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ESSAYS ON CAPITAL CONTROLS AND EXCHANGE RATE REGIMES

Yu You
University of Kentucky, f91yy83@gmail.com

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Yu You, Student

Dr. Yoonbai Kim, Major Professor

Dr. Aaron Yelowitz, Director of Graduate Studies

ESSAYS ON CAPITAL CONTROLS AND EXCHANGE RATE REGIMES

DISSERTATION

A dissertation submitted in partial fulfillment of the
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By
Yu You

Lexington, Kentucky

Director: Dr. Yoonbai Kim, Professor of Economics

Lexington, Kentucky

ABSTRACT OF DISSERTATION

ESSAYS ON CAPITAL CONTROLS AND EXCHANGE RATE REGIMES

This dissertation consists of three essays on capital controls and exchange rate regimes. The first essay, under the background of international monetary policy trilemma, empirically investigates the validity of the proposition that holding the degree of exchange rate stability constant, a decrease in capital mobility through imposition of capital controls will enhance monetary independence. Using a panel dataset covering 88 countries for the 1995-2010 period and system GMM estimation, this paper finds that 1) capital controls help improve a country's monetary independence; 2) the effectiveness of capital controls depends on the types of assets and the direction of flows they are imposed; 3) the choice of exchange rate regime has important impact on the effectiveness of capital controls on monetary independence.

The second essay examines the role of capital controls on economic growth. Conventional wisdom suggests that allowing international capital flows improves domestic investment and growth by providing extra resources through international capital market, yet the flows can be misallocated to finance speculative or low-quality domestic investments. Using a panel dataset covering 78 countries over 1995-2009, this paper finds that 1) capital control policies promote economic growth after taking into account a country's de facto level of capital flows; 2) controls on capital inflows helps a country's economic growth, but not controls on outflows; 3) restrictions on different asset types affect growth differently. Capital controls on equity type flows are less effective than controls on debt type flows or direct investment.

The third examines the role of exchange rate flexibility on current account balances. Global imbalances have become an important issue for economists and policy makers. Greater exchange rate flexibility is often suggested as a means to achieve faster and more efficient adjustment in the current account. However, previous empirical studies show little support for this hypothesis. This essay revisits this issue with a large panel dataset and Threshold VAR model and finds that 1) the speed of the current account adjustment is higher in a regime with greater exchange rate variability; 2) some existing popular exchange rate classifications may not capture actual exchange rate variability as well as expected.

KEYWORDS: International monetary policy trilemma, capital controls, economic growth, exchange rate regime, Threshold VAR

Yu You

Author's signature

May 31th, 2013

Date

ESSAYS ON CAPITAL CONTROLS AND EXCHANGE RATE REGIMES

By
Yu You

Dr. Yoonbai Kim
Director of Dissertation

Dr. Aaron Yelowitz
Director of Graduate Studies

May 31th, 2013
Date

To my parents Mingqin You and Lirong Ai, and all my loved ones

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Chapter One
Introduction

This dissertation consists of three essays on capital controls and exchange rate regimes. In the first two essays, I focus on the effects of government controls on capital movements and their effects on monetary policy making and long-term growth. Capital movement across countries has numerous benefits including consumption smoothing, improvement in domestic investment and growth potential. In a world with financial market imperfections, however, unrestricted capital flows may cause important macroeconomic problems such as undesired currency appreciation and inflation pressure of domestic country. It is widely agreed that major financial crises in the past two decades including the recent global financial crisis are closely related to massive increases in capital movement after a series of financial market liberalization in a number of countries. Thus, designing a more stable international financial system and regulating international capital movements became a pressing issue. In particular, the first essay studies the effectiveness of capital controls on monetary policy autonomy given the international macroeconomic trilemma constraint. The second essay investigates the impact of capital controls on economic growth. In addition to capital controls, exchange rate arrangement is also a perennial issue in international economics. This issue has been of particular interests along with persistent global imbalances. Many policy makers and economists believe that flexible exchange rate can facilitate current account adjustment since Friedman (1953) first made this proposition in 1950s. However, disagreement exists among economists (i.e. see Chinn and Wei, forthcoming). Given this background, the third essay examines whether exchange rate flexibility can play a role in the current account adjustment. This chapter provides a brief introduction to each of the three assays.

In my first essay, I investigate the role of capital controls in the context of the international monetary policy trilemma. According to the trilemma, there is a tradeoff among three policy objectives: monetary policy independence, exchange rate stability, and unrestricted capital mobility. A country cannot have all three at the same time. If any two are chosen, the other has to be sacrificed. As most governments pursue independent monetary policy for domestic stabilization purposes and more stable exchange rates, the trilemma suggests that some restrictions on capital movement are inevitable. In this essay,

I investigate an aspect of the hypothesis that has received relatively little attention thus far: whether a decrease in capital mobility through imposition of capital controls, while holding the degree of exchange rate stability constant, will enhance monetary independence. Using a novel panel dataset covering 88 countries for the 1995-2010 period with system GMM estimation, the essay finds that 1) capital controls help improve a country's monetary independence; 2) the effectiveness of capital controls depends on the types of assets and the direction of flows they are imposed; and 3) the choice of exchange rate regime seems to have important impact on the effectiveness of capital controls on monetary independence. This result suggests that policy makers may consider capital controls as a tool to obtain more monetary policy autonomy.

In my second essay, I consider long-term effects of capital controls – economic growth. Conventional wisdom suggests that allowing high level of international capital flows improves domestic investment and growth by providing extra resources through international capital market. Yet international capital flows can be misallocated to finance speculative or low-quality domestic investments, which cannot promote a long-run economic growth. How capital controls will empirically affect economic growth is more of interest. Using a panel dataset covering 78 countries for the 1995-2009 period and system GMM estimation, this paper finds that that 1) capital control policies promote economic growth after taking into account a country's de facto level of capital flows. As the same time, higher de facto capital flows is associated with higher growth rate. The positive effect of capital controls will be weakened as de facto level of capital flows increases. 2) Controls on capital inflows do help a country's economic growth, yet controls on outflows have little impact on growth. Again, de facto level of capital flows will weaken the positive effect of capital controls on inflows. 3) Restrictions on different asset types affect differently on growth. Capital controls on equity type flows impede growth; controls on debt type flows promote growth; controls on direct investment have positive but insignificant effects on growth.

In my third essay, I study a controversial question – does greater exchange rate flexibility promote the adjustment in the current account? Flexible exchange rate has long been asserted as a must-keep tool to facilitate the current account adjustment. In contrast, some studies show that exchange rate flexibility does not matter for the current account

adjustment using some widely used exchange rate regime classification. However, results from my essay suggest that the statement that greater exchange rate flexibility promotes the adjustment in the current account still holds. In particular, my study distinguishes exchange rate flexibility and exchange rate regime classification and finds that some widely used classifications may not fully capture exchange rate flexibility as clear as people think. After a full consideration of exchange rate flexibility, using the threshold VAR technique and a large panel dataset covering 90 countries for the period 1980-2010, the essay finds a strong positive link between exchange rate flexibility and the speed of the current account adjustment.

Chapter Two
Do capital controls enhance monetary independence?

2.1. Introduction

According to the international monetary policy trilemma, policymakers simultaneously may achieve any two, but not all, of the following three goals, 1) exchange rate stability; 2) unrestricted movement in international capital; and 3) monetary policy autonomy. The first goal, exchange rate stability, requires a fixed or heavily managed exchange rate regime. The second goal, free capital mobility, is usually associated with elimination of exchange controls on cross-border movement of international capital. The third goal, monetary policy autonomy is conceptual and thus difficult to define. Usually if a country can easily implement its own monetary policy without being forced to follow another country's monetary policy, it is considered to have a high level of monetary independence. One of most popular measures of monetary independence is deviation of the domestic interest rate from the foreign or base rate. Aizenman et al (2008), Frankel et al (2004), and Shambaugh (2004) examine monetary independence using this metric.

Previous studies in the trilemma mostly focus on the relationship between the exchange rate regime and monetary policy independence. See, inter alia, di Giovanni and Schambaugh (2008), Bluedorn and Bowdler (2010), Frankel et al (2004), and Schambaugh (2004). Most studies assume high capital mobility especially when industrialized economies are under consideration. In this case, the trilemma is reduced a simpler dilemma between exchange rate stability and monetary independence. For various reasons, however, the tradeoff between capital mobility and monetary independence – for instance, whether introducing more stringent capital controls will enhance monetary independence – has been underexplored. An important reason may be measurement of capital mobility. According to the International Monetary Fund (IMF), capital flows can be roughly categorized as portfolio flows (equity and bond), direct investment, and other financial flows. In addition, each main category can contain many subsets. This complexity of measurement makes capital mobility more difficult to quantify than monetary independence and the exchange rate regime.

The purpose of this paper is to investigate whether capital control policies enhance monetary independence in the context of the trilemma. Given that capital flows can take many different forms, it is of great interest to understand whether the effectiveness of capital controls depends on the type of financial assets they are imposed and whether controls on capital inflows and outflows have different effects. Instead of using an aggregate measure of capital controls as most existing studies do, we thus adopt a set of disaggregate capital control variables to measure the effectiveness of capital controls. We also employ dynamic panel-data system generalized method of moments (GMM) estimation to analyze a panel annual dataset covering 88 countries during the 1995-2010 period.

Main findings of this paper include 1) capital controls help improve a country's monetary independence, which is consistent with the trilemma theory; 2) the effectiveness of capital controls depends on the type of assets and direction of flows they are imposed; 3) the choice of exchange rate regime seems to have important impact on the effectiveness of capital controls on monetary independence.

The remainder of the paper is as follows. Section 2 provides a brief review of literature in related fields. Section 3 describes the methodology and the dataset. Section 4 reports the main results. Section 5 reports the robustness of the results. Section 6 concludes.

2.2 Literature review

Free and unrestricted movement of international capital has both benefits and costs. Benefits of allowing a high level of international capital flows include consumption smoothing, improvement in domestic investment and growth potential. On the other hand, international capital flows may generate undesirable outcomes especially when they are large and sudden. Magud et al (2011) summarize four important side effects of capital flows in terms of "four fears". They are 1) fear of appreciation of the domestic currency; 2) fear of "hot money" or volatile short-term capital flows that could be very destructive to the real economy; 3) fear of large inflows, which can fuel asset price bubbles and encourage excessive risk taking by cash-rich domestic intermediaries; 4) fear of loss of monetary autonomy which may arise if huge capital flows weaken the flexibility of

domestic monetary policy. These fears may rationalize the increasingly wider use of capital controls across countries. Even the IMF comes to view capital controls more favorably than before. It is now developing Framework to Manage Capital Inflows (IMF, 2011).[1]

This paper investigates empirical evidence regarding the fear of loss of monetary autonomy due to greater capital mobility. It can fit into two broad strands of literature: 1) the study of trilemma or tradeoffs among the three policy goals; and 2) the study of the effectiveness of capital controls. In the context of the trilemma, most studies pay attention to the relation between the exchange rate regime and monetary independence. Shambaugh (2004) investigates how fixed exchange rates affect monetary policy using the data of 155 countries over period 1973-2000. He finds that fixed exchange rates involve a loss of monetary policy autonomy. In particular, a country with fixed exchange rate regime has its nominal interest rate follow that of a base country more closely than a country which does not fix its exchange rate. Shambaugh (2004) also considers the effects of capital controls using IMF's binary (aggregate) dummy variables. He finds a positive effect of capital controls on monetary independence, although the coefficient estimates are statistically insignificant.

Frankel et al (2004) explore the impact of exchange rate regime on the sensitivity of local interest rates to international interest rates using 46 developing and industrialized economies during 1976–1996. They find that in the 1990s all exchange rate regimes exhibit high sensitivity of local interest rates to international ones in the long run even for countries with floating regimes. In the short run, however, interest rates of countries with more flexible regimes adjust more slowly to changes in international rates, implying some room for monetary independence. However, the paper does not explicitly consider the role of capital controls. Instead, it roughly distinguishes degree of world capital mobility by dividing the whole sample into three sub-periods under the assumption that capital mobility is higher in the more recent period.

[1] Recent Experiences in Managing Capital Inflows—Cross-Cutting Themes and Possible Policy Framework
Prepared by the Strategy, Policy, and Review Department, IMF (2011)

Bluedorn and Bowdler (2010) investigate the relationship between monetary independence and exchange rate regime by distinguishing monetary policy in base country (the US) into identified, unanticipated, and exogenous interest rate changes and study how different types of interest rate changes may affect home country's monetary policy. Yet, the paper fails to address the complexity of capital controls by using a single binary measure.

Unlike the above papers, some studies explicitly consider the framework of the trilemma in which all three aspects of the policy tradeoffs are explicitly taken into account. Using a panel of data from 22 countries between 1967 and 1992, Rose (1996) finds little evidence of an obvious tradeoff between fixed exchange rates, capital mobility, and monetary independent. However, as argued by Obstfeld et al (2005), the measure of monetary independence in the paper is obtained from the monetary models of the exchange rate, which yields limited credibility when identifying monetary policy shocks. Aizenman et al (2010) construct a continuous index for each variable of the trilemma. They find that the weighted sum of the three indexes adds up to a constant, confirming the idea that a rise in one trilemma variable should be traded-off with a drop of the weighted sum of the other two. Interestingly, they use a continuous index of financial openness rather than a binary dummy variable to proxy the extent of a country's capital mobility. Obstfeld et al (2005) use an interwar (1919-1938) annual dataset from 16 countries to explicitly investigate the trilemma. The analysis of interwar data finds strong support for the logic of the trilemma. A drawback of their dataset is a limited coverage of countries. The paper covers much less countries than the previous two papers. Also, the measurement of capital controls in the paper still suffers the same problem as does Shambaugh (2004). Miniane and Rogers (2007) examine the trilemma using a structural vector autoregressive model. They deal with capital controls by roughly splitting sample countries into high capital control group and low capital control group.

In sum, a common issue facing the above papers, except for Rose (1996), is that they typically use a coarse measure of capital controls. As a result, the empirical results provide little guideline to policymakers on the effectiveness of different capital control policies. If the government decides to regulate capital flows, should it choose to impose restrictions on bonds or equities, or direct investment? Do restrictions on inflow or

outflow make difference? These questions cannot be answered from the papers mentioned in the above. Another important problem of these papers is that they fail to address potential endogeneity and reverse causation issues. For instance, a country may choose to employ capital restrictions because it lacks monetary autonomy. A two-way causality between capital controls and monetary independence could undermine the legitimacy of conclusions made in these papers.

Another strand of literature considering the impact of capital controls on monetary policy deals with the effectiveness of various capital control measures. Most studies in the field try to answer the question of interest using individual-country case study. Often they consider very specific control policies and look at the "treatment effect" of these policies on the economy. Edison and Reinhart (2001), De Gregorio et al (2000), Kaplan and Rodrik (2002), Valdes-Prieto and Soto (1998), and many other studies provide evidence that capital controls positively affect monetary independence. Despite the interesting results, these studies are only limited to a small number of countries such as Malaysia and Chile. Only a small number of papers such as Montiel and Reinhart (1999) and Binici et al (2010) consider multiple countries while keeping a detailed measure of capital controls. Yet their research interest is the link between capital controls and the volume and composition of capital inflows and outflows. Although they consider a more specific set of capital control policies, they are silent about the effect of capital controls on monetary independence.

2.3. Data

Our annual panel dataset covers 88 countries for the 1995-2010 period. (See Table 2.8 for the list of countries.) Monetary independence is the ability of a country to set its own monetary policy for domestic purposes independent of external monetary influences. As monetary policy usually takes the form of interest rate targeting, an intuitive measure of monetary independence would be the difference of interest rate between the home country and the base country (or the rest of the world). We employ the methodology developed by Aizenman et al (2010) and define monetary independence for country i as follows:

$$MI = 1 - \frac{corr(r_i, r_b) + 1}{2}$$

where $\text{corr}(r_i, r_b)$ is measure the correlation of the monthly interest rates between the home country and the base country, denoted as b. Money market rates are used as the interest rate. By construction, the maximum and minimum values are 1 and 0, respectively. A higher value of the index means a lower correlation of interest rates and thus greater monetary policy independence.

For the measurement of capital controls, we follow the methodology developed by Schindler (2009). The original data source is from IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). Before 1995, AREAER reports each country's overall capital controls status using one single dummy; since 1995, the variable breaks down to many categories according to capital flows' asset type, ownership, or direction of flows. Using the information on capital controls from IMF's AREAER for the period from 1995 to 2005, Schindler first codes the restrictiveness of different types of capital controls at the level of individual transactions, and then takes average of these subindices to obtain more finely gradated asset or inflow/outflow specific indices. For example, equity transactions are classified into four types: residents buying or selling assets abroad, and nonresidents selling or buying domestic assets. Each of these basic transactions is coded as "1" if restrictions exist and "0" otherwise. Thus, an aggregate equity controls index would be the average of four binary variables and could thus take on five different values: 0, 0.25, 0.5, 0.75, or 1. The equity inflow and outflow indices, respectively, are the average of two underlying transaction variables, thus potentially assuming three values: 0, 0.5, or 1. We update the data to 2010.

For the measure of exchange rate regime, we follow the binary classification of Klein and Shambaugh (2008). A fixed exchange rate regime ($Peg_{it} = 1$) is defined as a situation where, over the course of a calendar year, the month-end bilateral exchange rate with the base country stays within a 2% band; $Peg_{it} = 0$ otherwise. Klein and Shambaugh's study covers data up to 2006. This paper updates to 2010.

Monetary independence may be affected by other variables including inflation rate, trade openness, financial development, and relative income. Inflation, especially when it is high, is a sign of loss of monetary control. Previous literature finds a negative

correlation between inflation rate and indicators of central bank independence. See, inter alia, Alesina and Summers (1993) and Cukierman et al (1992). In other words, the central bank of a higher inflation country is more likely to have a lower degree of independence from domestic political pressure. The external degree of monetary independence – the subject of this study – is also likely to be lower if the country hopes to borrow the reputation of low inflation policy of the base country by tying its currency to that of the base country.

International trade is an important channel of transmission of external influences. Trade openness –defined as the ratio of the sum of imports and exports to GDP – is likely to be positively related to the extent of the country's exposure to foreign shocks including foreign monetary policy and the monetary policy linkage, which lowers monetary independence. (Shambaugh 2004) Financial development – proxied by the private credit/GDP ratio − is often associated with financial integration with the world financial market, which tends to expose the country to international financial market shocks. This suggests that financial development is likely to lower monetary independence. The effect of relative income on monetary independence is ambiguous. A high-income country tends to be more open in trade and finance and therefore may interact with the above-mentioned factors. At the same time, a more advanced country is also likely to wish to exert its own monetary policy instead of being imposed by foreign policy decisions.

Data for inflation, trade openness, and relative income are obtained from Penn World Table 7.0; the measure of financial development is from World Development Indicators (WDI). Table 2.1 provides the summary statistics. Note that the trilemma variables range from 0 to 1 by construction. The mean of capital control variables is 0.36, suggesting that countries maintain some restrictions on capital flows but do not heavily rely on capital controls. The mean of exchange rate stability is 0.36, which implies that more than one third of the observations adopt a fixed exchange rate regime. Other variables including inflation, relative income, financial development, and trade openness have reasonable ranges. No obvious outliers are detected in the dataset.

