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SANTA CRUZ

**U.S. MONETARY POLICY SHOCKS AND THEIR IMPACTS ON
INTERNATIONAL CAPITAL FLOWS**

A dissertation submitted in partial satisfaction of the
requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ECONOMICS

by

Taeree Wang

March 2017

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Abstract

U.S. Monetary Policy Shocks and Their Impacts on International Capital Flows

by

Taeree Wang

During the 2008 global financial crisis, several emerging market economy (EME) author-
ities argued that advanced economy policies including large-scale asset purchases by the
U.S. Federal Reserve were primary sources of excessive capital flows and created adverse
spillover effects to the EMEs. More recently, EME policy makers have been concerned
about the adverse effects of advanced economy monetary policy normalization. Track-
ing the link between the monetary policy shocks in advanced countries and capital flows
to emerging markets can be crucial for informing the debate about appropriate policy re-
sponses to capital inflows by the EMEs.

Many studies investigate the role of advanced economy policy measures as drivers
of capital flows between countries. However, the estimation of the relationship between
U.S. monetary policies and EME capital flows needs to account for anticipatory movements
within the policy measures as well as endogeneity. That is why some of the recent literature,
for example Miranda-Agrippino (2015), applies the Romer and Romer shocks (Romer and
Romer (2004)) as a proxy for U.S. monetary shocks, to estimate the responses of global
asset prices and international credit flows to US monetary policy. However, Coibion, et al
(2016) recently found that the Romer and Romer proxy for U.S. monetary shock, does not
influence important U.S. macroeconomic variables for sample periods starting from 1980.

To investigate this issue and get valid estimates for U.S. monetary shocks, this paper revisits the Federal Reserve's information set which is created from observing the federal funds target rates set by the Federal Reserve around FOMC meetings. As a result, this paper derives a new measure for U.S. monetary shocks that adequately takes account of the Fed's true information set at the time of FOMC meetings. In detail, this paper uses projected values for the CPI for periods when the PCE was not used by fed, then uses forecasts for the PCE for the rest of the sample period, instead of GDP deflator. Forecasts for foreign GDP and CPI indices are also used to take international endogenous and anticipatory movements into account in setting the Fed's target rate.

The results show that using the new U.S. monetary shock measures reveals significantly different effects in responses of U.S. domestic macroeconomic variables to monetary shocks as well as in responses of some international financial variables, compared to results using the Romer and Romer shock. Specifically, a one percentage point increase in the new policy measure increases U.S. unemployment rate by 6 percent after one year, reduces GDP by 0.12 percent from its trend at the trough, and decreases the PPI by 35 percent at the lowest point. For international capital variables, a one percentage point rise in the U.S. policy shock increases cumulative net outflows of debt assets from Korea by over 10 billion dollars.

Part I

Chapter 1

Chapter 1

U.S. Monetary Policy Shocks and Their Impacts on International Capital Flows

1.1 Introduction

Recent studies on international capital flows found that there have been large and volatile surges in capital flows to EMEs after the recent global financial crisis (GFC), especially for portfolio investment (Fratzscher et al. (2012), Ahmed et al. (2014)). Several EME authorities argued that the advanced economy policies including large-scale asset purchases (LSAPs) in U.S. were primary sources for the excessive capital flows and created adverse spillover effects. More recently, EMEs have been concerned about the adverse effects of advanced economy monetary policy normalization (e.g tapering of LSAPs in

U.S.).

As the neoclassical growth model predicts, free capital flows can lead to efficient allocation of capital and also allow risk sharing among different countries against idiosyncratic shocks. Particularly, upon financial integration, a capital scarce country can borrow internationally to fulfill its optimal consumption and investment plans, attracting international investors with a high marginal product of capital.

However, in the shorter term, large capital inflows can overwhelm the capacity of the domestic financial intermediaries and lead to excessive credit creation and asset price bubbles that cause financial instability. In addition, large and volatile capital flows also increase leverage ratio and can lead to sudden stops posing challenges to policymakers trying to stabilize their countries. According to the literature on sudden stops, after periods of leverage buildups during periods of expansion, if the collateral constraint becomes binding, agents are forced to reduce their spending, lowering aggregate demand and leading to declines in real exchange rates, relative prices and asset prices. Since the value of collateral is tied to these relative prices, such declines tighten the collateral constraint further and trigger a vicious cycle of falling borrowing ability, falling spending, and collapsing exchange rates and asset prices (Mendoza (2010)). Also, currency appreciation caused by large capital inflows may hurt export and growth performance of EMEs. Therefore, it is important to investigate whether such volatile capital flows were primarily a result of factors, such as international investors' risk appetite, attractiveness of the recipient countries, including growth prospects, or "global financial cycle" created by the world power(s) (Rey (2013)).

However, the evidence on the impacts of the monetary policies in advanced coun-

tries is mixed in the existing literature. Byrne and Fiess (2011) found that U.S. interest rates were a crucial determinant of global capital flows to EMEs. Ghosh et al. (2012) reported various factors to be important in increasing the likelihood of a surge to EMEs, including lower U.S. interest rates, greater global risk appetite, and EME's own attractiveness as an investment destination. On the other hand, Forbes and Warnock (2012), found no significant evidence for changes in global interest rates or in global liquidity (money supply of key AEs) in affecting surges or stops of foreign inflows; however, they do find global risk aversion to be an important factor.

Given the policy tensions that arose between these two groups of economies, tracking the link between monetary policy shocks in advanced countries and capital flows to emerging markets is crucial for informing the debate about the appropriate policy responses to capital inflows by EMEs. However, most studies of the impact of monetary expansion in AEs are inferred from studies on the effect of long-term U.S. interest rates on the EME capital flows during the pre-crisis period. For the cases after the GFC, Ahmed et al (2014) found that there are significant relationships between capital flows to EMEs and those of policy rate differential between EME and U.S., real GDP growth differential between EMEs and AEs, and VIX. They also found that the sensitivities of capital flows to policy rate differential between EME and U.S. have changed before and after the GFC. However, they studied the capital flows of total portfolio assets of emerging countries, but did not look at the behaviors of capital flows depending on the type of the portfolio assets further closely, (that is, which type of the assets may be directly affected by the policy rate differential) that may give a clue to the channel of capital surges or retrenchment.

To provide more details on recent monetary policies in AEs, after policy interest rates in many AEs had reached at the zero lower bound, central banks in AEs, including the Federal Reserve, exercised unconventional monetary expansion in efforts to boost economic activity. These policies work through similar channels as conventional policy, but by affecting a broader range of interest rates in the economy to which private spending is sensitive. As the yields in various assets in each economy are affected by AE monetary policies, the international allocation of investment across various classes of assets are affected. Some studies find that unconventional policies lowered yields on the long-term U.S. Treasury bonds and similar securities (D'Amico and King (2013)). In turn, it also has been argued that the lower yields on long-term U.S. securities may have encouraged capital flows to EMEs (Fratzscher et al (2012)). However, these are two separate studies, and do not show the effect of the unconventional policies on capital flows to EMEs directly. Hence this paper provides, in more direct way, some new evidence of the effects of monetary policies on U.S. domestic macro-economic variables and on international capital flows during the recent sample periods from 1999 to 2010, including GFC.

In order to investigate the movements of international capital flows, many literature studies examine the interest rate differentials between countries. However, not only the long-term U.S. interest rates as well as the U.S. federal funds rate, a main indicator of U.S. monetary policy, often move endogenously with changes in the U.S. domestic economic conditions and international financial conditions in this globalized financial environment. Thus, the use of an inappropriate measure may obscure relationships between monetary policy in advanced countries and international economic variables including capital move-

ments between countries that actually exists, or create the appearance of a relationship where there is no true causal link.

Even if I use Federal Reserve's target rate for explanatory variable to eliminate this endogenous effect, that will almost surely contain anticipatory movements. Thus, as argued in Romer and Romer (2004), the Federal Reserve invests a huge amount of resources in forecasting the likely behaviors of output and prices also for foreign variables, so movements in its target series are often responses to information about future domestic and international economic developments. Some explicit examples can be the cases of global credit freeze started from the U.S. financial crisis, recent slowing down in Chinese growth rate, or European crisis. In such situations, if the fed anticipate that these scenarios will be continued, these economic conditions will be taken into account in exercising US monetary policy and the Federal Reserve's target rate is unlikely to rise. This anticipatory effects may cause researchers to underestimate the negative impact of increases in U.S. policy rates not only on domestic variables, but also on international financial variables, because the world economy is closely interconnected, and an anticipated slow down in the U.S. economy may be directly related to an ossifying world economy, and vice verse. Thus, it is important to control for those anticipatory effects and that is why many contributions to the recent literature in international economics such as Miranda-Agrippino (2015) use Romer and Romer shock as a proxy for U.S. monetary shock to estimate the responses of global asset prices and international credit flows to US monetary policy shocks.

However, Coibion et al (2016) recently found that the Romer and Romer proxies for U.S. monetary shocks do not seem to have valid influence on important U.S. macroe-

conomic variables for the sample period starting in 1980. They applied Impulse response analysis to study the impacts of U.S. monetary shocks (Romer and Romer shocks) on income distribution among U.S. households, and investigate how asset prices are differentially affected by U.S. monetary shocks using quarterly data from 1980Q1 to 2008Q4. Some Impulse response functions of important macroeconomic variables such as GDP and unemployment rate showed no significant effects on these variables of the Fed's monetary policy. Especially for GDP, the Impulse response function showed the opposite reaction to monetary shocks (that is, contractionary monetary shocks increase GDP), compared to what we would expect for the response, even though it was still not significant.

To investigate this issue, I develop a measure of U.S. monetary policy shocks that is free of endogenous and anticipatory movements with U.S. domestic economic variables and international financial variables. Following Romer and Romer (2004), I revisit the Fed's information set which is created when they set federal funds target rates around FOMC meetings. The forecasts made in Greenbook contain all the outlook for most of the important future U.S. and international economic variables. I used monthly data for the period from 1999 to 2010 in order to have the inputs for foreign projected variables as well.

The important finding is that the Romer and Romer used the forecasts for GDP deflator to account for Fed's prediction on future inflationary price level in the economy. However, GDP deflator might be an important indicator for price level at the earlier periods, but the Fed has developed various price indices to capture the economy's price level and recently began to emphasize personal consumption expenditures (PCE), produced by the Department of Commerce, rather than the GDP deflator for the price inflation measure,

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largely because the PCE index covers a wide range of household spending. Thus, considering forecasts for GDP deflator as an important indicator to gauge the economy's price level, may obstruct the analysis on what was truly on Fed's information set around FOMC meetings. Thus, I use projected values for CPI for periods when PCE was not used, and then use forecasts for PCE, instead of the GDP deflator to account for price level forecasts. I also included forecasts for foreign GDP and CPI indices to take international endogenous and anticipatory movements into account in fed target rate.

The results show that forecasts for foreign variables do not add much information, after accounting for U.S. domestic forecasts for predicting Fed's target rates. The Impulse response functions of monetary shocks including foreign forecasts, do not show much difference in responses of U.S. domestic macroeconomic variables compared to Romer and Romer shocks, even though they showed some significant differences in responses of international variables. These may be reasonable results because U.S. concerns on foreign economies started very recently, so strong effects may be unlikely to be seen in long time series data, even if there is some degree of explanatory power in setting U.S. target rate during recent short time periods.

However, U.S. monetary shocks measures accounting for forecasts for CPI/PCE indices, instead of GDP deflator showed significantly different effects in responses of U.S. domestic macroeconomic variables to the shock as well as in responses of some international financial variables. Thus, using forecasts for these indices in examining the influence of the shocks on domestic and international variables may be a better idea.

The paper is structured as follows. Section 1.2 shows some stylized facts on

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emerging markets capital flows. Section 1.3 presents relevant literature on monetary shock analysis and international capital flows. Section 1.4 explains data collection. Section 1.5 discusses the construction of U.S. monetary shocks measures and their implications on U.S. domestic and international variables. Section 1.6 presents the main results on the effects of monetary policy shocks on realized federal funds rates, various U.S. production measures, PPI, CPI, unemployment rates, and international capital flows. Section 1.7 concludes.

1.2   Stylized Facts : EMEs Capital Flows

In order to provide a general picture of the movement of aggregated capital flows of EMEs in recent periods, from 2002Q1 to 2014Q1, some figures and descriptions are presented in this section.

Figure 1.1 presents net outflows of various assets of major EMEs collected from their Balance of Payment (BOP) data[1]. Particularly, the left side of the figure includes net outflows of total portfolio assets, and the ones divided into debt and equity securities. The right side of the figure shows net outflows of other assets, respectively foreign direct investment (FDI), other investment, which mainly refers to bank deposits and loans, and reserve assets.

We can see from the left side of figure that the direction of flows changes dramatically before and after the GFC. For portfolio equity, the aggregated net outflow changes from negative (net inflows) to positive (net outflows) around the GFC, but after that periods, the direction changes back to negative (net inflows). Thus the direction change in portfolio

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[1] The EMEs covered in the graphs are total 16 countries and include Argentina, Brazil, Chile, China, Colombia, Mexico, India, Indonesia, Israel, Malaysia, Philippines, South Korea, South Africa, Taiwan, Thailand, and Russia.

equity around the GFC is somewhat temporary and could be occurred by worldwide spread uncertainties at that moment. On the other hand, the aggregated net outflow in portfolio debt changes the direction after GFC from positive (net outflows) to negative (net inflows) and the net inflows after GFC is very persistent and the magnitude is also very huge throughout the periods after GFC. Thus, from the figure, we can infer that the surges of capital flows to EMEs in portfolio investment after GFC mainly came from debt securities, not from equity investment.

The right side of the figure shows the aggregated net outflows of FDI, other investments, reserve, and we can confirm that the strong net inflows of FDI are maintained before and after GFC. The net outflow in other investments is also fairly constant and stable before and after the GFC except a small fluctuation during GFC. Finally, the EMEs also continued to increase the accumulation of the reserves assets denominated in foreign currencies during the sample periods, regardless of pre or post GFC periods except a small squiggle during GFC. Thus, from the figure, we can infer that there seems no particular change in movement of capital flows in other assets during before or after GFC periods, that can be regarded as surges.

Figure 1.1: EME Net Outflows

As confirmed in the figures, we could see that there was a huge surge of capital flows into EMEs in total portfolio assets after GFC, whose net position was previously around zero before GFC, and this is different from what we saw in other assets. Also, the main surge in total net portfolio investment came from portfolio debt assets not from the portfolio equity assets, because net outflows of equity assets around GFC went back to the original trend (net inflows) as the ones before GFC.

Now I look at how policy rate differentials have impact on EMEs capital flows in equity and debt assets differently, using the same method used in Ahmed et al (2014), which was not presented in their paper.

In Table 1.1, I replicated their result in the first column. Because I covered more EME countries than them, the actual values are different, but the results are consistent qualitatively. Then second and third columns are added by separating the total portfolio by debt and equity portfolio. As we can see from the results, the sensitivity change of

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net portfolio in response to policy rate differentials (D_post-crisis#Rate_diff) which is their

main finding, only works for equity portfolio, not for debt assets.

Variables Outflows	(OLS) Net portfolio/GDP	(OLS) Net equity/GDP	(OLS) Net debt/GDP
Rate_diff	-0.00175***	-0.000831**	-0.000920**
	(0.000503)	(0.000341)	(0.000382)
Growth_rate_diff	-0.00177**	-0.00139**	-0.000378
	(0.000862)	(0.000583)	(0.000655)
VIX	0.00104***	0.00142***	-0.000378
	(0.000365)	(0.000247)	(0.000278)
Trend	0.000170	0.000666***	-0.000496**
	(0.000297)	(0.000201)	(0.000226)
D_post-crisis	-0.0358	0.0283	-0.0641**
	(0.0356)	(0.0241)	(0.0271)
D_post-crisis #Rate_diff	-0.00257**	-0.00261***	4.69e-05
	(0.00111)	(0.000749)	(0.000840)
D_post-crisis#Growth_rate_diff	0.00160	0.000833	0.000771
	(0.00122)	(0.000825)	(0.000926)
D_post-crisis#VIX	-0.000143	-0.000938*	0.000795
	(0.000710)	(0.000481)	(0.000540)
D_post-crisis#Trend	0.000966	-0.000327	0.00129**
	(0.000760)	(0.000515)	(0.000578)
Constant	-0.00946	-0.0299***	0.0204***
	(0.00926)	(0.00627)	(0.00704)
Observations	616	616	616
R-squared	0.058	0.089	0.050

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.1: Structural break test for the determinants of net portfolio capital outflows to EMEs.

Therefore, the finding of Ahmed et al (2014) that the capital surges are resulted

from the sensitivity change of policy rate differentials is partially valid, because the inter-

action term only significant for the equity assets not for debt assets, and debt assets are the

ones that mainly show the surge. Thus the goal here should be investigating what are the

drivers of capital surges into portfolio debt of EMEs rather than those of total portfolio or

other assets.

1.3 Literature

Many literature on global imbalances has noticed different investment behaviors between heterogeneous groups of the countries. That is, while advanced economies hold a large share of risky assets (portfolio equity or FDI investments) in their external balance sheets (49% for the United States, 50% for Canada, 26% for the UK, 31% for France), emerging markets' external portfolios have a lower weight on risky assets (India 5%, Indonesia 5%, Russia 18%, China 9% , Brazil 21%), as these economies tend to invest in safer securities such as government bonds. Also it is a well-known fact that U.S is one of the largest debtor countries among industrialized countries, while Japan, and other emerging economies accumulate U.S. government bonds and other advanced countries bond assets substantially. To understand this phenomenon, many studies proposed asymmetries in financial development, risk-adverseness, and abilities to generate financial assets as the reasons for global imbalances as in Caballero et al. (2008) and Mendoza, et al. (2009).

However, even if these structural differences among countries can explain the long trend in global investments between heterogeneous groups of the countries, it is hard for them to also account for frequent changes in capital flows or the recent change in direction of portfolio investment among countries as we saw in section 1.2, because it is hardly possible for all emerging counties to innovate their financial structure at the same time. Thus. many researches on international capital flows have worked on investigating the key factors of behaviors of international capital flows.

Byrne and Fiess (2011) investigate the correlation of capital flows of 78 emerging countries, extract the common factor and examine their correlations with five global

macroeconomic variables, using data from 1993Q1 to 2009Q1. These explanatory variables include real non-oil commodity prices, the real short term and real long term US interest rate, VIX uncertainty index, and real GDP growth in the G7. They use quarterly data on gross capital inflows only so that they do not conflate foreign and domestic investors which occurs when net capital flows are examined, and also only consider U.S. part of interest rates. However, not only the US long run real interest rate but also real non-oil commodity prices endogenously move with U.S. domestic economic development and international economic situations, and they only report the correlations of all the combinations of those variables, it is very hard to derive causal determinants of capital flows. Also, the gross capital inflows data may not be the right data we want to look at, to investigate relative tension/force on the movement of net capital flows between two different worlds. Thus, some global factors may only affect capital outflows not inflows or vice verse, then some important change can be missed out, so to see comprehensive movement from both directions, we may also need to look at net flows. Indeed, Ahmed et al (2014) found that global variables like the VIX are significant when they estimate regressions on net flows, but not significant when they use gross inflows. Still Byrne and Fiess (2011) found that U.S. interest rate was a crucial determinant of global capital flows to EMEs, but it is still ambiguous whether U.S. interest rate affect the movement of capital inflows of EMEs, or vice verse. In addition, they found less evidence of an important role for short term rates, which suggest that most of the implication for global capital flows come from the long end of the yield curve which has more room for endogenous movement, and concluded that the capital flows were not clearly attributable to U.S. monetary policy. However, they didn't properly

handle the endogenous movement in change of U.S. interest rate. Also, they used quarterly data, and financial assets such as bond, tend to react fast to shocks, so quarterly data may be hard to capture the quick response of capital flows. They also performed the same panel analysis using disaggregate capital inflow data of equity issuance, bond issuance and syndicated bank lending, and found that equity flows were more influenced by U.S. short run and long run interest rates, than bond or bank products, which is different from my result. However, they didn't report the confidence levels, so we cannot tell whether these values were statistically significant or it was just a result of capturing volatility of the data.

To examines when and why capital surges to EMEs, Ghosh et al. (2012) analyzed annual data for 56 EMEs over 1980–2011. They first identified surges as exceptionally large net capital inflows to the country (flows in the top 30th percentile of the full sample's distribution of net capital flows in percent of GDP) and examined the correlates of their occurrence and magnitude, using probit and regression models. They found that during surges, the US real interest rate and global market uncertainty (S&P 500 index returns volatility) are significantly lower than at other times, while recipient countries tend to have larger external financing needs, faster output growth, more open capital accounts, less flexible exchange rate regimes, and stronger institutions. Also, they found that lower U.S. interest rates, greater global risk appetite, and EME's own characteristics are important in increasing the magnitude of the surge. However, the same argument for Byrne and Fiess (2011) can be applied here that they estimated correlates of capital flows to EMEs, using various endogenous variables including real U.S. interest rate, so it will be hard to derive causal relationships between the various important factors in the model and the magnitude

of the surge. Thus, the fact that the result didn't show any significant relationship between the key factors and the magnitude of the capital flows in the case of non-surges, may be a signal that there is a endogenous feed back from dependent variables to affect the interest rates and prices which obscure the true relationship, so we have to take care of this endogeneity issue.

