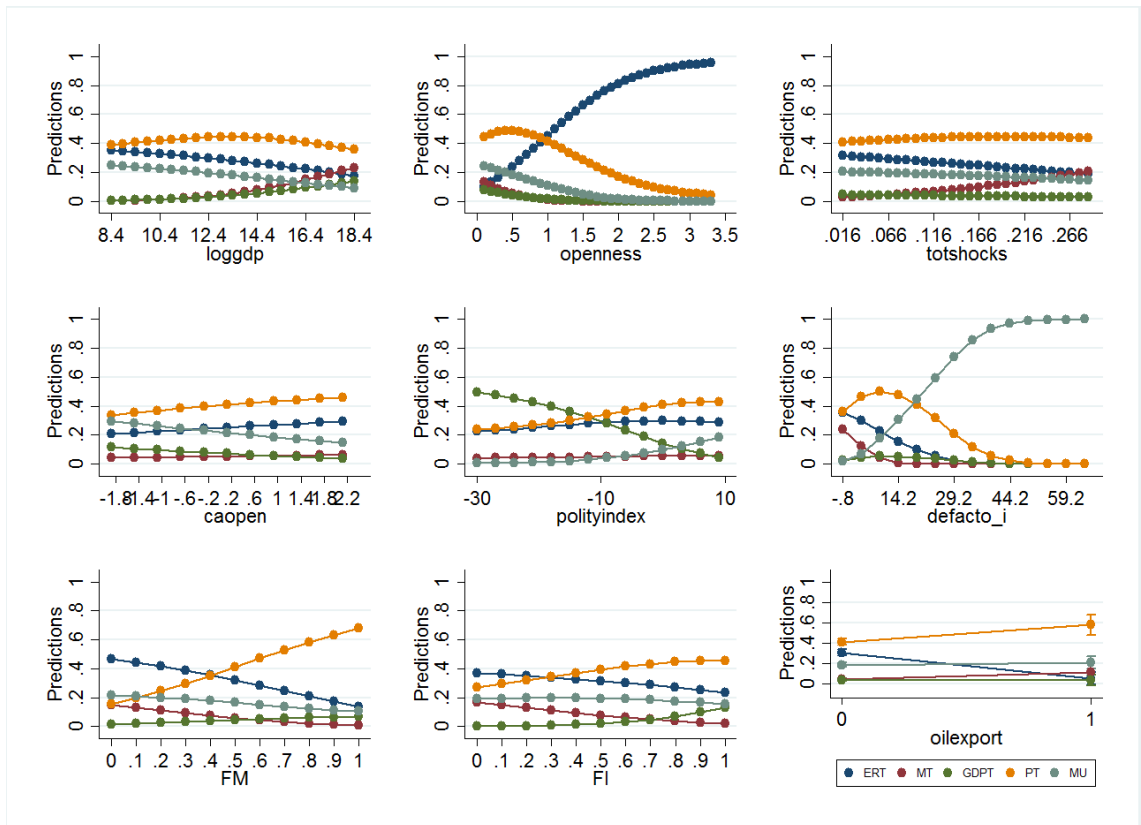


Figure 3.7: Predictive margins – Determinants of countries’ de facto monetary policy arrangements

The scale and significance of average marginal effects are consistent with the plots of predictive margins. Trade openness, historical inflation, being an oil exporter and financial markets are significant for most choices. From table 3.12, it is worth noting that terms of trade shocks have large impacts on countries’ chance to do MT and financial institutions have a large influence on countries’ probability to adopt income targeting.

	ERT	SM	SY	SP+MC	MU
Log of GDP	-0.0168 (0.0125)	0.0210* (0.00868)	0.0129 (0.00839)	-0.00145 (0.0164)	-0.0157 (0.0113)
Trade openness	0.335*** (0.0528)	-0.127* (0.0530)	-0.0598 (0.0522)	-0.0145 (0.0932)	-0.133 (0.0888)
Terms of trade shocks	-0.460 (0.441)	0.482* (0.225)	-0.0617 (0.213)	0.232 (0.506)	-0.192 (0.275)
Historical inflation	-0.0130* (0.00575)	-0.0154*** (0.00442)	0.00122 (0.00251)	0.0102 (0.00638)	0.0169*** (0.00255)
Oil exporter	-0.349*** (0.0861)	0.0609** (0.0213)	0.00640 (0.0271)	0.242** (0.0779)	0.0401 (0.0314)
Capital account openness	0.0190 (0.0241)	0.00348 (0.0109)	-0.0127 (0.0106)	0.0196 (0.0255)	-0.0294** (0.0101)
Polity index	-0.00287 (0.0147)	-0.000771 (0.00333)	-0.00664 (0.0103)	-0.00189 (0.0194)	0.0122* (0.00557)
Financial markets	-0.421*** (0.0946)	-0.166* (0.0704)	0.0560 (0.0533)	0.624*** (0.115)	-0.0935 (0.0800)
Financial institutions	-0.162 (0.117)	-0.130 (0.0695)	0.166* (0.0729)	0.155 (0.139)	-0.0288 (0.0710)

*Note: Average marginal effects of determinants reported. *, ** and *** represent p value at 10%, 5% and 1% respectively. The base category is ERT. Standard errors in brackets.*

Table 3.12: Average marginal effects – de facto monetary policy objectives

The direction and size of the effects of the determinants are similar in the de jure MPR and de facto objective studies. Trade openness, historical inflation, being an oil exporter and financial market development appear to be the most critical determinants of both countries' de jure and de facto monetary policy arrangements.

3.5 Conclusion

The contribution of this paper is twofold. First, I develop a chronology of de jure classification of countries' MPR for the post- Bretton Woods period for early OECD member countries. Second, I find several potential determinants of countries' MPRs from the literature and examine their significance.

I have tried to include more country-specific factors mentioned in the previous literature, but this study is restricted by data availability. Some variables such as central bank independence are dropped because no consistent time series can be found for all the countries in the sample. Though I want to extend this study to emerging and developing economies, information regarding monetary policy arrangements and explanatory variables for those economies are limited for the early years.

The results of this study suggest that economic size, trade openness, historical in-

flation, capital account openness, being an oil exporter, financial development and political institutions all have a role in determining countries' de jure MPRs. Among them, economic size, trade openness, historical inflation and financial market development have a higher determinant power. The results are mostly in line with the predictions from the OCA theory, the sustainability view of fixed exchange rates, Broda (2004), Obstfeld and Taylor (2003) and Cobham (2010). Using Cobham (2015)'s empirical study on what developed economies are trying to stabilise with monetary policy, I find that country-specific factors can also explain the de facto objectives of countries monetary policy arrangements in some degree. Trade openness, historical inflation and financial development remain vital determinants.

3.6 Appendix

Country	Year	Regime	Source
AUSTRALIA	<i>1974-1975</i>	D	OECD Economic Survey
	<i>1976-1985</i>	MT	OECD Economic Survey, Tease (1988)
	<i>1986-1992</i>	D	OECD Economic Survey
	<i>1993-2012</i>	IT	OECD Economic Survey
AUSTRIA	<i>1974-1980</i>	ERT**	OECD Economic Survey
	<i>1981-1998</i>	ERT	Mahadeva and Sterne (2012)
	<i>1999-2012</i>	EMU	OECD Economic Survey
BELGIUM	<i>1974-1998</i>	ERT	Mahadeva and Sterne (2012)
	<i>1999-2012</i>	EMU	OECD Economic Survey
CANADA	<i>1974</i>	D	OECD Economic Survey
	<i>1975-1982</i>	MT	Mishkin (2001), OECD Economic Survey
DENMARK	<i>1983-1990</i>	D	OECD Economic Survey
	<i>1991-2012</i>	IT	OECD Economic Survey
	<i>1974-2012</i>	ERT	Mahadeva and Sterne (2012), Central Bank Website
	<i>1999-2012</i>	EMU	OECD Economic Survey
FINLAND	<i>1974-1977</i>	ERT**	OECD Economic Survey, Ilzetzki et al. (2011)
	<i>1978-1992</i>	ERT	Mahadeva and Sterne (2012)
	<i>1993-1996</i>	ERT * IT	Mahadeva and Sterne (2012), Ilzetzki et al. (2011)
	<i>1997-1998</i>	IT	Mahadeva and Sterne (2012)
	<i>1999-2012</i>	EMU	OECD Economic Survey
FRANCE	<i>1974-1976</i>	D	OECD Economic Survey
	<i>1977-1978</i>	ERT	Mahadeva and Sterne (2012)
	<i>1979-1998</i>	ERT *	Mahadeva and Sterne (2012), Ilzetzki et al. (2011)
	<i>1999-2012</i>	EMU	OECD Economic Survey
GERMANY	<i>1974-1998</i>	MT	Ilzetzki et al. (2011), Mishkin (2001)
	<i>1999-2012</i>	EMU	OECD Economic Survey
GREECE	<i>1974-1994</i>	MT	Mahadeva and Sterne (2012)
	<i>1995-2000</i>	ERT	Mahadeva and Sterne (2012), Ilzetzki et al. (2011)
	<i>2001-2012</i>	EMU	OECD Economic Survey
ICELAND	<i>1974-2000</i>	D	Gumundsson and Kristinsson (1997)
	<i>2001-2012</i>	IT	OECD Economic Survey

IRELAND	<i>1974-1998</i>	ERT	Mahadeva and Sterne (2012)
	<i>1999-2012</i>	EMU	OECD Economic Survey
ITALY	<i>1974-1978</i>	D	OECD Economic Survey
	<i>1979-1983</i>	ERT	Mahadeva and Sterne (2012)
	<i>1984-1992</i>	ERT * MT	Mahadeva and Sterne (2012), Ilzet- zki et al. (2011)
	<i>1993-1996</i>	MT	Mahadeva and Sterne (2012), Ilzet- zki et al. (2011)
	<i>1997-1998</i>	ERT * MT	Mahadeva and Sterne (2012), Ilzet- zki et al. (2011)
JAPAN	<i>1999-2012</i>	EMU	OECD Economic Survey
	<i>1974-1998</i>	D	Mahadeva and Sterne (2012)
LUXEMBOURG	<i>1974-1998</i>	D	OECD Economic Survey
	<i>1999-2012</i>	D	OECD Economic Survey
LUXEMBOURG	<i>1974-1998</i>	ERT	OECD Economic Survey
	<i>1999-2012</i>	EMU	OECD Economic Survey
NETHERLANDS	<i>1974-1998</i>	ERT	Ilzetzki et al. (2011)
	<i>1998-2012</i>	MU	OECD Economic Survey
NEW ZEALAND	<i>1974-1983</i>	ERT**	Ilzetzki et al. (2011), Sullivan (2013)
	<i>1985-1988</i>	D	OECD Economic Survey
NORWAY	<i>1989-2012</i>	IT	OECD Economic Survey
	<i>1974-1994</i>	ERT	Mahadeva and Sterne (2012)
	<i>1995-2000</i>	D	OECD Economic Survey
PORTUGAL	<i>2001-2012</i>	IT	OECD Economic Survey
	<i>1974-1977</i>	D	OECD Economic Survey
	<i>1978-1990</i>	ERT	Mahadeva and Sterne (2012)
	<i>1991-1992</i>	MT	Mahadeva and Sterne (2012)
	<i>1973-1998</i>	ERT	Mahadeva and Sterne (2012)
SPAIN	<i>1999-2012</i>	EMU	OECD Economic Survey
	<i>1974-1988</i>	D	OECD Economic Survey
	<i>1989-1993</i>	ERT	Mahadeva and Sterne (2012)
	<i>1994-1998</i>	ERT * IT	Mahadeva and Sterne (2012), Ilzet- zki et al. (2011)
SWEDEN	<i>1999-2012</i>	EMU	OECD Economic Survey
	<i>1974-1992</i>	ERT	OECD Economic Survey
	<i>1993-2012</i>	IT	Hammond (2012)
SWITZERLAND	<i>1974-1999</i>	MT	Mahadeva and Sterne (2012), Mishkin (2001)
	<i>2000-2012</i>	D	OECD Economic Survey
TURKEY	<i>1974-1981</i>	ERT	OECD Economic Survey
	<i>1982-1989</i>	D	OECD Economic Survey
	<i>1990-1992</i>	MT	Mahadeva and Sterne (2012)