2.4. Methodology

The following regression equation is estimated to investigate the effectiveness of capital control policies on monetary independence in the context of the trilemma.

$$MI_{it} = \text{Constant} + \beta\ CC_{it} + \delta\ Peg_{it} + \gamma\ X_{it} + \epsilon_{it} \quad (1)$$

MI_{it} is a country i's level of monetary independence in year t , CC_{it} is a vector of various capital control variables. In some regressions, we also employ an aggregate measure of capital controls instead. Peg_{it} is a binary control variable, which measures a country's exchange rate regime. ($Peg_{it} = 1$ for a fixed exchange rate regime and 0 otherwise.) X_{it} is a group of control variables, including per capita income level relative to the US, trade openness, inflation rate and a measure of financial development.

Shambaugh (2004) uses a framework similar to Eq. (1). There are three notable differences between the his specification and ours. First, the measurement of monetary independence is different. He uses the interest rate differential between a country and its base country. This paper uses monetary independence developed by Aizenman et al (2010), which is based on the correlation of interest rates between the home and the base countries. Second, this paper uses a more disaggregated set of capital control variables based on their asset categories and types of flow, while Shambaugh (2004) uses a single aggregated capital control variable. Third, we employs a more sophisticated econometric method of estimation than the basic ordinary least squares used by Shambaugh (2004) which may suffer from omitted variable biases and endogeneity problems. Admittedly, it is very difficult to identify all possible explanatory variables for monetary independence. The explanatory variables that can be identified and included in the regression are limited and the omitted variable bias may be inevitable. For instance, a country's government can influence central bank's policy-making and further affect its monetary policy autonomy. Missing the proxy to measure a government's intervention may lead to an omitted variable bias. One could consider fixed effect panel regression, such as least-squares dummy variable (LSDV) regression. This apporach can remove some time-invariant individual fixed effect, largely mitigate the omitted variable bias, and provide less biased results. However, it cannot overcome the potential endogeneity problems. Some variables in Eq. (1) are likely to have endogeneity issues. For example, monetary independence and

inflation may affect each other in both directions. A country could try to control inflation by following another country's monetary policy, which, in turn, implies that high inflation leads to low monetary independence. Another example is capital controls: a country may choose its polices including capital controls in order to achieve a certain level of monetary independence. These econometric issues can be addressed with dynamic panel data system GMM estimation methodology pioneered by Arellano-Bond (1991), Arellano-Bover (1995), and Blundell-Bond (1998).[2] [3]

2.5. Results

2.5.1 Preliminary Analyses

Table 2.2 lists correlations among capital restrictions on various types of assets. Most correlations are high, suggesting that a country imposing capital restriction on one asset type, say, equities, is likely to impose restriction on the other types as well, say, bonds and direct investment. Table 2.3 reports correlations among capital restrictions on the direction of flows in addition to the type of assets. Within each asset type, correlations between inflow and outflow are also high except for direct investment, especially its inflows. It is not difficult to find reasons for relatively low correlation of restrictions on direct investment and other types of capital flows. In general, portfolio

[2] System GMM estimation can be used to deal with a general model as follows: $y_{it} = \beta x_{it} + \epsilon_{it}$; $\epsilon_{it} = \mu_i + \upsilon_{it}$; $E(\mu_{it}) = E(\upsilon_{it}) = E(\mu_{it}\upsilon_{it}) = 0$; where the disturbance term has two orthogonal components: the fixed effects, μ_i, and the idiosyncratic shocks, υ_{it}. The estimation addresses omitted variable bias by construction: system GMM uses data transformations such as first difference or "orthogonal deviations" for each individual to remove individual fixed effect. For instance, using first differences, $\Delta y_{it} = \beta \Delta x_{it} + \Delta \upsilon_{it}$. The individual fixed effect, μ_i, is removed from the model. Second, if some explanatory variables may be endogenous, the lagged values of these explanatory variables are used as instruments for estimation. In this way, potential endogeneity problems can be mitigated. Moreover, Windmeijer (2005) devises a small-sample correction to improve the accuracy of the standard errors provided by the estimation, which makes the estimation more practical. Overall, system GMM estimation provides less biased results than general estimation methods such as pooled OLS or LSDV.

[3] To use GMM estimation, it is important to check the validity of moment conditions. An important advantage of system GMM is that it can use lagged values of explanatory variables as instruments to deal with potential endogeneity issues. However, it relies on the assumption that changes in the instrumenting variables ω_{it} are uncorrelated with the individual fixed effects: $E(\Delta\omega_{it}\mu_{it}) = 0$ for all *i* and *t*. If this holds, then $\Delta\omega_{i,t-1}$ is a valid instrument for the endogenous variables in levels: $E(\Delta\omega_{i,t-1}\epsilon_{it}) = E(\Delta\omega_{i,t-1}\mu_{it}) + E(\omega_{i,t-1}\upsilon_{it}) - E(\omega_{i,t-2}\upsilon_{it}) = 0$. In the context of this paper, the estimation needs changes of inflation rate and capital controls to be orthogonal to the country fixed effect. This assumption holds since inflation stabilization and capital control policies are common tools for any countries.

flows involving purchase of stocks and bonds tend to be more short-term oriented while direct investment is more long-term oriented.

2.5.2 Main Results

Table 2.4 reports the main results of the regression analysis estimated by dynamic panel-data system GMM that allows for fixed effects and addresses the endogeneity problems of explanatory variables. This paper uses the following specification for estimation.

$$MI_{it} = \alpha_i + \beta\, CC_{it} + \lambda CC_{it} * Peg_{it} + \gamma\, X_{it} + \epsilon_{it} \qquad (2)$$

where i and t denote country and year. MI_{it} is monetary independence as defined in equation (1). CC_{it} is a vector of capital control variables. We consider three different levels of aggregate measurement for capital controls: (a) overall measure; (b) capital controls on three different types of capital flows as defined in Table 1 (equity + collective investment, bond + financial credit, and direct investment); (c) controls on inflows and outflows for each the 3 types of capital inflows. Thus in (c), there are six different capital control dummy variables in the equation. Eq (2) also examines the effects of capital controls when they are used in combination with the fixed exchange rate regime. X_{it} is a group of control variables which are potential determinants of monetary independence, including the level of income, inflation, the exchange rate regime ($Peg_{it} = 1$ for a fixed exchange rate), trade openness ("openc") as measured by the sum of exports and imports to GDP and the extent of financial development ("fin dvp"). The latter is defined as private credit to GDP ratio.

First, lagged values (up to 5 periods) instrument capital controls and inflation in order to mitigate potential endogeneity issues. Second, orthogonal deviations data transformation is used to accommodate unbalanced panels, because first difference amplifies gaps in unbalanced panels. For instance, if some y_{it} is missing, then neither Δy_{it} nor $\Delta y_{i,t+1}$ can be constructed using first difference. Instead, orthogonal deviations let each observation subtract the average of all future available observations of a variable. It is computable for all observations except the last one, so it minimizes data loss. Third,

two-step estimation and small sample correction are used to improve the accuracy and efficiency of the estimation.[4]

Regression (1) in Table 4 estimates the overall effect of capital controls. The estimation result suggests a positive effect of capital controls on monetary policy independence, although it is not statistically significant. The effects of control variables are reported at the bottom of the table. Maintaining a fixed exchange rate lowers monetary independence since monetary policy is constrained to keep the exchange rate fixed. Inflation also significantly reduces monetary independence. This is in line with previous studies that there is a negative correlation between inflation rate and indicators of central bank independence. Financial development slightly negatively affects monetary independence as expected. Relative income and trade openness tend to have little effect. The six control variables are consistently signed across 6 different specifications reported in Table 4. Among the variables that have statistically significant effects, a fixed exchange rate regime reduces monetary independence. This is consistent with the trilemma and also with Shambaugh (2004).

Interestingly, monetary independence is negatively is associated with both trade openness and financial development. Regarding the latter, to the extent that capital mobility typically advances along liberalization and development in the financial sector, this result is consistent with the trilemma as well. The negative effect of trade openness on monetary independence seems reasonable given that greater trade openness is associated with a smaller economy that tends to be exposed to more shocks of the external origin. See McKinnon (1963) for an early discussion about the linkage.

Regression (3) uses a disaggregate set of capital control variables including restrictions on equity and collective investment flows, restrictions on bond and financial credit flows, and restrictions on direct investment flows. Different types of capital flow restrictions seem to have different effects on monetary independence. In particular, restrictions on equity and collective investment and those on direct investment flows seem to help improve a country's monetary independence. Yet restrictions on bond and

[4] Windmeijer (2005) aruges that the two-step efficient GMM, with small sample correction, performs better than one-step in estimating coefficients, with lower bias and standard errors.

financial credit flows would decrease a country's monetary independence. This is an interesting result and requires further investigation.

In the trilemma, the tradeoff between capital mobility and monetary independence may depend on the exchange rate regime, so regression (2) and (4) add the interaction terms between the exchange rate regime and capital controls to regression (1) and (3), respectively. The coefficient of the interaction term in regression (2) is positive and statistically significant. However, no interaction term is statistically significant in regression (4).

Regression (5) employs a more detailed set of capital controls compared to regression (3). In this regression, we distinguish capital controls not only on their asset type but also on their type of flows – inflows or outflows. Results from regression (5) are quite similar to those of regression (3). All coefficients here have the same sign as before. An interesting finding is that the restrictions on inflows seem to be more effective than those on outflows. A joint test of insignificance of all capital controls on inflow is rejected at the 5 percent significance level, while a similar test on capital controls on outflow is not rejected. This is consistent with previous studies as summrized by Magud et al (2011): capital controls on inflows seem to make monetary policy more independent, yet controls on outflow are not as conclusive as those on inflows. Regression (6) adds interaction terms between capital controls and exchange rate regime based on specifications in regression (5). Results here are consistent with the other regressions: capital controls enhance monetary independence; the tradeoff between capital mobility and monetary independence depends on the exchange rate regime; restrictions on inflows are more effective than on outflows.

Table 2.5 reports a selection of validity tests for system GMM estimation developed by Hansen (1982) and Arellano and Bond(1991). The three tests are standard post-estimation tests that are used to test the validity of instruments used in system GMM estimation. Test for AR(2) is the Arellano-Bond test for autocorrelation among idiosyncratic disturbance terms. Existence of autocorrelation invalidates some or all lagged values as instruments. The test for validity of moment conditions is the Hansen test of over-identification. System GMM can generate many moment conditions using lagged values as instruments, but it relies on the assumption that changes in the

instruments are uncorrelated with the individual fixed effects. This test thus tests the joint validity of these moment conditions. The test for exogeneity of instrument subsets is Difference-in-Hansen test of exogeneity of instrument subsets. It tests for the exogeneity of instruments used in the regression. A rejection of any of these tests may weaken the reliability of system GMM estimation. Reported in Table 2.5 are P-values which confirm the validity of instruments and the reliability of system GMM estimation.

Overall, results from Table 2.4 clearly suggest that capital controls enhance monetary independence. Moreover, the effectiveness of capital controls depends on the types of assets and the direction of flows they are imposed. Restrictions on equity, collective investment and direct investment seem to be more effective than restrictions on bonds and financial credit. Restrictions on inflows appear to be more effective than those on outflows. In addition, a fixed exchange rate regime has negative impact on monetary independence. Furthermore, the choice of exchange rate regime seems to have important bearings on the effectiveness of capital controls on monetary independence.

2.6 Robustness check

Table 2.6 provides regression results using LSDV estimation. This estimation is commonly used to control for country fixed effects. However, it does not provide direct treatment to endogeneity issues. The results show that restrictions on capital flows statistically significantly affect monetary independence. All coefficients of capital control variables and control variables have the same signs as those of the GMM estimates. Clearly, result from LSDV estimation is highly consistent with system GMM estimation.

As an alternative measure of exchange rate regime, we consider the ERS (exchange rate stability) measure developed by Aizenman, Chinn, and Ito (2010) (ACI). It ranges from 0, the lowest exchange rate stability, to 1, the highest one and is based on annual standard deviations of the monthly exchange rate between the home country and the base country.[5] Table 2.7 reports the results obtained from using system GMM estimation along with the ACI measure of *de facto* exchange rate stablility instead of the Klein and

[5] ERS is defined as follows: $ERS = \frac{0.01}{0.01 + stdev(\Delta log(exch-rate)}$. Thus, greater exchange rate flexibility reduces the measure. With no exchange rate changes, ERS = 1.

Shambaugh (2008)'s binary exchange rate regime classification used in Table 2.5. All coefficients of capital control variables and control variables have the same signs as those reported in Table 2.4. Interestingly, the coefficients on interaction terms tend to be statistically significant. These results reinforce the conclusion from Table 4 that the choice of exchange regime seems to have important impact on the effectiveness of capital controls on monetary independence.

As part of robustness check, we also investigate whether capital controls affect monetary independence in a non-linear fashion. In particular, squared terms of capital control variables are added to the basic model. The results (not reported) indicate that the non-linear terms are not significant in any specification, which suggests that the linearity assumption on the relation between capital control and monetary independence seems to be valid.

2.7. Conclusion

International monetary policy trilemma – the tradeoff among exchange rate stability, monetary independence, and unrestricted capital mobility – is an important constraint for policymakers in an open economy. This paper empirically investigates the validity of the proposition that, holding the degree of exchange rate stability constant, a decrease in capital mobility through an imposition of capital controls will enhance monetary independence. Using a panel dataset covering 88 countries for the 1995-2010 period and system GMM estimation, this paper finds that 1) capital controls help improve a country's monetary independence; 2) the effectiveness of capital controls depends on the types of assets and the direction of flows they are imposed. Restrictions on equity, collective investment, and direct investment seem to be more effective than restrictions on bonds and financial credit. In addition, restrictions on inflows appear more effective than on those on outflows; 3) the choice of exchange rate regime seems to have important impact on the effectiveness of capital controls on monetary independence. Pegged exchange rate systems reduce monetary independence as expected. The results are fairly robust to changes in model specification or estimation method.

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Table 2.1. Descriptive statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
mi	Monetary independence	1382	0.387	0.220	0	0.967
Capital controls						
ka	Overall capital controls	1274	0.356	0.348	0	1
eqci	equity+collective investment	1456	0.348	0.362	0	1
bofc	bond+financial credit	1274	0.349	0.362	0	1
di	direct investment	1456	0.402	0.402	0	1
eqcii	equity+collective investment inflow	1456	0.297	0.358	0	1
eqcio	equity+collective investment outflow	1456	0.399	0.411	0	1
bofci	bond+financial credit inflow	1274	0.291	0.367	0	1
bofco	bond+financial credit outflow	1274	0.408	0.417	0	1
dii	direct investment inflow	1456	0.434	0.495	0	1
dio	direct investment outflow	1456	0.315	0.464	0	1
Control variables						
peg	exchange rate stability	1456	0.364	0.481	0	1
pi	inflation	1274	0.012	0.103	-0.610	0.569
openc	trade openness	1365	0.868	0.555	.132	4.534
fin_dvp	private credit/GDP	1414	0.637	0.534	0	3.194
y	relative income	1365	0.391	0.366	.0173	3.111

Note: Equity refers to shares and other securities, such as stocks; bond refers to bond and other securities; collective investment includes share certificates and registry entries or other evidence of securities investor interest in an institution for collective investment, such as mutual funds; financial credits includes credits other than commercial credits granted by all residents, including banks, to nonresidents, or vice versa; direct investment refers to investments for the purpose of establishing lasting investment economic relations both abroad by residents and domestically by nonresidents.

Table 2.2. Correlation between capital controls on different assets

	eqci	bofc	di
eqci	1		
bofc	0.877	1	
di	0.745	0.698	1

Table 2.3. Correlation between capital controls on different types of assets and flows

	eqcii	eqcio	bofci	bofco	dii	dio
eqcii	1					
eqcio	0.773	1				
bofci	0.766	0.720	1			
bofco	0.694	0.854	0.700	1		
dii	0.472	0.358	0.278	0.345	1	
dio	0.605	0.727	0.653	0.700	0.280	1

Table 2.4. Dynamic panel-data system GMM estimation

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ka	0.126	0.0415				
	(0.116)	(0.111)				
ka_peg		0.131*				
		(0.0745)				
eqci			0.191	0.249*		
			(0.122)	(0.147)		
bofc			-0.114	-0.245*		
			(0.0964)	(0.129)		
di			0.105**	0.0488		
			(0.0425)	(0.0668)		
eqci_peg				-0.105		
				(0.166)		
bofc_peg				0.201		
				(0.178)		
di_peg				0.0778		
				(0.122)		
eqcii					0.0595	0.0383
					(0.0972)	(0.0884)
eqcio					0.169*	0.170*
					(0.0886)	(0.0903)
bofci					-0.0100	-0.0580
					(0.0763)	(0.0653)
bofco					-0.121	-0.139*
					(0.0922)	(0.0751)
dii					0.0920***	0.0454
					(0.0324)	(0.0323)
dio					0.00447	-0.0272
					(0.0545)	(0.0456)
eqcii_peg						0.0724
						(0.128)
eqcio_peg						-0.106
						(0.148)
bofci_peg						0.105
						(0.111)
bofco_peg						0.163
						(0.144)
dii_peg						0.0845
						(0.0729)
dio_peg						-0.106
						(0.131)
y	-0.0866	-0.101*	-0.0537	-0.0828	-0.0673	-0.107**
	(0.0572)	(0.0533)	(0.0416)	(0.0562)	(0.0589)	(0.0510)
pi	-0.108**	-0.134**	-0.138***	-0.103	-0.127**	-0.119**
	(0.0500)	(0.0566)	(0.0484)	(0.0619)	(0.0560)	(0.0591)
peg	-0.0888***	-0.117***	-0.0989***	-0.155**	-0.0895***	-0.163***
	(0.0296)	(0.0414)	(0.0307)	(0.0676)	(0.0331)	(0.0601)
openc	-0.0275	-0.0101	-0.00227	0.0180	0.00474	0.0138
	(3.49)	(3.89)	(0.0314)	(0.0334)	(0.0255)	(0.0307)
fin_dvp	-0.0731***	-0.0863***	-0.0892***	-0.0929**	-0.0988**	-0.0922**
	(0.0251)	(0.0299)	(0.0292)	(0.0391)	(0.0397)	(0.0383)
Constant	0.504***	0.526***	0.455***	0.494***	0.460***	0.512***
	(0.0563)	(0.0571)	(0.0516)	(0.0466)	(0.0521)	(0.0393)
Observations	1,070	1,070	985	985	985	985
Number of nation	88	88	88	88	88	88

Table 2.5. Tests for validity of system GMM estimation

	(1)	(2)	(3)	(4)	(5)	(6)
A. Test for AR(2)	0.442	0.591	0.294	0.452	0.290	0.364
B. Test for validity of moment conditions	0.182	0.216	0.245	0.281	0.270	0.523
C. Test for exogeneity of instrument subsets	0.329	0.106	0.488	0.589	0.752	0.960