Forbes and Warnock (2012) use quarterly data on gross inflows and gross outflows which covers the period from 1980 through 2009 and includes over 50 emerging and developed economies, and also mainly investigate extreme episodes of "surge" and "stop" (sharp increases and decreases, respectively, of gross inflows), and "flight" and "retrenchment" (sharp increases and decreases, respectively, of gross outflows). They create a dummy variable which designates the episodes, and construct a probability function for that episodes. They study how the global factors contribute to the probability and find that global factors are related to certain types of episodes. That is, global risk is the only variable that consistently predicts each type of capital flow episode; an increase in global risk is associated with more stops and retrenchments and fewer surges and flight. Other global factors, such as strong global growth is associated with an increased probability of surges and decreased probability of stops and retrenchment. High global interest rates are associated with retrenchments. Similar to Ghosh et al. (2012), the reason that some global factors are only effective for the certain type of special events of capital flows, may be because they didn't take out the endogenous relationship between the probability of the episodes and its explanatory variables, and fail to find a persistent relationship between capital flows and global factors that permanently exist regardless of the type of the events.

As I briefly introduced and made some comments in their findings in section 1.2, Achmed et al (2014) examined the determinants of net private capital inflows to emerging market economies (EMEs) since 2002 using a structural-break regression model. They found that growth and interest rate differentials between EMEs and advanced economies, and global risk appetite are important determinants of net private capital inflows. Also, they found that there have been sensitivity changes in the behavior of net inflows to interest rate differentials from the period before the recent global financial crisis to the post-crisis period, and this explains the great surges of capital flows in portfolio investment to EMEs since the crisis. However, as mentioned previously, for disaggregated data, the sensitivity change only works for portfolio equity assets, while the capital flows reversal (net outflow from EMEs to net inflows to EMEs) after GFC mainly came from portfolio debt, so we have to find a measure which is free of endogeneity and also explains better the movements of portfolio debt, which encompasses the recent episode of surges after GFC .

As a paper from theoretical literature, Miranda-Agrippino et al (2015) used a medium-scale Bayesian VAR to analyze the interaction between US monetary policy and global financial variables such as credit spreads, cross-border credit flows, bank leverage, and they found that evidence of large monetary policy spillovers from the U.S. to the rest of the world. Thus, they incorporate global banks in their model, which can transmit monetary conditions from the center countries through cross-border capital flows, and influence the provision of global credit, so that the center countries such as U.S. may directly influence the global financial cycle by altering the cost of funding for major global banks. However, they used domestic and global credit and banking data which falls into other investment

category from Balance of Payment, and this assets category didn't show dramatic change in behaviors of net flows of EMEs before and after GFC in section 1.2, so the target asset of the interest is somewhat different from this paper. Since portfolio investment differs from other investment in that it provides a direct way to access financial markets to provide liquidity and flexibility, so involvement of banks is not necessary. Also, they used Romer and Romer's specification to get global monetary measure, which is also different from the specification I designed in this paper, and given that the shocks from Romer and Romer specification don't show valid impacts on most of the U.S. domestic macroeconomic variables for recent sample period, it is arguable whether it will be a right measure for U.S. monetary shocks. The results from using different specifications will be presented in section 1.6.

Coibion et al (2016) studied the effects of monetary policy shocks on consumption and income inequality in the United States since 1980, and found that contractionary monetary policy systematically increases inequality in labor earnings, total income, consumption and total expenditures. More specifically, they also followed Romer and Romer (2004) to identify innovations to monetary policy purged of anticipatory effects related to economic conditions and estimate the response of economic variables to monetary policy shocks at different horizons. The notable thing from this paper is when they use data from 1969:Q3 to 2008Q4 and get the shocks, contractionary monetary policy shocks lower real GDP and raise unemployment, and lower consumption, but for GDP and unemployment, the responses are not significant either at 68 percent or 90 percent confidences. When they used data from 1980:Q1 to 2008Q4, the responses of GDP and consumption even increased

to contractionary monetary policy shocks, which seems implausible. Therefore as I mentioned for Miranda-Agrippino et al (2015) we may need to examine the validity of the policy measure used in the papers first before using it.

1.4 Data

Data are collected from various sources. Detailed description on the data set is provided in this section.

1.4.1 Greenbook Forecasts

Outlooks for U.S. domestic and international development are available in Greenbook forecasts. Starting from October 1976 the international macroeconomic forecasts are made explicitly for real GNP and whole sale prices, considering 10 industrial countries by Federal Reserve[2]. However the forecast records for advanced countries are missed out from May 1991 to November 1994. Quantitative forecasts for emerging countries started to be recorded from January 1999 and kept being made up to the very recent period, for Asian and Latin countries. Thus, the full data set in this paper is started from January 1999 to accommodate forecasts for emerging countries as well, which are major participants in the recent surge of capital flows. However, the concern is that theses variables were probably not playing actually important role in setting policy for the entire sample periods, even though the forecasts for those countries were presented in Greenbook. Also, taking care of forecasts for both emerging and advanced economies reduces the degree of freedom in the

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[2]10 industrial countries includes Canada, Germany, France, Italy, Belgium, Netherlands, Switzerland, Japan, Sweden, and the United Kingdom.

model rapidly, so it attenuates the explanatory power of the explanatory variables for the relatively short time series data which ranges from January 1999 to December 2010.

Also, in the summary page of the Greenbook, the main indicators that the Feds consider the most evolve over time. Real GDP and unemployment rates keep holding the positions but the inflation indicators changes over time from GDP deflator to CPI, and to PCE for the very recent periods, and GDP deflator are not even explicitly shown in the main outlook for economic development any more. Also, we know from many evidences that the Feds more concern on PCE movement recently. Therefore we have to reflect the evolution of Feds information set, to properly consider the forecast values of key macroeconomic indicators that the FOMC is likely to consider in setting policy.

1.4.2   U.S. Macroeconomic Variables.

- Federal fund target rate: This series sources from Bloomberg as FDTR index.

- Unemployment rate: This monthly harmonized unemployment rates are from OECD Statistics and define the unemployed as people of working age who are without work, are available for work, and have taken specific steps to find work. This uniformly defined estimates of unemployment rates are more internationally comparable than estimates based on national definitions of unemployment. This indicator is measured in numbers of unemployed people as a percentage of the labor force and it is seasonally adjusted. The labor force is defined as the total number of unemployed people plus those in civilian employment.

- Industrial production, n.s.a: The data are from the Board of Governors web site. The

series used is B50001.

- Ratio to trend: This series is calculated by OECD Statistics and it refers to the deviation from the long-term trend of the series which is set by 100, and focuses on the cyclical behavior of the indicator. Hence, this presentation makes it relatively easy to detect a new turning point. This is one type of series in CLIs(Composite leading indicators) group. CLIs are calculated by combining component series in order to cover as far as possible the key sectors of the economy. The aggregation of components series into the CLI reduces the risk of "false signals", changes in the indicator due to irregular movements which do not correspond to any later developments in the aggregate economy.

- Business confidence index: This series is calculated by OECD Statistics and is based on enterprises' assessment of production, orders and stocks, as well as its current position and expectations for the immediate future. Opinions compared to a "normal" state are collected and the difference between positive and negative answers provides a qualitative index on economic conditions.

- Producer price index: This series is calculated by the Bureau of Labor Statistics. Producer price index measures the change in prices of products sold as they leave the producer, and is measured in index (2010 = 100). They exclude any taxes, transport and trade margins that the purchaser may have to pay. This PPI provide measures of average movements of prices received by the producers of all commodities.

- Consumer price index: This series is calculated by the Bureau of Labor Statistics,

and is defined as the change in the prices, in index (2010 = 100), of a basket of goods and services that are typically purchased by specific groups of households. This consumer price index is estimated as a series of summary measures of the period-to-period proportional change in the prices of a fixed set of consumer goods and services of constant quantity and characteristics, acquired, used or paid for by the reference population.

1.4.3   International Capital Flows

Quarterly EMEs Capital Flows

To get 16 EME countries capital flows in section 1.2, I collected the balance-of-payment (BOP) data of various assets of each emerging country. I first calculated net capital flows (Gross outflows from EMEs - Gross inflows to EMEs) for individual country as a fraction of their GDP levels and summed them up to get net capital flows for entire emerging countries. CEIC data provides each country's quarterly BOP data of portfolio debt, portfolio equity, other investment, direct investment, reserve assets and so forth in US dollars. This data set collects all the capital flows of the disaggregated assets based on IMF definition, from all different sources such as each country's central bank, IMF, and other data collection company, so some missing data can be filled with one of the different sources. I got GDP levels of the EMEs from Bloomberg.

IMF developed its own definition of the assets depending on the various functional characteristics of the assets, and disaggregated a country's entire BOP flows following the definition. More specifically, debt assets are the financial assets to store values for

future consumption, so any investors, financial institutions, or firms which need to hedge unfavorable risks or uncertainties will demand the this assets, especially when the uncertainties in the world increased and the financial legal systems in their countries are not strong. This is because in principle, debt assets guarantee the principal and interest rate, while equity assets are just residual claims (returns are not guaranteed). That is the reason why EMEs tend to invest in safer securities such as government bonds of advanced countries in exchange of equity assets in their countries. In this way I could infer the behaviors of investors in response to the change in US monetary policy by detecting the channel of the response of the capital flows.

Monthly Korean Capital Flows

In order to provide a policy guidance to EME's policy makers, I examined monthly Korean capital flows recorded by Central bank of Korea, rather than high frequency mutual funds data, which forms a fraction of the capital flows of the economy. This is because each policy makers' concerns are the entire capital flows from/to the economy. Also, from Romer and Romer (2004) as well as other empirical studies, a monetary shock tends to affect the economy for quite a long period (e.g. the macro variables start to response after 5-11 months and reach the minimum after 24-48 months) with some lagged values of the shock, so to examine the evolution of capital flows during the sample periods without discontinuities, we need to observe the movement for longer periods in macroeconomic point of view.

Also, compared to the literature used quarterly data, the financial variables, different from macroeconomic variables, are known to be react faster to the shocks, so quarterly

data may fail to capture the quick response of financial variables. Thus the monthly data is long enough to observe the entire movement of macroeconomic variables compared to daily data and short enough to capture quick movement of financial variables compared to quarterly data.

Lastly, since Korean economy is highly affected by the U.S. economic development and also considered as a small open economy in that it hardly affects other countries interest rates, so I used Korea as a representative country for the entire EMEs. Also it is the only country records monthly capital flows as far as I know.

1.5 Model

1.5.1 Identification of the Monetary Shocks

Romer and Romer (2004) used quantitative and narrative records from Greenbook reports and other governmental resources, to infer the Federal Reserve's intentions for the federal funds rate and its forecasts on domestic economy around FOMC meetings. To get the random U.S. monetary shock series, they first regress the change in the intended funds rate around forecast dates on these forecasts. The residuals from this regression is relatively free of both endogenous and anticipatory actions which cause issues in examining the effect of monetary shocks as discussed previously. Then they employ the residual series to analyze the responses of output and inflation to monetary developments. They accomplished this in their second regressions of the growth rates of industrial production and the producer price index for finished goods on the new series of monetary shocks. I basically do the same exercise as Romer and Romer (2004), but I use forecasts for CPI/PCE

instead of GDP deflator, for inflation indicators, and also add forecasts for international economies as well. However, as I explained previously in sections, the forecasts for international economies didn't have much explanatory power in predicting the changes in Federal Reserve's intentions for the federal funds rate, also didn't make much difference in predicting U.S. domestic macroeconomic variables in the second regression either, compared to Romer and Romer shocks. Also, adding forecasts for both emerging and advanced economies reduces the degree of freedom in the model rapidly, so it attenuates the explanatory power of the explanatory variables for the relatively short time series data. Thus, I only concentrate on presenting the method of getting the monetary shocks calculated by using forecasts for CPI/PCE as inflation indicator in the economy.

The particular forecasts I used are those for the real GDP growth rate, CPI/PCE, and the unemployment rate, which are three key macroeconomic indicators that the FOMC is likely to consider in setting policy. The unit of observation is FOMC meetings from 1999 to 2010. The forecasts are only released with a substantial lag, so the forecasts made for year 2010 in Greenbook are the latest released ones.

The specific equation for the first stage is:

$$
\begin{aligned}
\triangle ff_m \;=\;\; & \alpha \;+\; \beta ffb_m && + \; \sum_{i=-1}^{2} \gamma_i \widetilde{\triangle y_{mi}} && (1.1)\\
& + \; \sum_{i=-1}^{2} \lambda_i \left(\widetilde{\triangle y_{mi}} - \widetilde{\triangle y_{m-1,i}} \right) && + \; \sum_{i=-1}^{2} \varphi_i \widetilde{\pi_{mi}} \\
& + \; \sum_{i=-1}^{2} \theta_i \left(\widetilde{\triangle \pi_{mi}} - \widetilde{\triangle \pi_{m-1,i}} \right) && + \; \rho \widetilde{u_{m0}} \; + \; \varepsilon_m
\end{aligned}
$$

Here $\triangle ff_m$ is the change in the intended funds rate around FOMC meeting m. ffb_m is the level of the intended funds rate before any changes associated with meeting m. $\widetilde{\pi}$, $\widetilde{\triangle y}$, and $\widetilde{u}$ refer to the forecasts of inflation, real output growth, and the unemployment rate. As in Romer and Romer (2004) both the forecasts for the contemporaneous meeting and the change in the forecast since the previous meeting are included. The horizons of the forecasts are previous quarter, current quarter, and one and two quarters ahead. The difference from Romer and Romer shocks is that this paper considered forecasts for CPI and PCE since these indicators are highly on Feds information set in setting policy rather than GDP deflator as discussed previously. The extracted US monetary shocks, ε_m , from Equation (1.1) is considered to be free of both endogenous and anticipatory actions US-domestically.

The results of estimating Equation(1.1) are reported in Table 2. The coefficient estimates show that the FOMC tends to behave counter-cyclically in general. An increase from one meeting to the next in forecasted real growth for current quarter (GRAY0) and one quarter ahead (GRAY1) of one percentage point leads to a rise in the intended funds rate of 6.8 and 5.9 basis points (relevant coefficients are 0.068 and 0.059) respectively, using new specification. When Romer and Romer specification is used, the coefficient on the forecasted real growth for current quarter (GRAY0) is 0.040, and the coefficient on the forecasted real growth for one quarter ahead (GRAY1) is 0.061. Although the estimated coefficient on the growth variable of previous quarter (GRAYM) is negative, the strongest estimated effect is for the forecast of real growth for the current quarter (GRAY0) and one quarter ahead (GRAY1). It is a reasonable result, since FOMC would more concern on

current and future level of growth rate than the one of the past quarter, which they can't have any influence on. Also the negative effect on the growth variable of previous quarter may be a result of capturing a tendency toward mean reversion in FOMC behavior.

The results of the regression suggest that the Federal Reserve also resists forecasted inflation. The strongest estimated coefficient is for the forecast of inflation at two quarter ahead (CPIPCE2) and the coefficient is 0.196, using new specification. When Romer and Romer specification is used, the strongest estimated coefficient is for the forecast of inflation at current quarter (GRAD0), and the coefficient is 0.048. Here also the estimated coefficient on the inflation variable for previous quarter (CPIPCEM) is negative, but the forecasts for all other quarters show positive coefficients so the same reasoning of capturing a tendency toward mean reversion in FOMC behavior can be applied here as well.

The negative coefficient on the forecast of the unemployment rate for the current quarter also confirms the counter-cyclical tendency in FOMC behavior in new specification. However, when Romer and Romer specification is used, the coefficient on the forecast of the unemployment rate for the current quarter is positive, which seems implausible, but both coefficients are not statistically significant.

The R^2 of the regressions are 0.600 vs. 0.629 in Romer and Romer vs. new specification, respectively. Also the adjusted R^2 are 0.506 and 0.542, respectively. The different results from the two regressions suggest that forecasts for CPI/PCE explain Federal Reserve's intentions for the federal funds rate better than forecasts for GDP deflator do, and that a substantial fraction of Federal Reserve actions over the last decade have been taken in response to their forecasts of future growth and inflation. Thus, it is possible that con-

Table 1.2: Determinants of the Change in the Intended Federal Funds Rate

	Dependent variable:	
	DTARG	
	Romer Romer	New Specification
OLDTARG	−0.035* (0.019)	−0.031* (0.018)
GRAU0	0.003 (0.019)	−0.014 (0.018)
GRAYM	−0.022 (0.014)	−0.024* (0.014)
GRAY0	0.040* (0.024)	0.068*** (0.025)
GRAY1	0.061** (0.030)	0.059** (0.029)
GRAY2	0.017 (0.027)	0.003 (0.026)
IGRYM	−0.009 (0.025)	−0.012 (0.025)
IGRY0	−0.048 (0.033)	−0.082** (0.033)
IGRY1	0.125*** (0.043)	0.066 (0.043)
IGRY2	−0.049 (0.045)	−0.030 (0.040)
GRADM	0.015 (0.023)	
GRAD0	0.048* (0.027)	
GRAD1	0.113 (0.072)	
GRAD2	0.065 (0.077)	
IGRDM	−0.023 (0.051)	
IGRD0	0.008 (0.039)	
IGRD1	−0.006 (0.090)	
IGRD2	0.135 (0.126)	
CPIPCEM		−0.042*** (0.015)
CPIPCE0		0.002 (0.016)
CPIPCE1		0.006 (0.057)
CPIPCE2		0.196** (0.077)
ICPIPCEM		−0.043 (0.086)
ICPIPCE0		0.022 (0.027)
ICPIPCE1		−0.006 (0.061)
ICPIPCE2		0.025 (0.089)
Constant	−0.574** (0.228)	−0.359* (0.214)
Observations	96	96
R^2	0.600	0.629
Adjusted R^2	0.506	0.542
Residual Std. Error (df = 77)	0.168	0.161
F Statistic (df = 18; 77)	6.404***	7.257***

The sample period is 1999:1 to 2010:12.   *p<0.1; **p<0.05; ***p<0.01

trolling for these responsive actions using incorrect information could result in substantially

different conclusions or even bias estimates of the effects of policy.

1.5.2 Implication of the Monetary Shocks

In order to investigate how U.S. macroeconomic variables and international capital flows behave in the wake of monetary shocks, Equation (1.2) is applied.

$$
\begin{aligned}
\triangle x_t \;\; = \;\; a_0 \;\; + \;\; \textstyle\sum_{j=1}^{11} a_j D_{jt} \;\; + \;\; \textstyle\sum_{k=1}^{K} b_k \triangle x_{t-k} \\
+ \;\; \textstyle\sum_{l=1}^{L} c_l S_{t-l} \;\; + \;\; e_t
\end{aligned}
\tag{1.2}
$$

Where x is the dependent variables of the interest, i.e. U.S. macroeconomic variables and international capital flows, and all the variables are manipulated in order for $\triangle x_t$ to have a unit of percentage. S is the two measures of monetary policy shocks, and the D_{jt} are monthly dummies. The sample period is 1999M1–2010M12. The significance of coefficient c_l and its cumulative effect on the dependent variables are the interest of this paper.

For lag selection, some information criterion (Akaike information criterion (AIC), Hannan and Quinn information criterion (HQIC), and the Bayesian information criterion (BIC)) are considered, and then the Lagrange multiplier test for auto-correlation in the residuals are applied to choose proper lags eliminating all serial correlation in the residuals for all the dependent variables. A stable AR model requires the eigenvalues to be less than one and the formal test confirms that all the eigenvalues lie inside the unit circle. I also

29

follow the conventional assumption that monetary policy does not affect macroeconomic variables within the month; thus I do not include the contemporaneous value of the shock series. Also I considered the specification of Coibion et al (2016) in lag selection. The results will be summarized by examining responses of various dependent variables (in percentage term) to a one-time realization of one percentage point contractionary monetary policy shock (S) in the next section.

1.6 Results

In this section, the figures present the impulse response functions of various U.S. Macroeconomic variables, and international capital flows with 95 percent confidence intervals. The horizons of the impulse responses are 20 months except federal funds rates, which present 40 months of horizon. The figures are organized so that the columns of the matrix indicate the impulse responses to two different shocks I compare, Romer and Romer shocks vs. New shocks, and the rows of the matrix indicate various dependent variables which response to the shocks. Here the new shocks are obtained from accounting for forecasts for CPI/PCE indices. Each cell of the tables graphs the impulse responses over 20 months to a one percentage point (100 b.p.) contractionary monetary policy shock.