	<i>1993-2005</i>	D	OECD Economic Survey
	<i>2006-2012</i>	IT	Hammond (2012)
UNITED KING- DOM	<i>1974-1976</i>	D	OECD Economic Survey
	<i>1977-1986</i>	MT	Mishkin (2001), OECD Economic Survey
	<i>1987-1989</i>	D	OECD Economic Survey
	<i>1990-1992</i>	ERT	OECD Economic Survey, Cobham (2002)
	<i>1993-2012</i>	IT	Hammond (2012)
UNITED STATES	<i>1974-1987</i>	MT	Mishkin (2001), OECD Economic Survey
	<i>1988-2011</i>	D	OECD Economic Survey, Garrison (2009)
	<i>2012</i>	IT	OECD Economic Survey

D: Discretion. MT: Monetary Targeting.

ERT: Exchange Rate Targeting. ERT**: ERT by IMF

IT: Inflation Targeting. EMU: European Monetary Union.

Table 3.13: Countries' monetary policy regimes and data sources

CHAPTER 4 – FINANCIAL CONTAGION AND INTERNATIONAL RISK SHARING

4.1 Introduction

This paper studies two by-products of financial integration, international risk sharing and financial contagion with a theoretical model built upon Huggett (1993). I find that the relationship between financial integration and consumption smoothing is not monotonic, indicating there is a trade-off between the benefits of international risk sharing and the costs of financial contagion induced by unexpected negative shocks as observed in recent history.

The conventional wisdom suggests that we should move towards full financial integration to improve international risk sharing. However, empirical studies find that though there is a wide removal of capital controls, the international risk sharing is still limited. Heathcote and Perri (2004) and Sørensen et al. (2007) suggest that increasing financial integration is accompanied by a of trend home bias which is key to understanding the slow growth in international risk sharing. Bai and Zhang (2012) find that incomplete markets and limited enforceability of contracts in debt markets provide an explanation for limited international risk sharing. Krueger and Uhlig (2006) indicate that risk sharing can only be observed when interest rates are high. Some studies find that low risk sharing is a choice since the gain from sharing is small. Lucas (1987) and Cole and Obstfeld (1991) use empirical studies to show that the gain from international risk sharing is limited. Though Obstfeld (1998), using data from developing countries, finds that the gain from risk sharing is larger than previously predicted when consumption variability is high, overall the size of international risk sharing stays low. Tesar (1995) suggests that the gains from international risk sharing are insignificant when countries are able to “self-insure”. Thus in the model, I allow for regional in addition to international risk sharing and measure the “additional” gain.

Obstfeld (1998) raised concerns over the trade-off between risk sharing and financial contagion after the Asian financial crisis broke out in 1997, and suggested that in general the benefits of financial integration outweigh the costs and thus full and undistorted financial openness is preferable. However, a growing literature is challenging this idea and focuses on the study of global financial crisis. Most studies attribute the recent widespread sub-prime crisis to contagion. The disruption of financial sector matters because it may affect real activities and consumption. Gertler et al. (2010) and Brunnermeier and Sannikov (2014) each presents a closed economy

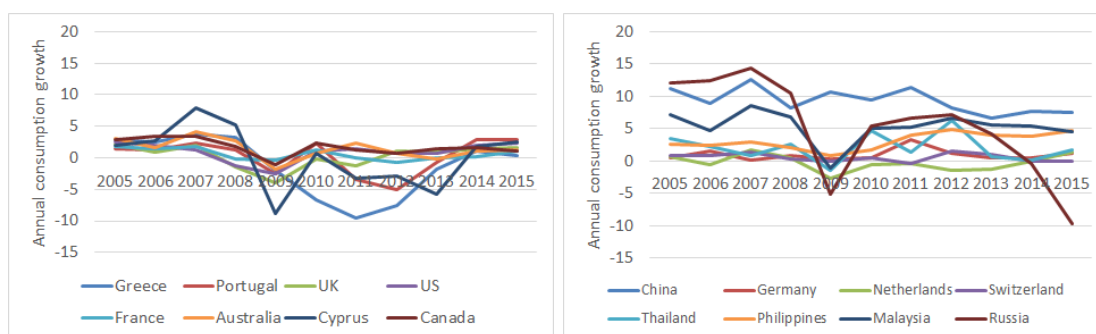
general equilibrium model showing how financial activities could influence production and consumption.

There are many potential channels for financial contagion. Dasgupta (2004) suggests that there are two types of contagion: one is from the spread of adverse information and the other is from linked portfolios and balance sheets among financial intermediaries. Kyle and Xiong (2001) use diverse but connected trader market to illustrate that financial contagion could happen through wealth effects. The traders who trade actively in different markets could spread the financial distress from one market to another when their wealth decreases. To insure against liquidity mismatch, agents and institutions in Allen and Gale (2000), Caballero and Simsek (2013) and Cifuentes et al. (2005) cross-hold assets of others. Thus when prices of asset or debt change due to fire-sale by one agent or a subgroup of agents, the whole financial market fails. Mendoza and Quadrini (2010) show that financial integration causes increased borrowing in the US and the spillover of the asset price shock to other countries. Goldstein and Pauzner (2004) focus on the self-fulfilling crisis, showing that contagion happens because countries share common investors and the crisis in one country makes investors more averse to the risk in all areas. Bacchetta and Van Wincoop (2013) also indicate that large spikes in risk among countries in the recent financial crisis episode are not directly caused by financial linkage or shocks to macroeconomic fundamentals. For instance, countries that are more exposed to US assets are not directly more affected by the crisis. They set up a two-country model to illustrate self-fulfilling shifts in risk (multi-equilibria). However, they conclude that multi-equilibria cannot fully explain the sudden and global-wide risk spikes. I do not discuss which is a more probable channel for contagion but take the financial linkage and transmission mechanism as given in the model.

The study of the trade-off between contagion and risk sharing is important but still limited. Stiglitz (2010*b*) outlines a simple model to study the trade-off and shows that under incomplete market and non-convex technology, autarky is preferable when there are only two extreme conditions: full financial integration and financial autarky. And Stiglitz (2010*a*) illustrates that the trade-off exists and raises the difficulty of designing an optimal capital market architecture. Grilli et al. (2014*a*) and Grilli et al. (2014*b*) study the trade-off on the firm and bank level, and indicate that a high degree of connectivity tends to generate bankruptcy cascades. Some studies find contradictory results regarding whether a more connected inter-bank market increases the chance of bankruptcy. Ladley (2013) shows that the co-existing phenomenon of contagion and risk sharing on the inter-bank market explains this phenomenon. Gallegati et al. (2008) also suggest that financial links that formed to share risk become a primary cause of subprime mortgage crisis. For the monetary

union, Auray and Eyquem (2014) show that in a second best environment with nominal rigidities, home bias and asymmetric shocks, financial integration could cause welfare reversal even if Arrow-Debreu securities exist.

This paper follows the existing literature on the study of the trade-off but with a more general macroeconomic setup. The model also incorporates the following stylised facts. First, consumers share risk domestically and internationally. Second, there is a surge of international debt in many advanced economies. Third, the impacts of global financial crises on consumers are asymmetric. Since this paper focuses on financial integration and its byproducts, I simplify the goods market by restricting the model to an endowment economy. In addition, there is an interesting phenomenon that is overlooked in the previous literature, that consumers in countries with current account deficits and surpluses seem to be impacted asymmetrically by the recent financial crisis. Figure 4.1 displays the annual growth rate of household final consumption expenditure per capita. It is obvious that countries with current account surplus and deficit are impacted by the 2007-2008 financial crisis differently. As shown in subfigure 4.1a, household consumption decreases significantly in 2007 in countries with current account deficits, and as in subfigure 4.1b, the consumption is relatively stable in economies with current account surplus. The only outlier is Russia, where household consumption drops drastically. However, the decrease should be attributed to its complex political situation rather than the recent financial crisis.



(a) Countries with current account deficit (b) Countries with current account surplus

Figure 4.1: Household consumption expenditure per capita growth

Data source: World Development Indicators

Data series: Annual growth rate of household final consumption expenditure per capita

There is a strand of literature recording financial integration and global imbalances. Many studies approach the problem from the case of the US and suggest that misalignments in economic policy between the US and the rest of world, especially emerging economies caused by the problem. Obstfeld and Rogoff (2005) attribute the imbalances to exchange rate misalignment and more importantly exchange rate

policy. They also raise that in order to re-balance the national accounts, policy coordination on both sides of the imbalances is necessary. Blanchard et al. (2005)'s model also shows that fixed exchange rate policy in other countries not only dampens American trade deficits but also further increases the demand for US assets. Krugman (2007) points out that the high level of external debt in the US is potentially damaging the position of the dollar. If it is true, the sharp depreciation of dollar will do great harm to the global economy. Asymmetry presence of capital controls can also explain part of the global imbalances. In Prades and Rabitsch (2012)' two country model, US's external debt position can be rationalised by noting that the degree of openness in the rest of world differ from the US.

Studies argue that differences in countries' productivity, demographics, financial development caused the imbalances. Smith and Prescott (2010) present significantly difference (4%) in returns on direct investment of the US and returns on investment in the US. The intangible assets include technology play a key role in the differences. Gourinchas and Jeanne (2013) argue that global capital flows do not necessarily go to regions with high productivity which raises an allocation puzzle, but the puzzle can be partially explained from saving decisions. With a theoretical framework, Caballero et al. (2008) show that with structural shocks on global capital flows, heterogeneity in countries' ability to produce financial assets causes differences in the equilibrium level of interest rates and hence global imbalances. Mendoza et al. (2009) suggest that differences in financial development between countries can explain the trend of financial integration, the decline in the US net foreign asset position and changing portfolio composition of US net foreign assets. With the examples of several Asian countries, Cooper (2008) indicates that dramatic demographic changes in many countries change people's saving and investment behaviour and influence national saving level significantly.

The data and previous studies motivate us to consider both country and consumer heterogeneity. I set up a Huggett (1993) type heterogeneous agent model with different types of countries and formalise two types of countries: Type I countries have a high domestic equilibrium interest rate and run a current account deficit; Type II countries have a low domestic equilibrium interest rate and current account surplus. The main findings indicate that lenders and borrowers in countries with current account surpluses and deficits respond to the financial crisis asymmetrically. I outline the model and solution strategy in section 4.2. Results and policy implications are discussed in section 4.3. I conclude the paper in the last section.