Table 2.6. Panel regression with country fixed effects

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ka	0.0777**	0.0730**				
	(0.0339)	(0.0360)				
ka_peg		0.0184				
		(0.0378)				
eqci			0.192***	0.204***		
			(0.0542)	(0.0566)		
bofc			-0.150***	-0.139***		
			(0.0430)	(0.0483)		
di			0.0709**	0.0458		
			(0.0276)	(0.0295)		
eqci_peg				-0.0747		
				(0.0901)		
bofc_peg				-0.0362		
				(0.0750)		
di_peg				0.108*		
				(0.0597)		
eqcii					0.102**	0.106**
					(0.0399)	(0.0448)
eqcio					0.0836**	0.0859*
					(0.0425)	(0.0449)
bofci					-0.0667*	-0.0687*
					(0.0366)	(0.0413)
bofco					-0.0677**	-0.0607*
					(0.0314)	(0.0343)
dii					0.0629***	0.0484**
					(0.0170)	(0.0208)
dio					-0.00510	-0.00387
					(0.0257)	(0.0266)
eqcii_peg						-0.0151
						(0.0719)
eqcio_peg						0.00335
						(0.0838)
bofci_peg						0.00295
						(0.0665)
bofco_peg						-0.0122
						(0.0694)
dii_peg						0.0440
						(0.0306)
dio_peg						-0.0133
						(0.0709)
y	0.0191	0.0184	0.0149	0.0233	0.00801	0.00866
	(0.0667)	(0.0666)	(0.0695)	(0.0660)	(0.0682)	(0.0664)
pi	-0.0625	-0.0621	-0.0372	-0.0381	-0.0387	-0.0381
	(0.0471)	(0.0471)	(0.0477)	(0.0473)	(0.0475)	(0.0475)
peg	-0.0347**	-0.0432*	-0.0366**	-0.0360	-0.0373**	-0.0431
	(0.0159)	(0.0253)	(0.0173)	(0.0289)	(0.0173)	(0.0316)
openc	-0.0892***	-0.0892***	-0.0695**	-0.0698**	-0.0754**	-0.0737**
	(0.0317)	(0.0317)	(0.0326)	(0.0326)	(0.0329)	(0.0330)
fin_dvp	-0.0407	-0.0406	-0.0505*	-0.0547**	-0.0700**	-0.0683**
	(0.0273)	(0.0273)	(0.0280)	(0.0274)	(0.0287)	(0.0284)
Constant	0.560***	0.564***	0.532***	0.523***	0.540***	0.534***
	(0.0628)	(0.0638)	(0.0668)	(0.0678)	(0.0657)	(0.0675)
Observations	1,070	1,070	985	985	985	985
Number of nation	88	88	88	88	88	88
R-squared	0.459	0.459	0.488	0.490	0.492	0.493

Table 2.7. Dynamic panel system GMM estimation using ACI exchange rate stability

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ka	0.0249	0.158				
	(0.0601)	(0.123)				
ka_ers		-0.00502				
		(0.162)				
eqci			0.245***	0.283***		
			(0.0388)	(0.0899)		
bofc			-0.228***	-0.389***		
			(0.0388)	(0.0956)		
di			0.0926***	0.0951**		
			(0.0180)	(0.0415)		
eqci_ers				-0.348***		
				(0.100)		
bofc_ers				0.451***		
				(0.124)		
di_ers				0.0591		
				(0.0742)		
eqcii					0.0717	0.0922***
					(0.0462)	(0.0258)
eqcio					0.189***	0.210***
					(0.0442)	(0.0137)
bofci					-0.0309	-0.127***
					(0.0331)	(0.0210)
bofco					-0.190***	-0.206***
					(0.0449)	(0.0228)
dii					0.0812***	0.0245**
					(0.0181)	(0.0103)
dio					-0.00908	0.0815***
					(0.0181)	(0.00954)
eqcii_ers						-0.141***
						(0.0318)
eqcio_ers						-0.124***
						(0.0190)
bofci_ers						0.239***
						(0.0303)
bofco_ers						0.133***
						(0.0351)
dii_ers						0.0875***
						(0.0183)
dio_ers						-0.198***
						(0.00901)
y	-0.145***	-0.0857*	-0.109***	-0.115***	-0.106***	-0.135***
	(0.0371)	(0.0490)	(0.0295)	(0.0353)	(0.0329)	(0.0105)
pi	-0.0721**	-0.0933*	-0.0773***	-0.0756**	-0.0820***	-0.0725***
	(0.0310)	(0.0552)	(0.0173)	(0.0305)	(0.0253)	(0.0148)
ers	-0.113***	-0.128*	-0.142***	-0.203***	-0.148***	-0.133***
	(0.0267)	(0.0701)	(0.0209)	(0.0661)	(0.0280)	(0.0249)
openc	-0.00799	-0.0147	0.00756	0.0266	0.0240	0.00876
	(0.0193)	(0.0350)	(0.0159)	(0.0217)	(0.0183)	(0.00889)
fin_dvp	-0.0672***	-0.0941***	-0.0834***	-0.0945***	-0.0898***	-0.0759***
	(0.0189)	(0.0247)	(0.0148)	(0.0223)	(0.0204)	(0.00804)
Constant	0.569***	0.541***	0.539***	0.577***	0.530***	0.556***
	(0.0332)	(0.0568)	(0.0184)	(0.0349)	(0.0302)	(0.0127)
Observations	1,070	1,070	985	985	985	985
Number of nation	88	88	88	88	88	88
Number of nation	88	88	88	88	88	88

Table 2.8. List of countries in the dataset

Low income	Middle income		High income
Bangladesh	Angola	Panama	Australia
Burkina Faso	Argentina	Paraguay	Austria
Cote d'Ivoire	Bolivia	Peru	Bahrain
Ghana	Brazil	Philippines	Belgium
India	Bulgaria	Romania	Brunei Darussalam
Kenya	Chile	Russia	Canada
Kyrgyz Republic	China	South Africa	Cyprus
Pakistan	Costa Rica	Sri Lanka	Denmark
Tanzania	Czech Republic	Swaziland	Finland
Togo	Dominican Republic	Thailand	France
Uganda	Ecuador	Tunisia	Germany
Uzbekistan	Egypt	Turkey	Greece
Yemen, Republic of	El Salvador	Uruguay	Hong Kong
Zambia	Georgia	Venezuela	Iceland
	Guatemala		Ireland
	Hungary		Israel
	Indonesia		Italy
	Jamaica		Japan
	Kazakhstan		Korea
	Latvia		Kuwait
	Lebanon		Malta
	Malaysia		Netherlands
	Mauritius		New Zealand
	Mexico		Norway
	Moldova		Portugal
	Morocco		Qatar
	Nicaragua		Saudi Arabia
	Oman		Singapore
			Slovenia
			Spain
			Sweden
			Switzerland
			United Arab Emirates
			United Kingdom

Chapter Three

Capital mobility and economic growth: the role of capital controls

3.1. Introduction

The recent global financial crisis (2007-2009) has generated a hot debate among economists on capital controls as an important means in policy makers' toolkit. For example, the IMF changed its own viewpoint on capital controls slowly in the past decade. During the East Asian financial crisis 1997-1998, the IMF provides bailout to Asian countries conditional on a more open capital account of the receiving country, because it believes that free capital mobility should provide a robust economic growth. However, after recent global financial crisis, the IMF no longer promotes free capital account convertibility for most countries. Instead, the IMF suggests the use of capital control with caution, especially in the short run, because it realizes capital controls can limit the contagion of financial crisis from one country to another and then mitigate the large negative effects of financial crises on economic growth (IMF, 2011).

The IMF's shift of its position on capital controls may lead to the following question: how can capital controls affect economic growth if there is any? Literature on either capital controls or economic growth is numerous, yet the impact of capital controls on economic growth is far from conclusive. One explanation may be due to ambiguous effects of capital controls on economic growth. As argued by Agenor (2003), allowing a high level of international capital flows improves domestic investment and growth by providing extra resources through international capital market. At the same time, Agenor (2003) also alerts that international capital flows can be misallocated to finance speculative or low-quality domestic investments, which cannot promote a long-run economic growth. In addition, to the country with high capital mobility, the pro-cyclical nature of capital flows makes it even worse when the financial crisis comes. Clearly, the lack of consistent theory linking capital controls and economic growth makes this question more empirical.

Literature that investigates the relation between capital controls and economic growth can be categorized into two groups according to their measure of capital controls. One large strand of studies focuses on the role of de jure measure of capital controls. That

evaluates the effect of capital controls using government official restrictions on capital flow as a measure of capital controls. Results from this category tend to vary greatly depending on the data source of capital controls. Using the IMF's annual report exchange arrangements exchange restrictions (AREAER), Alesina et al. (1994) find, for OECD countries, that capital controls have positive but insignificant effects on economic growth. Grilli and Milesi-Feretti (1995) obtains a similar result for developing countries. The problem of AREAER is that it only provides a coarse 0/1 measure of a country's capital control status before 1996. The lack of variation in the data makes research hard to find robust results. In contrast, some studies find robust results using alternative measures. Using a more finely classified measure of capital mobility, Quinn (1997) shows that capital account liberalization has had positive effects on economic growth.[6] Using data from emerging markets, Bekaert et al. (2001) finds that stock market liberalization contributes to growth shortly after liberalization, but the impacts diminish in the long run. Quinn and Toyoda (2008), using intensity measures of capital and current account openness, find that capital account liberalization has a positive association with economic growth.

Although few studies find direct impact of capital controls on economic growth, some studies do find indirect relation between the two. Eichengreen and Leblang (2003) find that capital controls serve to insulate economies from international crises and result in faster growth. Chanda (2005) finds that, for countries with relatively higher degrees of ethnic heterogeneity, the effects of capital controls on economic growth are particularly adverse whereas for countries with high degrees of homogeneity, capital controls actually have a net positive effect on economic growth. Satyanath and Berger (2007) report that capital controls negatively affect growth in authoritarian countries, while growth in democratic countries is insignificantly affected.

One possible explanation about why these studies cannot find a direct effect is that the measure of capital controls is too coarse or too broad. IMF's AREAER before 1995 only supports information about whether a country uses capital controls or not. Quinn's

[6] The measure is ranging from 0-2 (0, 0.5, 1, 1.5, or 2), which is based on the severity of restrictions (existence of approval requirements and frequency of approval).

measure considers intensity of capital controls but has limited countries coverage and is subjective. Furthermore, neither measure considers sub-categories of capital controls. It is possible that direct investment is more likely to affect long-run economic growth than portfolio flows, so capital controls on direct investment may be more significant than on other types of flows. Therefore, a more detailed dataset considering intensity, types of capital controls, and large coverage of countries would be better to study the effect of capital controls on economic growth.

Another strand of studies pays more attention to the de facto measure of capital control or the opposite -- capital mobility (financial integration). In this branch, capital mobility is often measured as capital flows or stocks as share of GDP. The logic behind this approach is that government official restrictions may not capture the true level of capital controls, to which the actual change in capital flows can be a better proxy. Taking this approach, empirical works by Kraay (1998), O'Donnell (2001), Reisen and Soto (2002), Edison, et al. (2002), and Schularick and Steger (2010) have found mixed impact of financial integration on economic growth. The advantage of this de facto measure of capital controls is that it provides more information regarding the real level of a country's capital mobility. However, policymakers cannot directly alter the actual level of capital flows but can only influence it through de jure policies. To policy makers, how de jure measures can affect a country's economic growth would be of more interest than de facto measures.

Despite rich literature on both measures of capital controls, few studies consider the linkage between the two measures. A few studies such as Kraay (1998), O'Donnell (2001), Edison, et al. (2002), and Quinn and Toyoda (2008) either use de jure or de facto measure as an alternative to each other, but never consider possible interaction effect between the two. The de jure capital controls measure reflects the existence of restrictions on capital flows, while the de facto measure captures the realized capital flows. Countries with very different de jure policies may experience quite different international capital flows. For instance, capital flight from some Latin American countries such as Brazil in the 1970s and 1980s are examples of involuntary de facto financial integration in economies that are de jure closed to financial flows. On the other hand, some countries in Africa such as Uganda have few capital account restrictions but have experienced only

minimal levels of capital flows (Prasad, et al., 2007). As the two measures report two different aspects of a country's capital mobility, the results obtained from either measure could be partial and even biased. The possibility that countries with high capital flows may impose capital control policies for economic performance purposes cannot be ruled out. Also, countries with few capital flows may not impose capital control policies because there is no need for regulation. It would be interesting to evaluate government official capital restrictions after controlling for the actual level of capital flows and the interaction effect between de jure capital controls and de facto capital flows on economic growth.

Given the ambiguous results and limitations of previous studies, this paper tries to revisit the relation between capital controls and economic growth with new elements. First, to address drawbacks of de jure measures on capital controls used by past studies, this paper uses a novel dataset about restrictions on capital flows. According to economic theory, international capital flows may not promote economic growth if they are misallocated such as allocated to financial speculative areas. In other words, different types of capital flows – stocks, bonds, or direct investment – may yield different results to economic growth. This dataset uses disaggregated data on capital control such as controls on equity or on direct investment instead of a coarse 0/1 measure employed in most previous studies. With this disaggregated measure on different forms of capital controls, policy makers can discover more detailed relations between capital controls and economic growth. In addition, the data reflects the intensity of capital controls by construction.[7] The data may capture the differences in capital controls across countries and provide a better estimation for the effect of capital controls.

Second, this paper gives equal look at both de jure and de facto measures of capital controls in one empirical setup. The use of either de jure or de facto measure may provide a partial picture of capital mobility as discussed above. To better evaluate how official capital control policies work, de facto capital flows need to be controlled rather than referring them as alternatives to de jure policies. Also, capital control policies may have non-linear effects on economic growth depending on the actual level of capital flows. An

[7] See section 2 for more detailed discussion on data construction.

interaction between de jure policies and de facto flows needs to be considered jointly with their individual effects.

With a novel dataset and a more careful treatment to de facto and de jure measures of capital controls, this paper finds that 1) capital control policies promote economic growth after taking into account a country's de facto level of capital flows, while higher de facto capital flows is associated with higher growth rate and the positive effect of capital controls tends to be weakened as de facto level of capital flows increases. 2) Controls on capital inflows promote economic growth, while controls on outflows have little impact on growth. Again, de facto level of capital flows tends to weaken the positive effect of capital controls on inflows. 3) Restrictions on different asset types affect differently on growth. Capital controls on equity-type flows impede growth; controls on debt-type flows promote growth; controls on direct investment have positive but insignificant effects on growth.

The paper is constructed as follows. Section 2 describes the dataset. Section 3 illustrates the methodology. Section 4 reports the main results. Section 5 examines the robustness of the results. Section 6 concludes.

3.2. Data

The most crucial part for examining the relation between capital controls and economic growth is to measure the existence and the intensity of capital controls. As de jure and de facto measures of capital controls measure two different aspects of a country's capital control status, it is important to consider both simultaneously. This paper takes into account both de jure and de facto measures in a uniform setup.

To measure the actual level of capital controls, this paper follows previous studies (i.e. Edison, et al., 2002), using the estimated stocks of foreign assets and liabilities as a share of GDP. The data source is from the IMF's international financial statistics (IFS) for the period 1995-2009.

To measure the intended level of capital flows of policy makers, a novel dataset is used. The methodology used for constructing the dataset is similar to that of Schindler (2009). The original data source is the IMF's AREAER. Until 1995, AREAER reports each country's overall capital controls status using the 0/1 dummy; beginning 1995, the

IMF breaks down the simple measure to several categories according to capital flows' asset type, ownership, and direction of flows. Based on this new coding system, Schindler first codes the restrictiveness of controls at the level of individual transactions, and then takes average of these subindices to obtain more finely gradated asset- or inflow/outflow- specific indices.[8] The advantages of this dataset include 1) restrictions on capital controls can be identified according to flows' asset type or direction of flows; 2) the intensity of capital control policies is also considered because of the coding method (see footnote 3). Schindler (2009)'s original paper covers the period from 1995 to 2005. This paper updates the data to 2010.

As a growth paper, the choice of growth variable and other control variables in this paper follows previous studies quite closely.[9] The growth rate of a country is calculated using real GDP per capita. The data source is Penn World Table (PWT) 7.0. Control variables include investment (investment to GDP ratio), inflation rate, schooling, life expectancy, initial income (initial per capital GDP), population growth rate, financial development (private credit to GDP ratio), trade openness (trade volume to GDP ratio), exchange rate regime, and domestic institution. The data source of investment, inflation rate, initial income, population growth rate, and trade openness is PWT 7.0. The source of schooling, life expectancy, and financial development is from World Bank's world development indicators (WDI). Exchange rate regime is from Klein and Shambaugh (2008). The original paper only covers data up to 2006, so this paper updates the data to 2010.

The main dataset is a 3-year average panel dataset covering 78 countries – developed and developing – during 1995-2009. In growth literature, five-year averages have used as a standard method to minimize cyclicality of the data. In this study, due to

[8] i.e. equity transactions are classified into four types: residents buying or selling assets abroad, and nonresidents selling or buying domestic assets. Each of these basic transactions is coded as 1 if restrictions exist and 0 otherwise. Thus, an aggregate equity controls index would be the average of four binary variables and could thus take on five different values: 0, 0.25, 0.5, 0.75, or 1. The equity inflow and outflow indices, respectively, are the average of two underlying transaction variables, thus potentially assuming three values: 0, 0.5, or 1. The construction of these variables takes different values like 0, 0.25, 0.5, 0.75, or 1, implicitly measuring the intensity of capital controls.

[9] See Levine and Renelt (1992) for more discussion on possible control variables.

the relatively short period of available data on capital controls, I only take three-year averages for more observations. Table 3.1 provides descriptive statistics of the variables used in the paper. Capital control variables range from 0 to 1 by construction. The average 3-year overall capital controls is 0.35, which suggests a moderate level of de jure restrictions on capital flows worldwide. The average 3-year overall capital stock is 241% with a large standard deviation, a minimum of 6% (Russia 1995-1997) and a maximum of 3797% (Ireland 2007-2009). The worldwide average 3-year growth rate is 8% meaning a 2.7% annual growth rate.

3.3. Methodology

The following regression equation is estimated to investigate the effectiveness of capital control policies on economic growth.

$$\Delta y_{it} = \alpha + \beta\, CCDJ_{it} + \lambda CCDJ_{it} * CCDF_{it} + \delta\, CCDF_{it} + \gamma\, X_{it} + \epsilon_{it} \qquad (1)$$

where i and t denote country and year. y_{it} is the natural log of a country's GDP. Δy_{it} measures a country's growth rate. $CCDJ_{it}$ is a vector of de jure capital control variables including restrictions on capital inflows and outflows and restrictions across different asset categories. $CCDF_{it}$ is a vector of de facto capital control variables including realized capital stocks to GDP ratio across different asset type and direction of flows. In some regressions, an aggregate capital control variable of de jure and de facto is used instead. Including both measures in a single equation can help identify the true effects of government capital control policies on economic growth after controlling for the actual level of capital flows. X_{it} is a group of control variables which are potential determinants of economic growth, including investment as a share of GDP, inflation rate, schooling, life expectancy, initial income, population growth rate, financial development, trade openness, and exchange rate regime. Most of these variables are commonly used in growth literature. In this model, I also include financial development, trade openness, and exchange rate regime, as these variables are closely linked to capital flows and capital account convertibility.

To estimate Eq. (1), dynamic panel data system generalized method of moments (GMM) estimation is used. The estimation is pioneered by Arellano-Bond (1991) and Arellano-Bover (1995)/Blundell-Bond (1998).

The system GMM estimation is developed to address a general model as follows:

$$y_{it} - y_{it-1} = (\alpha - 1)y_{it-1} + \beta x_{it} + \epsilon_{it}$$

$$\epsilon_{it} = \mu_i + \upsilon_{it}$$

$$E(\mu_{it}) = E(\upsilon_{it}) = E(\mu_{it}\upsilon_{it}) = 0$$

where the disturbance term has two orthogonal components: the fixed effects, μ_i, and the idiosyncratic shocks, υ_{it}.