1.6.1 Effects of US Monetary Policy Shocks on US Macroeconomic Variables

Figure 1.2 shows the implied response of federal funds rates to one percentage point change in the policy measures, together with 95 percent confidence bands. The estimated cumulative impact for RR shocks is significantly positive at least for 26 months

and can be raised up to 6.5 percent at least. The estimated effect is essentially 20 percent at month 27. The impact then weakens gradually to zero. For the new shocks, the estimated cumulative impact is significantly positive at least for 34 months and the rate can be raised up to 6.1 percent at least. The estimated effect is essentially 19 percent in months 27 through 33, then the impact also weakens gradually. Standard deviation band is also tightened when the new shock measure is used.
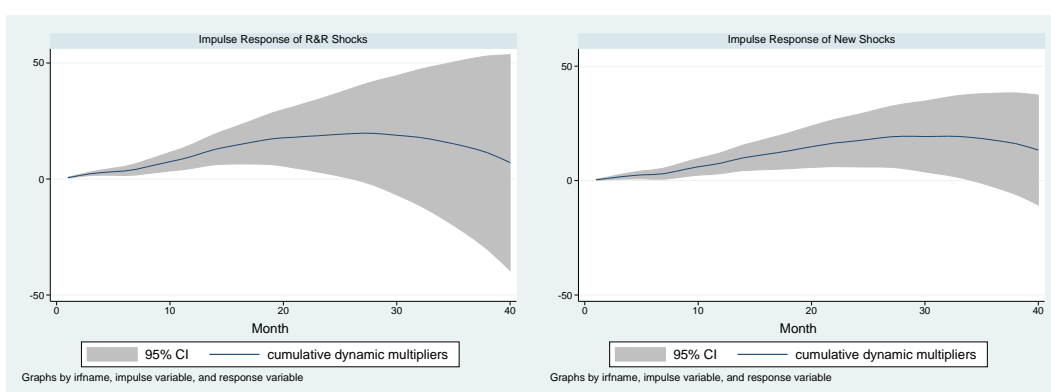

Figure 1.2: Federal Funds Rates (%)

Figure 1.3 shows the estimated cumulative impact on monthly unemployment rate to one percentage point change in the policy measures, together with 95 percent confidence bands. The estimated impact for RR shocks increases by 0.3% for the first 3 months and then is virtually zero, (i.e. not statistically significant) for the rest of the periods. The estimated unemployment rate maintains 1 percent in months 3 through 12, but is not statistically significant. One year after the contractionary policy shock, the unemployment rate begin to fall substantially which seems not plausible. For the new shocks, the estimated cumulative impact is significantly positive at least for 14 months and the rate can be raised up to 1.4 percent at least. The estimated effect is essentially 6 percent after one year, and

increases up to almost 9 percent in month 20, not taken in response to information about future unemployment level.
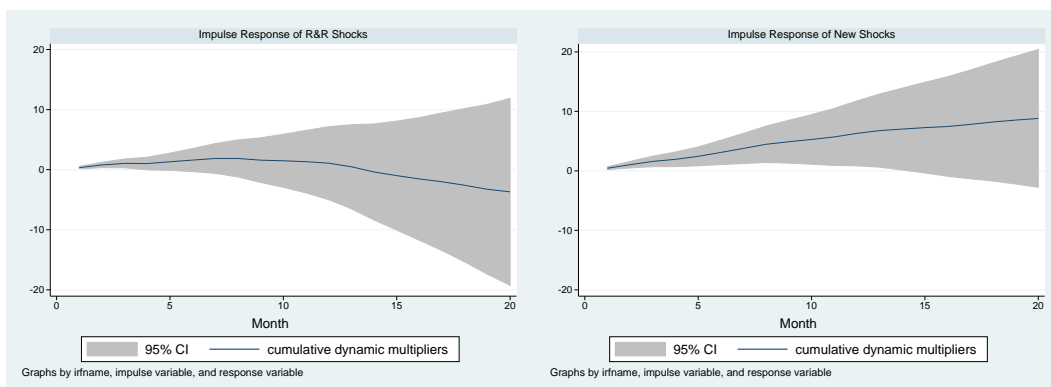

Figure 1.3: Unemployment Rate (%)

Figure 1.4 shows the implied response of various output indicators to one percentage point change in the policy measures, together with 95 percent confidence bands. The first row presents the response of non-seasonally adjusted industrial production in log to two monetary shocks. The estimated cumulative impact for RR shocks is positive for the first two months, also declines for the first three months then gradually increase after that, but the estimated effect is essentially not statistically significant. For the new shocks, the estimated impact is also positive for the first month, and declines for the first three months. This time the estimated effect is significantly lower than zero, -0.03 percent, in month 3. However, after month 4, the estimated response to the new shock bounces up and down at -0.01 percent level and is not statistically significant either.

The second row shows the estimated response of ratio to GDP trend to two monetary shocks. The estimated cumulative impact for RR shocks is significantly negative for the first ten months, and reduces GDP by 0.03 percent from its trend at the trough in month

8, After month 9, the estimated effect increase significantly, which seems not plausible. The result shows that twenty months after a contractionary shock, GDP will increase by more that 0.1 percent, not taken in response to information about future economic developments. This result also coincides with the result from Coibion et al (2016). For the new shocks, the estimated cumulative impact is significantly negative at least for 16 months and reduces GDP by 0.12 percent from its trend at the trough in month 12. After month 13, the impact weakens gradually, reaching -0.07 percent at month 20. The estimated impact in the middle months is highly significant, but the effect at longer horizons, on the other hand, is not precisely estimated.

The third row presents estimated response of business confidence in percentage term to two monetary shocks. The estimated cumulative impact for RR shocks decreases for the first seven months, and reduces business confidence index by 0.03 percent at the lowest point in month 7, but the impact is not statistically significant anywhere in the sample periods. For the new shocks, the estimated cumulative impact is significantly negative at least for 12 months and reduces business confidence by 0.085 percent at the lowest point in month 8. This means that a one percentage point rise in the Federal Reserve's intentions for the funds rate, not taken in response to information about future economic developments, reduces business confidence by over 0.08 percent. The impact then weakens gradually, reaching -0.045 percent at month 15. The estimated impact in the middle months is highly significant, but the effect at longer horizons is not precisely estimated.
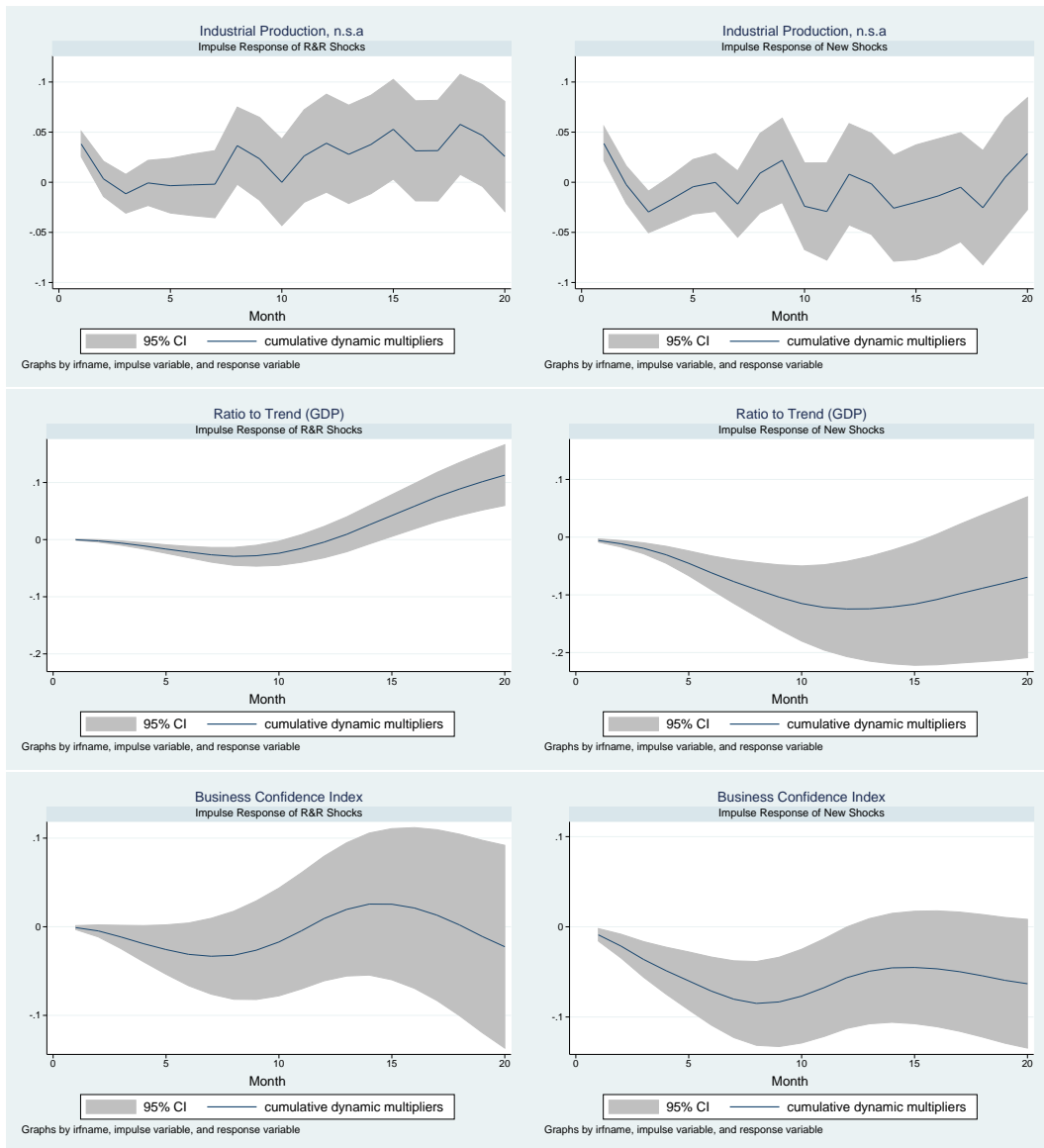
Figure 1.4: Production Indicators (%)

Figure 1.5 presents the estimated cumulative impact on the PPI and CPI for finished goods to one percentage point change in the policy measures, together with 95 percent confidence bands. The estimated cumulative impact for RR shocks decreases for the first eight months, and reduces producer price by 16 percent at the lowest point in month 8, and

then gradually increases again, but the impact is not statistically significant anywhere in the sample periods. For the new shocks, the estimated cumulative impact is significantly negative at least in months 4 through 12 months and the price index can be dropped at least by 10.6 percent. The estimated effect is essentially -35 percent at the lowest point in month 11, then the impact weakens gradually, reaching -22 percent at month 20. The estimated impact in the middle months is highly significant, but the effect at longer horizons, on the other hand, is not precisely estimated.
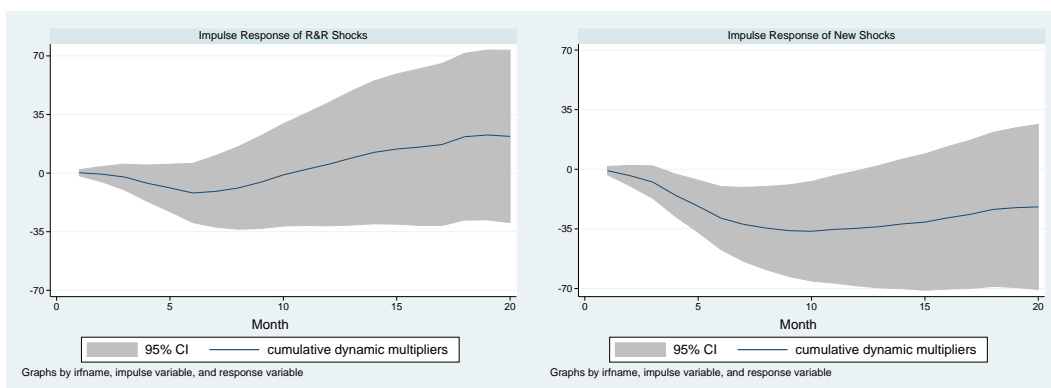

Figure 1.5: Producer Price Index

In Figure 1.6, the estimated cumulative impact for RR shocks decreases for the first six months, and reduces consumer price by 1.47 percent at the lowest point in month 6, and then gradually increases again, but the impact is not statistically significant anywhere in the sample periods. For the new shocks, the estimated cumulative impact is significantly negative at least in month 3 through 7 and the price index can be dropped at least by 1.1 percent at 95 percent confidence. The estimated effect is essentially -2.5 percent at the lowest point in month 5, then the impact weakens gradually. The estimated impact in the middle months is highly significant, but the effect at longer horizons, on the other hand, is
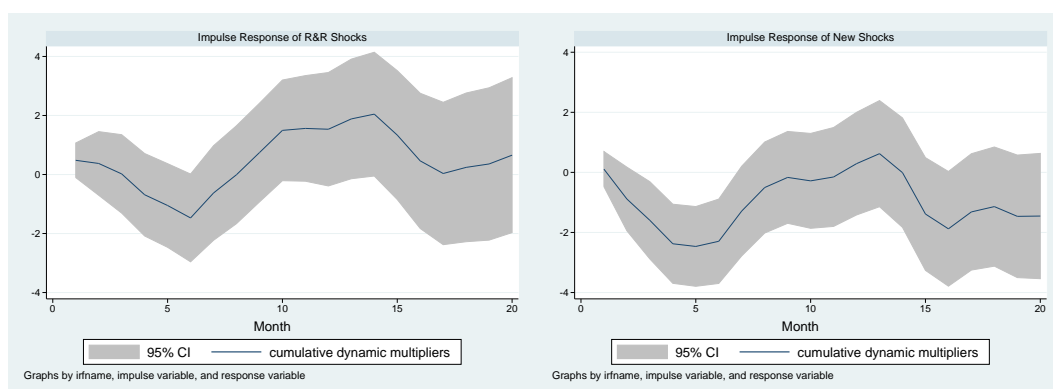
not precisely estimated.

Figure 1.6: Consumer Price Index

1.6.2 Effects of US Monetary Policy Shocks on International Capital Flows

In this section, the figures present the impulse response functions of net outflows of various assets from Korean Balance of Payment data, together with 95 percent confidence intervals.

Figure 1.7 presents the estimated cumulative impact on net portfolio debt outflows of Korea in million US dollars to one percentage point change in the policy measures, together with 95 percent confidence bands. The estimated impact of a RR shock is virtually zero for the first 10 months. Ten months after the contractionary policy shock, the net outflows begin to fall (i.e. Korea gets net inflows in debt assets from the rest of the world), but the impact is not close to statistically significant. For the new shocks, the estimated impact on net outflows increases right after the shock, and maintain significant positive net outflows for the first four months. Then the impact declines roughly linearly through month 20. The estimated cumulative effect is essentially 10,968 million dollars at the peak in month 2. This can imply that a one percentage point rise in the Federal Reserve's intentions

for the funds rate that is regarded as a U.S. monetary shock, attracts the investors of debt

assets to invest outside of the country and increases the cumulative net debt outflows by over

10 billion dollars. The impact then weakens gradually, and the effect at longer horizons is
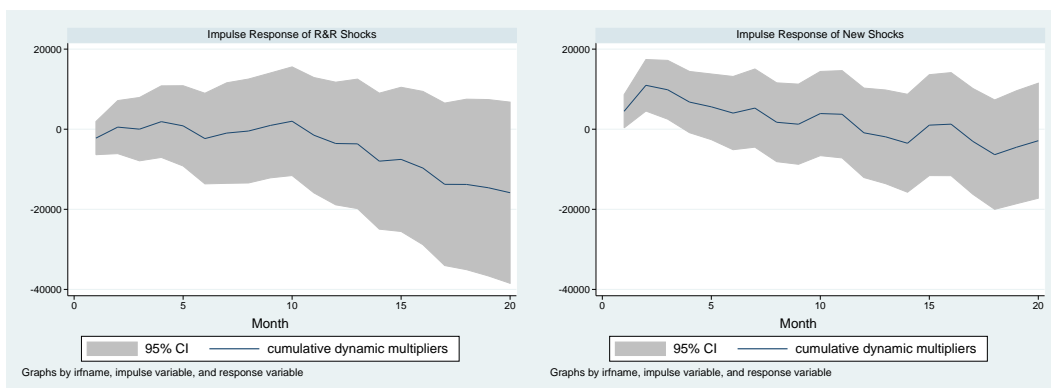
not precisely estimated.

Figure 1.7: KOR Net Portfolio Debt Outflows (mil. US dollar)

Figure 1.8 presents the estimated cumulative impact on net portfolio equity out-

flows of Korea in million U.S. dollars to one percentage point change in the policy mea-

sures, together with 95 percent confidence bands. Both estimated impact of two shocks are

virtually zero at any point of the forecast horizon. Thus it encompasses both no effect and

the estimated maximum impact. This can imply that the monetary shocks essentially have

no impact on capital flows in portfolio equity assets. This is a reasonable result because

the federal fund rate has heavier impact on the interest rates of the country's bond assets

rather than equity assets. Interests on equity assets are more relevant to capital performance

of the county, rather than monetary policy which heavily affects yields on a government's

bonds. This result is also consistent with the recent surge event we saw in section 1.2, in

that during recent monetary expansion periods by advanced countries, EMEs got unprece-

dented huge capital inflows to their portfolio debt assets, while the capital flows in EMEs

portfolio equity assets recovered the original trend of capital flows during the same periods.
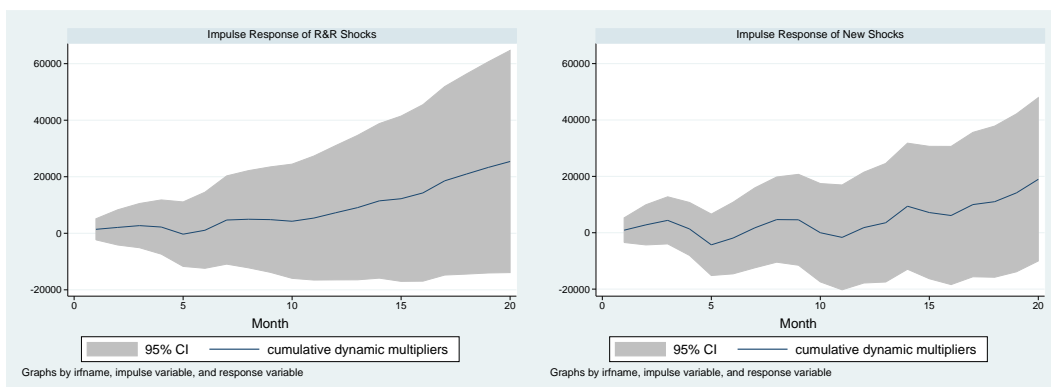

Figure 1.8: KOR Net Portfolio Equity Outflows (mil. US dollar)

Figure 1.9 presents the estimated cumulative impacts on net outflows of Korea for

entire portfolio assets in million U.S. dollars to one percentage point change in the policy

measures, together with 95 percent confidence bands. We can confirm that the response

of entire portfolio capital flows is consistent with the response of portfolio debt capital

flows, so we can infer that the increase in net outflows of the entire portfolio assets heavily

came from increase in net debt outflows in response to the new measure of U.S. monetary

shocks. More specifically, the estimated impact of a RR shock is virtually zero for the entire

sample periods. The impact is not close to statistically significant. For the new shocks, the

estimated impact on net outflows increases right after the shock, and maintain significant

positive net outflows for the first four months. The estimated cumulative effect is essentially

15,298 million dollars at the peak in month 3. This can imply that a one percentage point

rise in the Federal Reserve's intentions for the funds rate that is regarded as a U.S. monetary

shock, attracts the investors of portfolio assets to invest outside of the country and increases

the cumulative net outflows by over 15 billion dollars. The impact then weakens gradually,

and the effect at longer horizons is not precisely estimated.
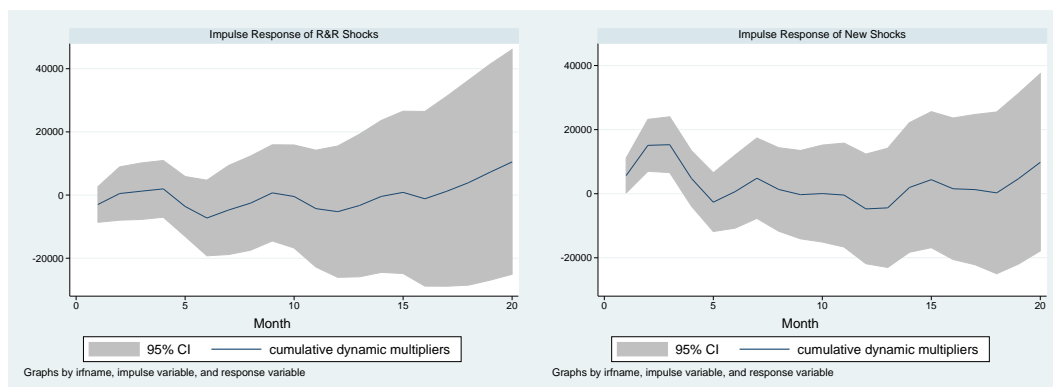
Figure 1.9: KOR Net Portfolio Outflows (mil. US dollar)

1.7 Conclusion

Recent debates on surges to emerging countries have brought attention of many

researchers to the issue of exercised monetary policy by advanced countries and its im-

pact on international capital flows. Determining how monetary policy affects the global

economy became a critically important issue both for distinguishing between competing

literature in international finance and for conducting policy by authorities of EMEs. As

more countries are closely connected to each other, conducting monetary policy as a ran-

domized experiment become more important. In deciding how to move its instruments, the

Federal Reserve considers a tremendous amount of information about likely future move-

ments in macroeconomic variables of U.S. domestic, also of world for very recent periods,

so measures of policy are likely to include many anticipatory movements. Thus getting a

right measure that properly account for the Fed's information set is extremely important to

estimate responses of any economic variables to the monetary policy.

To derive more accurate estimates of the effects of policy, this paper proposes a new specification for isolating monetary policy shocks. That is, for inflationary indicator on the Fed's information set at meetings, I propose using forecasts for CPI/PCE instead of GDP deflator, and also considering international forecasts variables for relatively recent sample periods. The results presented in Coibion (2016) that for the sample period of year 1980 to year 2008, the macroeconomic variables react rather oppositely to the shocks, compared to what is expected from the theories, may be considered as reasonable, given that they didn't account for the evolution of Fed's concerns or information set. Thus we have to reflect those changes when we estimate the policy measure. Even though international forecasts variables didn't show much of impact in predicting changes in the federal funds rate in this paper, it seems a reasonable result when I consider the Fed's concern on these variables for very short periods. But in the future for richer data set with long enough time series, the variables may show a significant impact in predicting changes in the federal funds rate. Thus, after considering all the issues, the resulting series should be largely free of interest rate movements that are either endogenous responses to economic developments or attempts by policy makers to counteract likely future developments. The movements in output and inflation in the wake of our new measure of monetary shocks should therefore reflect the impact of monetary policy, and not other factors.