4.2 Model

4.2.1 Model environment

This paper introduces heterogeneity in countries in addition to heterogeneity in consumers, which is largely overlooked in the previous literature. Studies built on the Bewley-Aiyagary-Huggett type of models usually adopt heterogeneous household setting. The differences in realised income are the main driver of agent heterogeneity. Some literature extends this line of work by introducing other types of heterogeneity such as preference, health status or marriage status. Heathcote et al. (2009)'s survey provides a comprehensive summary of heterogeneous household literature. More recent studies such as Bai and Zhang (2012, 2010) and Castro and Koumtingu (2014) further extend the model to study heterogeneous countries, but consumers within a country are assumed to be identical.

In the model, the world consists of n countries, denoted as country $j \in \{1, 2, \dots, n\}$. Each country has a continuum of infinitely lived consumers with a total mass of one, represented as $i \in (0, 1)$ and many banks. The income level and probability to transit between employment and unemployment differ across countries. Within a country, consumers receive full level of endowment when employed and a lower level of endowment during unemployment. The market is incomplete in the sense that no Arrow securities are present and there is a natural borrowing limit. There are financial intermediaries (FI) providing bond contracts. FIs are risk neutral and competitive, and they discount the future flows at the competitive interest rate. To tackle the uncertainty in endowment, consumers trade bonds. In a standard Huggett (1993) model, which is also the benchmark model, the equilibrium interest rate clears the domestic bond market.

Given that the endowment process is different across countries, the domestic interest rate differs. With financial integration, countries can borrow and lend internationally. Thus, there is a world interest rate that clears the global credit market and deviates from countries' equilibrium levels of interest rates. In an open economy, FIs behave the same as in a closed economy but manage international bond trading. Subsequently, given that countries have open capital markets, some countries which are borrowers would run negative credit balances and some which are lenders would have positive credit balances. The balance sheets of FIs are linked by the cross-holding of debt.

There are studies based on Diamond and Dybvig (1983) which examine the reasons for bank failure. They find that the bank failure is usually caused by liquidity

mismatch in incomplete markets. I model the crisis in an ad hoc approach since the origin of the crisis is not the focus of this paper. Financial crisis is introduced as an unusual event that has zero probability of happening in which one of the banks need to pay a lump sum of asset to an outsider. In such case, the deterioration of bank balance sheets spreads to other financial institutions through the interbank market, and that causes market failure: lenders lose their wealth and borrowers lose access to the credit market. The event allows us to observe if financial integration changes the impacts of the banking crisis on countries with different characteristics. In the following subsections I specify the problems faced by consumers and financial intermediaries, the timing of the model, and the equilibrium conditions.

Consumers

Consumers face idiosyncratic shocks to their endowment and choose consumption and bond holding to maximise their utility given the budget constraint. The bond price differs between countries and thus the budget constraints faced by consumers in different countries are different. The consumers' problem for country j can be written as:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t u(c_{ij,t}) \quad (4.1)$$

$$\text{s.t. } c_{ij,t} + q_{j,t} b_{ij,t+1} \leq e_{ij,t} + b_{ij,t} \text{ where } c_{ij,t} \geq 0 \text{ and } b_{ij,t} \geq -\underline{b}_j \quad (4.2)$$

where c is the consumption, e is the endowment, b is the bond holding, q is the bond price, and β is a time-invariant discount factor. The subscript ij denotes the consumer i in country j and t denotes time. The non-negativity constraint binds consumption and there is a limit on borrowing \underline{b} . The utility function satisfies the Inada conditions and is concave. I can rewrite the problem in recursive form.

$$V_{ij}(e_{ij}, b_{ij}, q_j) = \max u(c_{ij}) + \beta \sum_{e'|e} \pi(e'|e) V'_{ij}(e'_{ij}, b'_{ij}, q'_j) \quad (4.3)$$

$$\text{s.t. } c_{ij} + q_j b'_{ij} \leq e_{ij} + b_{ij} \text{ where } c_{ij} \geq 0 \text{ and } b_{ij} \geq \underline{b}_j \quad (4.4)$$

I suppress the time notation t for the current period and use letters with primes representing values in the next period. $\pi(e'|e)$ is the probability transition matrix of the endowment.

Financial intermediaries

I model one type of financial intermediaries, a bank, and use the word “bank” and FI interchangeably. There are many competitive, risk neutral, homogeneous FIs in a country, and I denote a representative FI in country j as FI_j . In closed economies, FIs break even at the bond price schedule

$$q_j = 1/R_j. \quad (4.5)$$

In open economies, the global market clears at the world interest rate and the bond price adjusts accordingly as

$$q_j = 1/R^* \quad (4.6)$$

where R^* is the world interest rate.

Timing of the model

The timing of the model is summarised in figure 4.2. At the beginning of each period, the endowment for individual consumers is realised. FIs repay loans and receive payments from other FIs. Following the clearance of credit in the interbank market, FIs make payments to consumers respectively and the returns to bond holding from last period are realised.

In the middle of the period, the FIs announce the bond price for the next period and consumers make consumption and bond holding decisions accordingly. Given each country’s demand for credit, FIs clear the global credit markets first and the domestic credit markets afterwards.

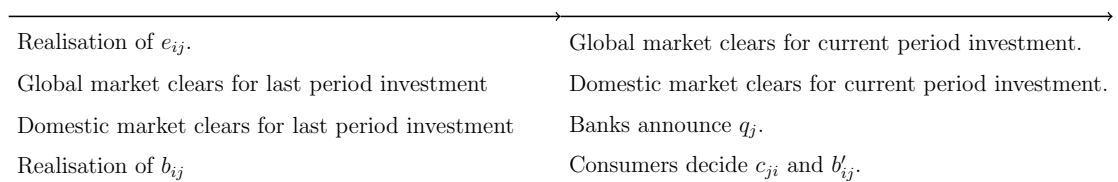


Figure 4.2: Timing

Equilibrium

The state space of an individual country j is $S_j = B_j \times E_j$ where B_j and E_j are possible values for bond holding and endowment for country j . Let $\phi_j(e, b)$ be the joint distribution of endowments and bonds in country j ’s population.

Let μ_j be the probability measure on (S_j, β_{S_j}) and β_{S_j} be the Borel σ -algebra on S_j . For $M \subset \beta_{S_j}$, $\mu_j(M)$ indicates the mass of consumers whose states lie in M in country j . Define the transition function P_j for country j : $S_j \times \beta_{S_j} \rightarrow [0, 1]$. Thus $P_j(x, M)$ is the probability that a consumer with state x will have an individual state vector lying in M in the next period.

Definition 4.2.1 *An equilibrium without financial integration consists of a sequence of distribution for $\{\phi_j\}$, a bond price schedule $\{q_j\}$, and decision rules of consumers $\{c(e, a; q), a'(e, a; q)\}$ for each country $j \in n$ such that given the initial distribution of ϕ_o :*

- *Given q_j , $c_j(e, a)$ and $b'_j(e, a)$ are optimal.*
- *Given R^* and decision rules, banks and international financial intermediaries break even for the asset price schedule.*
- *The bond market clears $\int_{S_j} a' d\mu_j = 0$.*
- *μ_j is the stationary probability measure: $\mu_j(M) = \int_{S_j} P_j(x, M) d\mu_j$ for all $M \subset \beta_{S_j}$.*

In open economies, countries can run a current account deficit or surplus and thus the domestic bond market does not necessarily need to clear as long as there is no excess or scarcity in the world credit market. Hence, there is a unique world price for the bond $q_j = q^* = 1/R^* \forall j$. Given q^* , the world bond market clears as

$$\sum_{j=1}^n \int_{S_j} a' d\mu_j = 0$$

In summary, the model is different from a standard Bewley-Huggett-Aiyagari type of setup because of the introduction of country in addition to consumer heterogeneity. The structure of linkages among FIs is circular and in line with the literature on interbank networks. The FIs' decisions form a parallel problem to consumers' utility maximisation problem.

4.2.2 Solution method

The problem can not be solved analytically and thus I use computational methods for the problem. Conventional computational methods use value or policy iteration to solve problems with heterogeneous agents. The value iteration method fixes a grid for b and iterates on $V(b')$ until a fixed point is found for the value function $V(b)$

for each possible endowment value and given the bond price. An improved version is stationary Markov policy iteration where researchers can directly approximate the optimal policy function $b' = g(b)$. I adopt Carroll (2006)'s endogenous grid method (EGM) to solve the model. The EGM significantly improves the efficiency of computation without compromising accuracy by exploiting the optimality condition. Expectations are not computed for non-used grid points in the final interpolation. In the model, the optimal policy for consumption can be characterised by the Euler equation:

$$u'(c_{ij}) \geq \beta R_j E_t[u'(c'_{ij})].$$

The equality holds when the borrowing constraint is not binding. The occasionally binding constraint imposes non-linearity on the problem. Instead of creating gridpoints for the policy functions, the EGM allows us to generate consumption decisions from a predetermined grid of values of “cash in hand”. For a given interest rate, I build a fixed grid for bond holding next period and obtain “cash in hand” $= e_{ij} + R_j b'_{ij}$ for each possible endowment value. Then I start with a guess for the consumption next period c'_{ij} , and the value of current consumption is determined by the inverse Euler equation 4.7. I interpolate the consumption to the cash in hand value and find the optimal level of consumption by comparing values of the old and new guesses. The bond holding decisions b_{ij} are easy to derive from here. I can calculate the invariant distribution of bonds for country j from consumers' bond holding decisions. Lastly, I find the interest rate that clears the market.

$$c_{ij} \geq u'^{-1}(\beta R_j E(u'(c'_{ij}))) \quad (4.7)$$

To summarise, the algorithm to solve the problem is as follows:

1. Guess an interest rate.
2. Given the interest rate, solve the optimal policy of each country $c_j(e, b)$ by iterating the Euler equation on a discrete grid of bonds b'_{ij} for employment and unemployment situations.
3. Derive the inverse of the bond accumulation policy from the optimal policy function from step two and find the invariant distribution of bonds. The law of motion of ϕ_j follows

$$\phi_j(b', e') = \sum_{e \in E_j} \sum_{b \geq -b_j} \phi_j(b, e) p_j(e' | e)$$

4. Use the bisection method, which repeatedly halves the interval and selects the sub-interval that fits the evaluation criteria, to find the equilibrium level of

interest rate that clears the global credit market

$$\sum_{j=1}^n \int_{S_j} b' d\mu = 0$$

4.2.3 Calibration

To ease the computation, I formalise two types of countries: type I is a more advanced economy with a high endowment level, lower probability of transiting to unemployment and a higher chance of finding a job; type II countries are less advanced economies. Half countries are type I and the other half are type II.