System GMM is popularly used in growth literature because of its advantages over other estimations such as OLS. First, the estimation addresses omitted variable bias by construction: system GMM uses data transformations such as first-difference or "orthogonal deviations"[10] for each individual to remove individual fixed effect. For instance, using first-difference, $\Delta y_{it} = (\alpha - 1)y_{it-1} + \beta \Delta x_{it} + \upsilon_{it}$. The individual fixed effect, μ_i, is removed from the model. Second, if some explanatory variables may be endogenous, lagged values of the variables are used as instruments. In this way, potential endogeneity problems can be mitigated. Third, growth rate of a country has been proved to be dependent on initial income, and system GMM allows the dynamic of dependent variable – growth rate. Fourth, it avoids Hurwicz bias which would bias the estimator downward when the time dimension of the panel is short in a dynamic model. Moreover, Windmeijer (2005) develops a small-sample correction to improve the accuracy of standard errors provided by the estimation, which makes the estimation more practical. Overall, system GMM estimation provides less biased results than conventional estimation methods such as pooled OLS or fixed effect panel regression.

3.4. Results

3.4.1 Preliminary analysis

Figure 3.1 provides an overview of world capital market. The dashed line shows the de facto average capital stocks of each country. World capital stocks as a share of GDP are doubled from 1995 to 2009, reflecting a fast past pace of the financial globalization. The global financial crisis of 2007-2009 did decrease the capital flows, but they recovered quickly. Solid line shows the average government restrictions on capital

[10] See Arellano-Bover (1995) for a full discussion.

flows. The restriction is ranged from 0 to 1 (highest restriction) for every country. Before the recent global financial crisis, the overall tendency is removing capital controls. However, during crisis, many countries reversed their capital account liberalization process in order to insulate themselves from spillovers of the crisis.

Table 3.2 reports some basic correlation tests between capital control policies and actual capital flows. From the table, correlations within different capital flows or within different capital control policies are usually high in the same direction. However, capital flows and restrictions on capital flows have a low correlation. Capital controls seem to run the course of limiting capital flows in general. This result provides support for the idea that the two different measures measure different aspects of a country's capital mobility. This result suggests that de jure and de facto measures could be considered independently rather than alternatively.

Table 3.3 shows how de jure capital control policies may affect de facto level of capital flows. The 20% percentile overall capital controls, ka, has a value of 0; 20% to 80% percentile ka ranges from 0 to 0.77; 80% and above percentile ka ranges from .77 to 1. In general, means of capital flows are decreasing in ka -- the heavier the restrictions on capital flows are, the lower the actual capital flows are. De jure capital controls seem to achieve its initial goal of controlling capital flows.

3.4.2 Main results

Table 3.4 contains a panel of four regressions with different specifications on capital flows and capital controls.[11] Regression 1 evaluates the effect of capital controls on growth in general. Overall, capital control policies would help improve a country's economic growth rate and they serve well a filter to prevent undesired international capital flows. While a higher level of capital mobility measured as capital stocks to GDP ratio will also increase growth rate. This result suggests that financial integration is good for economic growth. In addition, greater financial integration would decrease the positive effect of capital control policies. This can be explained by international monetary policy trilemma. Holding exchange rate system as fixed, countries with higher capital

[11] Control variables are included but not reported in each regression in table 4-6 in order to save space.

mobility are less capable of implementing monetary policy and achieving macroeconomic goals in the economy. But in total, the effect of de jure controls dominates that of de facto controls in magnitude. This implies that financial integration is good for economic growth but needs to be managed and regulated well with de jure policies.

Regression 2 distinguishes capital flows in terms of direction of flows. The overall capital control measure is replaced by controls on inflow and outflow. Similarly, the overall capital stock is split to capital inflows and outflows. The results show that capital controls on inflow increase growth rate maybe due to the fact that controls on inflow are used to absorb desired capital inflows and prevent undesired inflows. Yet controls on outflow have limited effect on economic growth. An explanation is that controls on inflows are often precautious policies and would be regulated well, while controls on outflows are often last-minute policies in desire to rescue the economy already in deep recession and are not well regulated. A high level of capital inflows also promotes economic growth as more economic resources are available from international capital market for domestic development. Similarly, a high level of capital outflows reduces growth as less external resources are available for home market. The positive effect of controls on capital inflow decreases in the level of capital inflows, which again can be explained by the international monetary policy trilemma.

Regression 3 distinguishes capital controls and flows in terms of asset type including the most important ones – equity, debt, and direct investment. The results show that restrictions on equity type flows decrease growth, which is consistent with the finding that stock market liberalization promote economic growth (Bekaert et al. 2001). In contrast, restrictions on debt increase the growth rate. Restrictions on direct investment increase growth rate but not significantly. Capital flows and interaction terms no longer significantly affect economic growth after breaking down to different asset type. However, F-test rejects the null of no effect of those three types of capital flows on growth as a whole.

Regression 4 distinguishes capital controls and flows in terms of both asset type and direction of flows. This specification does not show any significant results which

may due to some potential multicollinearity problems. However, the signs of variables tend to be consistent with other regressions.

In sum, some interesting results have been found in this panel of regressions. First, de facto and de jure measures of capital controls measure two different aspects of a country's level of capital mobility or financial integration, which may explain why the effects of these two measures of capital controls on growth seem different from previous studies. The results show that both more capital control polices and a higher level of capital flows help a country's economic growth. This suggests financial integration promotes economic growth, but it needs to be managed by de jure policies, which serve as a filter to international capital flows. Second, capital controls on different types of flows may affect growth differently. Controls on inflows increase growth rate, yet controls on outflows have little impact on growth. Controls on debt and direct investment flows help the economy more than those on equity flows.

3.5. Robustness check

Although using multiple-year average data has been a standard in growth literature, it is still interesting to see the results using annual data without any averaging because it can capture the capital control policies that are subject to change more frequently. Table 3.5 reports results from annual data using identical system GMM estimation and specifications as does Table 3.4. These results are consistent with what I have obtained using 3-year average data in terms of coefficient signs, although some may not be as significant as table 3. The lack of significance may be due to the effect of business cycles, which shadows the effect of capital controls. Overall, Table 3.5 serves well for robustness check purpose.

Cross-sectional regression is suitable for permanent growth effects such as education in general; however, when facing the effect of capital controls, cross-sectional regression is no longer appropriate. As argued by Henry (2007), the effect of capital account liberalization on growth is more like a short-run (less than 5 years) rather than a long-run effect. But for the purpose of robustness check, it is worth comparing the panel results with cross-sectional results. Table 3.6 reports pure cross-sectional results during 1995-2009. To address endogeneity issues, all explanatory variables are calculated using

data from the first half (1995-2001) of the whole period. The results are in line with the main findings of this paper as most coefficients have the same signs.

3.6. Conclusion

The role of capital controls or capital mobility on growth has been debated for a long time, yet the empirical evidence is still far from conclusive.

This paper revisits this long-lasting topic using a novel dataset and a new empirical framework. First, following Schindler (2009), we construct the de jure measure of capital controls according to the asset types and directions of capital flows. In addition, the data considers the intensity of capital controls by construction. With the new dataset, more detailed results can be found. Second, as de jure and de facto measures of capital controls report two different aspects of a country's level of capital mobility, the results obtained from using either measure only could be partial and even biased. Therefore, this study considers both measures simultaneously. With this improved setup, some interesting results merge.

They can be summarized as follows: 1) capital control policies promote economic growth after taking into account a country's de facto level of capital flows. At the same time, greater de facto capital flows are associated with higher growth rate. And the effectiveness of capital control policies seems to be weakened as a country involves in the international capital market more deeply. 2) Controls on capital inflows do help a country's economic growth, while controls on outflows have less impact on growth. Again, a high level of de facto capital flows weakens the positive effect of capital controls on inflows. Restrictions on different asset types of capital flows affect growth differently. Capital controls on debt flows and direct investment seem to be more effective than those on equity flows.

Indeed, from the results in this paper, overall financial integration promotes economic growth, but de jure capital control policies are also necessary and even more important for a country to absorb the desired capital flows from international capital flows and prevent undesired capital flows which may in turn impede economic growth. It is ideal for a country to abstract more international capital flows in a managed and

regulated way. In addition, instead of looking for a one-size-fit-all policy, policymakers should be more discretionary when interacting with international financial market.

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Figure 3.1. World capital mobility 1995-2009

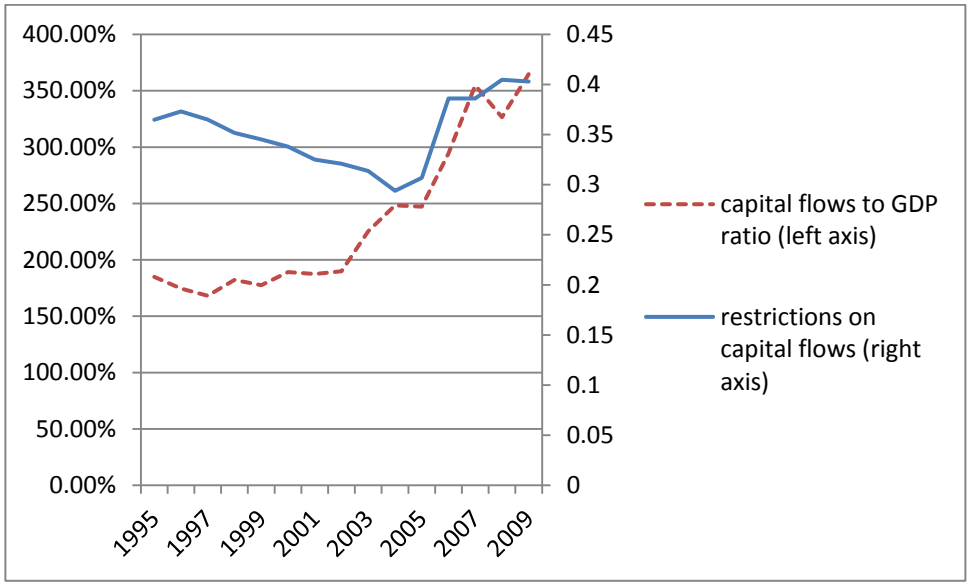

Table 3.1. Descriptive statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Dependent variable						
growth	growth rate	364	0.081	0.082	-0.160	0.495
De jure capital controls						
ka	Overall control	455	0.352	0.344	0.000	1.000
kai	inflow control	455	0.321	0.327	0.000	1.000
kao	outflow control	455	0.383	0.389	0.000	1.000
eq	equity control	455	0.358	0.368	0.000	1.000
debt	debt control	455	0.333	0.387	0.000	1.000
di	direct invest control	455	0.393	0.388	0.000	1.000
eqi	equity inflow control	455	0.319	0.375	0.000	1.000
debti	debt inflow control	455	0.275	0.386	0.000	1.000
dii	di inflow control	455	0.472	0.468	0.000	1.000
eqo	equity outflow control	455	0.397	0.420	0.000	1.000
debto	debt outflow control	455	0.392	0.427	0.000	1.000
dio	di outflow control	455	0.314	0.447	0.000	1.000
De facto capital controls (all flows here mean capital stocks)						
flowg	gross flow to GDP	345	2.414	4.011	0.059	37.974
inflowg	inflow to GDP	345	1.263	1.959	0.026	19.427
outflowg	outflow to GDP	345	1.150	2.081	0.020	18.546
flowg_di	di flow to GDP	350	0.456	0.738	0.000	6.634
flowg_eq	equity flow to GDP	346	0.297	0.806	-0.000	9.253
flowg_debt	debt flow to GDP	346	0.445	0.974	0.000	11.675
inflowg_di	di inflow to GDP	350	0.268	0.378	0.000	3.512
inflowg_eq	equity inflow to GDP	349	0.157	0.505	-0.000	6.161
inflowg_debt	debt inflow to GDP	349	0.217	0.449	0.000	4.453
outflowg_di	di outflow to GDP	350	0.188	0.382	-0.007	3.122
outflowg_eq	equity outflow to GDP	346	0.138	0.321	0.000	3.092
outflowg_debt	debt outflow to GDP	346	0.226	0.607	0.000	7.222
Control variables						
ki	investment to GDP (%)	455	23.094	7.311	5.324	48.538
peg	exchange rate regime	455	0.368	0.445	0.000	1.000
openk	trade openness (%)	455	85.018	54.966	17.237	429.911
fin_dvp	financial development (%)	448	62.762	52.156	2.714	257.285
inflation	inflation rate (%)	433	14.814	115.135	-2.405	2345.359
life_exp	life expectancy	455	71.128	8.798	41.706	82.675
sec_sch_gro	2nd school enrollment (%)	414	82.224	28.132	5.366	158.453

Table 3.2. correlation between capital control policies and actual capital flows

	ka	flowg				
ka	1					
flowg	-0.2481	1				
	kai	kao	inflowg	outflowg		
kai	1					
kao	0.8563	1				
inflowg	-0.2121	-0.2485	1			
outflowg	-0.2303	-0.2516	0.9708	1		
	eq	mm	di	flowg_eq	flowg_debt	flowg_di
eq	1					
mm	0.8544	1				
di	0.7813	0.7495	1			
flowg_eq	-0.2071	-0.2095	-0.1413	1		
flowg_debt	-0.2196	-0.2375	-0.1219	0.8906	1	
flowg_di	-0.2178	-0.2368	-0.1828	0.6041	0.5168	1

Table 3.3. Mean of capital flows by de jure overall capital controls ka

ka percentile	20% and below	20% to 80%	80% and above
value of ka	0	0 to 0.77	0.77 to 1
		mean	
flowg	2.893	2.765	0.687
flowg_eq	0.401	0.341	0.027
flowg_debt	0.474	0.560	0.041
flowg_di	0.644	0.474	0.164

Table 3.4. 3-year average system GMM estimation during 1995-2009

Dependent variable: growth rate							
Regression	1		2		3		4
capital controls	coefficient	capital controls	coefficient	capital controls	coefficient	capital controls	coefficient
ka	0.0711*	kai	0.148*	eq	-0.0974**	eqi	-0.032
	(0.0421)		(0.0765)		(0.0474)		(0.0517)
ka×flowg	-0.0254**	kao	-0.0526	debt	0.0926**	debti	0.0586
	(0.0121)		(0.0579)		(0.0431)		(0.0487)
flowg	0.00964*	kai×inflowg	-0.0952**	di	0.0192	dii	0.0149
	(0.00509)		(0.0381)		(0.0427)		(0.0316)
		kao×outflowg	0.0257	eq×flowg	-0.02	eqi×inflowg	-0.389
			(0.0167)		(0.091)		(0.244)
		inflowg	0.0620**	debt×flowg	-0.0732	debti×inflowg	-0.127
			(0.0252)		(0.0525)		(0.159)
		outflowg	-0.0438**	di×flowg	0.0305	dii×inflowg	-0.0913
			(0.0193)		(0.056)		(0.0694)
				flowg_di	-0.00981	inflowg_di	0.181
					(0.0338)		(0.125)
				flowg_eq	-0.0238	inflowg_eq	0.0477
					(0.0272)		(0.0574)
				flowg_debt	0.0254	inflowg_debt	0.0581
					(0.0239)		(0.0596)
						eqo	-0.0264
							(0.0417)
						debto	0.0112
							(0.048)
						dio	0.0195
							(0.0622)
						eqo×outflowg	0.238
							(0.318)
						debto×outflowg	-0.059
							(0.11)
						dio×outflowg	0.0984
							(0.221)
						outflowg_di	-0.0581
							(0.0742)
						outflowg_eq	-0.104
							(0.155)
						outflowg_debt	-0.0304
							(0.0349)
Observations	281		281		278		278
countries	78		78		78		78

Note: Robust standard errors in parentheses. Control variables are included but not reported in each regression.

Table 3.5. Annual data system GMM estimation during 1995-2009

Dependent variable: growth rate							
Regression	1		2		3		4
capital controls	coefficient	capital controls	coefficient	capital controls	coefficient	capital controls	coefficient
ka	0.0296	kai	0.0366	eq	-0.0138	eqi	-0.0335*
	(0.0266)		(0.0258)		(0.0209)		(0.02)
ka×flowg	-0.00627	kao	0.00559	debt	0.0298*	debti	0.0398
	(0.00454)		(0.0188)		(0.0168)		(0.024)
flowg	0.00527**	kai×inflowg	-0.0218*	di	0.014	dii	-0.0117
	(0.00262)		(0.0129)		(0.0156)		(0.0127)
		kao×outflowg	0.00125	eq×flowg	0.021	eqi×inflowg	0.0651
			(0.00875)		(0.0389)		(0.212)
		inflowg	0.000734	debt×flowg	-0.015	debti×inflowg	-0.161
			(0.00698)		(0.0185)		(0.211)
		outflowg	0.00859	di×flowg	-0.00459	dii×inflowg	0.0321
			(0.0066)		(0.0184)		(0.0267)
				flowg_di	-0.00124	inflowg_di	-0.0235
					(0.0105)		(0.0442)
				flowg_eq	0.00301	inflowg_eq	0.0222
					(0.00841)		(0.0452)
				flowg_debt	0.000195	inflowg_debt	-0.0133
					(0.00793)		(0.0147)
						eqo	0.00541
							(0.0215)
						debto	0.0258
							(0.0223)
						dio	-0.00407
							(0.0164)
						eqo×outflowg	-0.0117
							(0.108)
						debto×outflowg	-0.0926*
							(0.0532)
						dio×outflowg	0.105
							(0.119)
						outflowg_di	0.000916
							(0.0507)
						outflowg_eq	0.0106
							(0.0362)
						outflowg_debt	-0.00567
							(0.0239)
Observations	791		791		788		788
countries	78		78		77		77

Note: Robust standard errors in parentheses. Control variables are included but not reported in each regression.

Table 3.6. Cross-country OLS estimation during 1995-2009

Dependent variable: growth rate							
Regression	1		2		3		4
capital controls	coefficient	capital controls	coefficient	capital controls	coefficient	capital controls	coefficient
ka	5.525	kai	6.145	eq	-11.75	eqi	4.418
	(11.23)		(18.48)		(14.66)		(14.25)
ka×flowg	-7.549***	kao	-0.173	debt	23.16**	debti	25.57
	(2.692)		(12.71)		(11.45)		(15.77)
flowg	1.284**	kai×inflowg	-3.802	di	-7.834	dii	-2.934
	(0.558)		(13.08)		(8.931)		(7.305)
		kao×outflowg	-12.27	eq×flowg	-50.43	eqi×inflowg	-122.5
			(19.06)		(76.87)		(142.4)
		inflowg	-0.834	debt×flowg	-48.91	debti×inflowg	-112.3
			(7.153)		(34.93)		(122.6)
		outflowg	2.988	di×flowg	23.08	dii×inflowg	5.601
			(6.633)		(33.48)		(36.02)
				flowg_di	4.322	inflowg_di	12.15
					(5.015)		(21.34)
				flowg_eq	-2.208	inflowg_eq	16.81
					(7.768)		(11.59)
				flowg_debt	5.178	inflowg_debt	-1.229
					(8.264)		(25.66)
						eqo	-19.38
							(15.01)
						debto	5.391
							(13.45)
						dio	-0.25
							(12.51)
						eqo×outflowg	54.59
							(179.8)
						debto×outflowg	-33.81
							(32.26)
						dio×outflowg	-49.87
							(139.7)
						outflowg_di	2.969
							(28.53)
						outflowg_eq	-50.06
							(38.26)
						outflowg_debt	6.777
							(19.87)
countries	68		68		68		68
R-squared	0.398		0.398		0.414		0.465

Note: Robust standard errors in parentheses. Control variables are included but not reported in each regression. To address endogeneity issues, all explanatory variables are calculated using data from 1995-2001.