Estimates of the effects of policy using the new shock series indicate that monetary policy has large and statistically significant effects on real U.S. output also for recent period. For prices, I found that the one-percentage-point shock had much effect for the

new specification, compared to the old specification. Therefore qualitatively, the findings are very consistent with textbook views of the effects of monetary policy and robust to the measure of outputs and prices used. Thus contractionary monetary policy reduces both output and inflation. In predicting international capital flows, the results suggest that when the new specification is used we could see that the significant impacts of U.S. monetary policy on net outflows of Korea in total portfolio and portfolio debt investment. In the new specification, a shock of one percentage point starts to increase net debt outflows of Korea for the first four months, with a maximum increase of more than 10 billion dollars at the peak in month 2. For total portfolio investment, I find that the one-percentage-point shock also has a significant effect for four months, because the net outflows in total portfolio investment mostly came from net outflows in portfolio debt investment, as we saw in 1.2, and the estimated cumulative effect is essentially more than 15 billion million dollars at the peak in month 3.

A. Appendix

In this section, net capital outflows of Korea in other assets categories are presented for completeness. Those assets in this section are not the interest of this paper, while the portfolio investment is.

Figure 1.10 presents the estimated cumulative impact on net other investment outflows of Korea in million U.S. dollars to one percentage point change in the policy measures, together with 95 percent confidence bands. The estimated impact of a RR shock increases from month 2 through 5, and then starts to decrease and converges to certain level (-20,000 million dollars), but is not close to statistically significant. For the new shocks, the estimated impact on net outflows also shows similar pattern to the response of net outflows to RR shocks, but the impact is upward shifted and is not statistically significant at any point of the forecast horizon. Assets fall into other investment are basically bank products including bank loans and deposits. This net inflows in other investment to Korea, may be interpreted as that the increase in global interest rate makes Korean bank loans more attractive because the borrowing costs become relatively cheaper in Korea. However the impacts are not close to statistically significant in both cases. Thus they encompasses both no effect and the estimated maximum impact.
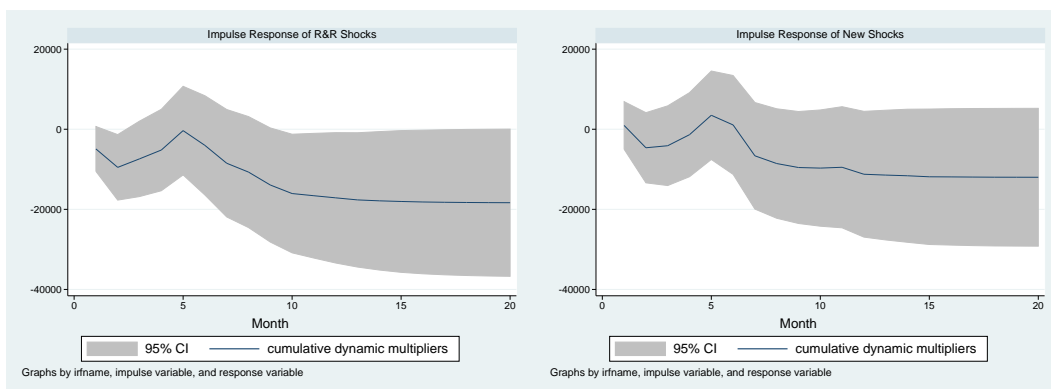
Figure 1.10: KOR Net Portfolio Other Investment Outflows (mil. US dollar)

Figure 1.11 presents the estimated cumulative impact on net direct investment outflows of Korea in million U.S. dollars to one percentage point change in the policy measures, together with 95 percent confidence bands. The estimated impact of a RR shock keep increasing for the entire sample periods, but is not close to statistically significant. For the new shocks, the estimated impact on net outflows also shows a little increase, but the impact is not statistically significant at any point of the forecast horizon. Direct investment is related to control or a significant degree of influence by cross-border entities, and tends to be associated with a lasting relationship, so a different relationship exists between the counter-parties for direct investors compared with portfolio investors. In other words, direct investment is highly involved in investment in indirectly influenced or controlled enterprises, investment in fellow enterprises, and reverse investment depending on each enterprise's own situation. However, the investment is also related to decision making of the enterprise with potentially important implications for future profit flows, so it also may react to global interest rate shocks in relatively long term. Thus the result may imply that the response of net outflows in direct investment to monetary shocks is positive. However,

both estimated impacts of two shocks are not close to statistically significant at the forecast horizon. Thus it encompasses both no effect and the estimated maximum impact. Also, this assets are not the interest of this paper (i.e. it didn't show a big change in direction of capital flows before and after GFC as in section 1.2).
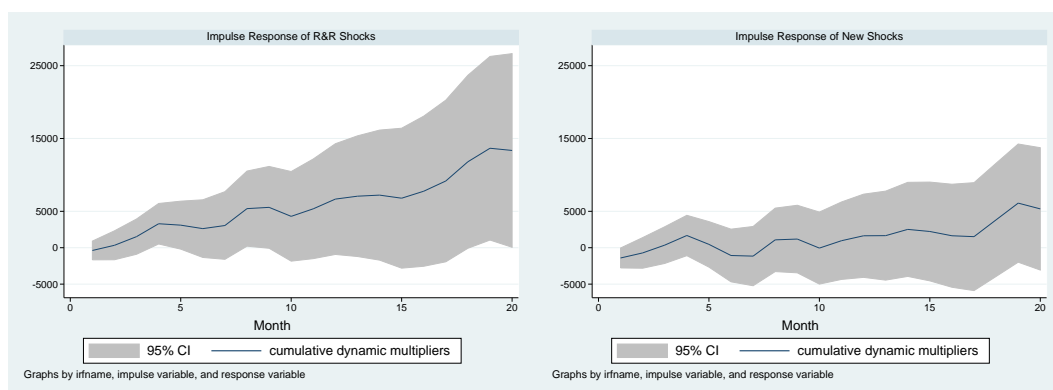
Figure 1.11: KOR Net Portfolio Direct Investment Outflows (mil. US dollar)

Figure 1.12 presents the estimated cumulative impacts on net outflows of Korea for reserve assets in million U.S. dollars to one percentage point change in the policy measures, together with 95 percent confidence bands. The estimated impact of a RR shock is not statistically significant for the entire forecast horizon, even though it shows a little rebound in the middle months. For the new shocks, the estimated impact on net outflows also shows an increase, and this time the impact is significantly positive from month 9 through 14. The estimated impact is even bigger and longer than the impact on portfolio debt to the new shocks. The biggest response is 30 billion dollars in month 13, at the peak. This is a reasonable result, because the reserve asset is denominated in foreign currencies, mostly in U.S. dollar, and a contractionary monetary shock results in appreciation of U.S. dollar, and makes the reserve assets more attractive.
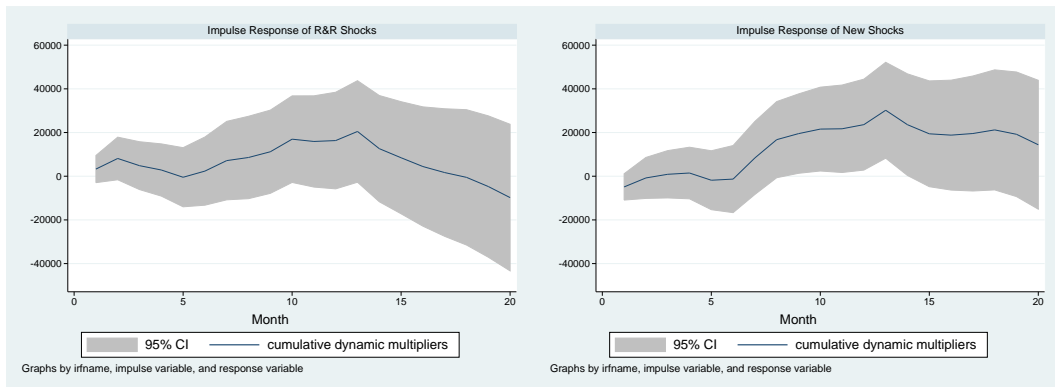
Figure 1.12: KOR Net Reserve Outflows (mil. US dollar)

Part II

Chapter 2

Chapter 2

U.S. Shadow Policy Rate and Surges in Capital Flows to Emerging Markets

2.1 Introduction

Recent studies on international capital flows found that there have been large and volatile surges in capital flows to EMEs after the recent global financial crisis (GFC), especially for portfolio investment (Fratzscher et al. (2012), Ahmed et al. (2014)). As the neoclassical growth model predicts, free capital flows can lead to an efficient allocation of capital and also allow risk sharing among different countries against idiosyncratic shocks. Particularly, upon financial integration, a capital scarce country can borrow internationally to fulfill its optimal consumption and investment plans, attracting international investors

with a high marginal product of capital.

However, large and volatile capital flows also increase the leverage ratio and can lead to sudden stops and pose challenges to policymakers trying to stabilize the economy. According to the literature on sudden stops, after periods of leverage increases during the expansion periods, if the collateral constraint becomes binding, it forces agents to reduce their spending, which lowers aggregate demand and leads to declines in real exchange rates, relative prices and asset prices. Since the value of collateral is tied to these relative prices, such declines tighten the collateral constraint further and trigger a vicious circle of falling borrowing ability, falling spending, and collapsing exchange rates and asset prices (Mendoza (2010)).

In addition, in the shorter term, large capital inflows can overwhelm the capacity of domestic financial intermediaries and lead to excessive credit creation and asset price bubbles that cause financial instability. Also, currency appreciation caused by large capital inflows may hurt export and growth performance of EMEs.

To address these concerns, several EME authorities argued that the advanced-economy policies including large-scale asset purchases (LSAPs) in U.S. were primary causes of the excessive capital flows and created adverse spillover effects. More recently, EMEs have been concerned about the adverse effects of advanced-economy monetary policy normalization (e.g tapering of LSAPs in U.S.). Therefore, it is a very important research to figure out whether such inflows were primarily a result of factors such as international investors' risk appetite, or attractiveness of the recipient countries, including growth prospects.

There is a large literature addressing the question of what are the main drivers of international capital flows into EMEs. However, answers are not settled in the existing literature. Byrne and Fiess (2011) found that U.S. interest rate was a crucial determinant of global capital flows to EMEs. Ghosh et al. (2012) reported various factors to be important in increasing the likelihood of a surge to EMEs, including lower U.S. interest rates, greater global risk appetite, and EME's own attractiveness as an investment destination. On the other hand, Forbes and Warnock (2012), found no significant evidence for changes in global interest rates or in global liquidity (money supply of key advanced economies (AEs)) in affecting surges or stops of foreign inflows; however, they do find global risk aversion to be an important factor.

Moreover, despite the policy tensions that arose between these two groups of economies, there have been few studies that investigate the channel of recent capital surges in EMEs after GFC. Tracking the channel would be crucial for informing the debate about the appropriate policy responses to capital inflows by EMEs. However, most conclusions about the impact of monetary expansion in AEs are inferred from studies on the effect of long-term U.S. interest rates on EME capital flows mostly during the pre-crisis period. Analyses of the period of recent unconventional monetary policies are limited. Ahmed et al (2014) found that there was a structural change before and after the GFC and also found that the sensitivities of capital flows to explanatory variables changed between two periods. These determinants include policy rate differentials between EMEs and the U.S., real GDP growth differentials between EMEs and AEs, and financial market volatility measured by the VIX, but variables only explain part of the portfolio investment flows which are not the

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primary assets causing capital surges to EMEs.

To provide more details on recent monetary policies in AEs, after policy interest rates in many AEs had reached at the zero lower bound, central banks in AEs, including the Federal Reserve, exercised unconventional monetary expansion in efforts to boost economic activity. These policies work through similar channels as conventional policy, but by affecting a broader range of interest rates in the economy to which private spending is sensitive. Some studies find that unconventional policies lowered yields on the long-term U.S. Treasury bonds and similar securities (D'Amico and King (2013)). In turn, it has been argued that lower yields on long-term U.S. securities may have encouraged capital flows to EMEs (Fratzscher et al (2012)). However, these are separate studies, and didn't show the effect of the unconvetional policies on capital flows to EMEs directly. Hence I provide, in more direct way, some new evidence on the effects of unconventional policies on interest differential of assets and in turn, on capital flows to EMEs, using an estimated measure of shortest maturity interest rate (shadow short-run rate).

The shadow short-run rate (SSR) is an estimated counter-factual interest rate that would prevail if the nominal interest rate could fall below its zero lower bound. The SSR is obtained from a shadow yield curve, which is estimated from the term structure of observed interest rates at different maturities (i.e. Gaussian affine term structure model, such as arbitrage-free Nelson and Siegel (1987) models). In other words, the quantitative easing policy (QE) exercised by Federal Reserve after the nominal policy rate hit the zero lower bound (ZLB) will impose downward pressure on the federal funds rate (FFR). This is observed in yield declines for long-term U.S. Treasury bonds, but this cannot be captured by

a negative FFR, so the SSR shows what the rate would be if the FFR could fall below zero (Krippner 2014). Using this measure, I capture the effect of U.S. unconventional monetary policy on the interest rate, and in turn investigate how this effect changes the interest differential for assets between AEs and EMEs, invested by international investors, and affects capital flows to EMEs.

In general, the FFR is closely related to other U.S. market interest rates in a non-ZLB environment because the FFR indicates future settings of market interest rates, and participants in financial markets observe this indication and appropriately incorporate this into wider financial markets, such as equity prices, currency rates, and the many different categories of interest rates in the economy. Policy makers in central banks would first gauge the state of the real economy and inflation relative to their objectives and then freely set the policy rate above or below their judgment of a neutral interest rate.

However, under a ZLB, the FFR and the FFR/10-year T-bill spread (measure tightness of monetary policy) no longer contain any useful information about the stance of policy. That is, since late-2008 the FFR has remained static, suggesting a steady stance of policy, while the FFR/10-year spread has risen, suggesting a tighter stance of policy. However, neither of them was the actual stance of policy in real world. Thus, rational investors would not consider the FFR as well-represented short-term rate for their investment decisions.

On the contrary, the SSR can capture the real market's view of the stance of monetary policy. The underlying concept of SSR is, whether or not monetary policy settings are being delivered through policy rate changes, asset purchases, forward guidance, or any

combination of the three, the influence of those policy actions should be reflected in the markets settings of interest rates of different maturities along the yield curve. Thus we can distill the information of the market's view of the stance of monetary policy, from interest rates of different maturities, using a term structure model. Also the SSR can quantify the degree of monetary stimulus in a standardized and consistent manner over conventional and unconventional policy periods. Thus, the SSR can gauge whether current monetary policy is relatively stimulatory or restrictive, compared to previous years or some point within the sample periods. Therefore, the SSR would represent the effective policy rate better than the FFR from the point of market participants, especially under ZLB environment. That is why I consider the SSR to capture the interest differential between EMEs and AEs (U.S.), rather than using the FFR.

The short rate r(t) at time t is a linear function of the state variables x (t) at time t:

$$r(t) = a_0 + b_0 x(t)$$

where r(t) is a scalar, a_0 is a constant scalar, b_0 is a constant $N \times 1$ vector containing the weights for the N state variables $x_n(t)$, and $x(t)$ is an $N \times 1$ vector containing the N state variables $x_n(t)$.

$$dx(t) = \kappa[\theta - x(t)]dt + \sigma dW(t)$$

where θ is a constant $N \times 1$ vector representing the long-run level of $x(t)$, κ is a constant $N \times N$ matrix that governs the deterministic mean reversion of $x(t)$ to θ, σ is

a constant $N \times N$ matrix representing the potentially correlated variance of innovations to $x(t)$, and $dW(t)$ is an $N \times 1$ vector with independent Wiener components $dWn(t) \sim N(0,1)$. The dynamics for the state variable vector $x(t)$ are given by the solution to the stochastic differential equation in equation 3.2. From Meucci (2010) .

The remainder of this paper is organized as follows. As background, section 2 provides the main properties of capital flows to EMEs over the past decade and compares the changes before and after the GFC. Section 3 presents a review of literature I rely on, and the missed out part of them, also compares the methodology to previous empirical literature. Section 4 presents the empirical methodology I utilize to answer the the questions posed in this paper, and describes the data used in the paper. Section 5 presents the regression results, and interprets them. Section 6 discusses the results.

2.2 Capital flows to EMEs : Stylized Facts

For the purpose of showing changes in pattern of capital flows between the world before and after the GFC, I present details and figures in this section. Dividing portfolio investment assets into debt and equity securities, depending on different functional characteristics, the stylized facts I found show that the surges in portfolio investment mainly came from debt securities, not from equity investment. Thus we can conclude that at least regarding net portfolio investment flows, changes in investments of debt instrument generated the big capital surges to EMEs, and investment in equity assets behaved the same as before the financial crisis. Therefore, the finding of Ahmed et al (2014) that the capital surges are resulted from the sensitivity changes of explanatory variables is partially valid, because the

explanatory variables mostly explain the equity assets not debt assets, and debt assets are the ones that mainly account for the surges.

Also, I am going to show that net flows in other assets categories such as foreign direct investment (FDI) or other investment, which mainly refers to bank deposits and loans, did not change much before and after the financial crisis. Thus I can conclude that the most capital surges to EMEs mainly came from huge inflows to portfolio debts assets in EMEs, and investigating the impact of external factors on portfolio debts assets will answer the question of what are the drivers of capital surges to EMEs.

Fig. 2.1 shows accumulated net portfolio investment outflows (Gross outflows from EMEs- Gross inflows to inflows) of major emerging economies since 2002, along with the flows that are separated by portfolio equity and portfolio debt assets. The negative values mean that Gross inflows dominate Gross outflows. From the picture, we can see that the total net portfolio investment fluctuated around zero during the pre-crisis periods, and there have been huge surges in the post-crisis recovery. However, we can also confirm that the main surges in total net portfolio investment flows came from net portfolio debt assets not from the net portfolio equity assets. Fig.2.2 shows accumulated net flows in other assets (i.e FDI, OI - other investments-, Reserve). The cumulative net inflows of FDI have been quite strong before and after the GFC. Other investments are fairly constant and stable before and after the GFC. Finally, many EMEs have strongly increased the accumulation of the reserves assets denominated in foreign currencies during the sample periods except for the collapse during the crisis.
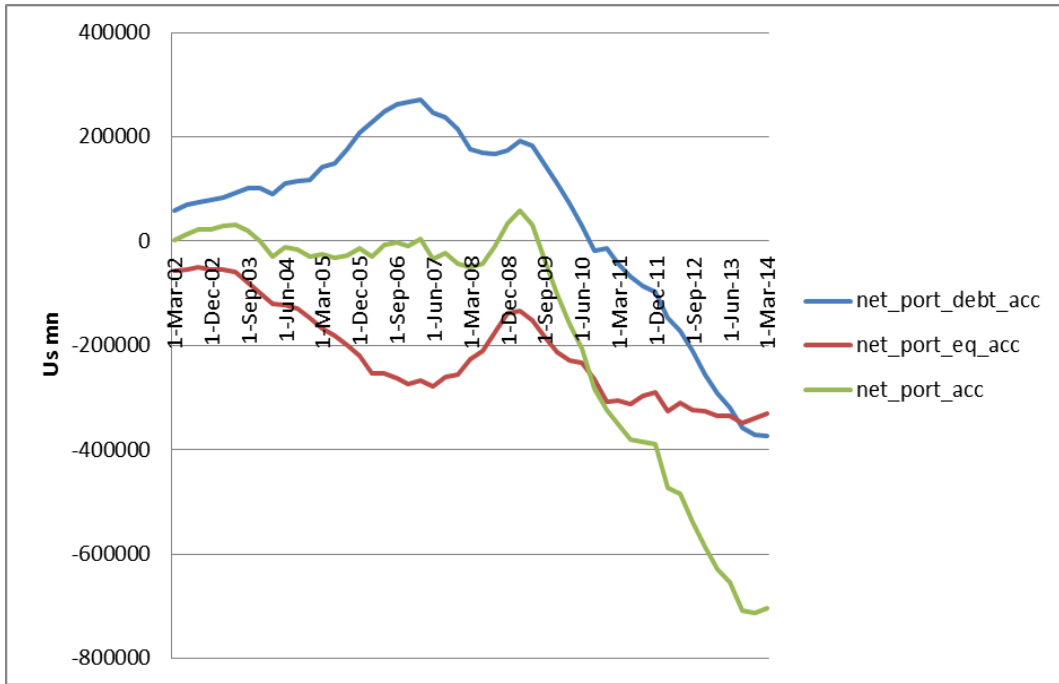
Figure 2.1: Accumulated Net Outflows Portfolio Investment (EME)
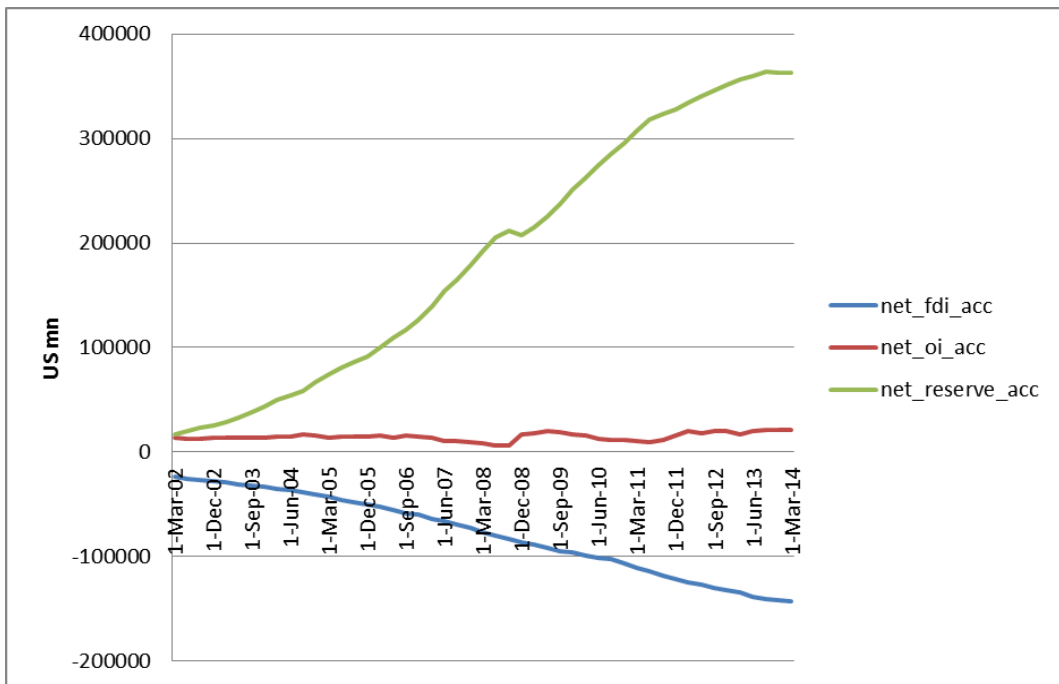
Figure 2.2: Accumulated Net Outflows Other Assets (EME)