I summarise the calibration of the model parameters in table 4.1. Utility takes the CRRA form of $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$. For the transition matrix between employment and unemployment for type I countries, I use the estimated value from Shimer (2005). As comparing to type I, type II countries are less developed, so I set a lower value

Parameter	Description	Value
β	Discount factor	0.98
σ	Coefficient of relative risk aversion	2
Type I country		
e_h	Level of endowment during employment	1
e_l	Level of endowment during unemployment	0.25
$P_{e,u}$	Transition probability to unemployment	0.057
$P_{u,e}$	Transition probability to employment	0.882
Type II country		
e_h	Level of endowment during employment	0.6
e_l	Level of endowment during unemployment	0.25
$P_{e,u}$	Transition probability to unemployment	0.157
$P_{u,e}$	Transition probability to employment	0.782

Table 4.1: Model calibration

for the level of endowment during employment, and higher probability of staying in and transiting to unemployed. I use the natural borrowing limit $b_j = e_{l,j}/R_j$ which is the maximum amount that a consumer in country j can repay in the next period given that he is unemployed.

4.3 Results

4.3.1 Benchmark model and financial openness

In the benchmark model, I solve a standard Huggett (1993) model with natural borrowing limits. Then I introduce the international credit market by allowing excess demand or supply in individual countries but clearing the global credit market at the world interest rate. The relationship between the deficit in the local credit market for type I countries is shown in figure 4.3a and for type II countries in 4.3b. The equilibrium interest rates for two countries in financial autarky are different: type I countries have a higher competitive interest rate. As a consequence, if the capital markets of both types of countries are open, both lenders and borrowers would have arbitrage opportunities by lending or borrowing abroad. Type I countries will demand credit from the international market due to high domestic interest rates and type II countries will supply credit to the global market. The world interest rate is set at the point where demand meets supply as shown in figure 4.3c: the international credit is 0.1 with a gross interest rate of 1.01895. The model prediction fits the stylised fact that, in most cases, the less advanced economies are the international lenders while advanced economies are borrowers.

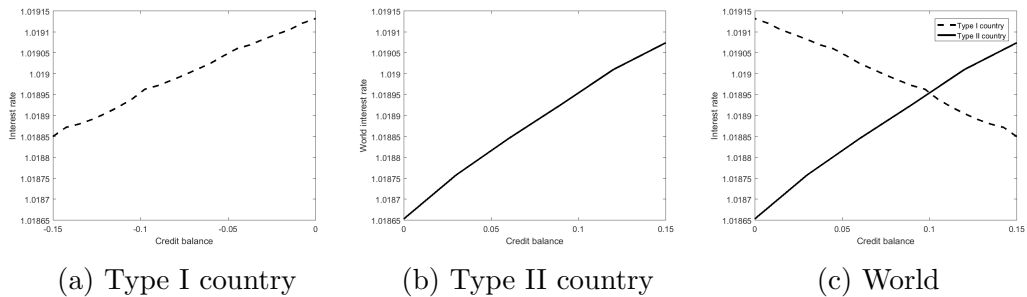
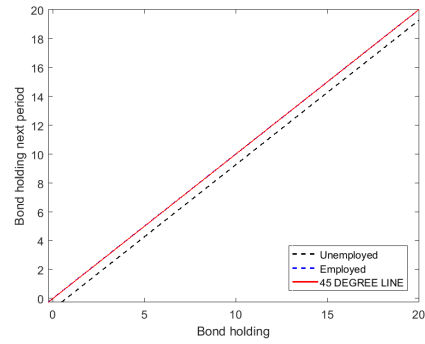
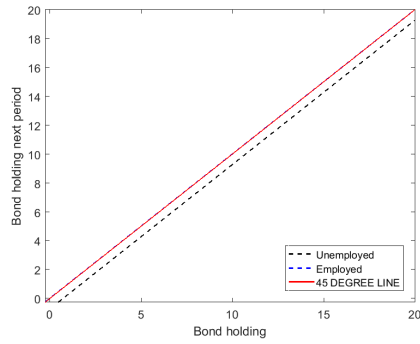
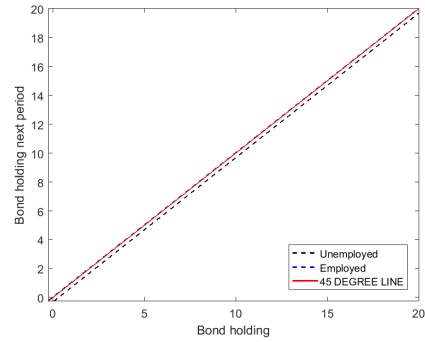
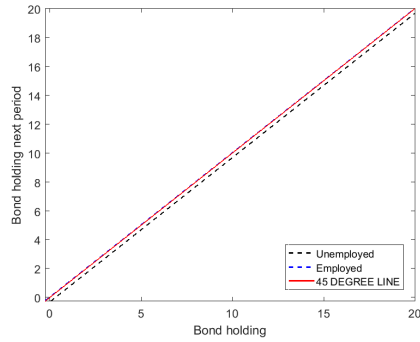


Figure 4.3: Interest rates

I show the saving decisions of employed and unemployed consumers from both types of countries in financial autarky and open economy scenarios in figure 4.4. The downward adjustment after unemployment is larger while the upward adjustment during employment is smaller in type I countries than in type II countries.



(a) Type I country - financial autarky (b) Type I country - open economy



(c) Type II country - financial autarky (d) Type II country - open economy

Figure 4.4: Saving decisions

Figure 4.5 shows the stationary wealth distribution of both types of countries with and without access to international financial market. With international asset trading, there are more borrowers in the type I country and more lenders in the type II country. From the differences in wealth distribution, we can infer that individual consumers accumulate more savings in type II countries but more debts in type I countries in an open economy.

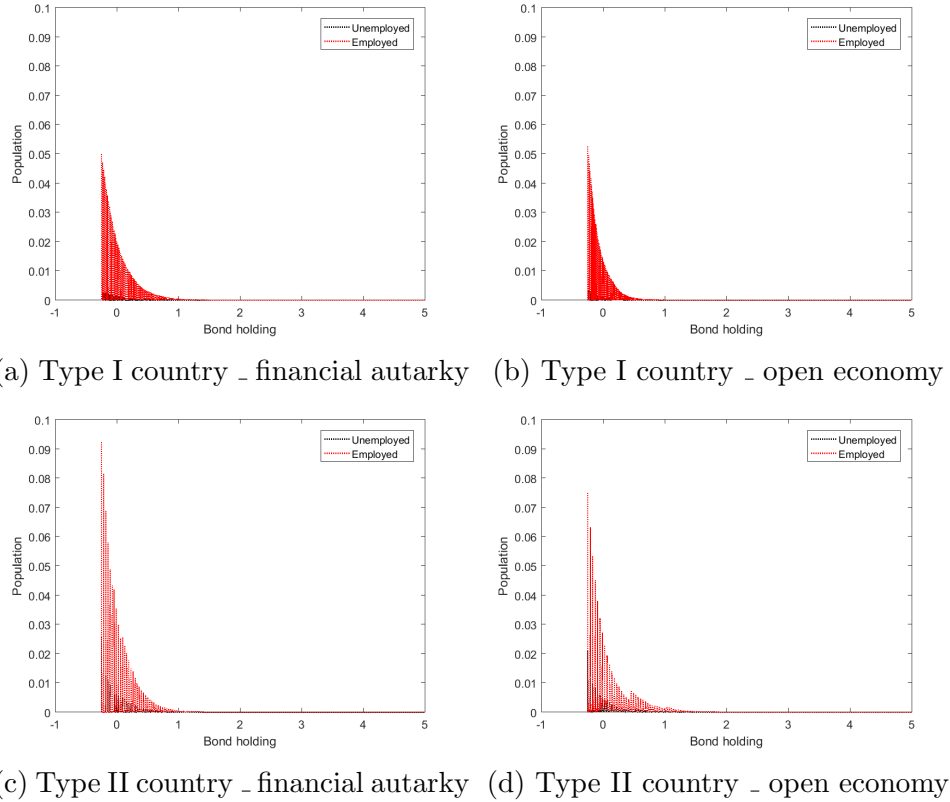


Figure 4.5: Wealth distribution

The variations in the distributions of wealth under financial autarky and integration show that current account deficits and surplus are not only an issue on the aggregate level but change the optimal policy of individual consumers. In type I countries, more consumers are on the lower borrowing limit and vulnerable to swings in international capital flows. Challe and Ragot (2011) indicate that a lower than equilibrium level of interest rates may lead to price bubbles which could cause self-fulfilling crisis. The accumulation of wealth is significantly higher under financial integration in type II countries and thus consumers are exposed to financial risks in both domestic and international markets.

4.3.2 Model simulations and banking crisis

There is a zero probability event, in which there is contagious banking crisis. There are many probable channel of contagion, I present one potential channel, interlinked financial intermediaries balanced sheet, based on Caballero and Simsek (2013).

The balance sheet of a FI in a open economy is presented in figure 4.6. L^C and D^C are loans to and deposits from consumers respectively. FIs match the supply and demand of credits within the country and across the country by receiving deposits

and making loans. It is widely observed in the real world that banks hold assets of other banks. Ashcraft et al. (2011) document extensive empirical evidence for the interbank market and its role in the 2007 financial crisis. The paper suggests that banks, especially small constrained banks, increase precautionary saving during the crisis, which explains the sudden stop of interbank lending after the Lehman bankruptcy. Following Caballero and Simsek (2013) and similar studies on bank connectivity, I construct an interbank market, allowing FIs to borrow from or lend to each other. I assume that the linkage between homogeneous intermediaries is circular: each FI has a forward neighbour FI that holds its deposits and a backward neighbour FI that holds its loan. Z_f^F is the one-period debt on the forward FI and Z_b^F is the one-period debt held by a backward FI. To clear the interbank market, $Z_f^F = Z_b^F$ holds. The higher the value of cross-FI debt holding, the higher the connectivity between FIs. The decision of cross debt holding and bond price is separate from the consumer utility maximisation problem. However, consumers' bond holding positions and the price schedule of financial institutions reach an Nash equilibrium.

Asset	Liability and capital
Consumer loans L^C	Consumer deposits D^C
Deposits in another FI Z_f^F	Deposits held by another FI Z_b^F

Figure 4.6: Bank balance sheet

I do not further discuss the channel of financial contagion in the model but take the phenomenon as given. However, the mechanism of contagion, common exposure, cross-holding of assets or the fire sale of assets, do not change the results significantly. Similarly, the topology of FI linkages, circular or hierarchical has a limited impact on the stability of credit markets in the model. The magnitudes of bank buffers vary with the financial architecture, but as long as the size of shock exceeds the buffer, the pattern of the results remains the same given the assumption that the market is not segmented. The reason for us to simplify the origin of the banking crisis and the topology of financial linkages is not because those issues are unimportant. On the contrary, the causes of financial crisis and the designs of financial architecture play key roles in determining the resilience of financial markets. The frequency of global financial crisis is a key determinant of the welfare trade-off between contagion and international risk sharing. However, the pattern of results, that consumers with different wealth levels respond to the financial integration asymmetrically, holds as long as financial crisis occurs in the model.

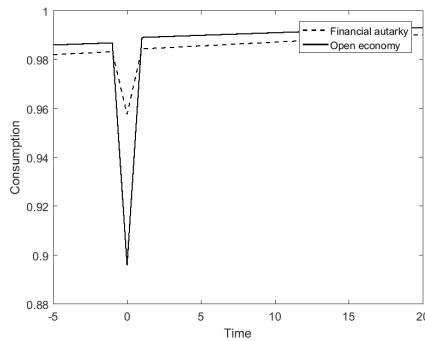
The banking crisis hits when one of the FIs receive a large negative shock θ on its

balance sheet at the end of the day. The shock could be interpreted as a lump sum payment to an outsider. This shock is contagious through financial markets. Consumers' claims on the bank assets have priority. Thus as long as the size of shock is smaller than the debt of the other bank and international financial intermediaries, the payment to consumers will remain the same. If the shock would have a real impact on consumption depends on the magnitude of the shock.