Chapter Four

Exchange Rate Flexibility and Current Account Adjustment: A Threshold VAR Analysis

4.1. Introduction

The role of exchange rate flexibility in current account (CA) adjustment is a perennial issue in international finance. The founders of the Bretton Woods system believed that maintaining the fixed exchange rate system worldwide would bring prosperity to the world economy. This system could insure the stability of cross-country economic activities. Friedman (1953) argued against this opinion. He believed that exchange rate was the result not the cause of economic imbalances. A market-driven change in exchange rate is the consequence of economic balancing between countries; a flexible exchange rate system, in fact, would make corrections to potential economic imbalances, especially external imbalances such as CA balances, by allowing the exchange rate to be determined by market. Unlike Friedman's direct argument on exchange rate flexibility and CA balances, most theoretic models including Mundell (1962), Dornbusch (1980), and Obstfeld and Rogoff (1995) focus on the relation between real exchange rate (RER) and CA balances. In all of these models, CA adjustment is following the movement of RER, regardless of whether the nominal exchange rate regime is fixed or flexible. In particular, RER adjustment will occur in response to a CA imbalance either via money-supply and price-level movements under a fixed exchange rate system or via movements in nominal exchange rate under floating exchange rate system. The point is due to sticky price and wages, the movements in price level is very slow and costly while the change in exchange rate seems less costly. This implies the hypothesis that flexible exchange rate facilitates CA adjustment. Despite the hypothesis implied by theory, there had been few empirical studies for many years until recently. Thanks to the hot discussion regarding global imbalances, empirical studies regarding exchange rate flexibility and CA adjustment have emerged.

The global imbalances, some countries with huge CA deficits mapped by other countries' large CA surplus, has attracted economists' attention. In recent years, discussions are focusing on the sustainability of the CA imbalances given that the global imbalance is so large and persistent. In particular, two issues seem to be important. First,

how fast are imbalances in the CA adjusted? To the first question, Taylor (2002) responds that the every country will show CA balancing (stationary CA) at least in very long term (a century long period). However, the CA is non-necessarily mean-reversion in one or two decades. Given the potential long mean-reversion time, the second question tends to be really important – does greater exchange rate flexibility promote the adjustment in the CA? As argued by Friedman and implied by theory regarding RER and CA balances, the answer to this question seems to be yes. Many policy makers take this as a must-do suggestion to facilitate CA adjustment, but Chinn and Wei (2013) call this as a faith-based initiative without empirical support.

As probably the first paper to empirically and systematically examine the relation between exchange rate flexibility and CA adjustment, Chinn and Wei (2013)'s paper uses panel regression and some commonly used exchange rate regime classifications to argue that exchange rate flexibility does not make clear contribution to CA adjustment. The authors use Levy-Yeyati and Sturzenegger (2003) and Reinhart and Rogoff (2004) classifications to capture exchange rate flexibility. Based on different exchange rate regimes, they divide the full sample (170 countries over 1971-2005) into different subsamples and estimate a first-order autoregression model in each subsample. By comparing the estimated first-order autoregressive coefficients across different exchange rate regime subsamples, they find no clear evidence that CA adjustment is faster under more flexible exchange rate regimes than under less flexible regimes. They also create a dummy for each exchange rate regime as an alternative to splitting the full sample. By comparing the coefficients among interactions between these dummies and lagged value of CA balances, they confirm their main findings. In addition, their results are not altered by adding more control variables, adding squared terms of CA to address non-linearity, or using two-stage regression to address endogeneity of exchange rate regimes. Similar to Chinn and Wei, Kim (1991) find little influence of exchange rate flexibility on trade balance (main component of CA balance) adjustment using the US data. Also, Decressin and Stavrev (2009) do not find a strong link between CA dynamics and RER rigidity across the European Economic and Monetary Union countries.

Despite the systematic study from Chinn and Wei, some studies such as Herrmann (2009) and Ghosh et al. (2013) reject Chinn and Wei's conclusion by arguing their

inappropriate use of exchange rate regime classifications. Instead, they construct their own classification on exchange rate flexibility and find that flexible exchange rate substantially facilitates CA adjustment.

Another related strand of literature on CA adjustment examines the effect of exchange rate regimes on the probability of incurring CA reversals. Milesi-Ferreti and Razin (2000), Adalet and Eichengreen (2007), De Haan et al. (2008), Pancaro and Rueffer (2009), and Mu and He (2013) in general find that flexible exchange rate regime tends to increase the probability of CA reversal, although results from some studies are not statistically significant.

The presumption of any similar study on exchange rate flexibility is that a country's exchange rate regime captures its exchange rate flexibility. Exchange rate regime classification is not a trivial but in fact a really difficult task. The IMF's conventional de jure classification is known for its inconsistency with countries' de facto exchange rate regimes.[12] To capture a country's true exchange rate regime, Levy-Yeyati and Sturzenegger (2003), Reinhart and Rogoff (2004), and Klein and Shambaugh (2008) developed their own de facto classifications (more detailed discussion in section 2). However, from the results of this paper in section 2, we find that some existing widely used exchange rate regimes may not capture exchange rate flexibility as well as expectation. Therefore, some studies relying on the above classifications such as Chinn and Wei (2013)'s paper needs close scrutiny.[13]

Does exchange rate flexibility really matter for CA adjustment? In this paper, we reconsider the question and extend empirical analysis in at least three dimensions. First, our study uses a large panel dataset containing a long time series (up to 2010) as well as a large country group (90 countries). Second, we measure exchange rate variability using the actual market effective exchange rates instead of bilateral rates against the base country or using existing popular exchange rate regime classifications. Third, we employ

[12] i.e. Philippines announced float in late 1980s, but were "soft peg" in the following 1990s until financial crisis in the late 1990s. Similar experience applies for many other Southeast Asian countries.

[13] Interestingly, we find that even in Chinn and Wei's paper, exchange rate regime with the lowest exchange rate flexibility (based on the constructed variables in this paper) does exhibit most current account persistency.

a threshold VAR model and classify exchange rate regimes based on actual exchange rate movements.

We find that first, the speed of CA adjustment is higher in a regime with greater exchange rate variability. This result is consistent with Friedman's hypothesis. Second, using our own constructed exchange rate variability variables, we find that some existing exchange rate classifications may not capture actual exchange rate variability as well as expected. The unconventional result from Chinn and Wei (2013) is probably due to the inability of capturing exchange rate variability by some regime classifications for certain exchange rate regimes.

The remainder of the paper is organized as follows. Section 2 checks the relation between exchange rate regime and exchange rate variability. Section 3 exhibits the Threshold VAR estimation of exchange rate variability and CA adjustment. Section 4 describes the data used in the paper. Section 5 reports the estimation results. Section 6 show results from some existing exchange rate regime classifications. Section 7 concludes.

4.2. Exchange rate regime classifications and exchange rate flexibility

An exchange rate regime, by definition, reflects how the exchange rate authority manages its currency in relation to other currencies and the foreign exchange market. Regime classification is no easy task. As Klein and Shambaugh (2010) noted in their book, "Exchange rates are precisely measured. Exchange rate regimes are not." The IMF first developed its exchange rate regime classification (covering 1970-1999) which was based on countries' official notifications to the Fund. The de jure classification distinguished between three broad categories—pegged regimes, regimes with limited flexibility (usually within a band or cooperative arrangement), and more flexible arrangements (those with managed or free floats)—which were divided into 15 subcategories.[14] One main problem with this *de jure* classification is that there are wide

[14] The classification consists of three large categories including hard pegs, soft pegs, and floating arrangement. Hard pegs includes no separate legal tender and currency board; soft pegs includes conventional pegged arrangement, stabilized arrangement, pegged exchange rate within horizontal bands, crawling peg, and crawl-like arrangement; floating arrangement includes floating and free floating.

differences and inconsistencies between government declaration and actual exchange rate variation. For instance, Obstfeld and Rogoff (1995) show that few countries committed to their pegged system to extended periods of time. (They call this phenomenon "the mirage of fixed exchange rate.") In contrast, Calvo and Reinhart (2002) find "fear of floating" – that is, most countries that claim a floating system do extensively intervene in the foreign exchange rate market to stabilize the exchange rate. In response to the inconsistency between the actual and declared classifications, IMF stopped publishing *de jure* classification in 1999 and has started to publish a *de facto* classification since 1998 with similar 15 subcategories. But this de facto classification is relatively short in time horizon and is subject to revision.[15]

Levy-Yeyati and Sturzenegger (2003) (LY-S hereafter), Reinhart and Rogoff (2004) (R-R hereafter), and Klein and Shambaugh (2008) (K-S hereafter) respectively coded their own de facto exchange rate regime classification based on actual data. LY-S classification is based on cluster analysis using data on the mean of absolute monthly percentage change in the bilateral exchange rate in a calendar year (σ_e), the standard deviation of monthly percentage changes in the exchange rate ($\sigma_{\Delta e}$), and the percentage change in net reserves relative to money supply (σ_r).[16] In addition to exchange rate itself, the LY-S scheme captures the change in countries' net reserves in order to identify whether and to what extent the exchange rate authority intervened in the foreign exchange market. However, the combination of information on reverses and exchange rate flexibility may result in misleading conclusion about a country's exchange rate flexibility. For instance, while Hong Kong is well known for its currency board with the

[15] Since 2009, to allow for greater consistency and objectivity of classifications across countries, the IMF has started to revise its classification. See Habermeier et al. (2009) for detailed revision.

[16] The classification provides a 5-way and a 3-way classification. 5-way consists of 1 = inconclusive, 2 = float, 3 = dirty, 4 = dirty/crawling peg, and 5 = fix. 3-way consists of 1 = float, 2 = intermediate, and 3 = fix. The cluster analysis is based on the following table:

	σ_e	$\sigma_{\Delta e}$	σ_r
Inconclusive	Low	Low	Low
Flexible	High	High	Low
Dirty float	High	High	High
Crawling peg	High	Low	High
Fixed	Low	Low	High

HK dollar pegged to the US dollar, the LY-S scheme classifies Hong Kong as inconclusive regime. Thus, while the LY-S scheme may be useful for research on government intervention in the foreign exchange market, it may incorrectly capture a country's exchange rate policy.

The R-R classification codes exchange rate regimes heavily based on the parallel, market-determined exchange rates of a country instead of official rate.[17] The authors argue that this is more economically meaningful to a country's international economic activities. Unlike other exchange rate regime classifications, the R-R coding is based on a five-year rolling window. It first calculates the mean of nominal exchange rate in the 5-year window, then evaluates month by month whether the exchange rate is within certain bands of the mean, and finally calculates the probabilities that the exchange rate remains in each band over any given period such as a 5-year rolling window. This 5-year window however may potentially smooth the exchange rate flexibility and thus fail to capture the short-term dynamics of exchange rates, which makes the classification less comparable to other annual-data based classifications.

The K-S classification takes a more straightforward and less data-demanding method. It mainly relies on the official exchange rate and codes a country as either pegged or non-pegged. In particular, the authors consider a country as having a fixed exchange rate in a given calendar year, with its currency pegged to the currency of a base country, if its month-end official bilateral exchange rate stays within a ± 2 % band both each month and over the course of that year. This classification does a very good job in capturing conventional fixers/pegs, but it also has some limitations. It is a 0/1 dummy variable by construction, which cannot distinguish intermediate and floating regimes and therefore captures less information about a country's exchange rate flexibility.

[17] The classification provides a fine and a coarse classification. The fine classification consists of 1 = no separate legal tender, 2 = pre announced peg or currency board arrangement, 3 = pre announced horizontal band that is narrower than or equal to +/-2%, 4 = de facto peg, 5 = pre announced crawling peg, 6 = pre announced crawling band that is narrower than or equal to +/-2%, 7 = de factor crawling peg, 8 = de facto crawling band that is narrower than or equal to +/-2%, 9 = pre announced crawling band that is wider than or equal to +/-2%, 10 = de facto crawling band that is narrower than or equal to +/-5%, 11 = moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time), 12 = managed floating, 13 = freely floating, 14 = freely falling, and 15 = dual market in which parallel market data is missing. The coarse one consists of 1 = the pool of the fine class 1-4, 2 = the pool of the fine class 5-8, 3 = the pool of the fine class 9-12, 4 = freely floating, 5 = freely falling, and 6 = dual market in which parallel market data is missing.

The above three commonly used exchange rate classifications use bilateral exchange rates vis-à-vis the base currency. One main problem with using the bilateral exchange rate is that it does not necessarily reflect a country's overall exchange rate flexibility. For example, if the Chinese renminbi (RMB) is pegged to the US dollar, and then China is considered to maintain a fixed exchange rate. Yet the RMB floats against other currencies just like the dollar does. Consequently, the effective (or average) exchange rate of the RMB is not fixed. Moreover, the effective exchange rate would not necessarily be more stable when the RMB is pegged to the US dollar than when it "floats" against it (Ghosh et al. 2013). This shows that the bilateral exchange rate is a flawed measure of exchange rate flexibility in the multiple-country world.

A more interesting question would be how closely these commonly used regime classifications are related to a country's actual exchange rate flexibility. For this purpose, we construct four different measures of exchange rate variability: $|\%\Delta neer|$, $|\%\Delta nber|$, $SD(\%\Delta neer)$, and $SD(\%\Delta nber)$. $|\%\Delta neer|$ is the absolute value of annual percentage change in nominal effective exchange rate; $|\%\Delta nber|$ is the absolute value of annual percentage change in bilateral nominal exchange rate; $SD(\%\Delta neer)$ is the standard deviation of monthly percentage change in nominal effective exchange rate in a yearly base; $SD(\%\Delta nber)$ is the standard deviation of monthly percentage change in bilateral nominal exchange rate also in a yearly base.[18] A larger value of each variable means greater flexibility of the exchange rate.

The use of multilateral effective exchange rates is to address the issue that exchange rate regime classification should reflect the country's exchange rate arrangement with all of its trading partners rather than just one "base" currency. But in order to make the exchange rate flexibility comparable to the above regime classifications which use bilateral exchange rate, we also use bilateral exchange rate to construct $|\%\Delta nber|$ and $SD(\%\Delta nber)$. Note that we use both annual changes in the annual exchange rate and the standard deviation of monthly change in exchange rate on a 12-month period. A same change in the exchange rate by the former measure can have vastly

[18] The use of standard deviation is commonly used as a measure of exchange rate flexibility. i.e. Rose (2000), Devereux and Lane (2003), and Levy-Yeyati and Sturzenegger (2003).

different degrees of flexibility according to the second (SD) measure. For instance, a crawling peg/band would have smaller standard deviation than a conventional peg with the same total annual change in the exchange rate. The combination of four different proxies of exchange rate flexibility would give a more comprehensive and reliable evaluation of each regime classification.

Table 4.1 provides a simple correlation test between these 4 measures and the 4 popular regime classifications. The data are from the authors' website. IMF classification is from Carmen Reinhart's website. The raw data of constructed variables are from IMF's international Financial Statistics (IFS). The LY-S 3-way classification and the R-R coarse classification are employed in the table and for other comparison results. The use of the LY-S 5-way and the R-R fine classification yields little difference and thus the results are not reported. Originally a greater value of the LY-S classification means a less flexible exchange rate regime, which is the opposite of the other classifications. For the purpose of comparison, the values are switched so that a larger value means a more flexible exchange rate regime.

Several interesting results emerge. First, within the four constructed variables, correlation between bilateral exchange rate and multilateral effective exchange rate is relatively high (0.5-0.8). This suggests that a country's currency arrangement against other currencies is usually dominated by one major currency. However, the effective exchange rate and the bilateral exchange rate move quite differently as indicated by the correlation coefficient that is significantly less than one. Second, the four popular regime classifications are correlated but not strongly correlated with each other (0.4-0.6). Frankel (2003) also finds low correlation between the IMF, LY-S, and RR classifications (0.2-0.4). This lack of strong correlation reflects the difficulty of the popular regime classification methods to accurately code exchange rate arrangement of countries. Third, the correlation between the 4 measures and the existing de facto regime classifications is quite low (0.05-0.35). This may reflect several facts, 1) regime classifications are discrete measures while exchange rate flexibility measures are continuous variables, which makes the comparison hard to match; 2) the existing regime classifications seem to have difficulty coding actual behavior in the exchange rate (more discussion can be found below in this section); 3) some classifications such as the LY-S use information on

foreign reserves besides the exchange rate itself in regime classification. This seems to make the scheme less comparable with other classification schemes; 4) the four exchange rate flexibility measures employ the market rate rather than the official rate. That is why these measures have a higher correlation with the R-R scheme but a lower correlation with the K-S scheme.[19]

In Table 4.2, we repeat the same exercise for the two groups of countries: OECD and non-OECD. For OECD countries, the exchange rate regime classification fits exchange rate flexibility somewhat better. This seems to suggest that exchange rate classification is a more difficult task for developing (non-OECD) countries. Clearly, heterogeneity among countries makes exchange rate regime classifications more ambiguous. There are several possible reasons. First, most OECD countries adopt either floating or fixed exchange rate regimes; few of them adopt intermediate regimes. Thus, regime classification in this case would be relatively straightforward. On the other hand, a large proportion of non-OECD countries have employed intermediate regimes. As discussed earlier, it is naturally more difficult to determine exchange rate flexibility in intermediate regimes. For instance, if a currency is pegged to an unknown basket of currencies, regime classification has to determine which bilateral exchange rate to use. This is inevitably subjective and thus weakens the accuracy of the classifications. Secondly, OECD countries have a higher quality of legal system. They are more capable of maintaining the exchange rate regime that they choose for a longer period of time. Persistent regimes are more likely to be correctly captured in regime classifications than are temporary regimes. However, for non-OECD countries, the legal system is less reliable and the government is less credible. Government's commitment toward exchange rate regime could be broken more easily by external negative shocks. All these result in frequent flippers – changing exchange rate regimes more often. This flipping activity also increases the difficulty of correctly identifying the exchange rate regimes in non-OECD countries (Alesina and Wagner 2006).

[19] The R-R scheme is using market-determined exchange rate when it is available, but K-S scheme is only using official rate.

To address the country heterogeneity, Table 4.3 uses country-fixed effect panel regression to remove country-time invariant effect (quality of legal system) and reports how the exchange rate regime classification is related to actual exchange rate flexibility. Each regime has a corresponding dummy. The base regime (omitted group) is the fixed exchange rate regime. The coefficient for each regime is the difference of exchange rate variability between base regime and that regime.

Reported R-squared's are generally low, revealing the problems as mentioned in the previous section. Among the 4 classifications, the R-R classification has the highest R-squared's suggesting that it is most closely related to actual exchange rate movement.

Under the R-R classification, shown in the top panel, the base group is the hard peg coded as "1". Interestingly, the soft pegs – coded "2" and "3" – have insignificant effects on exchange rate flexibility over and beyond the hard peg. However, there is a significant difference between hard pegs and floats ("4"). Free falling ("5") has the highest variability.[20]

Under the LY-S classification, the base group is fixers ("1"). Intermediates ("2") have exchange rate variability much larger than fixers and, interestingly, even greater than floaters. This result may reflect the fact that the LY-S classification is based on not only exchange rate movement but also variability in foreign reserves. As can be seen in the table of footnote 16, exchange rate variability is high for both the float and intermediate regimes. The two regimes are distinguished only with the combined use of the variability of foreign reserves.

Under the K-S classification, there are only two groups – pegs and non-pegs – that are exclusively divided by exchange rate movement. Clearly non-pegs are more variable and the differences are statistically significant. The low correlation between the exchange rate flexibility measures and the K-S classification is probably due to the fact that the former employs market exchange rates while the latter does official exchange rates as well as the limited match between continuous numbers and the 0/1 dummy.

[20] Group 6 is not considered because in this group countries that have a dual market do not have parallel market data for classification.