To see whether these net flow surges may result from the asset side—residents selling their assets abroad and repatriating the proceeds, or simply not purchasing as many foreign assets as before- I present the gross accumulated assets and liabilities flows in two assets categories in Fig 2.3 and Fig 2.4. The surges in net inflows in debt instruments are indeed derived from increases on the side and not from drops on the assets side. Thus, we can confirm that the recent capital inflow surges are the result of foreigners pouring money into the countries, increasing the country's stock of foreign liabilities. Since the surges are caused by exceptionally large net capital inflows across the emerging market countries, they must be associated with some exceptional behavioral changes to global factors.
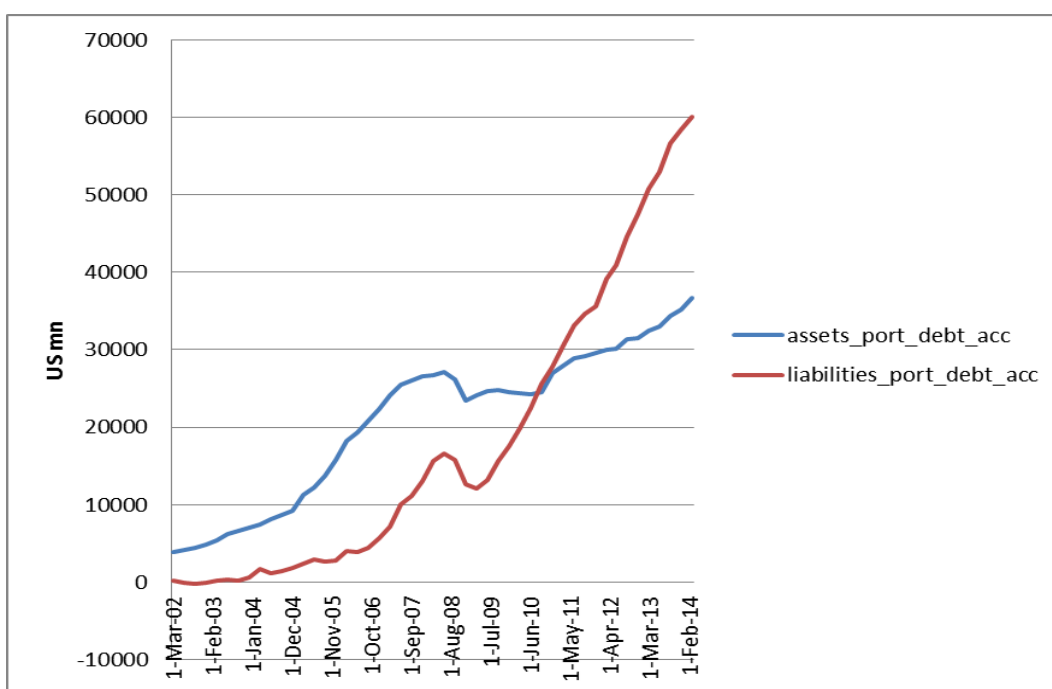
Figure 2.3: Accumulated Gross Inflows in Debt (EME)
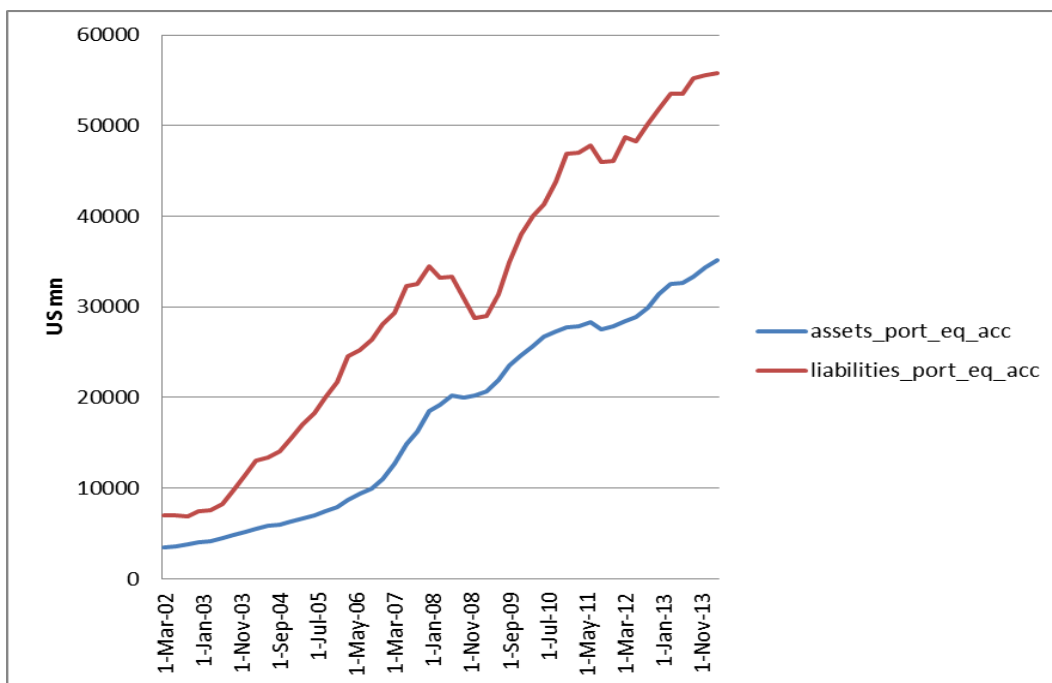
Figure 2.4: Accumulated Gross Inflows in Equity (EME)

Next, we look at the movement of variables which are used to explain the net capital flows movement, during the same sample periods. First, the policy rates in the EMEs and the U.S. (using the FFR and the SSR), and the differential between the two. The policy rate differentials will be used for instrument variables of the interest differentials. As can be seen from Fig. 2.5 there is little difference in policy rate differentials before and after the GFC, and for some periods, policy rate differentials are even higher before the GFC, which seems contradicting to large inflows to the EMEs.[1] Second, the volatility index (VIX) is also similar before and after the GFC, and there are some periods when

[1]Note that I have used a policy differential with the United States only, rather than with the AE aggregate, because most discussions of the impact of AE policies on EME capital flows focus primarily on U.S. policies, and U.S. interest rates are also used generally as a proxy for global interest rates in empirical work. However, in practice, it makes little difference if the U.S. policy rate is substituted by an aggregate AE policy rate. This result suggests that the relationship between the U.S. policy rate and capital flows to EMEs captures not just the effect of U.S. monetary policy, but of AE monetary policies more broadly.

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risk is highly perceived after GFC as shown in Fig. 2.7. VIX is an indicator of global risk appetite, computed by the Chicago Board Options. This is a measure of the implied volatility of the S&P 500 index and serves as a proxy for the combination of perceived risk and risk aversion. So when the VIX is high, it generally refers that EME bonds are avoided during that time of periods. Third, real GDP rate differentials between EMEs and AEs also have not varied much before and after the GFC in Fig 2.6.
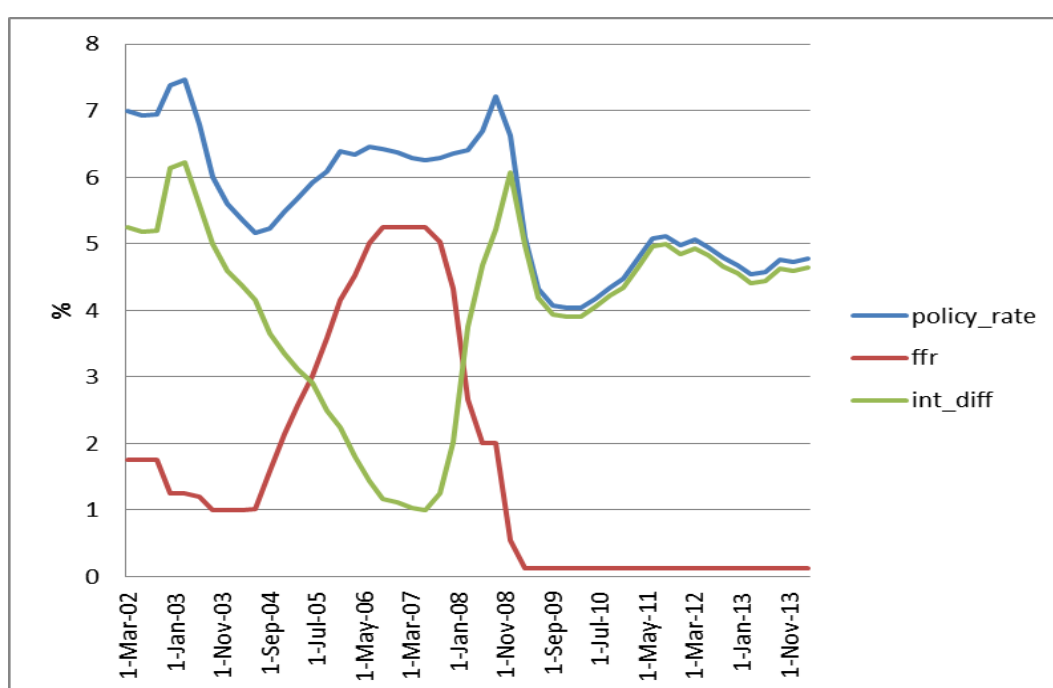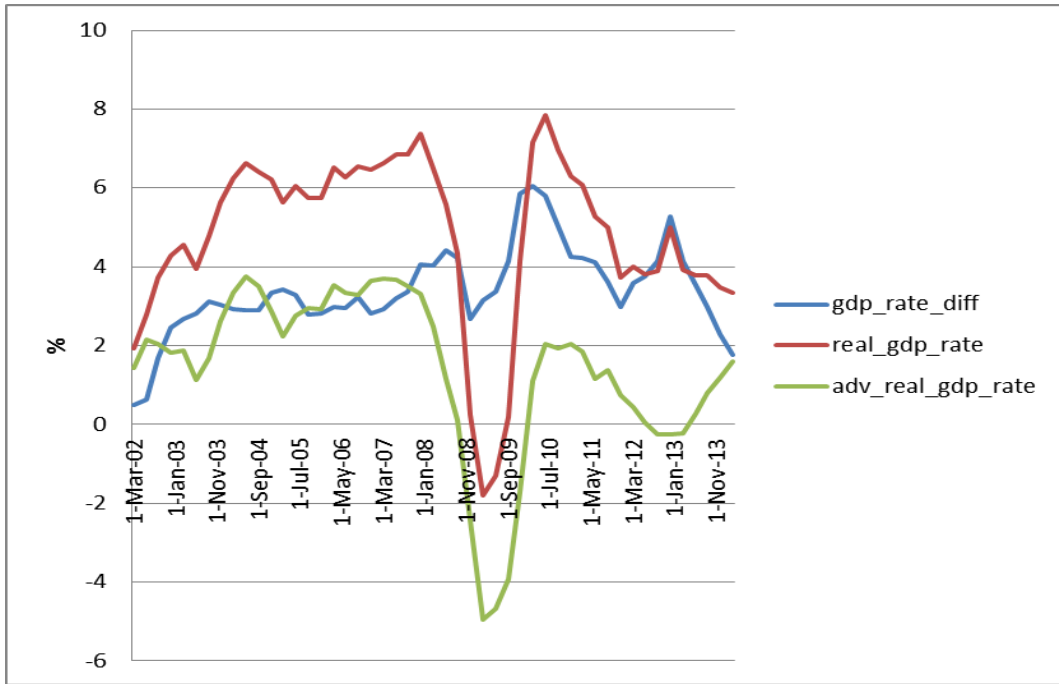

Figure 2.5: Policy Interest Rate

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Figure 2.6: Real GDP
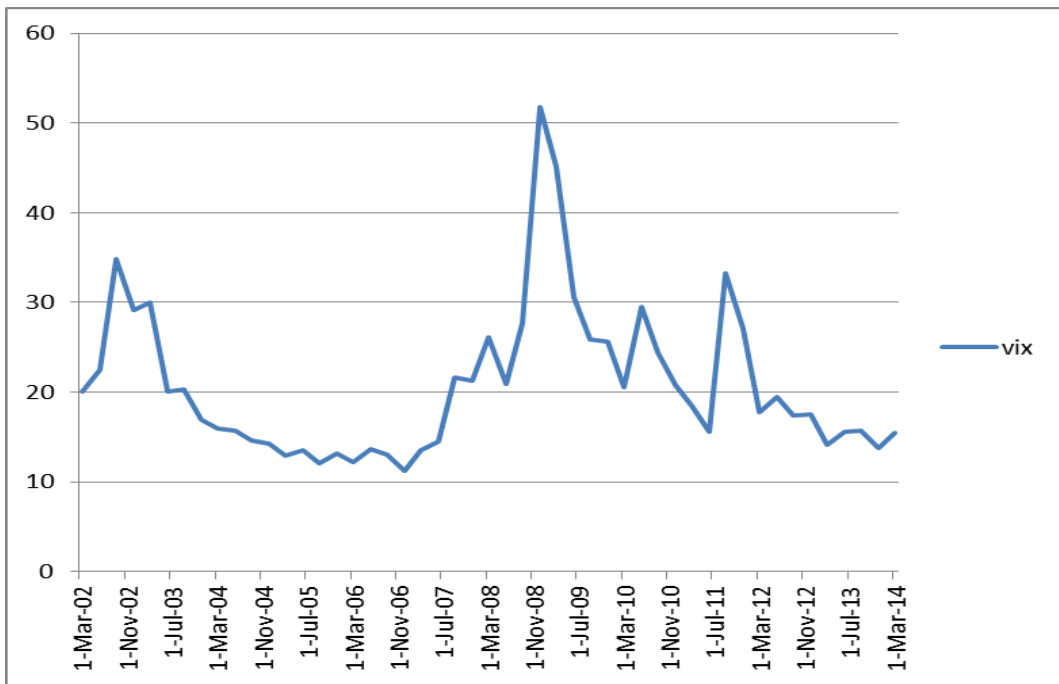
Figure 2.7: Volatility Index (VIX)

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As it will be followed by the next section, literature on global imbalances explain that the different degree of development in financial system among countries triggered precautionary savings motives in developing countries, and make investors in EMEs accumulate foreign debt assets which, in principle, guarantees the principal and interest rate, while they provide foreign equity assets to the rest of the world, which are residual claims (returns are not guaranteed). This in turn generated persistent global imbalances between two heterogeneous worlds, and this is also consistent with what we observed in EME data before GFC occurred. Thus, EMEs accumulated foreign debt assets even though the interest rate is higher in EME in real world, as is known from "saving glut" literature. On the other hand, foreign equity assets are held more in U.S., thus we do not observe accumulation of foreign equity assets flows in EMEs by precautionary savings motives during the same periods. Therefore net accumulation of debt assets of AEs by EMEs would be predicted, as long as the EMEs are underdeveloped in financial system compared to advanced economies.

However, the recent financial crisis marked a change in these pattern of global imbalances, specially for portfolio debt assets. After the GFC, the cumulative net debt assets (stock) dropped from positive to negative, meaning EMEs used to accumulate debt assets, but now became net seller of the assets from Fig. 2.8 and 2.9. Also the relationship between net debt flows and interest rate differential also changed as in Fig 2.9. The regression results will show this more explicitly, but before the GFC, the net debt flows and interest rate differential move in an opposite way, but after GFC, the net debt flows are somewhat constant, regardless of interest rate differential movement. I claim that this can be explained by unconventional U.S. monetary policy, because it mostly affects the debt flows.
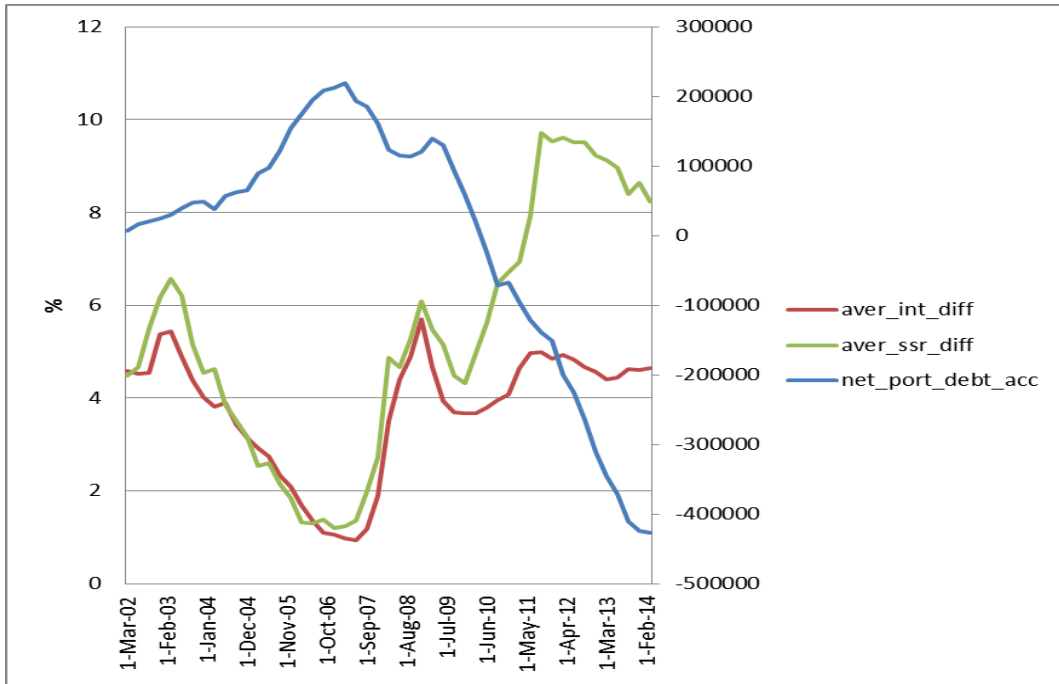
Figure 2.8: Accumulated Net Debt Flows and Interest Rate
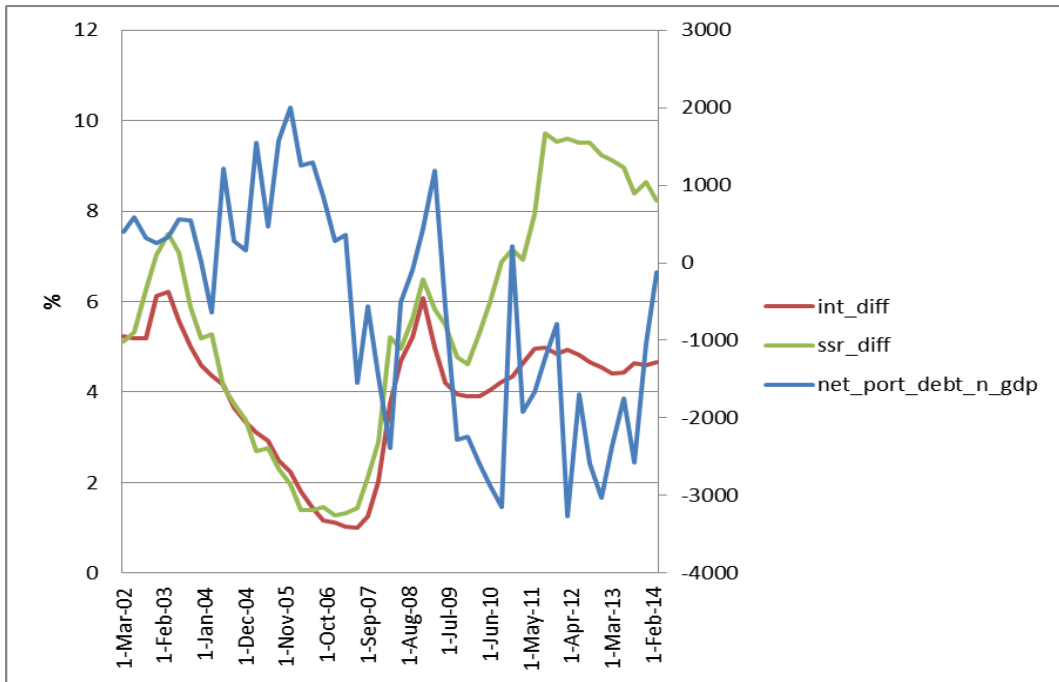
Figure 2.9: Net Debt Flows and Interest Rate

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2.3 Literature Review

My study mostly follows the theoretical literature on global imbalances and empirical literature on capital flows between heterogeneous groups of the countries. Global imbalance literature mainly investigates the questions of external adjustments between countries in international macroeconomics. That is, U.S is one of the largest debtor countries among industrialized countries, while Japan, and other emerging economies accumulate U.S. government bonds. Also another example of global imbalances is, while advanced economies hold a large share of risky assets (portfolio equity or FDI investments) in their external balance sheets (49% for the United States, 50% for Canada, 26% for the UK, 31% for France), emerging markets' external portfolios have a lower weight on risky assets (India 5%, Indonesia 5%, Russia 18%, China 9% , Brazil 21%), as these economies tend to invest in safer securities such as government bonds. To answer these questions, the more recent theories in this literature provide a link between asymmetries in financial development between countries and global imbalances.