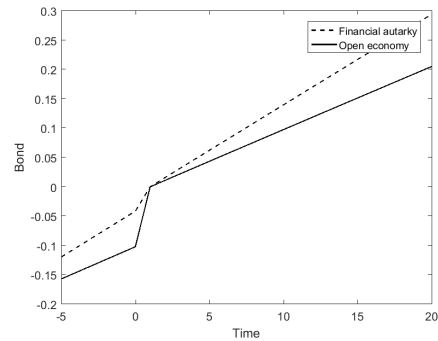
$$\begin{cases} \theta \leq Z_b^F & \text{There is no impact on consumption level.} \\ \theta > Z_b^F & \text{There is impact on consumption level.} \end{cases}$$

The threshold value that if the shock will impact the consumption level is called the bank buffer. The stability of the credit market is increasing with connectivity.

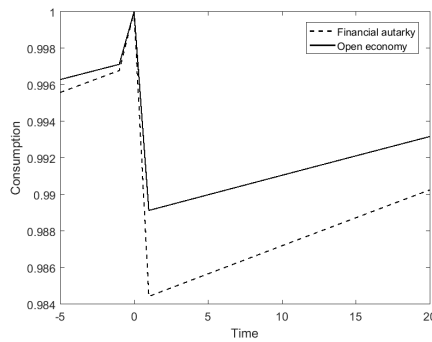
If the unusual shock exceeds the level of the bank buffer, lenders among consumers can only recover a fraction φ of savings. To ease the computation, I set $\varphi = 0$ in the primary results and will change this in the sensitivity analysis. The credit market shuts down in the following period. The world economy starts from the beginning when all agents hold no bonds. Figures 4.7 and 4.8 show the transition of consumption and bond holding after a surprising bank balance sheet shock for simulated type I and type II countries respectively.



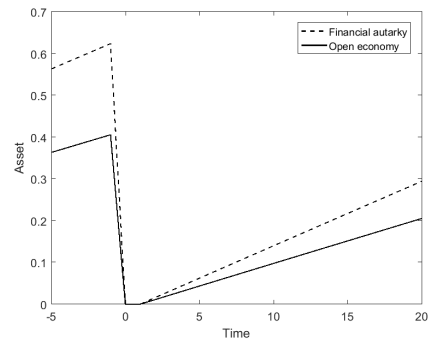
(a) Type I country - Borrowers



(b) Type I country - Borrowers



(c) Type I country - Lenders



(d) Type I country - Lenders

Figure 4.7: Transitions of Type I country

Figures 4.7a and 4.7b show the transition of bond holding and consumption for a representative borrower in the type I country. The solid line represents the condition of an open economy and the dashed line that for a financial autarky economy. The level of consumption drops rapidly after the shock and then moves back to the pre-crisis level given that there is no other shock nor unemployment. The level of bond holding moves up to zero from a negative value after the shock due to the inability to access the credit market after the shock. The accumulation of wealth adjusts upwards gradually afterwards. The sudden drop of consumption level is deeper in an open economy since borrowers in type I country tend to accumulate more debts as the world interest rate is lower than the domestic interest rate. Thus the cost of losing access to the credit market is larger. For lenders, as shown in figures 4.7c and 4.7d, since there is less wealth accumulated in the open economy than in financial autarky, the loss of wealth is smaller with financial openness. The sudden rise in the consumption level is due to the inability to save, but the increase is followed by a drop in consumption caused by a loss of wealth.

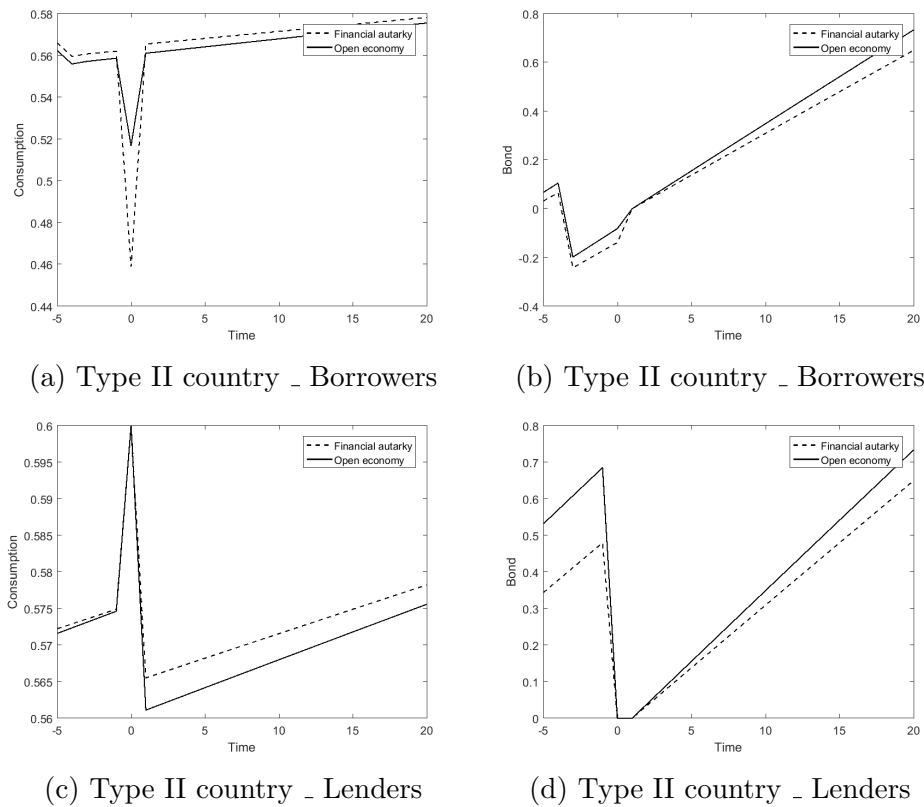


Figure 4.8: Transitions of Type II country

The effects of financial integration on consumers in type II countries are opposite to type I countries. As shown in figures 4.8a and 4.8b, borrowers accumulate less wealth in the open economy as the world interest rate is higher than the domestic rate. As a consequence, the sudden drop in consumption after a surprising shock

is smaller. Figures 4.8c and 4.8c show the transition for the lenders: the drop in consumption level is higher in the open economy since lenders make more loans when the interest rate is higher.

Overall, there is no straight answer to the question whether financial openness alleviates or deepens the cost of financial contagion. The impacts of financial integration are asymmetric among lenders and borrowers in different types of countries. Even though I set the banking crisis as a one-time event with zero probability of happening, it does repeatedly happen in modern economic history. To examine the welfare trade-off between risk sharing and financial contagion, I calibrate the frequency of banking crisis ¹ and simulate the model with reoccurring financial crises. However, I still set financial crisis to be unpredictable by market participants. This seemingly unrealistic assumption depicts the real world. Though there are several episodes in which a financial tsunami hits a continent and more, mainstream economists and investors still fail to predict the incidence of a financial crisis before it happens.

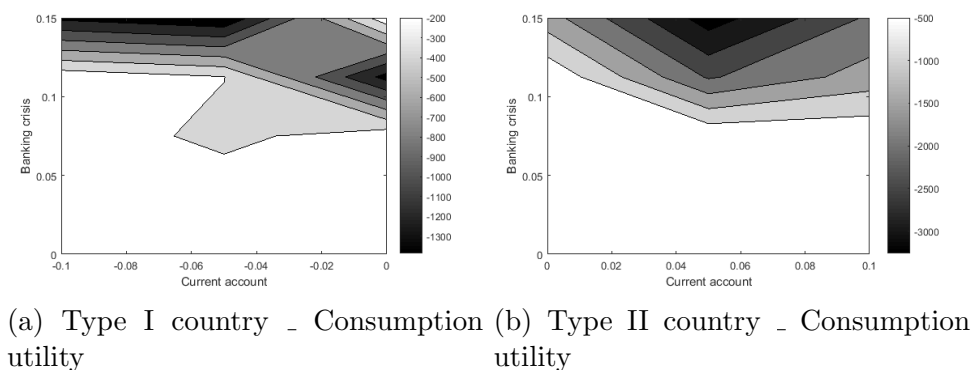


Figure 4.9: Consumption smoothing

Figure 4.9 presents welfare values for a simulated agent in type I and type II countries given the level of countries' current account and frequency of banking crisis. Given that the model is with endowment economy, welfare only measures the smoothness of consumption. There are five possible values in a linearly spaced vector from zero to $2 \times$ calibrated probability. For the value of the current account, I use the value of financial autarky, the equilibrium level of countries' current account under financial integration and the midpoint value of the two. In the contour map, the lighter the colour, the higher utility. Since the model is of an endowment economy, the welfare mainly measures the level and smoothness of consumptions in the country. Figure 4.9a shows the welfare for type I countries. It is obvious that welfare decreases as the chances of the banking crisis go up. However, when there is a positive probability

¹I calibrate the frequency of the unusual state based on the incidence of banking crisis. Reinhart and Rogoff (2011) provides a database for a variety of crises for seventy countries from 1800 to 2010. The calibrated frequency of banking crisis using data from 1900 to 2010 is 0.0755.

of a banking crisis, the welfare trade-off of financial openness is ambiguous. For type II countries, as shown in figure 4.9b, welfare decreases when there is a higher probability of a banking crisis given all levels of the current account. Nevertheless, the relationship between the current account and welfare is not monotonic. Overall, the interplay between international risk sharing as approximated by the level of the countries' current accounts and the contagion caused by the incidence of a banking crisis is complicated as there is no apparent pattern on the level of consumption utility.

4.3.3 Policy interventions

I discuss the effectiveness of two types of policies that are widely used by policy-makers: one aims to avoid a domino effect of bank defaults when a crisis occurs, for example quantitative easing (QE), and the other one is designed to improve the stability of the financial market by reducing the size of the debt. Macro-prudential policy and capital controls fit the second type.

Quantitative Easing

Quantitative easing (QE) aims to inject credit to the economy when the financial market is in distress. This paper models quantitative easing as releasing credits to the economy when a banking crisis occurs. Hence, instead of being cut off from borrowing capacity, consumers are able to borrow from the government. QE does not change the equilibrium level of the interest rate or the wealth distribution.