The IMF classification and the R-R coarse classification employ the same coding. Thus, the results are similar for the two. In particular, while floating regimes are most flexible, hard pegs show greater exchange rate flexibility than do soft pegs under some measures of exchange rate flexibility. However, the R-squared is much lower for the IMF classification than for the R-R, reflecting the gap between the claims of the government and their actual actions.

In Tables 4.4 and 4.5, we report the same regressions estimated for the OECD and non-OECD countries, separately. The LY-S and the K-S classifications show similar patterns for both groups of countries compared to the full sample. The R-R classification, however, shows quite different patterns for soft pegs. For the OECD countries, soft pegs seem to be more flexible than floating regimes, which is in line with the phenomenon called the "fear of floating" (Calvo and Reinhart, 2002); yet for non-OECD countries, soft pegs exhibit less flexibility than hard pegs, which is consistent with "the mirage of fixed exchange rate" (Obstfeld and Rogoff, 1995). As argued by Alesina and Wagner (2006), "countries with poor institutional quality have difficulty in maintaining pegging and abandon it often. In contrast, countries with relatively good institutions display fear of floating, perhaps to signal their differences from those countries incapable of maintaining promises of monetary stability."

Table 4.6 compares the mean of exchange rate variability for each group under the four regime classifications. The R-R (except the freely falling regime "6") and the K-S classifications capture exchange rate variability more consistently as the regime becomes more flexible, the mean of exchange rate variability increases. On the other hand, the LY-S and the IMF de jure classifications are not necessarily correlated with actual exchange rate movement.

In summary, this section compares various measures of exchange rate flexibility and four widely used exchange rate regime classifications. The results indicate that that those classifications can only partially related to actual exchange rate flexibility. This conclusion is obtained after considering country heterogeneity.

4.3. Real Exchange Rate and Current Account Adjustment: A Threshold VAR Analysis

4.3.1. A benchmark model

The relationship between the RER and the CA has become one of the key building blocks in open economy modeling. Conventional open economy models suggest that real appreciation (depreciation) of the domestic currency will decrease (increase) the CA balance. In many open-economy models, a floating exchange rate is preferred to a fixed exchange rate mainly because it is expected to facilitate the adjustment of the CA.[21]

To investigate the relation between the RER and the CA, we employ a benchmark vector autoregressive (VAR) model as follows:

$$Y_t = B(L)Y_t + \beta X_t + U_t$$

where Y_t is a vector of endogenous variables including the RER and the CA balances; X_t is a vector of exogenous control variables containing relative income, trade openness, and financial development; U_t is a vector of disturbances.

Rather than using nominal exchange rate, we use RER, which is by definition the nominal exchange rate adjusted for price level. In theory, CA follows the movements of RER either via change in price level (fixed exchange rate system) or via change in nominal exchange rate (floating exchange rate system). In addition, in a low-inflation environment, the real and nominal exchange rates move very similarly (Mussa, 1986). Therefore, RER is more relevant to CA adjustment than is the nominal exchange rate. For the RER, we use the IMF's CPI-based real effective exchange rate, which can better reflect a country's cross-country economic activities than bilateral exchange rate. As documented by the IMF in its IFS database, "it is designed to make it particularly relevant with respect to movements in costs and prices affecting exports and imports of manufactured goods". Discussion about control variables can be found in data section.

Table 4.7 employs the IPS panel unit root test (Im, Pesaran, and Shin, 2003). The results show that the null of unit root is strongly rejected for each variable. The VAR model uses a recursive ordering — $Y_t = [rer_t, ca_t]$. An alternative ordering does not change the basic finding in this paper. The lag length of the endogenous variables is two

[21] i.e. Mundell (1962), Dornbusch (1980), and Obstfeld and Rogoff (1995)

(reasonable for annual data) and is determined by the common information criteria (Akaike, Bayesian, and Hannan–Quinn information criterion). The estimation method used for the VAR model is the least square dummy variable (LSDV) regression. Country dummies are included in the system as exogenous variables besides the control variables mentioned above. This estimation will yield similar performance as famous Arellano-Bond type GMM estimation given the particular panel structure in this paper.[22]

Figure 4.1 shows the impulse responses for the benchmark model. The responses of the REER and CA to a shock in the REER (CA) are shown as real lines on the two panels on the left (right) hand side. The dotted lines show one standard deviation error bands.

An increase in REER (real appreciation) deteriorates the CA although the results are not statistically significant. An increase in CA leads to a decline of the REER (real depreciation). The former is consistent with textbook models while the latter is not. Nonetheless, both REER and CA exhibit strong stationarity.

4.3.2 A Threshold VAR Analysis

One major purpose of this paper is to investigate whether the bilateral relationship between the REER and CA is different in different exchange rate regimes.

As discussed in introduction section, in theory, RER will influence movements in CA balances through two channels – money-supply and price-level movements under a fixed exchange rate system or via movements in nominal exchange rate under floating exchange rate system. Due to sticky price, price-level adjustment is more costly than nominal exchange rate movement. This implies that CA adjustments would be very different under different exchange rate variability regimes. In addition, from the results in the benchmark model section, a pooled VAR system does not capture the relation between RER and CA very well. Therefore, there is a strong need for a test for the existence of any regime-switching effect (threshold effect) in the VAR model. In

[22] In fixed effect panel model containing lags of the dependent variable, the estimator can be severely downward biased when the time series (T) is short regardless of the cross-sectional size of the panel (N). This is known as Hurwicz bias. This bias will disappear when $T \to \infty$. Arrellano-Bond type estimation can correct this bias by introducing instruments if T is small, but it will increase mean squared error due to the nature of IV estimation and more importantly will not correct the bias when T is large. In this paper, the panel consists of 90 countries (N=90) and 31 years (T=31). According to the simulation results of Alvarez & Arellano (2003), Arrellano-Bond GMM and LSDV estimation have similar performance when N=50-100 and T=25-50. When T=31, Hurwicz bias in LSDV is only around 3% (1/31).

particular, we need to see whether CA behaves very differently under different exchange rate flexibility regimes.

To perform a threshold test, a threshold variable is needed. How to choose a threshold variable distinguishing different regimes is an important empirical question. Existing exchange rate regime classifications could be potential candidates as some studies such as Mussa (1986) show that exchange rate variability is distinctly different across exchange rate regimes. However, the discussion in section 3 suggests that popular exchange rate classification fail to reflect the degree of exchange rate flexibility.

For the threshold variable, therefore, we use the absolute value of annual percentage change in real effective exchange rate obtained as $s_t = 100 \times |\log(reer_t) - \log(reer_{t-1})|$ to capture exchange rate flexibility. If s_t is a good candidate of threshold variables, we would expect that any threshold test will detect threshold effect from the VAR system.

As discussed in section 3, exchange rate regimes are classified according to the behavior of the *nominal* exchange rates. For the following reasons, we employ the REER as the threshold variable. First, it is the real not nominal exchange rate that is responsible for the adjustment in the CA. Second, in the short run, the real and nominal exchange rates behave in a similar way (See Mussa (1986), Bergin et al. (2012)).

In addition, we use annual rather than monthly data because transactions in international trade usually take at least several months from exchange rate changes. This suggests that the CA may not be sensitive to monthly exchange rate but more responsive to annual exchange rate. Table 4.8 shows the simple correlation test between $\boldsymbol{s_t}$ (|%Δreer|) and regime classifications. The results have patterns similar to those of Tables 3 and 4 but with slightly lower values. This is not surprising since $\boldsymbol{s_t}$ is in real terms but the comparison between regime classifications in section 3 is based on nominal terms.

Once the threshold variable is decided, a test for the existence of regime-switching effect is followed. We use the arranged autoregression test proposed by Tsay's (1998) to test the null of no threshold effects.[23] The test strongly rejects the null of no threshold

[23] The Arranged Autoregression Test first runs recursive least squares estimations, with the data points added in the order of the test threshold variable, and then compares residuals from recursive least squares estimation with those from

effect with a p-value of 0. Therefore, a regime-switching model is required in the benchmark VAR system.

Overall, the above discussion suggests that the bilateral relationship between the RER and the CA may differ under different exchange rate regimes. In order to test the hypothesis, we employ a regime-switching model in the section.

In general, models with hidden regimes require a Markov switching type model, while models with observable regimes need a Threshold VAR type model. In this paper, we employ a threshold VAR model (TVAR) since the threshold variable can be well specified in this study. A similar method has been used in Balke (2000) and Afonso et al. (2011). Balke (2000) uses credit market condition as a threshold variable and see how output, inflation, federal funds rate, and credit can behave differently under "tight" and "normal" credit regimes. Afonso et al. (2011) use financial stress index as a threshold variable and study whether the effects of fiscal policy on economic activity differ depending on financial market conditions. Both papers have a clear cut-off for different regimes, so the Threshold VAR is adopted as the first choice.

A Threshold VAR is specified as follows:

$$Y_t = B^1(L)Y_t + \beta^1 X_t + (B^2(L)Y_t + \beta^2 X_t)I[s_{t-d} > \gamma] + U_t$$

where Y_t is a vector of endogenous variables including the RER and the CA balances; X_t is a vector of exogenous control variables containing relative income, trade openness, and financial development; $B^1(L)$ and $B^2(L)$ are lag polynomial matrices; s_{t-d} is the threshold variable that determines which regime the system is; U_t is disturbance; and $I[s_{t-d} > \gamma]$ is an indicator function that equals 1 when $s_{t-d} > \gamma$, and 0 otherwise. In particular, the absolute value of the annual percentage change in RER would be the natural threshold variable, s_{t-d}, that distinguishes exchange rate regimes. If s_{t-d} is large enough to surpass an unknown threshold value γ, the system is in high exchange rate variability regime. Otherwise, the system is in low exchange rate variability regime.

Tsay's test suggests a threshold effect. However, the test does not return the threshold value. To find the threshold value, we first search the threshold variable and list

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least squares estimation using all data points. Under the null of no break, the residuals should be fairly similar to the least squares residuals, so there should be no correlation between the recursive residuals and the regressors.

all possible threshold values. And then we calculate the log likelihood of the VAR system for each threshold value and find the threshold value yielding the largest log likelihood. To guard against overfitting, the possible threshold values are restricted so that at least 15% of the observations plus the number of parameters (for an individual equation) are in each regime.

One advantage of VAR analysis is that it provides the dynamics of endogenous variables in the system through impulse response (IRFs) analysis. In a linear model, the impulse responses are not history-dependent and the magnitude of the shock does not alter the time profile of the responses. However, this is no longer true for non-linear models such as Threshold VAR. The IRFs are now conditional on the entire past history of the variables and the size and direction of the shock. For instance, in our case, if the change in RER is far below the threshold value, the model is under the low exchange rate variability regime and the IRFs are generated using this branch of the whole system. If an exchange rate shock to the low variability regime system is large enough, the system can jump into the high variability regime system. To deal with these two issues, Koop et al. (1996) propose generalized impulse response functions (GIRFs) defined as the difference between the forecasted paths of variables with and without a shock to a variable of interest. Formally, the GIRFs are defined as:

$$GIRF_y(k, \epsilon_t, \Omega_{t-1}) = E(Y_{t+k}|\epsilon_t, \Omega_{t-1}) - E(Y_{t+k}|\Omega_{t-1})$$

where Y_{t+k} is a vector of variables at horizon *k*, Ω_{t-1} is the information set available before the time of shock *t*. This formulation implies that the impulse response functions depend on the initial condition and that the same shocks with different signs may generate asymmetric responses.

To generate GIRFs, the conditional expectations, $E(Y_{t+k}|\epsilon_t, \Omega_{t-1})$ and $E(Y_{t+k}|\Omega_{t-1})$, must be calculated by simulating the model. First, a sequence of shocks for the periods from 0 to *k* is drawn randomly and then is fed through the model for a given initial condition (Ω_{t-1}) to produce forecasts. Second, for the same sequence of shocks, an additional random shock is added at period 0, and then the modified sequence is fed through the model again to produce another group of forecasts. The difference between these two forecasts is the impulse response function. The whole simulation is

repeated 5000 times, and the resulting average is the estimated GIRF. Third, the initial conditions for each regime are used to generate GIRFs for both regimes. Fourth, the confidence bands are derived from the quantiles of the distribution of the average GIRFs, which are generated from the 5000 draw mentioned above. The reported error band is the 16.5th and 83.5th percentile of the distribution.[24]

4.4. Data

The dataset used in this paper covers 90 countries from 1980 to 2010. Sample countries involve both developing and developed countries. Table 4.9 lists all countries included in this paper.

The real effective exchange rate data is from the IMF's IFS. It is the ratio (expressed on the base 2005=100) of an index of a currency's period average exchange rate to a weighted geometric average of exchange rates for the currencies of selected countries, adjusted for relative movements in national price of the home country and selected countries. An increase in the index means real appreciation. This is a trade-weighted multilateral exchange rate adjusted for CPI-based price level. It is designed to make it particularly relevant with respect to movements in costs and prices affecting exports and imports of manufactured goods, which is very suitable for the study in this paper.

The current account balances, defined as the ratio of current account balance to GDP, are from World Bank's World Development Indicators (WDI).

Trade openness, defined as (exports + imports)/GDP, is from Penn World table 7.0 (PWT7.0). Financial development is proxied by the private credit/GDP ratio and obtained from WDI. Greater trade openness makes it easier for trade and therefore facilitates CA adjustment, while greater financial development makes it easier to finance CA balance, resulting in slower CA adjustment.

[24] The reported band includes around $\pm$ 1 standard deviation in a standard normal distribution. As argued by Miniane & Rogers (2007), this confidence band is "conservative", in the sense that it will lead us to find *more* evidence of a significant effect, compared to using a wider $\pm$ 2 standard deviations band. In turn, this makes the finding of essentially *no* significant effect even stronger.

Relative income, defined as (per capita GDP)/(US per capita GDP), is a proxy for a country's development stage. It is obtained from PWT7.0. Countries in different development stage may have different saving and investment decisions, thus affecting the CA balances.

Table 4.10 provides a summary statistics of all variables used in this study. The sample mea of the CA balance is -3.12%. The range of the CA balance is really broad, from -132.80% to 38.60%. The record CA deficit and surplus are created by Equatorial Guinea in 1996 and Trinidad and Tobago in 2006, respectively. The real effective exchange rate has a mean of 123.26. Ghana experienced the highest exchange rate, 3578.93, in 1983; while Poland experienced the lowest exchange rate, 37.51, in 1990 when the economy was in transition. Nominal effective exchange rate has a really large mean due to the outlier – Brazil from 1980 to 1988.

4.5. Empirical Results

As mentioned in section 4, a natural threshold variable for the model is the absolute value of annual percentage change in the RER measured as $s_t = 100 \times |\log(rer_t) - \log(rer_{t-1})|$. We consider the choice reasonable since the transactions in international trade usually completed in several months or more. With the chosen threshold variable, we perform the Tsay's test to detect the significance of the threshold effect. The test result strongly rejects the null of no threshold effect with a p-value of 0. Then, we calculate the log likelihood of the system within each branch of the model for all possible threshold values and find the threshold value maximizing log likelihood. A complete search returns a threshold value of 7.41. That is, if the absolute value of percentage change in the RER is less (more) than 7.41 percent, then the observation is considered to be in the low (high) exchange rate variability (ERV) regime.

The selected threshold value will split the whole sample into two sub-samples—low and high exchange rate variability regime respectively. The same VAR system is estimated for the two sub-samples. Table 4.11 reports the estimation results in each regime. The persistency of the CA balances under two different regimes are of particular interest. Under the low ERV regime, the coefficients for the first and second lag of CA are 0.82 and -0.15, respectively. Under the high ERV regime, they are 0.64 and -0.13,

respectively. Both are statistically significant at the 1% level. This suggests that the CA balance is more persistent in the low ERV regime. In other words, the CA balance is adjusted more quickly when the RER is more flexible. This is consistent with the hypothesis of Friedman (1953).

The estimation results of a VAR model can be better summarized by impulse responses. For each regime, GIRFs are generated under different initial conditions.[25] Figure 4.2.1 and 4.2.2 report the GIRFs of low and high variability regime with confidence intervals, respectively. To make a better comparison and read more clearly any potential difference between the two regimes, Figure 4.2.3 groups two regimes' GIRFs without confidence intervals.

In Figure 4.2.3, solid (dotted) line is the GIRFs for the low (high) ERV regime. The left-side panel shows the responses to a unit shock in RER. The upper-left chart is the responses of RER (domestic currency appreciation). Interestingly, the shock is temporary under high ERV regime, but is permanent under low ERV regime. One explanation could be due to the natural of each regime. In the low ERV regime, once a shock changes the RER, RER is not allowed to re-adjust accordingly, so it is more persistent; while in the high ERV regime exchange rate can correspond to the shock immediately, and the shock will disappear as time goes. The lower-left chart is the response of CA. In the low ERV regime, after currency appreciation, the CA starts to decrease gradually because net exports will decrease following appreciation. RER is hardly allowed to adjust accordingly for rebalancing the relative price of imports and exports, so country has less ability to prevent deterioration of the CA. In the high variability regime, the adjustment of CA balance is similar to that of the J-curve effect, although the adjustment is not very significant. Flexible exchange rate will adjust relative price of imports and exports and rebalance the CA.

The right-side panel shows the responses to a unit shock in CA. The upper-right chart is the response of RER. In the low ERV regime, there is a real appreciation

[25] In particular, some initial values of CA and RER are drawn from the low flexibility regime subsample and are imposed to the model for the graph in Figure 1. Similarly, initial values of CA and RER are drawn from the high flexibility regime subsample and are imposed to the model for the graph in Figure 2. Different initial conditions have been tried and yield very similar GIRFs.

following CA improvement, although the response is minimal due to limited ERV; in the high ERV regime, the RER decreases (depreciation) after CA improvement, which contradicts with conventional open economy models. The lower-right chart is the response of CA. In both regimes, the shock will decay over time. However, the speed of CA reversion seems faster in high ERV regime than in the low ERV regime. The half-lives of CA are about 1.3 and 2.2 years for high and low ERV regimes, respectively. This is consistent with Friedman's hypothesis that greater exchange rate variability facilitates CA adjustment.

4.6. Analysis from Threshold VAR under R-R and K-S exchange rate regime classifications

The results in section 3 suggest that the R-R and K-S classifications outperform other regime classifications in terms of capturing exchange rate flexibility. In this section we employ the R-R and K-S classifications and repeat the Threshold VAR analysis. The threshold value for the R-R classification is 4 using the same technique discussed in section 3, which split the sample into two parts – floaters (high ERV regime including floating and free falling) and non-floaters (low ERV regime including others). In section 3, we have showed that floaters indeed have a greater ERV than non-floaters. This splitting lets R-R valid to use without losing the appropriate exchange rate variability.[26] The K-S classification is a bilateral classification, so the threshold value is 1. It splits sample into pegs and non-pegs. Again, from the results in section 3, non-pegs have a greater ERV than pegs.

Figure 4.3 reports the GIRFs using the R-R classification. Figure 4.3.1 and 4.3.2 report the GIRFs for low and high ERV regime with confidence intervals, respectively; Figure 4.3.3 does the comparison between two regimes. Overall, results in Figure 4.3 are similar to those in Figure 4.2. There are some differences. First, Responses of RER to its own shock under less and more flexible exchange rate regimes are both decays over time. That is the RER shows mean reversion in both regimes, but the half-life is much longer in

[26] In Chinn and Wei's paper, they also use the R-R classification, but their use (grouping fixers, soft-pegs, and floaters) does not necessarily reflect the order of exchange rate variability because R-R classification does not distinguish fixers and soft-pegs well in terms of exchange rate variability.

high ERV regime than in low ERV regime. Second, in the high ERV regime, in response to an increase in CA, the RER increases initially (real appreciation) although it is not very significant. Nonetheless, the estimated speed of mean reversion for the CA seems similar in both Figure 4.2 and Figure 4.3. The half-lives for CA in high and low ERV regimes are about 0.7 and 1.8 years respectively. The difference is 1.1 years which are even larger compared to Figure 4.2. This is even a stronger support to Friedman's hypothesis.