Caballero et al. (2008) set up an overlapping generations model without any risk, applying a perpetual youth model as in Blanchard (1985). The essential part of the model is the absence of Ricardian equivalence: households currently alive are unable to issue or buy claims on the resources of unborn generations. The barrier to financial transactions can be even more severe if asynchronicity between income and consumption decisions becomes extreme. With these financial frictions, lower fraction of output that can accrue to the financial assets can exacerbate the shortage of stores of value. In this way the model captures the notion that financial markets in many emerging economies are not sufficiently developed

and that these countries suffer from a shortage of stores of value. Under financial autarky, low capacity of a developing country's financial system depresses equilibrium real interest rates in the economy and creates demand for assets from outside country to capitalize streams of future income into real assets, incurring global imbalances.

Unlike Caballero et al. (2008), Mendoza, et al. (2009) specify and model capital flows in risky assets separately from capital flows in riskless assets. They borrow the model from Aiyagari (1994) and generate global imbalances resulted from precautionary savings in developing countries, where idiosyncratic risks cannot be insured in Bewley (1986) model of economy. They introduce discrepancies in the degree of financial development across countries (specifically, the abilities to detect diverted assets, and fake default), which creates differences in consumption pattern between countries. That is, when a negative endowment shock hits the countries, the countries with less developed financial system suffer from reduced consumption in the next period because of those diverted assets, while financially advanced countries enjoy stable consumption by additional income from contingent bonds. These discrepancies in turn generate precautionary savings in the less developed countries, and financial integration between two groups of countries induces over-accumulation in bond (riskless) assets in less developed countries. This is because, in equilibrium this strong self-insurance motive depresses autarky interest rates below the riskless rates of the neoclassical model. Thus stronger the precautionary saving motive induces lower the autarky interest rate and higher desire for riskless assets.

In Mendoza, et al. (2009), regarding risky (physical capital or productive) assets, when a negative investment shock hits the countries, less developed countries also face

marginal risk premium for productive assets, which is also caused by the incomplete market assumption, and this attracts investment capital from developed countries. In other words, advanced countries invest in foreign high-return assets and finance this investment with foreign debt. However, the advanced countries will still be in a negative NFA position, because precautionary savings in less developed countries allow advanced countries to keep borrowing until their net worth position equals to zero (this is a limited liability condition). Thus this model also exhibits how financial integration leads to a gradual and persistent process of the global imbalances, as well as to heterogeneous portfolio balances between two different countries by setting different degree of domestic financial development.

Turning to the literature on assets purchase under ZLB, Caballero and Farhi (2013) argue that during this financial crisis, the phenomenon called 'safety trap' occurred. That is, when the supply of safe assets is not enough to cover the demand for the assets, the return of safe assets has to decrease to set a new equilibrium by lowering demand for the assets, but if there is a limit where the return cannot adjust further by going down, a recession is triggered and this is safety trap, which has many similarities to liquidity trap. In their study, they assume that Knightian (risk averse) agents only purchase the safe assets no matter how profitable or marketable the risky assets are. That is the reason why safety trap is generated in the first place. In my research, I also take the assumption of their model where some portion of investors prefer to have debt assets or some fraction of their portfolio has to be composed of debt assets. This is reasonable assumption for any investors, financial institutions, or operating firms which need to hedge their unfavorable risks or uncertainties. In that way, if the return of debt assets in one country drop a lot due to some events, or the

return differential is big enough to cancel out the benefit of debt assets in one country, then under the financial integration, the demand for the debt assets in domestic country would transfer to demand for debt assets in another country.

In literature on international capital flows among countries, Byrne and Fiess (2011) investigate the correlation of capital flows of 78 emerging countries, extract the common factor and examine their correlations with five global macroeconomic variables, using data from1993Q1 to 2009Q1. These explanatory variables include real non-oil commodity prices, the real short term and real long term US interest rate, VIX uncertainty index, and real GDP growth in the G7. They use quarterly data on gross capital inflows only so that they do not conflate foreign and domestic investors which occurs when net capital flows are examined, and also only consider U.S. part of interest rates. However, the gross capital inflows data may not give the right picture to explain the relative tension/force on the movement of net capital flows between two different worlds, such as a global capital flow cycle that affects gross flows everywhere without necessarily affecting net inflows. Indeed, Ahmed et al (2014) found that global variables like the VIX are significant when they estimate regressions on net flows, but not significant when they use gross inflows. Still Byrne and Fiess (2011) that U.S. interest rate was a crucial determinant of global capital flows to EMEs, but it is ambiguous how U.S. interest rate affect the movement of net capital flows of EMEs. Also interest rate should be considered as high or low, relative to other countries. During the global crisis, if every country experience dropped interest rate, then it will be difficult to say that the rate is lower than previous periods. They also perform the same panel analysis using disaggregate capital inflow data of equity issuance, bond issuance and

syndicated bank lending, and found that bank and equity flows show the evidence of commonalities, while bond flows do not display evidence of a common factor which is different from my result. This may also be resulted from using gross capital flows data and using different sample periods. Since I too present the aggregate gross flows to and out of EMEs in the figures, I can infer that the main change in net flows is derived by the change in liability side of the capital flows, and also how the change in gross inflows is reflected and concluded in net flows to EMEs.

To examines when and why capital surges to EMEs, Ghosh et al. (2012) analyze annual data for 56 EMEs over 1980–2011. They first identify surges as exceptionally large net capital inflows to the country (flows in the top 30th percentile of the full sample's distribution of net capital flows in percent of GDP) and examine the correlates of their occurrence and magnitude. They find that lower U.S. interest rates, greater global risk appetite, and EME's own characteristics are important in increasing the likelihood of a surge to EMEs. Analyzing unusual capital flows separately from normal time capital flows seems reasonable, but it cannot show how much of the unusual flows is a result of exceptional movements in the explanatory variables that influence these flows in normal times as well, and how much truly cannot be explained by models that apply during normal times. A model failing to capture this difference may result in ignoring important change in effects of global factors on the unusual pattern of capital flows. This is because the global factors may work in a way to offset previous effects and make them insignificant during the surges periods.

Forbes and Warnock (2012) use quarterly data on gross inflows and gross out-

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flows which covers the period from 1980 through 2009 and includes over 50 emerging and developed economies, and also mainly investigate extreme episodes of "surge" and "stop" (sharp increases and decreases, respectively, of gross inflows), and "flight" and "retrenchment" (sharp increases and decreases, respectively, of gross outflows). They create a dummy variable which designates the episodes, and construct a probability function for that episodes. They study how the global factors contribute to the probability and find that global factors are related to certain types of episodes. That is, global risk is the only variable that consistently predicts each type of capital flow episode; an increase in global risk is associated with more stops and retrenchments and fewer surges and flight. Other global factors, such as strong global growth is associated with an increased probability of surges and decreased probability of stops and retrenchment. High global interest rates are associated with retrenchments. Similar to Ghosh et al. (2012), since they only focus on special events of capital flows and corresponding global factors, rather than on finding persistent relationship between capital flows and global factors throughout whole sample periods, it is difficult to identify how the longer-term determinants of capital flows may have changed over time. However, one of the key questions with respect to recent EME capital flows is whether the post-GFC period has impact in terms of what is driving these flows. Therefore, I follow the traditional approach of estimating the same model irrespective of the size of the flows, but looking for structural breaks at different times.

2.4 Methodology

2.4.1 Regression Model

In modeling net portfolio capital flows into EMEs, I consider determinants that could directly alter the differences between expected returns of investment in EMEs versus those in AEs and a measure of global risk aversion. Specifically, I estimate variants of the following general empirical model:

$$\frac{Netflows_{it}}{Nominal\,GDP_{it}}$$

$$= \alpha_0 + \alpha_1\left(i_{it} - i_{us,t}\right) + \alpha_2\left(rGDP rate_{it} - rGDP rate_{AE,t}\right) + \alpha_3 VIX_t + \alpha_4 trend_t$$

$$+ D_t\left[\alpha_5 + \alpha_6\left(i_{it} - i_{us,t}\right) + \alpha_7\left(rGDP rate_{it} - rGDP rate_{AE,t}\right) + \alpha_8 VIX_t + \alpha_9 trend_t\right]$$

The left-hand side represents the ratio of net portfolio investment flows either total portfolio, portfolio debt, or portfolio equity securities only to country i during time t as a fraction of the country's nominal GDP. I also do the panel analysis, using fixed country effect model. In detail, the explanatory variables are, respectively, policy rate differential between EME and U.S., real GDP growth rate differential between EMEs and AEs, VIX, time trend, and country dummy variables (for fixed effect model). The growth differentials are intended to capture differences in expected returns due to differing growth prospects between EMEs and AEs, both due to long-term differences in potential growth and due to different cyclical positions. The policy rate differentials are meant to capture differences in returns due to the divergence of short-term interest rates, which might, for example, lead

to carry trade positions being undertaken. Here D is dummy variable for post crisis, and the value is assigned to 1 if the period falls into post crisis periods. Dummy is introduced to capture the difference in estimates between effects in the post-crisis vs. the pre-crisis period.

$$\frac{Cumulative\,net\,flows_{it}}{Nominal\,GDP_{it}}$$

$$= \beta_0 + \beta_1\left(i_{it} - i_{us,t}\right) + \beta_2\left(rGDPrate_{it} - rGDPrate_{AE,t}\right) + \beta_3 VIX_t + \beta_4 trend_t$$

2.4.2 Data

In this study I consider balanced, quarterly net capital flow in emerging countries data up to 16 countries for total portfolio investment flows, and 12 countries for portfolio debt flows from 2002Q1 to 2013Q1. This sample period covers not only the global wave of capital flows from before the 2008-09 crisis, but also the post-crisis surge through mid-2013. I analyzed the portfolio investment balance-of-payment (BOP) data in each emerging country and divided the portfolio investment into two different types of assets by functional categories defined by International Monetary Funds (IMF). This is because looking at the flows of portfolio investment in one piece may not show the separate changes of the flows in different characteristics of assets and of the investor's behavior which can detect the channel of the capital inflows. As I discussed in literature review on global imbalances, equity and debts securities have different functional characteristics. Since debt assets are the financial assets to store values for future consumption, any investors, financial institutions, or operation firms which need to hedge unfavorable risks or uncertainties will demand the

debt assets, especially they will demand more when the uncertainties in the world increased a lot and the financial legal system in their countries is not strong. In principle, debt assets guarantees the principal and interest rate, while equity assets are just residual claims (returns are not guaranteed). That is why developing economies tend to invest in safer securities such as government bonds. Thus I claim that we should look at total portfolio assets separately into portfolio debt and portfolio equity because that way will show better what is going on in the world, otherwise total portfolio assets will contain mixed characters.

Also I examined country level data, rather than EME-dedicated international funds, which form just a small part of the total capital flows to these economies, because my research question is on the actual aggregate portfolio composition changes between two groups of countries during the sample periods, and what influenced this structural/fundamental changes, not the fluctuations of that particular international funds. This is also the reason why I mainly focus on finding the connection of capital surges to global determinants, than investigating pull factors of individual emerging countries.

For the dependent variables, I use quarterly BOP data on total portfolio, portfolio debt, and portfolio equity net capital inflows as a share of nominal GDP, both expressed in U.S. dollars. I source these capital flows to EMEs from CEIC, which is collected by IMF from governmental institution in each country, and nominal GDP from Bloomberg. Since the quarterly data is discontinued, the old version ends at 2011 and the new version starts from 2005, I lengthen the data series, merging two series together. That is, I generally adopt capital flows in old version, and add capital flows in new version, using growth rate of the values in new version. Nominal GDP is transferred from domestic currency at London end

of day foreign exchange rate.

Net capital flows (net capital outflows) refers to the difference between a county's gross outflows and gross inflows in a given period. Gross inflows are BOP liabilities, and consist of the nonresidents' purchases of domestic assets net of sales. Gross outflows are BOP assets, and consist of the residents' purchases of foreign assets net of sales. For China, since the quarterly BOP data is available only after 2010, I applied moving average technique, and generated quarterly data from yearly data.

For the explanatory variables, the policy interest rate differential is computed as the difference between the nominal policy rate for each EME and the U.S. Federal Funds rate. I source the nominal policy rate for each EME from CEIC and bloomberg. As shown in Fig. 5, the policy rate differential (yellow green line) has been positive, but fluctuated notably over the sample period. During the post-crisis recovery, the differing cyclical positions of the EMEs and advanced economies called for different monetary policy settings, and drove up the rate differential. However, more recently, as several EMEs lowered policy rates in the face of slower growth, the differentials have narrowed.

The growth differential is measured as the difference between four-quarter (YoY) real GDP growth rates in each EME and an aggregate of advanced economies.[2] I source these real GDP growth rates in EMEs and AEs collected from OECD statistics and CEIC. For those which the data is not available, I collected GDP volume index or GDP in chained price for those countries, and separately calculated the YoY GDP growth rates. As shown in Fig. 6, aggregate real GDP growth in EMEs (the red line) has consistently outpaced that in

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[2]The aggregate of advanced economies includes Australia, Canada, the euro area, Japan, Sweden, the United Kingdom, and the United States.

the advanced economies (the yellow green line). The growth differential (the blue line) has fluctuated over the sample period, widening in late-2009 and early-2010 with the EMEs' faster pace of recovery from the crisis, but then narrowing as EME growth slowed more than AE growth.

As an indicator of global risk appetite, I use the quarterly average of the Volatility Index (VIX) computed by the Chicago Board Options. I source VIX from Bloomberg. This is a measure of the implied volatility of the S&P 500 index and serves in the regressions as a proxy for the combination of perceived risk and risk aversion. Generally, capital flows to EMEs plunge with highly perceived risk (increase in VIX) and capital flows to EMEs increase with lower perceived risk.

2.5   Results

I first compare the results to the one on total portfolio investment flows in Ahmed et al (2014). The results are consistent with them, and the only difference in data set is that I have more countries (observations) than them. The countries covered in this paper are total 16 countries and include Argentina, Brazil, Chile, China, Colombia, Mexico, India, Indonesia, Israel, Malaysia, the Philippines, South Korea, South Africa Taiwan, Thailand, and Russia. The introduced interaction term of the explanatory variables with a post-crisis dummy variable confirm the sensitivity change after GFC. The first four rows show the estimates of the pre-crisis period and the next five rows represent the difference between effects in the post-crisis vs. the pre-crisis period. Thus if we add these differences to the corresponding effects from the first four rows, we get the total effects for the post-crisis

period.

The regression results in Table 1 show that the explanation of total net portfolio assets came mostly from portfolio equity not from portfolio debts. The policy rate differential has much bigger effects in the post-crisis period compared to the pre-crisis period, with the differences being statistically significant, but only for total net portfolio investment flows and the portfolio equity flows, not for net portfolio debt assets flows. For the FE model which is not presented in the paper also show similar results, except that a percentage point increase in the policy rate differential had a small effect on the net outflows in the pre-crisis period for total portfolio flows and portfolio debt flows (i.e., the coefficient was slightly negative but not statistically significant). However, the interaction term of policy rate dierential appears to be the significant reason behind the post-crisis flows being stronger than the pre-crisis model would predict, also for total portfolio flows and portfolio equity flows only. Combining with Fig. 1 in the last section, for portfolio net debt flows, which are the main reason for recent capital surges, the sensitivity to policy rate differentials do not increase in the post-crisis period. Thus, the sensitivity change in interest rate differential, the result from Ahmed et al (2014) does not fully explain the surges to the EMEs, because the explanation is only restricted in equity assets, which do not show huge capital inflows after the crisis periods. Now my research goal is what would be the global factors derived the surges to EMEs in debt assets after the GFC.

Variables Outflows	(OLS) Net portfolio/GDP	(OLS) Net equity/GDP	(OLS) Net debt/GDP
Rate_diff	-0.00175***	-0.000831**	-0.000920**
	(0.000503)	(0.000341)	(0.000382)
Growth_rate_diff	-0.00177**	-0.00139**	-0.000378
	(0.000862)	(0.000583)	(0.000655)
VIX	0.00104***	0.00142***	-0.000378
	(0.000365)	(0.000247)	(0.000278)
Trend	0.000170	0.000666***	-0.000496**
	(0.000297)	(0.000201)	(0.000226)
D_post-crisis	-0.0358	0.0283	-0.0641**
	(0.0356)	(0.0241)	(0.0271)
D_post-crisis #Rate_diff	-0.00257**	-0.00261***	4.69e-05
	(0.00111)	(0.000749)	(0.000840)
D_post-crisis#Growth_rate_diff	0.00160	0.000833	0.000771
	(0.00122)	(0.000825)	(0.000926)
D_post-crisis#VIX	-0.000143	-0.000938*	0.000795
	(0.000710)	(0.000481)	(0.000540)
D_post-crisis#Trend	0.000966	-0.000327	0.00129**
	(0.000760)	(0.000515)	(0.000578)
Constant	-0.00946	-0.0299***	0.0204***
	(0.00926)	(0.00627)	(0.00704)
Observations	616	616	616
R-squared	0.058	0.089	0.050

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.1: Structural break test for the determinants of net portfolio capital outflows to EMEs.

In order to see the change in sensitivities to interest rate differential before and after GFC, I performed the same structural break tests, respectively the one using the federal fund rate (FFR) differentials and the other replacing the normal policy interest rate to the shadow short-run rate (SSR). Also I realized that there are some countries having not well defined data, such as for some periods there are no separated data for debts and equity, so I dropped those countries, which include India, Malaysia, and Russia. Also for Taiwan, the regression only run for that country shows that there is a significant sensitivity change after financial crisis when shadow short rate is used. However, when I add it into the sample, it

reduces the significance, this is may be because of its unique assets accumulation pattern, which it accumulates more debt assets after the GFC, while most of other countries get the huge capital inflows, so I also dropped the country and run the regression separately. The results show that the model fits better when I use the SSR instead of the FFR. R-squared was higher for model with the SSR and Root MSE was smaller for model with the SSR. For the significance of the interaction term with post-crisis dummies, the interaction term using the SSR is statistically significant while the one with the FFR is not or less significant. Therefore I can conclude that the SSR could track down the sensitivity change of interest rate differential better than the FFR and also improve the model fitness. Thus, the SSR may be the better measure for U.S. monetary policy than the FFR at least in explaining capital flows to EMEs. Also this result provides possible explanation of recent capital surges to EMEs by unconventional U.S. monetary policy. The results with the SSR in Table 3, are also consistent with what we saw in the Fig 8 and 9, in terms of the change in direction of net debt accumulation by EMEs, and the sensitivity change in interest rate differential before and after the GFC. I will discuss more in detail on the results in the next section.

Variables Outflows	(OLS) Net debt/GDP	(FE) Net debt/GDP
Rate_diff	-0.00203***	-0.00105
	(0.000665)	(0.000912)
Growth_rate_diff	0.00130	-0.000275
	(0.000833)	(0.00103)
VIX	0.000389	0.000256
	(0.000355)	(0.000351)
Trend	-0.000235	-2.71e-05
	(0.000283)	(0.000285)
D_post crisis	0.00207	-0.00323
	(0.0167)	(0.0163)
D_post crisis#Rate_diff	0.00117	0.00204*
	(0.00120)	(0.00119)
D_post crisis#Growth_rate_diff	-0.000874	-0.000859
	(0.00106)	(0.00106)
D_post crisis#VIX	-0.000262	-0.000129
	(0.000564)	(0.000549)
D_post crisisr#Trend	-0.000154	-0.000264
	(0.000349)	(0.000338)
Constant	-0.00523	-0.00451
	(0.00862)	(0.00843)
Observations	503	503
R-squared	0.062	0.1628
Number of country_id		12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.2: The effect of FFR differential on net capital outflows.

Variables Outflows	(OLS) Net debt/GDP	(FE) Net debt/GDP
Rate_diff vs. SSR	-0.00206***	-0.000869
	(0.000661)	(0.000848)
Growth_rate_diff	0.00128	-0.000258
	(0.000834)	(0.00103)
VIX	0.000537	0.000291
	(0.000370)	(0.000372)
Trend	-0.000189	1.67e-05
	(0.000279)	(0.000274)
D_post-crisis	-0.00150	-0.00661
	(0.0165)	(0.0159)
D_post-crisis#Rate_diff vs. SSR	0.00237**	0.00263**
	(0.00107)	(0.00103)
D_post-crisis#Growth_rate_diff	-0.000776	-0.000745
	(0.00107)	(0.00106)
D_post-crisis#VIX	-0.000390	-0.000118
	(0.000574)	(0.000564)
D_post-crisis#Trend	-0.000197	-0.000465
	(0.000350)	(0.000348)
Constant	-0.00778	-0.00603
	(0.00849)	(0.00818)
Observations	503	503
R-squared	0.062	0.1679
Number of country_id		12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.3: The effect of SSR differential on net capital outflows.