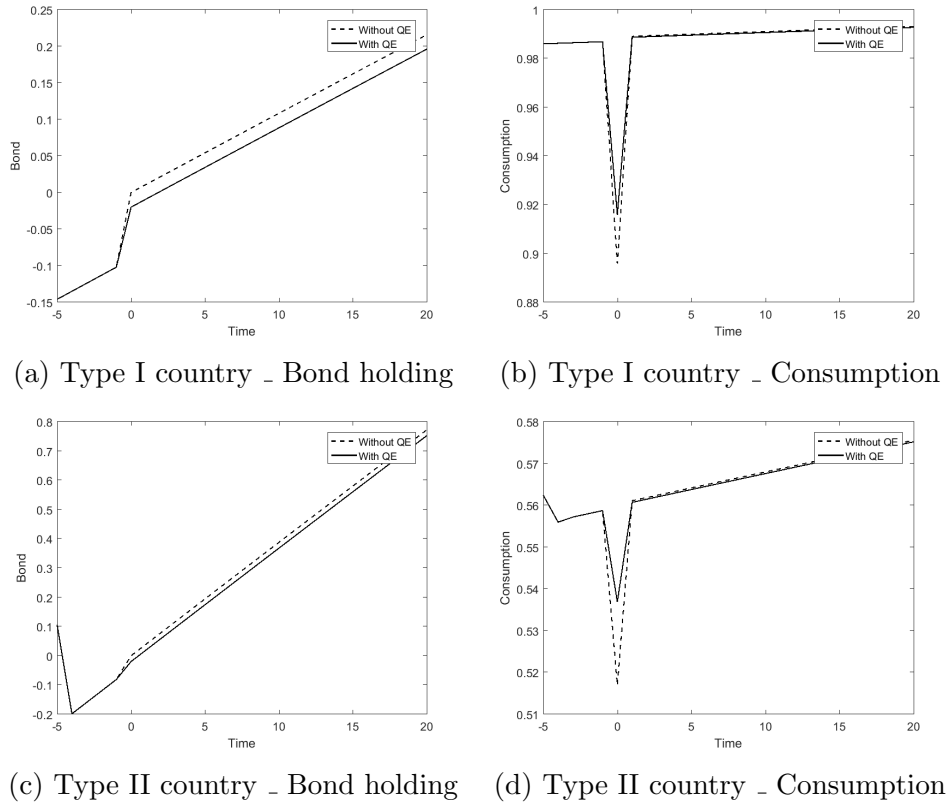


Figure 4.10: Quantitative easing

The solid lines in figure 4.10 are the transition of asset and consumption when there is an injection of credits with QE, and the dashed lines are when there is no policy intervention. Borrowers cannot borrow in the period after the crisis, and as a consequence, there will be a sudden and significant drop in consumption depending on the original debt level. If the governments can provide additional credit to the economy and allow the debtors to borrow, it will help countries to smooth consumption. The drop in consumption is smaller as the asset level does not need to hit zero borrowing within a period as shown in figures 4.10b and 4.10d. For lenders in the economies, conducting QE does not change their post-crisis consumption. Besides, if the governments recover the cost of QE gradually by imposing a small tax on consumption or asset returns, the overall utility will improve because consumers in the country are risk averse and benefit from consumption smoothing. However, one underlying assumption of the model of QE is that credits provided by the government are endowment equivalent, not just paper money. Since I do not model price explicitly, the helicopter drop of money has no influence on the real economy or the consumption level.

Macro-prudential policy and capital controls

Both macro-prudential policy and capital controls aim to decrease the level of leverage, especially that of international debt. Since the primary purpose of macro-prudential policy is to limit the leverage ratio, this paper models it as an ad hoc borrowing limit which is smaller than the natural one. Following the literature, I model capital controls as the tax on capital gains. Both policies change the equilibrium level of interest rates for domestic and international credit markets. The policy function and stationary distribution of bonds alter accordingly. Whether the policies are imposed unilaterally or bilaterally does not significantly change the mechanism of the policies.

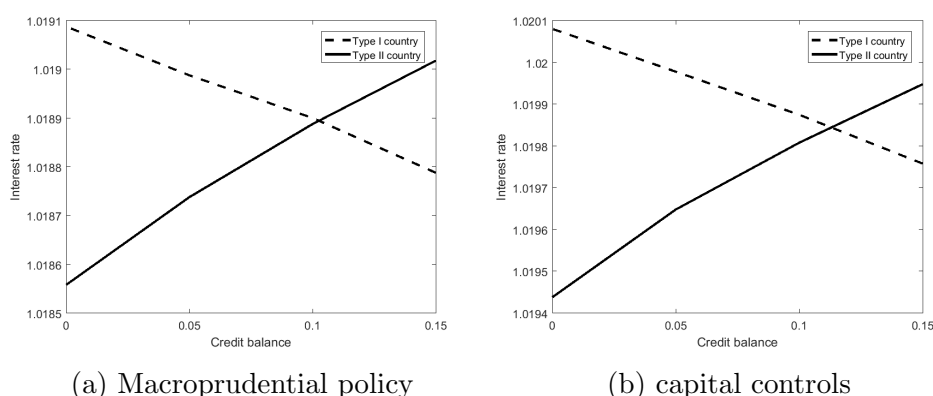
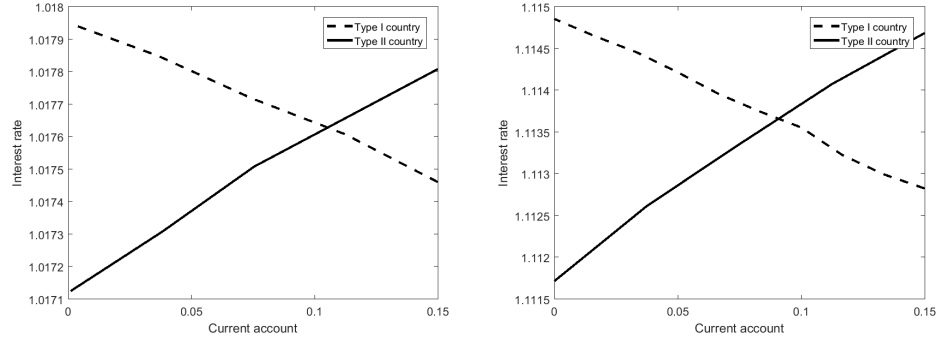


Figure 4.11: Equilibrium interest rates with policy interventions

I set 90% of the natural borrowing limit as an ad hoc borrowing constraint and 5% as the tax on capital gains. Figure 4.11 shows the world interest rates with policy interventions. The equilibrium level of countries' current account deficit and surplus remains close to the level without policy interventions. With macro-prudential policy, demand for credit decreases, and thus interest rate falls. With the tax on capital gains, interest rate jumps to motivate consumers to lend. Overall both policies reduce the gains from lending and thus decrease borrowing. Hence, the consumption transition after a financial crisis is smoother with policy interventions because of reduced borrowing. Figures 4.13 and 4.14 in the Appendix show the transition for consumption and bond holding for borrowers and lenders in type I and II countries. As predicted, the sudden drop in consumption after the banking crisis with macro-prudential policy and capital controls, as shown with solid lines, is smaller comparing to the no policy scenario.

4.3.4 Sensitivity analysis

In this section, I assign different values to three key parameters and examine whether the results are robust to alterations in calibration.



(a) Higher relative risk aversion (b) Lower subjective discount factor

Figure 4.12: Equilibrium interest rates with different calibrations

First, I assign a higher value for consumers' degree of risk aversion by setting $\sigma = 4$. In this case, consumers prefer to save more to cope with the uncertainty in the endowment. Hence, the supply of credit increases, which lowers the equilibrium level of interest for the world credit market as shown in figure 4.12a. Second, I set a lower discount factor $\beta = 0.89$, which means that consumption in the future is more heavily discounted. In this case, consumers are more likely to borrow and drive up the interest rate as in figure 4.12b. Third, I change the parameter φ which represents the liquidation cost of assets during financial distress. The change in the liquidation cost does not change the equilibrium level of the interest rate. Instead of losing all accumulated assets, lenders lose some of their wealth. The pattern of transitions for bond and consumption does not differ significantly from the main results as shown in the Appendix figures 4.15, 4.16 and 4.17. Overall, though it is not certain that the results hold for all of the parameter space, the main results are robust for other conventional calibrations.

4.4 Conclusion

As far as I know, there is limited literature directly exploring the impact of financial integration on consumers with different wealth status (being a borrower or lender). One reason behind this is that there is little data on consumption or investment decisions for consumers with different asset levels. The US consumer expenditure survey provides consumption levels for people from various age, racial and income

groups, but there is no categorisation based on accumulated wealth. The paper tries to fill this gap in the literature from a theoretical perspective.

In this paper, I study two main by-products of financial openness, contagion and risk sharing. I set up a heterogeneous agent model with different country characteristics. Consumers in the country can trade bonds and share risk domestically and internationally. Type I countries with higher endowments and a more stable employment environment are more likely to be international borrowers with current account deficits. Type II countries are international lenders. There is a unique equilibrium interest rate that clears the global credit market. The structure of financial arrangements is facilitated by international financial intermediaries. When there is only endowment risk associated with unemployment, the arrangements help consumers smooth consumption and share endowment risk. However, when there is a banking crisis, which is contagious through financial markets, some consumers face higher losses with international bond trading. Since the world interest rate is lower than the domestic rate in type I countries, borrowers in type I countries tend to accumulate more debts in open economy and face higher loss in global financial distress, while lenders in type I countries face lower loss as they tend to accumulate less wealth in a low-interest rate environment. For type II countries, world interest rate is higher than the domestic market interest rate, and hence lenders tend to over-accumulate wealth and borrowers take fewer loans in the open economy. Overall the impacts of financial openness on how consumers tackle financial crisis is asymmetric among consumers with different characteristics and country. I also calibrate the historical probability of banking crisis to see the overall welfare trade-off between international risk sharing and financial contagion, and find that the relationship is ambiguous. When deciding whether to adopt financial-liberalisation regime or how open should financial markets be, policymakers should consider the distribution of the wealth of consumers as well as countries' current account status. If only two choices, full financial integration and financial autarky are given, this chapter suggests that a decision matrix as table 4.2. In type I countries with more borrowers, financial autarky is preferable, and in type I countries with more lenders, financial integration is preferable. The reverse is true for type II countries. Given the heterogeneous nature of consumers in countries, a re-distributional policy should be considered at the same time.

	More borrowers	More lenders
Current account surplus	Financial autarky	Financial integration
Current account deficit	Financial integration	Financial autarky

Table 4.2: Policy implication

This paper discusses several potential policies that aim to help countries transit through global financial crises more smoothly. The results suggest that QE, macro-prudential policy and capital controls can potentially improve the smoothness of consumption. However, for QE to be effective, governments need to inject credit that is exchangeable with endowments, not just paper money. Thus the conducting of QE requires the government to have real savings. I cannot be sure that the results hold for all of the parameter space, but I experiment on several sensitivity analyses to make sure the results hold for other conventional calibrations. Comparing to the benchmark calibrations, the same pattern of results holds for higher risk aversion coefficients, lower discount factors and lower liquidation costs.

In summary, the model focuses on the trade-off between the benefits and costs of financial integration. With an incomplete market and heterogeneous agent model, I find that financial openness affects agents with different characteristics differently, and raise the importance of equality and redistribution when making policies relating to financial integration. I simplify the goods market by assuming an endowment economy, and thus the results are mainly driven by the over-accumulation of debt and wealth on the private level. The issues of current account imbalances should be examined not only on the aggregate level but also on how they influence private saving decisions.