Figure 4.4 reports the GIRFs using the K-S classification. Figure 4.4.1 and 4.4.2 report the GIRFs of pegged and non-pegged exchange rate regime with confidence intervals, respectively; Figure 4.4.3 compares the two regimes. Main results in Figure 4.4 are comparable and similar to those in Figure 4.2 and 4.3 with some exceptions. The response of RER is persistent when there is a RER shock in the fixed exchange rate regime. Two reasons may be offered. First, the exchange rate is fixed by the government. Second, if the home country experiences a higher inflation than the base country, the RER will even appreciate further if the nominal exchange rate is fixed. However, a positive RER shock improves the CA, which contradicts with conventional textbook models and results from other regimes classifications.

4.7. Conclusion

Friedman's hypothesis that flexible exchange rate can facilitate current account adjustment has been asserted as obvious for a long time. However, a recent study by Chinn and Wei (2013) shows that there is no such evidence to support the hypothesis. In this paper, we reconsider the hypothesis and extend empirical analysis in at least three dimensions. First, our study uses a large panel dataset containing a long time series (up to 2010). Second, we measure exchange rate variability using the actual market effective exchange rates instead of bilateral rates against the base country or using existing popular regime classifications. Third, we employ a threshold VAR model and classify exchange rate regimes based on actual exchange rate movements.

There are two main findings in our study. First, the speed of mean reversion of current account balance is higher in a regime with greater exchange rate variability. This result is consistent with Friedman's hypothesis. Second, by utilizing our own constructed exchange rate variability variables, we find that some existing exchange rate

classifications, especially those used in Chinn and Wei (2013)'s study, may not capture actual exchange rate variability as well as expected. The unconventional result from Chinn and Wei (2013) is probably due to the inability of capturing exchange rate variability by some regime classifications for certain exchange rate regimes.

Hence, two implications follow our study. First, adpoting a more flexible exchange rate regime is still a useful tool for a country to adjust its external balance. Second, there is a disconnection between acutal exchange rate variablity and some popular bilateral exchange rate classifications. Future work may need to rethink the use of these classifications as a proxy to actual exchange rate variability.

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Figure 4.1. IRFs for real exchange rate and the ccurrent account balances using basic VAR

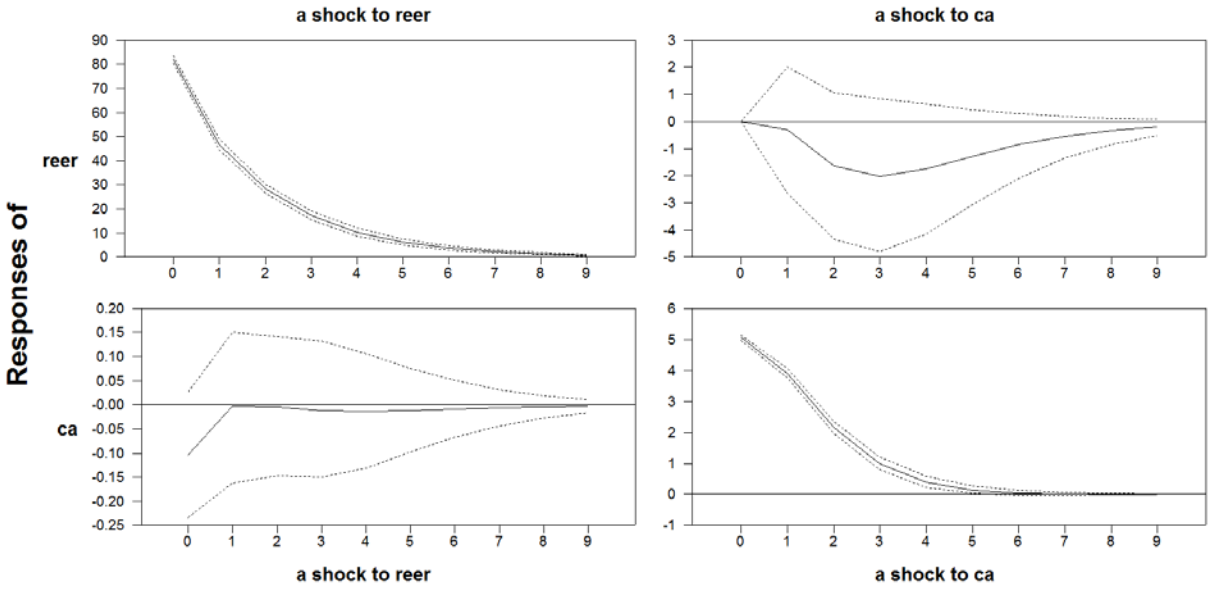


Figure 4.2. GIRFs using log different in RER as exchange rate regime classification

Figure 4.2.1: GIRFs under low ERV regime

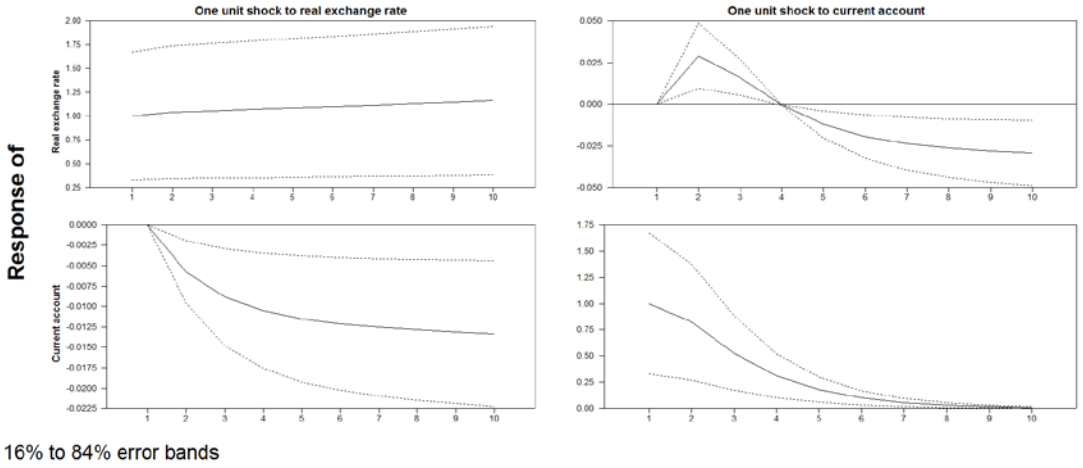


Figure 4.2.2: GIRFs under high ERV regime

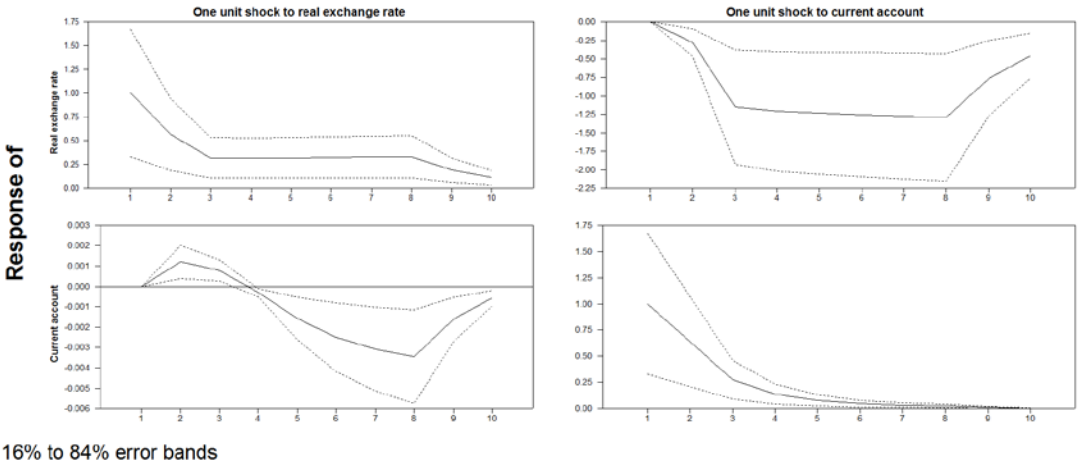
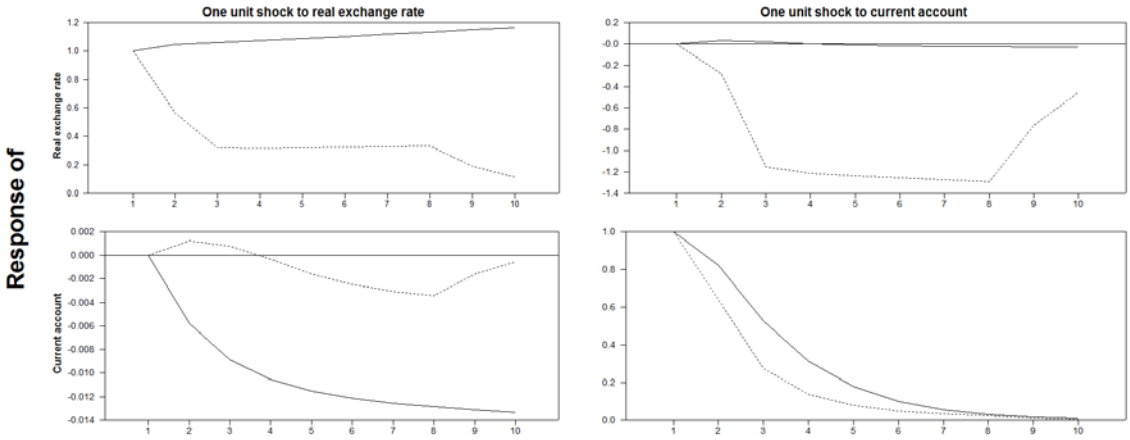


Figure 4.2.3: Comparison of GIRFs between low and high ERV regime



Dotted line: High ERV regime; Solid line: Low ERV regime

Figure 4.3. GIRFs using the R-R classification as exchange rate regime classification

Figure 4.3.1: GIRFs under low ERV regime

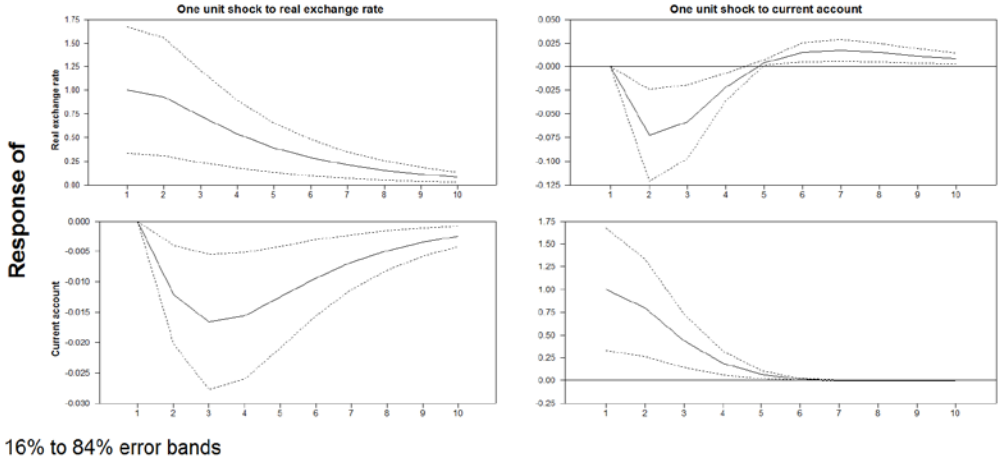


Figure 4.3.2: GIRFs under high ERV regime

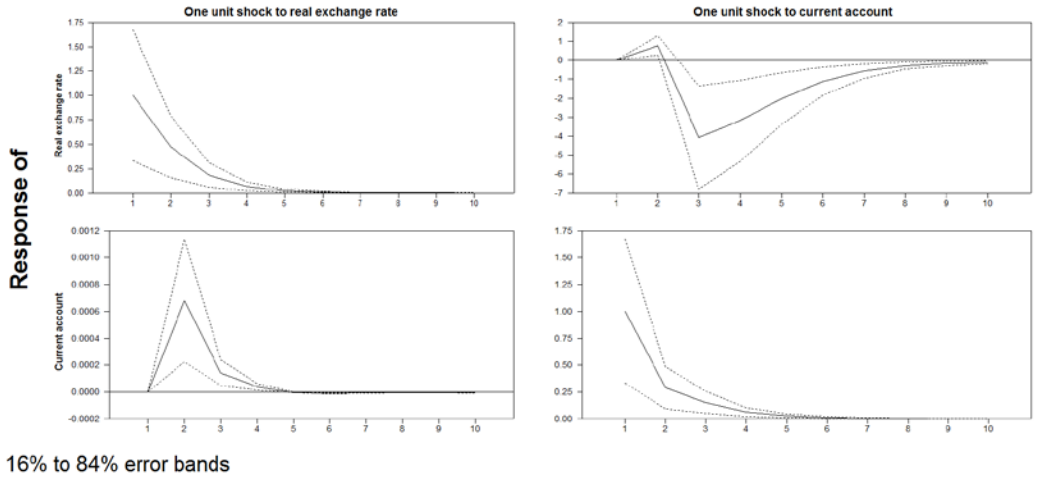
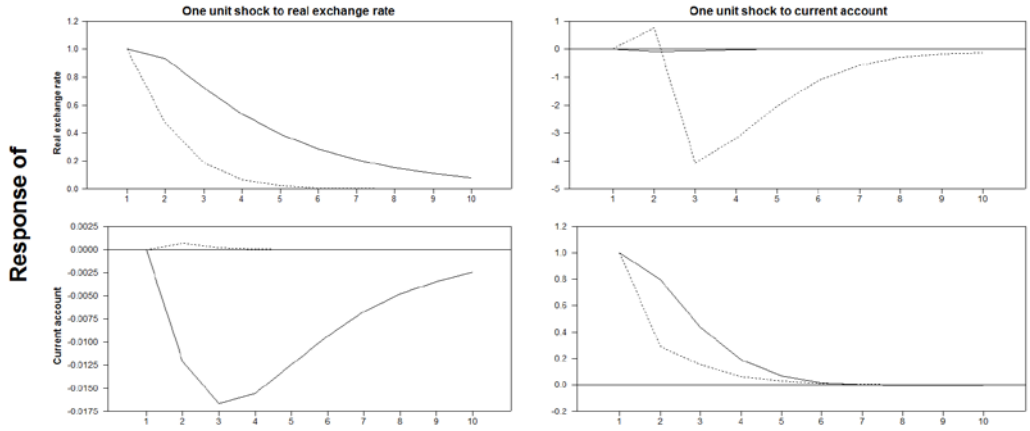


Figure 4.3.3: Comparison of GIRFs between low and high ERV regimes



Dotted line: High ERV regime; Solid line: Low ERV regime

Figure 4.4. GIRFs using the K-S classification as exchange rate regime classification

Figure 4.4.1: GIRFs under pegged exchange rate regime

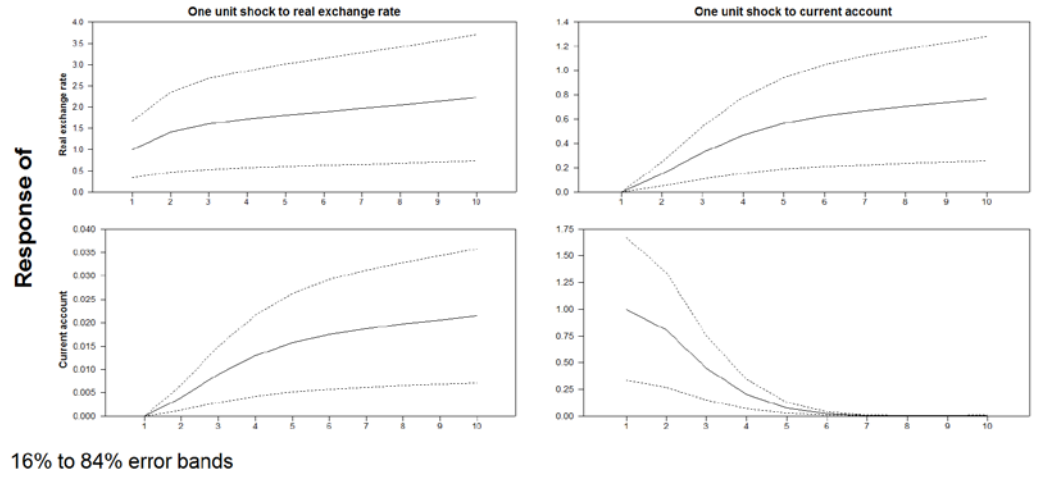


Figure 4.4.2: GIRFs under non-pegged exchange rate regime

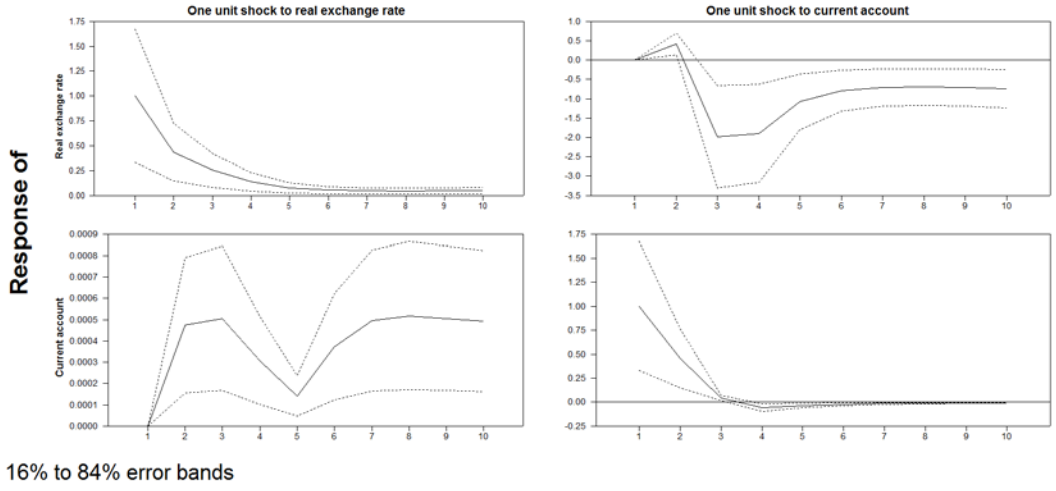
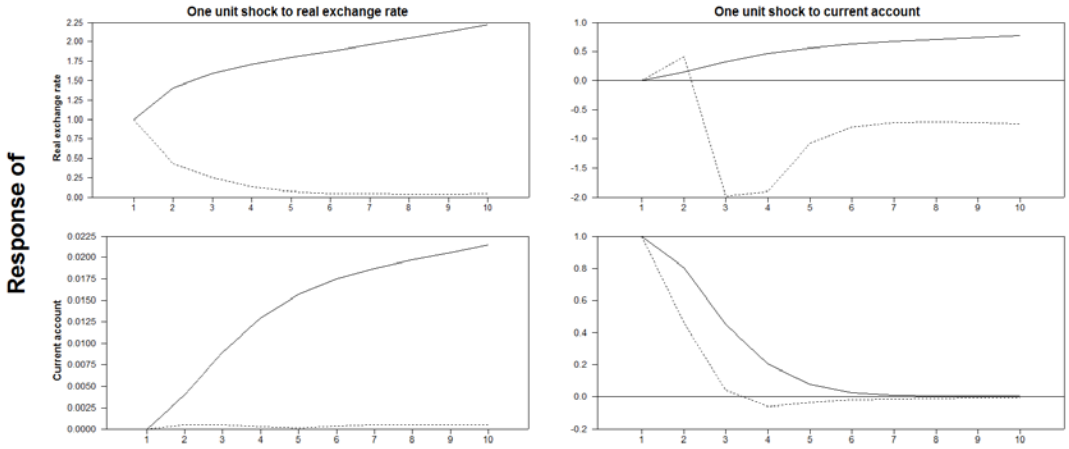


Figure 4.4.3: Comparison of GIRFs betwwen pegged and non-pegged exchange rate regimes



Dotted line: Non-pegged exchange rate regime; Solid line: Pegged exchange rate regime

Table 4.1. Correlation test between different exchange rate regime classifications

	|%Δneer|	|%Δnber|	SD(%Δneer)	SD(%Δnber)	IMF	R-R	LY-S	K-S
|%Δneer|	1							
|%Δnber|	0.7806	1						
SD(%Δneer)	0.6065	0.6491	1					
SD(%Δnber)	0.5116	0.8022	0.7807	1				
IMF	0.1106	0.1437	0.075	0.0969	1			
R-R	0.3288	0.3506	0.2958	0.2928	0.5627	1		
LY-S	0.0796	0.1248	0.0653	0.1099	0.533	0.4571	1	
K-S	0.1723	0.2238	0.1841	0.2107	0.5966	0.5853	0.6177	1

Note: |%Δneer| denotes absolute value of annual percentage change in nominal effective exchange rate; |%Δnber| denotes the absolute value of annual percentage change in bilateral nominal exchange rate; SD(%Δneer) denotes the standard deviation of monthly percentage change in nominal effective exchange rate in a yearly base; SD(%Δnber) denotes the standard deviation of monthly percentage change in bilateral nominal exchange rate in a yearly base; IMF stands for IMF de jure exchange rate regime classification; R-R stands for Reinhart and Rogoff (2004) de facto exchange rate regime classification; LY-S stands for Levy-Yeyati and Sturzenegger (2003) de facto exchange rate regime classification; K-S stands for Klein and Shambaugh (2008) de facto exchange rate regime classification.