2.6   Discussion

Looking at the accumulated net flows in portfolio debt assets from Fig 8, we can confirm that (1) there is a dramatic sign change from positive to negative before and after the GFC, meaning the emerging markets used to be net lenders to the rest of the world but now they became net borrower. Also (2) the other one to be emphasized is that the speed

of net outflows to the emerging economy also changed before and after the GFC. In other words, before the GFC, the acculturated outflows increased at increasing rate, but after the GFC the EME got huge net outflows at fairly constant rate. Thus, this implies that there is a sensitivity change in net portfolio debt after GFC, but in opposite way, so the speed of net flows was increasing before the GFC, but it became constant after GFC by some forces to negate this increasing speed. We can confirm this pattern also looking at net flows and interest rate changes from Fig 9 and interaction term of interest rate differential with post-crisis dummy in Table 3.

Regarding the first observed facts (1) that there is a sign change before and after financial crisis, can be explained by the interest rate differential and other explanatory variables. Therefore there is no change in relationship between accumulated stock of debts assets and interest rate differentials (i.e stock of debts assets are explained better when the SSR is used, without the interaction term with post-crisis dummy variable after the GFC) before and after the GFC. However, for the relationship between net flows and interest rate differentials, there seems to be a structural break before and after the GFC, and the regression results also confirm this pattern of the flows. More specifically, the sign change in interaction term of interest rate differential with post-crisis dummy indicates that the relationship between the net portfolio debt flows and interest rate differential has been changed before and after the GFC. This implies that after financial crisis, there have been a force to negate this increasing net flows by one percent decrease in interest rate differential, and to make the net flows stabilized, meaning the speed of flows is constant after the GFC.

In detail, the negating force (i.e. the interaction term in Table 3) indicates that

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when there is an increase in interest rate differential, there will be an increase in net outflows out of the EMEs, and this seems not reasonable. Possible explanation of this force can be found in the difference between the FFR and the SSR. Since the increase in interest rate differential after the GFC mainly came from drop in the SSR while the FFR is kept at zero, this gap can be seen as a subsidy to U.S. bonds. Thus while the nominal effective interest is the SSR, the nominal earning from U.S. bond represented as a policy rate is the FFR, so when the SSR drop more, the U.S. bond purchaser can earn more subsidy. This may result in more purchase of U.S. debt assets as interest rate differential increase more. However, note that this is only explaining the relationship between net debt flows (speed of the change in debt assets holdings)and interest rate differential, and. Since the net flows are still negative, EMEs will keep experiencing the strong net debt inflows.

From Fig 2.10, which represent accumulated debt flows and shadow rate movement during the sample periods, I hypothesize that even if the SSR may not impact the accumulation of the debt assets flows directly, it may partially affect the speed of the net flows to the EME, by imposing the force we found earlier and cancel the increasing speed of debt flows out. This can be seen because of the fact that the strength of QE in the beginning of post-crisis periods accelerate the net inflows to the EMEs, and later when QE become tapered off, the intensity of net inflows also become weaker. Thus, the pattern of the net portfolio debt flows somewhat reflect the movement of U.S. shadow short-term policy rate (SSR) and QE before and after the GFC. Thus I may be able to confirm that the speed of falling rate in the SSR was very high right after the GFC because of the initial strong intensity of the QE and this explain the initial strong inflows to the EMEs, using a

empirical model, and finally construct a theoretical model which can derive and show how this sensitivity change of interest rate differential by AE's unconventional monetary policy affect the bond flows to the EMEs.
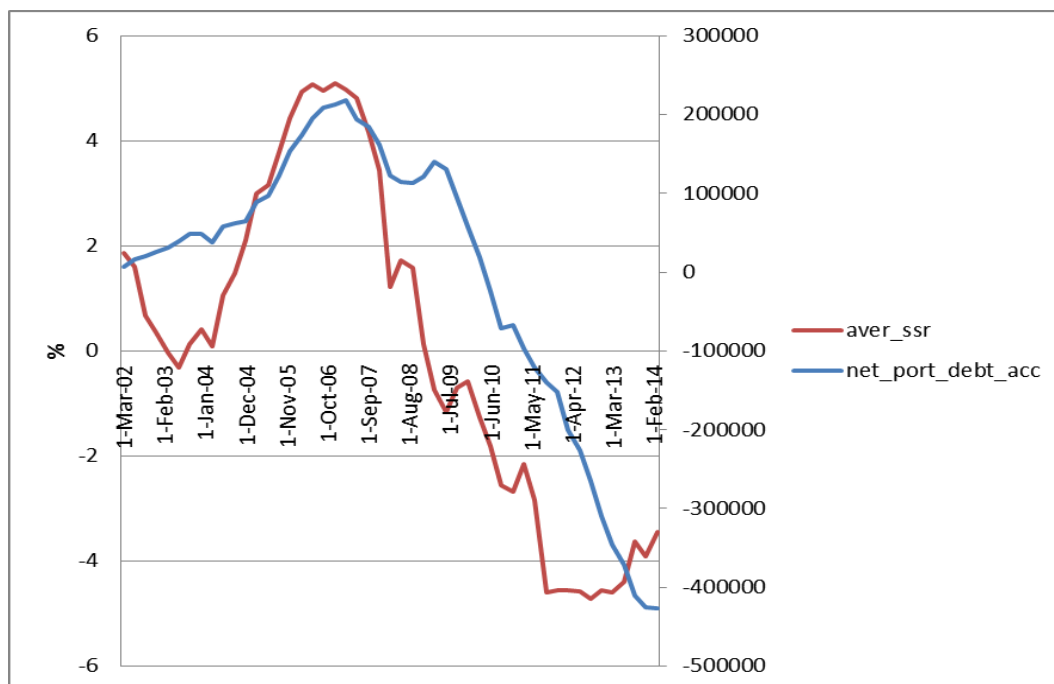
Figure 2.10: Accumulated Net Debt Flows and Shadow Rate

Part III

Chapter 3

Chapter 3

Impact of Financial Frictions and Financial Crisis on Capital Flows

3.1 Introduction

Resulting from gradual worldwide financial integration, over the last two decades, the U.S. has experienced large and sustained capital inflows from foreigners seeking U.S. assets as liquid stores of values in search of safety. Foreign demand for U.S. assets has been dominated by so-called riskless debt instruments, and a large portion of the investors in these assets have been foreign central banks and governments who do not possess specialized knowledge in speculative investment and are merely searching for a store of value. On the other hand, emerging markets with rapid economic growth and high returns on their equity investment have attracted speculative capital, associated with large volatility and high degrees of leverage and equipped with the most state-of-the-art investment expertise, as

emphasized in the literature on sudden stops. As a result of this movements of capital flows between advanced economies and emerging market economies, current account imbalances between the two different groups have increased persistently. Also, financial market heterogeneity, which will be discussed in greater detail, is identified as a possible cause of global imbalances.

However, the recent financial crisis marked an abrupt change in these unprecedented global imbalances. The data from Lane and Milesi-Ferretti (2011) show that the trends of persistent imbalances in riskless and risky assets broke from 2007, the starting point of the recent global crisis. More specifically, in the case of debt instruments and international reserves (riskless assets), advanced countries received increasing net inflows by foreigners and emerging markets (EMEs) held an increasing net positive position in foreign assets before the crisis. Regarding portfolio equity and FDI (foreign direct investment) (risky assets), EMEs kept huge negative net holdings, while advanced economies continued to accumulate large positive net assets in pre-crisis periods. However, starting in 2007 the trends of widening financial account gaps in two heterogeneous assets markets stopped or rotated in opposite directions. The strong surge of capital flows into emerging risky capital markets also became weaker. Figure 3.1 and 3.2 displays net assets positions in riskless and risky assets of two heterogeneous markets.
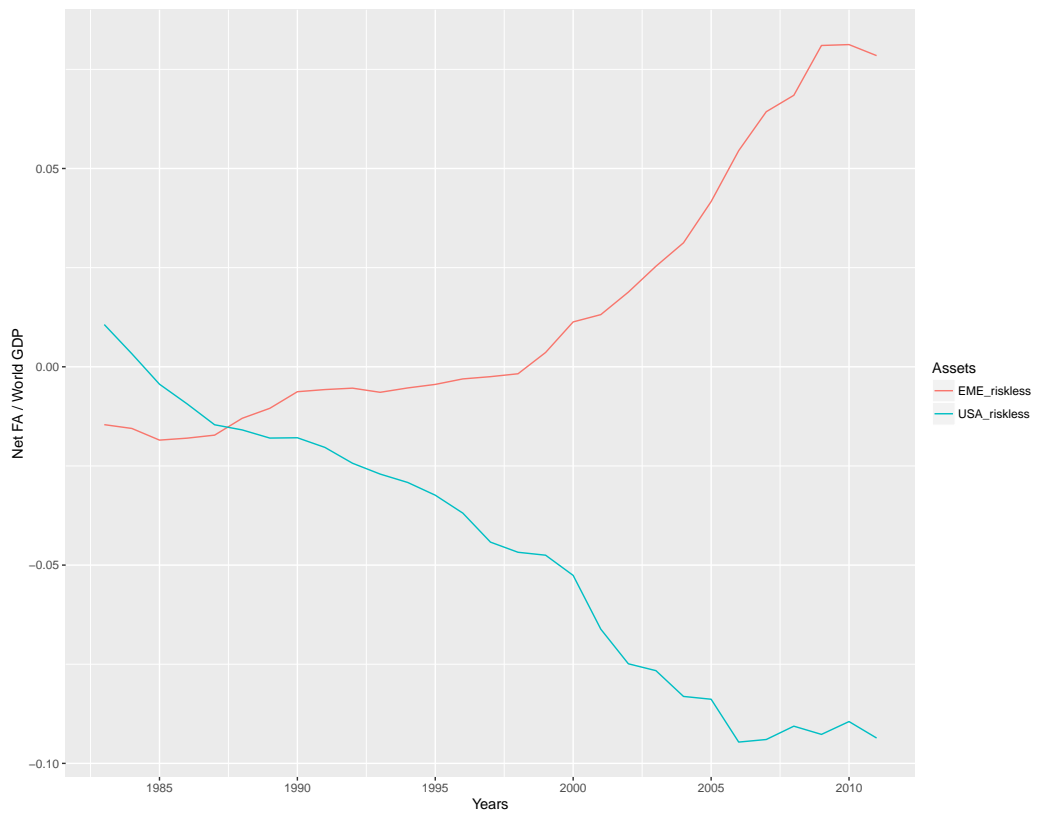
Figure 3.1: NFA in Debt and International Reserves
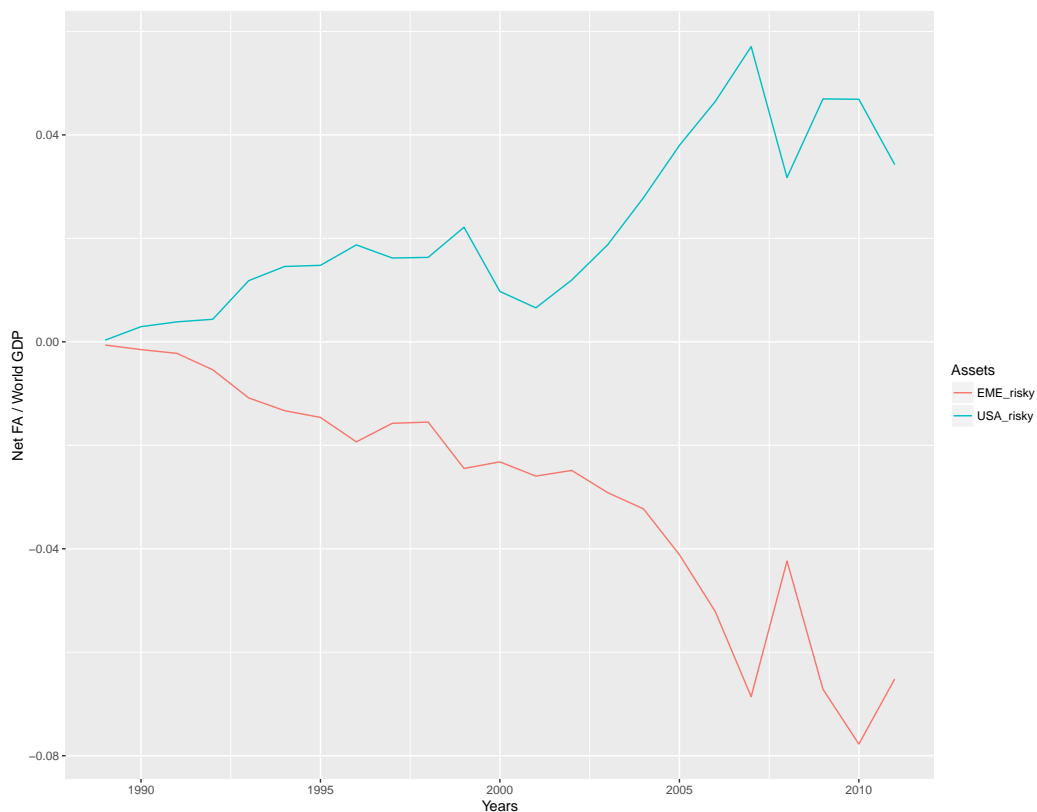
Figure 3.2: NFA in Portfolio Equity and FDI, Data from Lane and Milesi-Ferretti (2011)

In this chapter, I develop a stylized model that can explain the recent financial account movements between two financially different groups, advanced economies and emerging markets (i.e. financial account reversals during post-recent financial crisis). More specifically, the important features of capital markets during pre-crisis periods, already introduced in existing literature, will be inherent in the model, and newly observed facts during the crisis, will be added to the model. The key structure of the model is as follows.

First, heterogeneous characteristics in financial developments between two market systems leads to excess foreign demand for riskless assets in advanced countries. (Mendoza, Quadrini and Rios-Rull (2009)). Second, foreign demand is associated with the risk-

iness of the assets, lowering interest rates on riskless assets in advanced countries through precautionary savings. Third, purchasing of the riskless assets by foreigners raises the leverage ratio of financial institutions in advanced countries. Fourth, negative aggregate (liquidity) shocks and highly leveraged financial institutions in advanced countries lead to increasing risk premia in advanced countries. Fifth, lowered interest rate and increasing risk premia alter the returns on riskless and risky assets in advanced countries which cause the current account reversals.

Another important hypothesis addressed in this paper is that heterogeneity in different financial markets creates excess preference toward specific assets, which satisfy each financial market's needs. In turn leaning to one asset develops vulnerability to the other asset. For example, in case of EMEs *collateral constraint* plays an important role for driving sudden stops, but for advanced countries, *liquidity constraint* is key driving force for current account reversals because of difference in composition of assets holdings in those countries. Thus, since EMEs lack productive assets, when standard TFP shocks (as in Mendoza (2010)) hit EMEs, collateral constraints more easily bind for EMEs than for advanced countries. However, for advanced countries, insufficient liquid assets are the source of fragility, while EMEs over-accumulate the assets due to precautionary savings, so advanced countries are generally more fragile to liquidity shocks, and when aggregate liquidity shocks hit, interest rates are easily affected in advanced countries.

3.2 Literature review

This study will be the combination of three streams of literature on: (1) global imbalances in DSGE models, (2) liquidity risk sharing in international banking system and financial crises, and (3) current account reversals associated with credit market friction (Sudden Stops).

In the first stream of literature (as in (1)), Hunt and Rebucci (2005), IMF (2005), and Faruqee, Laxton, and Pesenti (2007) study traditional global imbalances within a DSGE model, but they manufacture the capital flows which result in global imbalances by exogenous shocks, such as an increase in the U.S. fiscal deficit, decrease in time preference in the U.S., and an increase in foreign demand for U.S. financial assets.

In contrast, later theories put more efforts to provide a link between asymmetries in financial development between countries and global imbalances. Caballero et al. (2008) focuses on supply side of the financial assets. That is, developing countries suffer from a shortage of 'stores of value' and this shortage tends to drive up the price of financial assets, and in turn drive down the equilibrium interest rate. Caballero et al. (2008) set up an overlapping generations model without any risk, applying a perpetual youth model as in Blanchard (1985). The essential part of the model is the absence of Ricardian equivalence: households currently alive are unable to issue or buy claims on the resources of unborn generations. The barrier to financial transactions can be even more severe if this asynchronicity between income and consumption decisions becomes extreme. With these financial frictions, lower fraction of output that can accrue to the financial assets, can exacerbate the shortage of stores of value. In this way the model captures the notion that financial markets

in many emerging economies are not sufficiently developed and that these countries suffer from a shortage of stores of value. Under financial autarky, low capacity of a developing country's financial system depresses equilibrium real interest rates and creates demand for assets form outside country to capitalize streams of future income into real assets, incurring global imbalances.

Mendoza, Quadrini and Rios-Rull (2009) also emphasize discrepancies in the degree of financial development across countries, borrowing the model from Aiyagari (1994) which emphasizes the general equilibrium effects of precautionary saving with un-insurable idiosyncratic risk. However, in their model financial imperfections have a direct impact on savings, thus, on the demand for assets, with a fixed supply of assets unlike Caballero et al. (2008). To produce the results, they introduce the verifiability constraint which creates differences in consumption pattern between countries that have ability to detect the diverted income and countries that cannot verify those hidden assets. As the countries have highly developed financial systems, they can smooth consumption against shocks that hit their economies. When a negative endowment shock hits the countries, the countries with less developed financial system suffer from reduced consumption in the next period because of those diverted assets, while financially advanced countries enjoy stable consumption by additional income from contingent bonds. These discrepancies in turn generate precautionary savings in the less developed countries, and financial integration between two groups of countries induces over-accumulation in bond (riskless) assets in less developed countries. This is because, in equilibrium this strong self-insurance motive depresses autarky interest rates below the riskless rates of the neoclassical model. Thus the stronger the precautionary

saving motive, the lower the autarky interest rate.

In addition, Mendoza, et al. (2009) specify and model capital flows in risky assets separately from capital flows in riskless assets. When a negative investment shock hits the countries, less developed countries also face marginal risk premium for productive assets, which is also caused by the incomplete market assumption, and this attracts investment capital from developed countries. In other words, advanced countries invest in foreign high-return assets and finance this investment with foreign debt. However, the advanced countries will still be able to hold a negative net foreign assets (NFA) position as a whole, because precautionary savings in less developed countries allow advanced countries to keep borrowing until their net worth position equals to zero (limited liability condition). Under both shocks, as long as the endowment shock is sufficiently large, the model derives the same result, thus advanced countries holding negative NFA positions and EMEs holding positive NFA positions. Therefore by assuming different degree of domestic financial development, this paper also shows how financial integration leads to gradual and persistent process of the global imbalances, as well as the heterogeneous composition of net foreign assets the different country groups hold.

A large recent literature points out liquidity risk sharing in international banking system as a reason for financial crises (as in (2)). The papers especially focuses on destabilizing effects of integration on international financial markets as a result of sharing liquidity risks among banks. Caballero and Krishnamurthy (2009) emphasize that while concern focuses on speculative capital flows to emerging markets, paradoxically, the excess demand for liquid stores of values by emerging economies is the main source of financial instabil-

ity in the advanced markets like U.S.. Thus, such demand not only triggered a sharp rise in U.S. asset prices, but also exposed the U.S. financial sector to extreme concentration of risk onto its balance sheet. This is because, in order to accommodate this foreign demand for debt instruments, the U.S. increased the equilibrium level of leverage of the domestic financial sector, producing debt claims out of all types of products. In other words, since foreign debt holders must be promised a fixed repayment, the domestic equity holders hold a residual claim that becomes riskier as leverage rises. As a result, as global imbalances rise, the extreme securitization pushes the U.S. to hold larger risky assets.

Castiglionesi, Feriozzi, and Lorenzoni (2012) also analyze the impact of financial integration on international banking sector. However, the authors investigate more complementary channel through which financial integration leads to lower marginal value of liquidity compared to under autarky, and in turn creates incentives for banks to hold lower liquidity than under autarky. More specifically, under autarky there are two kinds of assets in the model, liquid and illiquid assets, and some fraction of endowment is used for purchasing liquid assets and the rest is spent on illiquid assets. The return on liquid assets is 1, and return on illiquid assets is represented by a parameter R, which is greater than 1. In addition, the identical two countries are hit by uncorrelated or correlated shocks randomly. Thus, there are cases when a country is hit by a high liquidity shock, while the other is hit by a low liquidity shock and vice versa (HL/LH), or the cases when both regions are hit by the same shocks (HH/LL). If enough amount of the liquidity assets are held by banks, then there will be a roll over to the next period, and if the funding wasn't enough and a significantly big liquidity shock hits a country, the first period consumption will be

restricted (liquidity constraint binds). Now, the two economies are integrated. As long as $R>1$, the bank will not hold sufficient liquidity to cover all states of the shocks. Rather, it will keep more illiquid assets, because the competitive bank maximizes the consumers' value functions which are strictly concave. Thus, at least in one state, naturally when high liquidity shocks hit both region(HH), (or even when only one country is hit by), no roll over will occur, depending on the bank's decision. The key factor generating the bank's incentive to hold lower liquidity is return on illiquid long term assets (R), and corresponding assumption made by the model is that R is lower than some cutoff value $\hat{R}$. Thus, when $\hat{R}$ is low enough, the opportunity cost of holding liquid asset is low, so except for one extreme case, HH, the banks in each country will hold excess liquid assets to cover the liquidity shocks, and smooth consumptions by sharing liquidity-risks though interbank markets in the rest of the three states (HL/LH/LL). This implies in the rest of the three states, there will be roll overs ((liquidity constraint is slack), which in turn make marginal values of liquidity low, sharing the same marginal values of liquidity between the countries. Therefore, these low and same marginal values make the economies enjoy benefit of integration by lending liquidity when it is hit by low liquidity shock, canceling the shock out. However, the optimization results under integration that the marginal values of liquidity is lower than the values under autarky, in turn leads to lower investment in the liquid asset by banks under integration. This naturally causes high spike in interest rate (due to lack of liquidity) in rare and extreme case where both countries are hit by high liquidity shocks, while interest rates are low and stable in most of normal cases (hit by uncorrelated shocks or same low liquidity shocks).