4.5 Appendix

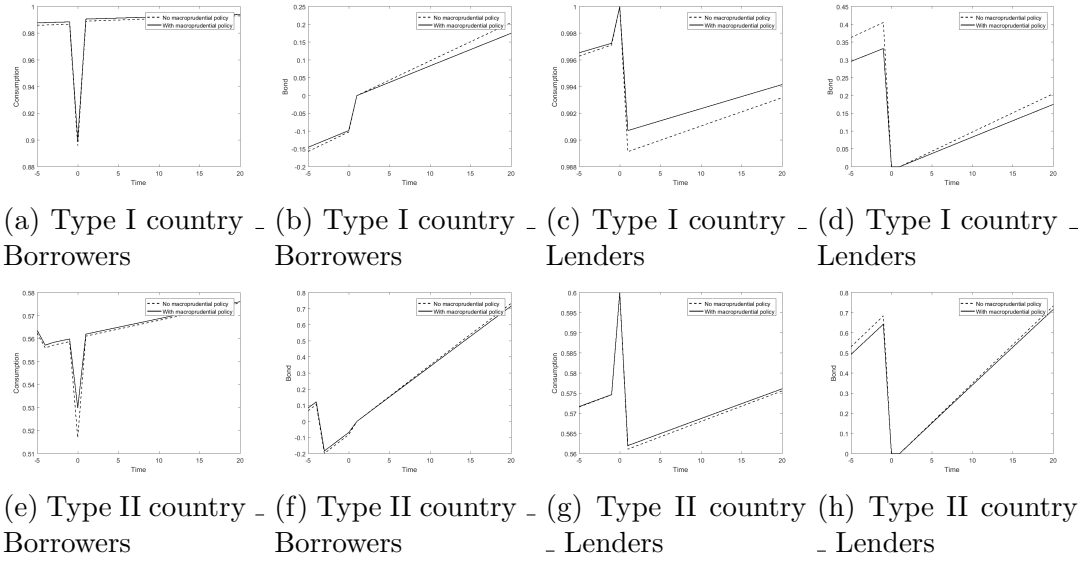


Figure 4.13: Macro-prudential policy - transitions

Figure 4.13 shows the transition of bond holding and consumption for consumers under financial integration. In the benchmark scenario (dashed line), there are no policy interventions, and the real line shows the condition when the macro-prudential policy is implemented. The four sub-figures at the top show the transition of a representative borrower (top-left two figures) and lender (top-right two figures) in type I countries. Comparing to the scenario without policy interventions, macro-prudential policy improves the smoothness of consumption as the sudden drop in consumption is smaller. The four sub-figures in the second row display the transition for type II countries. The macro-prudential policy is effective since it reduces the dent in consumption.

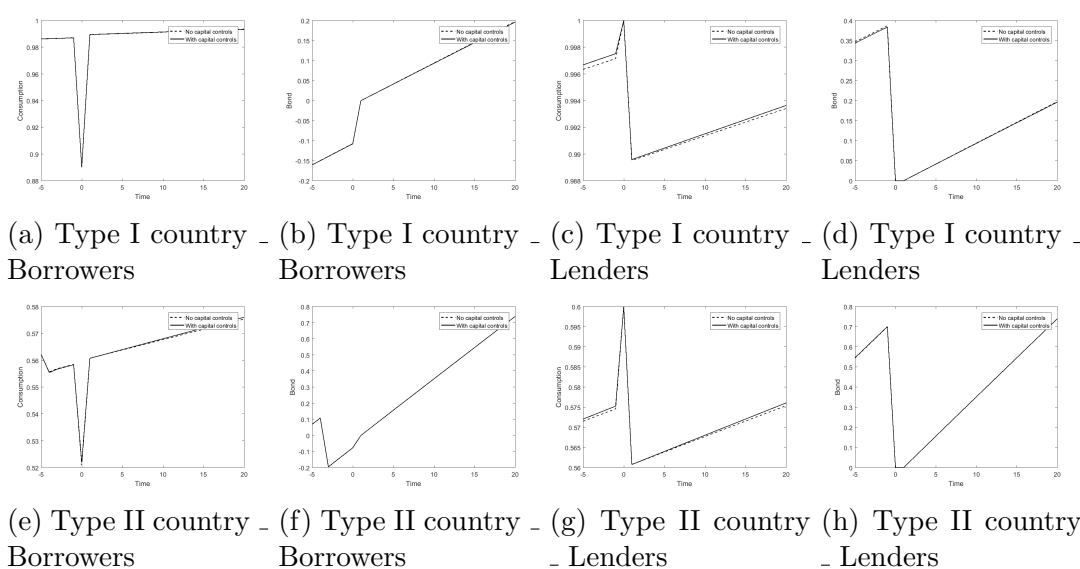


Figure 4.14: Capital controls - transitions

Figure 4.14 shows the transition of bond holding and consumption for consumers under financial integration. In the benchmark scenario (dashed line), there are no policy interventions, and the real line shows the condition when a capital tax is imposed. The top four sub-figures are for type I countries and the bottom four are for type II countries. Though not significant in the graph, 5% of capital tax reduces equilibrium level of borrowing and lending and thus limits the size of the sudden drop in consumption during a financial crisis.

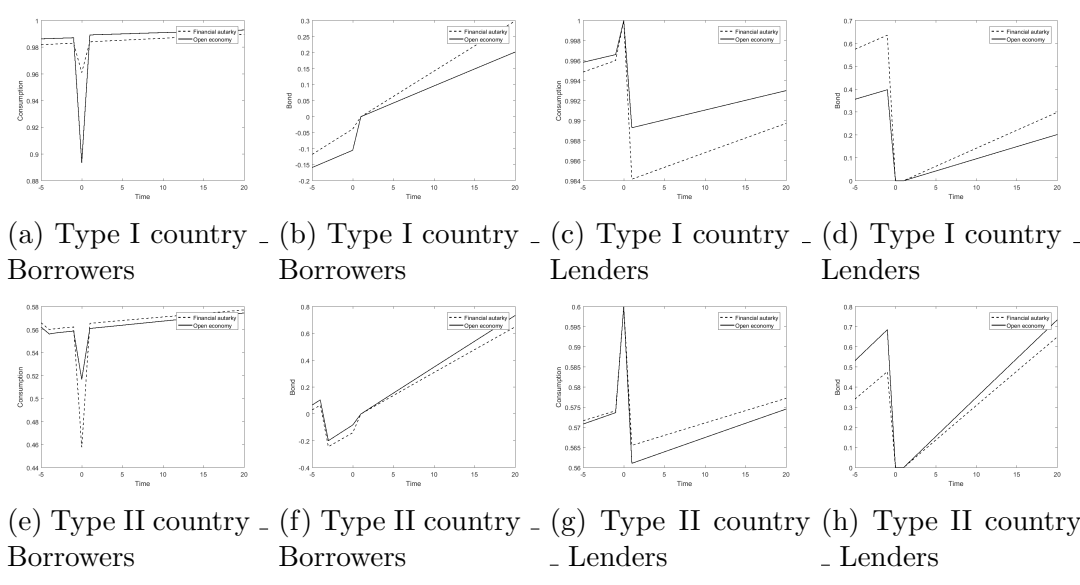


Figure 4.15: Sensitivity analysis - σ

Figure 4.15 shows the transition of bond holding and consumption for consumers under financial autarky (dashed line) and integration (real line). The pattern of results is in line with the main results in which the degree of risk aversion is lower.

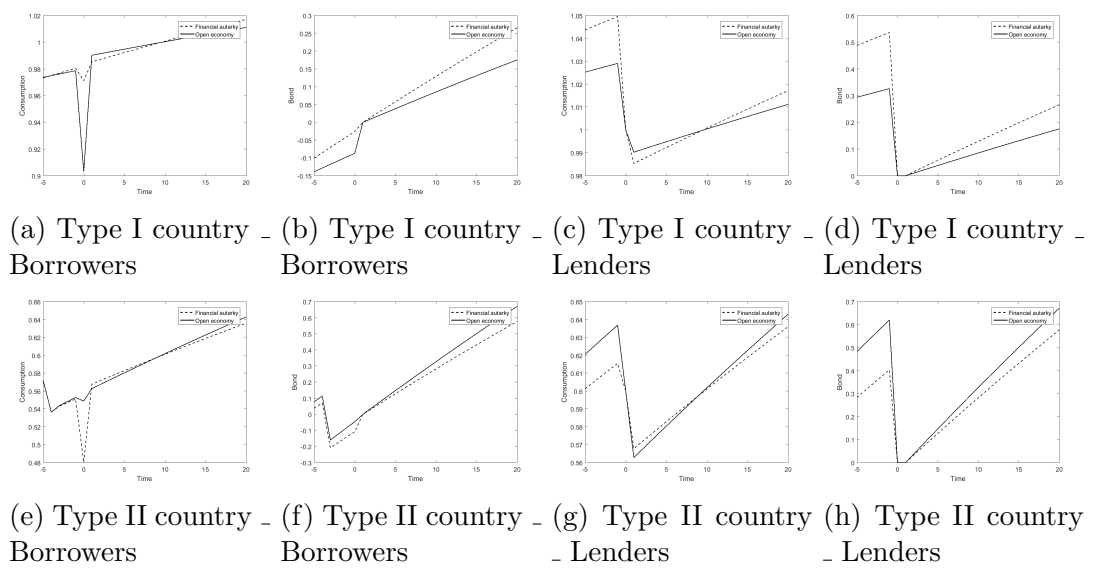
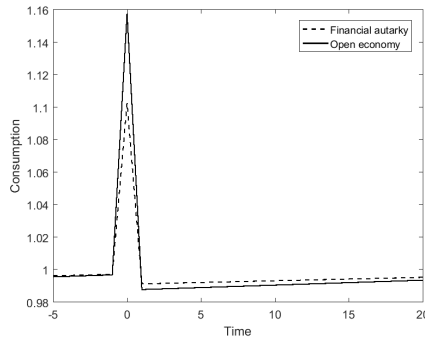
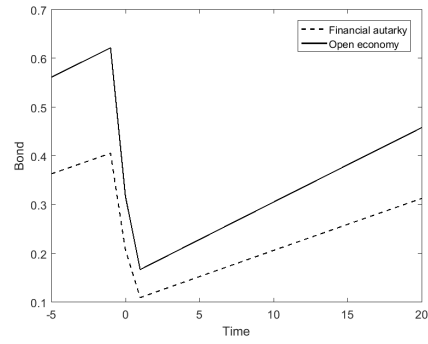


Figure 4.16: Sensitivity analysis - β

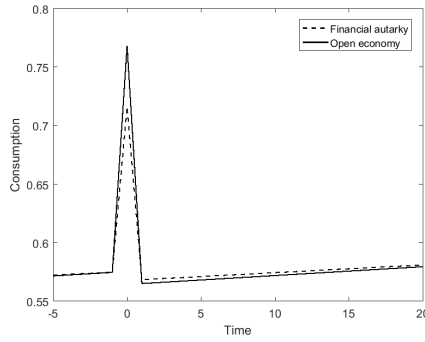
Figure 4.16 shows the transition of bond holding and consumption for consumers under financial autarky (dashed line) and integration (real line). The pattern of results is in line with the main results in which the discount factor is higher.