Table 4.2. Correlation test: OECD and non-OECD

OECD	|%Δneer|	|%Δnber|	SD(%Δneer)	SD(%Δnber)	IMF	R-R	LY-S	K-S
|%Δneer|	1							
|%Δnber|	0.7732	1						
SD(%Δneer)	0.5213	0.5028	1					
SD(%Δnber)	0.4421	0.6013	0.7833	1				
IMF	0.2655	0.2718	0.489	0.5156	1			
R-R	0.3796	0.4574	0.5258	0.6935	0.641	1		
LY-S	0.268	0.3232	0.4179	0.5691	0.6216	0.6736	1	
K-S	0.2913	0.4602	0.4821	0.6842	0.5961	0.6501	0.5659	1
Non-OECD								
|%Δneer|	1							
|%Δnber|	0.7709	1						
SD(%Δneer)	0.5926	0.639	1					
SD(%Δnber)	0.4962	0.8014	0.7742	1				
IMF	0.1293	0.1676	0.0694	0.0808	1			
R-R	0.3467	0.3604	0.3039	0.2762	0.5399	1		
LY-S	0.0755	0.1237	0.0496	0.079	0.479	0.352	1	
K-S	0.1993	0.2396	0.2038	0.2025	0.5963	0.5646	0.6528	1

Note: |%Δneer| denotes absolute value of annual percentage change in nominal effective exchange rate; |%Δnber| denotes the absolute value of annual percentage change in bilateral nominal exchange rate; SD(%Δneer) denotes the standard deviation of monthly percentage change in nominal effective exchange rate in a yearly base; SD(%Δnber) denotes the standard deviation of monthly percentage change in bilateral nominal exchange rate in a yearly base; IMF stands for IMF de jure exchange rate regime classification; R-R stands for Reinhart and Rogoff (2004) de facto exchange rate regime classification; LY-S stands for Levy-Yeyati and Sturzenegger (2003) de facto exchange rate regime classification; K-S stands for Klein and Shambaugh (2008) de facto exchange rate regime classification.

Table 4.3. Country fixed effect panel regression

Dependent variables	|%Δneer|	|%Δnber|	SD(%Δneer)	SD(%Δnber)
R-R classification				
2	-2.818	-0.635	-0.458	-0.205
	(1.969)	(2.005)	(0.353)	(0.363)
3	-2.215	3.644	0.482	0.668
	(2.290)	(2.337)	(0.412)	(0.425)
4	12.42***	10.20***	0.954	1.464**
	(3.627)	(3.735)	(0.667)	(0.688)
5	47.15***	54.44***	6.096***	6.350***
	(2.688)	(2.793)	(0.484)	(0.508)
6	2.063	5.358	1.020	1.594*
	(4.833)	(4.930)	(0.881)	(0.906)
Constant	7.900***	5.885***	1.618***	1.439***
	(1.299)	(1.318)	(0.234)	(0.240)
Observations	2,138	2,111	2,217	2,191
R-squared	0.219	0.229	0.113	0.104
Number of countries	88	88	88	88
LY-S classification				
2	17.10***	24.68***	4.076***	5.267***
	(1.966)	(2.024)	(0.347)	(0.359)
3	3.518*	9.060***	1.391***	2.369***
	(2.130)	(2.173)	(0.374)	(0.383)
Constant	7.426***	4.332***	1.114***	0.576***
	(0.977)	(0.997)	(0.171)	(0.175)
Observations	1,719	1,696	1,784	1,761
R-squared	0.051	0.088	0.079	0.115
Number of countries	88	88	88	88
K-S classification				
Non-peg	5.548***	10.05***	1.811***	2.664***
	(1.607)	(1.566)	(0.288)	(0.306)
Constant	8.151***	5.334***	1.135***	0.651***
	(1.048)	(1.017)	(0.187)	(0.198)
Observations	1,896	1,871	1,975	1,951
R-squared	0.007	0.022	0.020	0.039
Number of countries	79	79	79	79
IMF classification				
2	-1.162	-1.250	-0.446	0.114
	(2.496)	(2.572)	(0.458)	(0.469)
3	-0.888	2.660	-0.814**	0.0349
	(1.894)	(1.975)	(0.340)	(0.351)
4	3.758*	7.223***	-0.0931	1.435***
	(2.162)	(2.272)	(0.387)	(0.403)
5	8.286	20.50*	2.159	4.135**
	(11.20)	(11.47)	(2.060)	(2.097)
Constant	10.82***	9.301***	2.522***	1.885***
	(1.119)	(1.174)	(0.200)	(0.207)
Observations	1,917	1,889	1,985	1,958
R-squared	0.003	0.007	0.005	0.010
Number of countries	89	89	89	89

Note: in LY-S, IMF, and R-R, small value mean more fixed exchange rate regime and vice versa. For detailed description of each value, see footnotes for LY-S and R-R in section 3. In K-S, non-peg means a non-fixed exchange rate regime. IMF classification is from Carmen Reinhart's website, the definition of each value is equivalent to R-R coarse regime classification.

Table 4.4. Country fixed effect panel regression: OECD

Dependent variables	|%Δneer|	|%Δnber|	SD(%Δneer)	SD(%Δnber)
R-R classification				
2	3.239***	5.471***	0.262***	0.741***
	(0.561)	(0.671)	(0.0841)	(0.0884)
3	4.188***	5.745***	0.656***	0.912***
	(0.789)	(0.947)	(0.118)	(0.124)
4	1.696	3.016*	0.550***	0.754***
	(1.422)	(1.700)	(0.211)	(0.222)
5	39.69***	39.80***	2.582***	3.072***
	(2.611)	(3.123)	(0.360)	(0.378)
6	-	-	-	-
	-	-	-	-
Constant	2.134***	1.523***	0.818***	0.747***
	(0.420)	(0.502)	(0.0639)	(0.0671)
Observations	680	676	705	702
R-squared	0.269	0.232	0.098	0.152
Number of countries	26	26	26	26
LY-S classification				
2	4.273***	5.129***	0.0411	0.248**
	(0.828)	(0.997)	(0.104)	(0.121)
3	4.255***	5.002***	0.646***	0.984***
	(0.804)	(0.968)	(0.101)	(0.117)
Constant	2.583***	2.834***	0.920***	0.976***
	(0.387)	(0.466)	(0.0488)	(0.0566)
Observations	524	524	543	543
R-squared	0.073	0.071	0.082	0.123
Number of countries	26	26	26	26
K-S classification				
Non-peg	2.526***	5.093***	0.491***	0.992***
	(0.624)	(0.726)	(0.0809)	(0.0862)
Constant	3.138***	2.240***	0.835***	0.708***
	(0.438)	(0.510)	(0.0568)	(0.0605)
Observations	576	576	600	600
R-squared	0.029	0.082	0.060	0.187
Number of countries	24	24	24	24
IMF classification				
2	0.554	1.426**	0.212***	0.496***
	(0.579)	(0.669)	(0.0748)	(0.0841)
3	4.358***	5.840***	0.484***	0.751***
	(0.725)	(0.857)	(0.0920)	(0.105)
4	1.491*	0.577	0.717***	0.679***
	(0.840)	(0.973)	(0.105)	(0.119)
5	-	-	-	-
	-	-	-	-
Constant	3.291***	3.799***	0.777***	0.867***
	(0.396)	(0.462)	(0.0501)	(0.0566)
Observations	671	666	693	690
R-squared	0.054	0.072	0.087	0.120
Number of countries	26	26	26	26

Note: in LY-S, IMF, and R-R, small value mean more fixed exchange rate regime and vice versa. For detailed description of each value, see footnotes for LY-S and R-R in section 3. In K-S, non-peg means a non-fixed exchange rate regime. IMF classification is from Carmen Reinhart's website, the definition of each value is equivalent to R-R coarse regime classification.

Table 4.5. Country fixed effect panel regression: Non-OECD

Dependent variables	|%Δneer|	|%Δnber|	SD(%Δneer)	SD(%Δnber)
R-R classification				
2	-8.344**	-7.213**	-1.234**	-1.229*
	(3.446)	(3.523)	(0.608)	(0.631)
3	-6.436*	0.473	0.151	0.222
	(3.567)	(3.654)	(0.635)	(0.661)
4	12.18**	9.045	0.741	1.231
	(5.354)	(5.535)	(0.984)	(1.021)
5	43.55***	50.96***	5.765***	5.877***
	(3.840)	(3.976)	(0.683)	(0.720)
6	-1.121	1.844	0.625	1.062
	(6.184)	(6.323)	(1.120)	(1.159)
Constant	12.60***	10.22***	2.224***	2.084***
	(2.119)	(2.156)	(0.373)	(0.387)
Observations	1,458	1,435	1,512	1,489
R-squared	0.224	0.236	0.117	0.110
Number of countries	62	62	62	62
LY-S classification				
2	20.68***	30.90***	5.283***	6.883***
	(2.698)	(2.781)	(0.472)	(0.489)
3	3.754	11.70***	1.842***	3.160***
	(3.020)	(3.078)	(0.525)	(0.537)
Constant	9.363***	4.878***	1.190***	0.395
	(1.357)	(1.382)	(0.234)	(0.240)
Observations	1,195	1,172	1,241	1,218
R-squared	0.060	0.107	0.103	0.150
Number of countries	62	62	62	62
K-S classification				
Non-peg	7.013***	12.54***	2.407***	3.456***
	(2.329)	(2.280)	(0.414)	(0.443)
Constant	10.35***	6.722***	1.302***	0.660**
	(1.468)	(1.426)	(0.260)	(0.277)
Observations	1,320	1,295	1,375	1,351
R-squared	0.007	0.024	0.025	0.045
Number of countries	55	55	55	55
IMF classification				
2	-5.720	-9.153	-2.107*	-0.966
	(5.967)	(6.265)	(1.096)	(1.147)
3	-2.844	1.683	-1.481***	-0.207
	(2.826)	(2.955)	(0.505)	(0.525)
4	3.240	8.283**	-0.696	1.499**
	(3.205)	(3.401)	(0.573)	(0.603)
5	7.289	20.89	1.563	4.099
	(13.92)	(14.25)	(2.560)	(2.616)
Constant	15.59***	13.27***	3.546***	2.570***
	(1.718)	(1.811)	(0.304)	(0.318)
Observations	1,246	1,223	1,292	1,268
R-squared	0.005	0.010	0.009	0.012
Number of code_ifs	63	63	63	63

Note: in LY-S, IMF, and R-R, small value mean more fixed exchange rate regime and vice versa. For detailed description of each value, see footnotes for LY-S and R-R in section 3. In K-S, non-peg means a non-fixed exchange rate regime. IMF classification is from Carmen Reinhart's website, the definition of each value is equivalent to R-R coarse regime classification.

Table 4.6. Mean of exchange rate flexibility variables by exchange rate regimes

	|%Δneer|	|%Δnber|	SD(%Δneer)	SD(%Δnber)
R-R classification				
1	5.329	4.536	1.249	1.154
2	6.551	7.084	1.395	1.363
3	8.358	10.077	2.188	2.180
4	11.016	10.962	2.204	2.811
5	63.142	63.090	8.591	8.579
6	10.314	13.560	3.396	3.544
LY-S classification				
1	6.666	5.259	1.426	1.120
2	28.284	28.100	4.998	5.123
3	9.707	12.042	1.950	2.271
K-S classification				
Peg	5.285	3.743	1.122	0.795
Non-peg	15.836	16.581	2.956	3.205
IMF classification				
1	8.443	8.650	2.110	2.054
2	4.674	3.282	0.938	0.831
3	14.130	14.708	2.289	2.192
4	16.426	17.087	3.012	3.320
5	14.657	23.213	4.344	5.144

Table 4.7. IPS panel unit root test

H_0: unit root					
Variable	N	T	T stat	P-value	Result
CA	90	8 to 30	-8.55	0	Reject
REER	90	16 to 30	-3.55	0	Reject

Table 4.8. Correlation test between real effective exchange rate and regime classifications

Sample		IMF	R-R	LY-S	K-S
All countries		0.0326	0.2968	0.0269	0.1341
OECD	|%Δreer|	0.3207	0.3404	0.253	0.3147
Non-OECD		0.0158	0.2941	-0.0038	0.1356

Table 4.9. List of countries in the dataset

High income	Middle income		Low income
Antigua and Barbuda	Algeria	Nigeria	Burundi
Australia	Armenia	Pakistan	Central African Republic
Austria	Belize	Papua New Guinea	Gambia, The
Bahamas, The	Bolivia	Paraguay	Ghana
Bahrain	Brazil	Philippines	Malawi
Belgium	Bulgaria	Poland	Sierra Leone
Canada	Cameroon	Russia	Togo
Croatia	Chile	Samoa	Uganda
Cyprus	China,P.R.: Mainland	Solomon Islands	Zambia
Czech Republic	Colombia	South Africa	
Denmark	Costa Rica	St. Kitts and Nevis	
Equatorial Guinea	Côte d'Ivoire	St. Lucia	
Finland	Dominica	St. Vincent and the Grenadines	
France	Dominican Republic	Tunisia	
Germany	Ecuador	Ukraine	
Greece	Fiji	Uruguay	
Hungary	Gabon	Venezuela, Rep. Bol.	
Iceland	Georgia		
Ireland	Grenada		
Israel	Guyana		
Italy	Iran, Islamic Republic of		
Japan	Lesotho		
Luxembourg	Macedonia		
Malta	Malaysia		
Netherlands	Mexico		
New Zealand	Moldova		
Norway	Morocco		
Portugal			
Saudi Arabia			
Singapore			
Slovak Republic			
Spain			
Sweden			
Switzerland			
Trinidad and Tobago			
United Kingdom			
United States			

Table 4.10. Summary statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
ca	Current account balances	2517	-3.115	8.986	-132.796	38.594
reer	Real effective exchange rate	2661	123.264	117.986	37.510	3578.930
fin_dvp	Financial development	2618	54.148	45.708	1.385	319.461
openc	Trade openness	2686	83.204	51.968	3.843	440.432
relative_inc	Relative income	2686	37.106	34.278	0.877	204.514
neer	Nominal effective exchange rate	2635	4.27E+09	1.22E+11	0.72	4.92E+12
SD(%Δneer)	SD(%Δneer)	2636	2.132566	4.203309	0.043556	83.15371
SD(%Δnber)	SD(%Δneer)	2605	2.092276	4.303915	0	81.30399
IMF	IMF regime classification	2022	2.363501	1.246832	1	5
R-R	R-R regime classification	2257	2.280461	1.297752	1	6
LY-S	LY-S regime classification	1810	2.303315	0.845265	1	3
K-S	K-S regime classification	2000	0.4295	0.495129	0	1

Table 4.11. Adjustment of current account balance under low and high flexibility regimes

	Low exchange rate flexibility regime				High exchange rate flexibility regime			
Dependent variable: Real exchange rate	Coeff	SD	T-Stat	P-value	Coeff	SD	T-Stat	P-value
REER {1}	1.043	0.007	149.707	0.000	0.566	0.045	12.501	0.000
REER {2}	-0.030	0.007	-4.267	0.000	-0.001	0.044	-0.022	0.983
CA {1}	0.029	0.021	1.377	0.169	-0.278	1.251	-0.222	0.824
CA {2}	-0.038	0.022	-1.777	0.076	-0.817	1.245	-0.656	0.512
Constant	-0.299	1.384	-0.216	0.829	37.922	66.907	0.567	0.571
RELATIVE_INC	0.064	0.019	3.404	0.001	1.747	1.451	1.204	0.229
OPENC	-0.014	0.007	-2.067	0.039	-1.325	0.520	-2.551	0.011
FIN_DVP	-0.001	0.004	-0.207	0.836	0.101	0.372	0.271	0.786
Dependent variable: Current account balance								
REER {1}	-0.006	0.008	-0.711	0.477	0.001	0.002	0.669	0.504
REER {2}	0.002	0.008	0.234	0.815	-0.001	0.002	-0.391	0.696
CA {1}	0.822	0.025	33.411	0.000	0.639	0.050	12.820	0.000
CA {2}	-0.148	0.025	-5.893	0.000	-0.132	0.050	-2.650	0.008
Constant	-1.853	1.612	-1.150	0.250	-0.586	2.667	-0.220	0.826
RELATIVE_INC	0.038	0.022	1.721	0.085	-0.035	0.058	-0.609	0.543
OPENC	-0.008	0.008	-1.002	0.317	0.023	0.021	1.131	0.259
FIN_DVP	-0.011	0.005	-2.432	0.015	-0.018	0.015	-1.227	0.221

Note: the country dummies are included in each regression but not reported.

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VITA

Yu You

Personal
Citizenship: China

Education
M.S. Economics, University of Kentucky (2011)
M.A. International Studies, Ohio University (2009)
B.A. Computer Science, Huazhong University of Science and Technology, China (2005)

Professional Experience
Instructor of Record, University of Kentucky, 2010-2013
"Economic and Business Statistics" (2 semesters)
"Principles of Macroeconomics" (2 semesters)
Teaching Assistant, University of Kentucky, 2009
Intermediate Macroeconomics
International Trade (undergraduate)
International Monetary Economics (undergraduate)

Awards
University of Kentucky Teaching Assistantship, 2009-2013
Virgil L. Christian fellowship, 2012
Max Steckler Fellowship, 2009
Gatton Fellowship, 2009

Professional Affiliations
American Economic Association
Southern Economic Association
Society for the Study of Emerging Markets