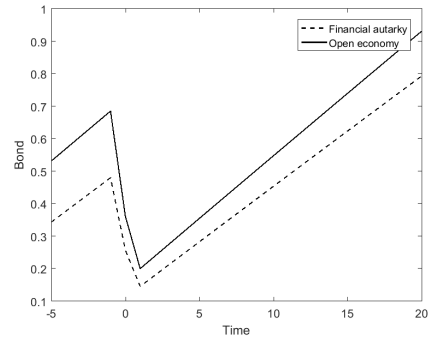
(a) Type I country - Lenders



(b) Type I country - Lenders



(c) Type II country - Lenders



(d) Type II country - Lenders

Figure 4.17: Sensitivity analysis - φ

Figure 4.17 shows the transition of bond holding and consumption for consumers under financial autarky (dashed line) and integration (real line). The changes in liquidation cost do not affect borrowers and thus only the transition of borrowers are presented. The top two sub-figures shows the consumption and bond holding dynamics of lenders in type I countries. And the two sub-figures at the bottom show the consumption and bond holding dynamics of lenders in type II countries. The results are in line with the main results in which the liquidation cost is higher.

CHAPTER 5 – CONCLUSION

This thesis includes three studies on different areas of monetary and international economics. The studies cover important issues regarding monetary policy such as exchange rate regime, monetary policy regime and financial integration. This chapter summarises the main findings of the thesis and their policy implications.

The second chapter studies the network effects of countries' ERR choices. Previous studies mainly use country-specific factors to explain countries' exchange rate regime choices. However, though some papers found strong correlation between idiosyncratic factors and ERR choices, these factors cannot fully explain the contemporary movement of the choices. It is possible that large swings in regime choices are caused by network effects: a few countries change their ERR and other countries follow. If this snowball effect is true for countries' decisions, we should be able to observe spatial autocorrelations among countries' ERR choices. I use spatial autoregressive multinomial probit model to test the spatial autocorrelation between countries' choices. The choice of ERR is the dependent variable, and the choices of other countries are included in the right hand side of the regression together with idiosyncratic factors. I need to specify a weighting matrix for the influence of other countries' choices. I use geographical distance, trade volumes to GDP and if countries have shared a common coloniser in the past as the weighting matrix. The idiosyncratic factors I used are common in previous studies, including OCA, political and financial factors. I also provide an alternative treatment of eurozone countries as the robustness check. I conduct several spatial analyses with different weighting matrix. The spatial autocorrelation coefficients vary between 0.096 and 0.687 and are mostly significant at the 99% level, suggesting that the spatial dependence is positive and strong. Compared to other channels, trade better reflects the impact of spatial interdependence for countries' ERR choices and past colonial relationships better reflect the network effects for countries' ERR and anchor currency choices. Overall the signs of the parameters support the OCA theory in terms of trade openness, the currency mismatch hypothesis in terms of the foreign debt to GDP ratio, and Cobham (2010)'s argument in terms of financial development.

The results show that currency network effects are strong: countries are likely to follow the ERR choices of their major trade partners; and countries are likely to follow the anchor currency and ERR choices of other countries if they have had a common coloniser in the past. In addition, I re-examine the country-specific determinants proposed by earlier studies and find some of them significant, suggesting that the country's choice of ERR is made under the influences of both other countries and idiosyncratic factors. As currency network effects are strong, countries would face

multiple equilibria which may lead to path dependence along with coordination failure, and thus are highly likely to be locked in suboptimal equilibria. Similar to the example in Meissner and Oomes (2009)'s game theory model, though two countries' optimal ERR choice is pegging to the euro (euro-euro choice), they may end up with pegging to the USD (dollar-dollar choice) to avoid the dollar-euro or euro-dollar situation if they start from the dollar-dollar position. In most multi-equilibria games, players may end up in a bad equilibrium but could improve their utilities by all moving to a good equilibrium together. Countries might be better off switching to a different anchor simultaneously, but no country has an incentive to switch on its own. Take southeast Asian countries as an example, most southeast Asian countries peg to the USD, though they do not necessarily trade more with the USA. The intra-east-Asia trade is of higher importance, but a large volume of intra-Asia trade is denominated in the USD. Renminbi and the Yen should have played a larger role in southeast Asian countries. In the meanwhile, with economic development and political reforms, many southeast Asian countries have better political institutions and financial infrastructure, making them ready to pursue free exchange rates and independent monetary policy in the future. However, if any country switches to free floats on its own, it will face disadvantages in global markets. In summary, the findings on currency network effects indicate that countries, especially small open economies and emerging markets that fix their exchange rates, can achieve higher welfare by escaping the suboptimal equilibrium and jointly choosing their ERRs with their major partners through cooperation and negotiation.

In the third chapter, I am trying to answer the question why countries target the particular variables they target by studying the determinants of countries' MPRs. In the aftermath of the end of the Bretton Woods system, many countries are not exclusively concerned with inflation. Some countries target inflation directly and some target other factors such as exchange rates to control it. My study focuses on original OECD member countries, and in order to find the determinants, I develop a chronology of de jure MPRs for early OECD member countries for the post-Bretton Woods period. The main source of the classification is the survey sent to world central banks from the BoE. OECD economic surveys of countries were the main source for countries that did not reply to the Bank of England survey. Presentations and studies on individual countries such as Andolfatto and Gomme (2003), Mishkin (2001), Gumundsson and Kristinsson (1997), Berg and Gröttheim (1997), Sullivan (2013) and Nascimento (2005) are referred to when there are conflicts in the main sources. The detailed list of countries' MPRs is in the appendix with the sources of data. I select the potential determinants of countries' MPRs from the literature. The explanatory variables include economic size, trade openness, terms of trade shocks, capital account openness, financial market development, financial institu-

tions development, the polity index, being an oil exporter and historical inflation. I also study the determinants of countries' monetary policy arrangements based on de facto analysis with Cobham's (2015) classification as the cross-reference.

The results suggest that economic size, trade openness, financial development and political environment all have a role in determining the MPR. The results are mostly in line with the predictions from the OCA theory, the sustainability view of fixed exchange rates, Broda (2004)'s assertion that term of trade dynamics are different for oil exporting countries, the impossible trinity hypothesis in Obstfeld and Taylor (2003), and the suggestion in Cobham (2010) that countries' monetary policy arrangements are linked with their financial infrastructure development. Country-specific factors can also explain the de facto objectives of countries' monetary policy arrangements in some degree.

The fourth chapter studies two by-products of financial integration, international risk sharing and financial contagion, with a theoretical model. I follow the existing literature on the study of the trade-off but with a more general macroeconomic setup. The model incorporates the following stylised facts. First, consumers share risk domestically and internationally. Second, there is a surge of international debt in many advanced economies. Third, the impacts of global financial crises on consumers are asymmetric. This paper introduces heterogeneity in countries in addition to heterogeneity in consumers, which is largely overlooked in the previous literature. I set up a Huggett (1993) type heterogeneous agent model with different types of countries and formalise two types of countries: Type I countries have a high domestic equilibrium interest rate and run a current account deficit; Type II countries have a low domestic equilibrium interest rate and current account surplus. Consumers maximize their consumption utility subject to the budget constraint. FIs provide the bond contracts to help consumers tackle idiosyncratic endowment risks. FIs are able to borrow from or lend to each other, and the linkage between homogeneous FIs is circular. I use the endogenous grid method (EGM) to solve the model. With international asset trading, there are more borrowers in the type I country and more lenders in the type II country. From the difference in wealth distribution, we can infer that individual consumers accumulate more savings in type II countries but more debts in type I countries in an open economy. The variations in the distributions of wealth under financial autarky and integration show that current account deficits and surplus are not only an issue on the aggregate level but change the optimal policy of individual consumers. In type I countries, more consumers are on the lower borrowing limit and vulnerable to swings in international capital flows. Challe and Ragot (2011) indicate that a lower than equilibrium level of interest rates may lead to price bubbles which could cause self-fulfilling crisis. The accumulation

of wealth is significantly higher under financial integration in type II countries and thus consumers are exposed to financial risks in both domestic and international markets.

When there is only endowment risk associated with unemployment, the arrangements help consumers smooth consumption and share endowment risk. However, when there is a banking crisis, which is contagious through financial markets, some consumers face higher losses with international bond trading. Since the world interest rate is lower than the domestic rate in type I countries, borrowers in type I countries tend to accumulate more debts in the open economy and face higher loss in global financial distress, while lenders in type I countries face lower loss as they tend to accumulate less wealth in a low-interest rate environment. For type II countries, the world interest rate is higher than the domestic market interest rate, and hence lenders tend to over-accumulate wealth and borrowers take fewer loans in the open economy. I also calibrate the historical probability of banking crisis to see the overall welfare trade-off between international risk sharing and financial contagion, and find that the relationship is ambiguous. I simplify the goods market by assuming an endowment economy, and thus the results are mainly driven by the over-accumulation of debt and wealth on the private level. Thus the issues of current account imbalances should be examined not only on the aggregate level but also on how they influence private saving decisions. When deciding whether to adopt financial-liberalisation regime or how open should financial markets be, policymakers should consider the distribution of the wealth of consumers as well as countries' current account status. Chapter four suggests that in type I countries with more borrowers, financial autarky is preferable, and in type I countries with more lenders, financial integration is preferable. The reverse is true for type II countries. With an incomplete market and heterogeneous agent model, we can see that financial openness affects agents asymmetrically, and raise the importance of equality and redistribution when making policies relating to financial integration.

I summarise the topics, results and policy implications from the essays in table 5.1. The theme of this thesis to find the determinants of countries' macro-monetary regime. Normative determinants of a regime are factors that countries should consider when making a choice, and positive determinants are factors that are being taken into consideration by policymakers. The first two essays are empirical studies and find the positive determinants of countries' ERR and MPR. The last essay builds a theoretical framework and presents the normative determinants of countries' financial-liberalisation regime.

As mentioned in the first chapter, there are many important issues in monetary and international economics that are not covered in this thesis. Possible follow-up works

of the thesis include studies on policy coordination of countries' ERR, pure Bayesian estimation of the network effects of countries' ERR choices, alternative estimation of spatial multinomial model with copula based approaches as robustness checks, alternative setup of the panel in countries' MPR studies, lining the model in chapter four with data and pinning down the optimal degree of financial integration.

Topic	Methodology	Main findings	Policy implications
Exchange rate regime	Empirical: Spatial autoregressive multinomial probit model	The country's choice of ERR is made under the influences of both "neighbouring" countries and idiosyncratic factors.	Countries, especially small open economies and emerging markets that fix their exchange rates, can achieve higher welfare by escaping the suboptimal equilibrium and jointly choosing their ERRs with their major partners through cooperation and negotiation.
Monetary policy regime	Empirical: Multinomial Logit Model	The results of this study suggest that economic size, trade openness, historical inflation, financial development and political institutions all have a role in determining countries' de jure MPRs. Country-specific factors can also explain the de facto objectives of countries' monetary policy arrangements in some degree	Countries' choices of MPR are mostly in line with the predictions from the OCA theory, the sustainability view of fixed exchange rates, Broda (2004)'s assertion that terms of trade dynamics are different for oil exporting countries, the impossible trinity hypothesis in Obstfeld and Taylor (2003), and the suggestion in Cobham (2010) that countries' monetary policy arrangements are linked with their financial infrastructure development.
Financial integration	Theoretical: Heterogeneous agent model	Lenders and borrowers in countries with current account surpluses and deficits respond to the financial crisis asymmetrically. Moreover, the relationship between financial integration and consumption smoothing is not monotonic.	When deciding whether to adopt financial-liberalisation regime or how open should financial markets be, policymakers should consider the distribution of consumers as well as countries' current account status. QE, macroprudential policy and capital controls can potentially improve the smoothness of consumption during a banking crisis.

Table 5.1: Summary

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