For literature on current account reversals associated with a credit market friction(as in (3)), since Kiyotaki and Moore (1997) and Bernanke and Gertler (1989) had studied macroeconomic implications of credit constraints over business cycles, a broad class of DSGE models on sudden stops views credit frictions as the central feature of the transmission mechanism that drives sudden stops. Braggion, Christiano, and Roldos (2009) characterize a financial crisis as a shock in which collateral constraints unexpectedly bind and are expected to remain in place permanently. The collateral constraint put in the model is total value of collateral cannot be lesser than the payout value of the firm's external debt. Then the model shows that the friction hinders resource allocation, but then the monetary policy mechanism reverses its real economic movement. Thus, when a shock increases in the cost of foreign borrowing, the constraint limits the firm's ability to purchase foreign intermediate inputs and this decline in the input in turn induces drops in production. Also the sharp rise in the borrowing cost causes agents to pay down that debt by running a current account surplus. However, when the constraint is binding, the monetary policy, raising interest rate, prevents the marginal cost of production in traded sector from increasing, since employment of labor by firms is predetermined in that sector. As a result, relative price of non-traded goods increases, and this raises the value of the capital stock of traded-good in the non-traded sector, working as collateral. Therefore this is helpful for relaxing the constraint and, in so doing imports of intermediate goods increase, so does the production. Thus, a rise in the interest rate increases economic activity and welfare. Over time, as the real frictions wear off, the monetary transmission mechanism corresponds to the traditional one in which low interest rates stimulate output and raise welfare.

Mendoza (2010) also explains sudden current account reversals (Sudden Stops) in assets market and big drops in consumption in emerging markets in the frame work of a business cycle model with a collateral constraint. However, he focuses on the amplification and asymmetry of macroeconomic fluctuations that result from Irving Fisher's (1933) classic debt-deflation transmission mechanism. For that he generates an endogenous transmission mechanism driving sudden stops, with occasionally binding collateral constraint and replicate similar business cycles observed in the data.

$$\phi R_t exp(\varepsilon_t^R)(w_t l_t + p_t exp(\varepsilon_t^P)v_t) - q_t^b b_{t+1} \leq \kappa q_t k_{t+1}$$

This collateral constraint limits total debt, including both debt in one-period bonds, $q_t^b b_{t+1}$, and atemporal working capital loans,$w_t l_t + p_t exp(\varepsilon_t^P)v_t$, not to exceed a fraction κ of the market value of the physical capital, $q_t k_{t+1}$that serves as collateral. Here κ implies a ceiling on the leverage ratio. Interest and principal on working capital loans enter in the constraint because these are within-period loans, and thus lenders consider that collateral must cover both components.

By imposing this constraint, sudden stops are driven by two sets of credit channel effects. The first effect is endogenous financing premia that affects inter temporal debt, working capital loans, and equity. Thus, the effective cost of borrowing rises when the collateral constraint binds. The second effect is the debt-deflation mechanism. Thus, when the constraint binds, agents are forced to liquidate capital. This fire sale of assets reduces the price of capital and tightens further the constraint, setting off a spiraling collapse in the price and quantity of collateral assets. As a result, consumption, investment, and the

trade deficit suffer from contemporaneous reversals and future capital, output, and factor allocations fall in response to the initial investment decline. In addition, the reduced access to working capital induces contemporaneous drops in production and factor demands.

Getting insights from literature, in order to model current account (flip side of financial account) reversal during the recent global financial crisis, I start off with the model environment of global imbalances, and then by adding relevant financial constraint (liquidity constraint), I try to produce the reversed capital flows, observing changes in real interest rate movements between different countries. That is, countries with autarky interest rates above the equilibrium world interest rate will experience capital inflows under financial integration, and those with autarky interest rates below the world interest rate will experience capital outflows. Also a higher equity premium attracts risky capital investments.

3.3 Motivating Facts

Broner, Didier, Erce, and Schmukler (2013) implement some empirical gross capital flows analysis and demonstrate there are indeed differences in capital flows depending on different types of income groups which are high-income, upper-middle-income, and lower-middle-income countries. However, in the paper the authors concentrate more on gross capital inflows (CIF) and outflows (COD) during crises, not much on net capital flows (difference between CIF and COD). But they also mention the importance of the types of capital flows, since countries, categorized differently, hold different composition of capital flows, and which flows type is composed of the most in their gross flows determines the pattern of the net flows during the crises. For example, high-income countries and upper-

middle-income countries show decline in almost all of the components of CIF and COD (in direct investments, portfolio debt and portfolio equity flows, and other investments) during crises. However, reserves in high-income countries, on the other hand, actually increase the year after the crises, while others keep declining. In contrast to high-income countries, reserves in upper-middle-income countries contract also among CODs. Thus, while, during crises, every type of gross capital flows, including direct investments, other investments, portfolio debt, and portfolio equity collapses or retrenches, the behavior of reserves differs across income groups, playing an important role in the contraction of capital outflows in middle-income countries and none in high-income ones. If during a crisis foreign agents had lower incentives to invest in the domestic economy, it should also probably increase the incentives for domestic agents to invest abroad, so as mentioned earlier, asymmetrical behaviors of different income groups in gross capital flows reveals that other financial frictions might exist, in order to be able to match the movement in gross capital flows.

There are several hypotheses to explain this asymmetrical behaviors of domestic and foreign agents. The first one is asymmetric information. For example, Brennan and Cao (1997) and Tille and van Wincoop (2008) argue that a retrenchment during crises can take place if foreign agents are less informed than domestic agents about the return of domestic assets, and crises increase this information asymmetry. Shocks to risk aversion can also lead to retrenchments during crises if agents consider foreign assets as riskier than domestic ones. This happens when, for example, assets are denominated in domestic currency and the nominal exchange rate is volatile. Milesi-Ferretti and Tille (2010) also claim that risk aversion might have been the driver of the retrenchment in flows observed during the 2008

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global financial crisis. Broner et al.(2013) show evidence consistent with increases in risk aversion playing an important role during crises in middle-income countries.

Another source of the asymmetry between domestic and foreign agents is sovereign risk. For example, Broner et al.(2010) show that if domestic agents are less likely to be defaulted on than foreign agents, foreigners have an incentive to sell domestic assets to domestic agents in secondary markets, naturally leading to a retrenchment when the risk of default rises. More generally, models in which crises are associated with a relative deterioration of foreigners' property rights are likely to predict a retrenchment during crises. Furthermore, a tightening of domestic financial constraints during crises can lead to a retrenchment as a result of deleveraging. However, in the absence of frictions that specifically affect international asset trade, this retrenchment should not take place for all flow types. In particular, while domestic agents might find it more difficult to borrow, there should be an increase in sales of domestic firms to foreigners which counteracting initial capital adjustment. This implies imposing collateral constraint only cannot sufficiently explain aggregate capital flows during crises. Thus, in this paper I consider a financial constraint which may affect all types of capital flows.

3.4   Model

The model suggested in this paper is based on two countries model by Mendoza, Quadrini, Rios-Rull (2009). I now briefly describe the features of the base model and explain newly modified properties of the model in detail.

There are two countries, $i \in \{1,2\}$, identical except for the exogenous difference

in financial development represented by a parameter ϕ^i. A continuum of agents of total mass one in each of the countries maximize expected life time utility $E[\sum_{t=0}^{\infty} \beta^t U(c_t)]$. The utility function satisfies typical Inada conditions. Each country is endowed with a internationally immobile productive asset $k_t = 1$, purchased at price P_t^i, and there is no aggregate accumulation of capital. The production function is $y_{t+1} = z_{t+1} k_t^{\upsilon}$, with one-period lagged productive asset. Here $\upsilon < 1$, so the production function indicates decreasing returns to scale.

There are three shocks in the model, respectively, two idiosyncratic shocks specific to productive investment, z_{t+1}, and specific to endowment, w_{t+1}, and one aggregate liquidity shock, $(w_{t+1}^i, w_{t+1}^{-i})$, associated with a restriction imposed on the next period borrowing. Different from Mendoza, Quadrini, and Rios-Rull (2009), which does not consider aggregate shocks, this model introduces aggregate liquidity shocks, to investigate the impact of these shocks on capital flows after global imbalances become persistent trends, the main goal of this paper. Specific properties of aggregate liquidity shock are when a normal bad endowment shock hits one economy, since the other economy also suffers from the same type of the shock, a restriction imposed on the next period borrowing, $\rho_t^i < 1$, disturbs existing borrowing and lending activity. In other words, an aggregate shock induces a surge of high demand on bond assets in both countries but supply was not sufficient enough to cover the demand, so the delivery of the amount of the promised bonds is restricted or the value of the delivered assets is discounted by the fraction ρ_t^i, relative to the amount written in ex ante original contract. Thus, we can infer that the liquidity constraint would bind only during global financial crisis periods following the definition by Broner, Didier,

Erce, and Schmukler (2013) from empirical data. Also the aggregate shock is made up of composition of endowment shocks only. This is because the unavoidable characteristics of endowment shocks and riskless assets represents well the features of aggregate shocks to be investigated in the model. As the same as the base model in Mendoza, Quadrini, Rios-Rull (2009), the two idiosyncratic shocks follow a Markov transition process but have different characteristics. That is, the influence of the endowment shock is inevitable while capital investment shock can be avoided by not purchasing productive assets, so two different assets in the model can be distinguished as riskless and risky assets, following their characteristics and responses to the shocks.

By introducing additional aggregate endowment shock into the base model, the evolution of the state within one country will also be influenced by the endowment shock in the other country. Let $s_t^i \equiv (w_t^i, w_{t,}^{-i} z_t^i)$ is the pair of endowment shocks in residing country i and in the other country$-i$, and investment shock in the residing country i with a Markov transition process denoted by $g(s_t, s_{t+1})$. Agents can purchase contingent claims, $b(s_{t+1})$ and price of one unit of consumption goods contingent on the realization of s_{t+1} is $q_t^i(s_t, s_{t+1}) = \frac{g(s_t, s_{t+1})}{1+r_t^i}$, where r_t^i is the equilibrium interest rate. Also define a_t as the net worth at the end of period and its evolution:

$$a_t \quad = \quad c_t + k_t P_t + \sum_{s_{t+1}} b(s_{t+1}) q^i(s_t, s_{t+1}),$$

$$a(s_{t+1}) \quad = \quad w_{t+1} + z_{t+1} k_t^v + k_t P_{t+1}^i + b(s_{t+1}),$$

Following Mendoza, Quadrini, Rios-Rull (2009), the market frictions are introduced to the model. The first market friction is the incentive compatibility condition, where

the degree of financial development (enforcement of financial contracts), ϕ^i, plays an important role.

$$a(s_n) - a(s_1) \geq \left(1 - \phi^i\right) \left[(w_n + z_n k_t^\gamma) - (w_1 + z_1 k_t^\gamma)\right],$$

Here, this condition requires that the variation in incomes of the different realization of states, multiplied by $\left(1 - \phi^i\right)$, cannot exceed variation in the net worth of the states. When this condition holds, banks are willing to offer contingent claims. Even though international banking markets are not explicitly modeled, all borrowing and lending take place in these markets. Here $n \in \{1, \ldots, N\}$ is the index for possible realization of the shocks, with s_1 the lowest realization. With sufficiently high ϕ^i, the agent can access full insurance, conducting smoothing consumption. Also the degree of non-alienability, ϕ^i, depends on the country of residence of the agents, not the location where the assets are.

The second assumption is the limited liability condition which requires that net worth cannot be negative.

$$a(s_n) \geq 0.$$

The last friction is the liquidity constraint, which is newly added in this paper. As mentioned earlier, contingent claims are riskless and liquid assets react to endowment shocks. Thus, when an aggregate liquidity shock hits, these claims are supposed to be traded without any cost or a long lag, while investment capital is expensive to liquidate quickly so that Tobin's q is not always equal to one. This constraint implies that when

negative aggregate liquidity shocks hit both economies, any agent in the world will find difficulty in maintaining the same level of consumption as in the previous period, without relying on financial assets. Therefore the agents have to consume the existing claim stocks or borrow further if the existing assets are not sufficient enough to cover the current consumption. However, in this case the value of the claims delivered in the next period is less than promised in the original contingent contract, and equals $\rho_t \bar{b}_{t+1}$ ($\rho_t < 1$). This is because aggregate shocks affect the whole world, and a sudden increase in demand for contingent claims exceeds the reserved supply of them. As a result, claims diminished in value are delivered to agents who purchased the contingent claims in the previous period.

$$w^1_{t+1}(w^2_{t+1}) + \bar{b}_t - \frac{\rho_t \bar{b}_{t+1}}{1 + r_t} \geq c_t$$

The proper value of ρ_t can be determined as a function of foreign debt-to-asset ratio (leverage) of financial institutions in that country, or a subjective index which reflects the perception of agents on the promised claims issued in that country, and a proper discount rate in the value of the next period debt based on the perception. As the economy is accumulating huge debt, agents in the other country may recognize high risks (by bringing back the risk through an increase in leverage as in Caballero and Krishnamurthy (2009) e.g. reached limits of securitization capacity), within the claims and impose a handicap on next period debt. Thus, as foreign debt-to-asset ratio (leverage) of financial institutions in that country increases, the next period debt is largely discounted (ρ_t decreases).

In Castiglionesi, Feriozzi, and Lorenzoni (2012), financial integration provides financial institutions with lower opportunity costs of holding liquid assets, and induces banks

to reduce liquidity holdings and to acquire more profitable but illiquid assets. Even when aggregate, world wide shocks hit, when the liquid assets are the most beneficial, the aggregate liquid resources in the financial system are lower than autarky, because the competitive banks do not choose to hold enough liquidity. Therefore, financial integration leads to high spikes in interest rates, and huge drops in consumption during the extreme cases of global crises periods. When we consider the bond assets as collateral for the most liquid assets, which are prepared as a back up plan for a large drop in consumption, advanced countries with a large stock of debt in riskless instruments and low liquidity holding can be more fragile than emerging markets which posses large bond assets due to precautionary saving, to large aggregate liquidity shocks.

3.4.1 Optimization Problem

Given the degree of financial development, ϕ^i, and initial distributions of wealth,

$M_t^i(s, k, b)$, optimization problem solves (1) policy functions for agents' consumption, productive assets, contingent claims, (2) value functions, (3) prices $\{P_t^i, r_t^i, q_t^i(s_t, s_{t+1}), \rho_t^i\}_{t=\tau}^\infty$, and (4) distributions, $\{M_\tau^i(s, k, b)\}_{\tau=t+1}^\infty$. This is the optimization problem for the deterministic sequence of the prices $\{P_t^i, q_t^i(s_t, s_{t+1})\}_{t=\tau}^\infty$, in that country under capital mobility.

$$V_t(s, a(s)) = \max_{c,k,b(s')} \left\{ U(c) + \beta \sum_{s'} V_{t+1}(s', a(s'))g(s, s') \right\}$$

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subject to

$$\{\gamma_t\} : \widetilde{w_n}(s_t^i, s_t^{-i}) + \widetilde{z_n}(s_t)k_{t-1}^v + k_{t-1}P_t^i + \bar{b}_t - \frac{\Psi}{2}(k_t - k_{t-1})^2 \geq c_t + k_t P_t^i + \frac{\bar{b}_{t+1}}{1+r_t}$$

$$[Budget\ constraint]$$

$$\{\mu_t\} : b(s_n) - b(s_1) \geq -\phi^i\left[(w_n + z_n k_t^v) - (w_1 + z_1 k_t^v)\right]$$

$$[Incentive\ compatibility\ condition]$$

$$\{\lambda_t\} : \widetilde{w_n}(s_t^i, s_t^{-i}) + \widetilde{z_n}(s_t)k_{t-1}^v + k_{t-1}P_t^i + \bar{b}_t - \frac{\Psi}{2}(k_t - k_{t-1})^2 \geq 0$$

$$[Limited\ liability\ constraint]$$

$$\{\psi_t\} : \widetilde{w_n}(s_t^i, s_t^{-i}) + b_t - \frac{\rho_t^i \bar{b}_{t+1}}{1+r_t} \geq c_t \quad [Liquidity\ constraint]$$

Market Clearing

$$\sum_i \int_{s,k,b} k_\tau^i(s,a)M_\tau^i(s,k,b) \quad\quad = \quad 2$$

$$\sum_i \int_{s,k,b,s'} b_\tau^i(s,a,s')M_\tau^i(s,k,b)g(s,s') \quad = \quad 0$$

Price Equilization

$$q_t^1(s_t, s_{t+1}) = \frac{g(s_t, s_{t+1})}{1+r_t^1} \quad = \quad q_t^2(s_t, s_{t+1}) = \frac{g(s_t, s_{t+1})}{1+r_t^2}$$

$$P_t^1 \quad\quad = \quad\quad P_t^2$$

Since agents are indifferent about productive assets of domestic or foreign investment, only net position of holding foreign assets(NFA) is determined at equilibrium. The NFA position in the country i is

$$NFA_\tau^i \quad = \quad \int_{s,k,b}[k_\tau^i(s,a) - 1]P_\tau M_\tau^i(s,k,b)$$

$$+ \quad \int_{s,k,b,s'} b_\tau^i(s,a,s')M_\tau^i(s,k,b)g(s,s').$$

Here, the economy with contingent claims is equivalent to an economy where contingent claims are not allowed but agents face a different process for the exogenous shocks. Thus, the exogenous shocks and contingent claims can be transformed to newly defined shocks and non-contingent claims for computational convenience.

Let $\bar{b}_t$ be the expected next period value of contingent claims, $\bar{b}_t = \sum_{s_{t+1}} b(s_{t+1})g(s_t, s_{t+1})$. Then after rearranging the incentive compatibility constraint, the transformations of the shocks can be defined as:

$$\widetilde{w_n}(s_t^i, s_t^{-i}) \quad = \quad w_n - \phi^i W_n(s_t^i, s_t^{-i})$$

$$\widetilde{z_n}(s_t^i) \quad = \quad z_n - \phi^i Z_n(s_t^i)$$

where $W_n(s_t^i, s_t^{-i}) = w_n - \sum_l w_l g(s_t, s_l)$ and $Z_n(s_t^i) = z_n - \sum_l z_l g(s_t, s_l)$.

Using the transformed shocks, the next period assets become:

$$a(s_{t+1}) = \widetilde{w_n}(s_{t+1}^i, s_{t+1}^{-i}) + \widetilde{z_n}(s_{t+1})k_t^v + k_t P_{t+1}^i + \bar{b}_{t+1}$$

Therefore, by using transformations of the exogenous shocks, the problem becomes a standard portfolio choice between productive assets, k_t, and bond assets, $\bar{b}_t$. Also, differences in the stochastic properties of transformed shock capture the differences in financial development. For instance, if $\phi^i = 1$, the transformed shocks become constant and full insurance is achieved. If $\phi^i = 0$, the transformed shocks go back to original shocks and

no insurance is allowed. If ϕ^i is somewhere in between, partial insurance will be allowed.

Equilibrium

This section reports the characteristics of the new equilibrium when newly added liquidity constraint is binding. Since this constraint is imposed to show how an aggregate liquidity shock affects the economy, I will mainly focus on the aspects of the equilibrium of the economy associated with endowment shocks in the two countries rather than the impact of capital investment shock which will have not a big difference from Mendoza, Quadrini, Rios-Rull (2009) qualitatively.

Under autarky regime, the sufficiently highly developed countries (with sufficiently high value of ϕ) will experience a standard feature of the complete market without the liquidity constraint because incentive compatibility constraint will not be binding in the optimization problem. Thus, competitive equilibrium will achieve maximized utility only restricted by budget constraint without generating any financing premium. Now the liquidity constraint is imposed and introduces distortions via credit channel in the economy. The competitive equilibrium can be derived from Euler equation for b_{t+1} and the interest rate can be expressed as:

$$1 + r_t \quad = \quad \frac{U'(c_t) - (1 - \rho_t)\psi_t}{\beta E U'(c(w_{t+1}^1, w_{t+1}^2) + E\lambda(w_{t+1}^1, w_{t+1}^2)}$$

where $\lambda(w_{t+1}^1, w_{t+1}^2)$ and ψ_t is Lagrange multiplier associated with the limited liability constraint and the liquidity constraint respectively. When the liquidity constraint is not binding, the interest rate collapses the one in the complete market under autarky,

because the country will not accumulate any debt and hit the limited liability constraint. However, under financial integration when the liquidity constraint binds, the economy faces an endogenous external financing premium on debt (EFPD) measured by the difference between the effective real interest rate $1 + r_{t+1}^h$, which refers to the intertemporal marginal rate of substitution in consumption, and $1 + r_t$:

$$EFPD \quad = E\left[1 + r_{t+1}^h\right] - E[1 + r_t] \quad = \frac{(1-\rho_t)\psi_t}{\beta E U'(c(w_{t+1}^1, w_{t+1}^2) + E\lambda(w_{t+1}^1, w_{t+1}^2)}$$

Under autarky ($\lambda(w_{t+1}^1, w_{t+1}^2) = 0$), the steady state EFPD equals to zero if liquidity constraint is not binding. Since $0 < \rho_t < 1$, low ρ_t increases EFPD if the constraint is binding. Therefore, when an aggregate liquidity shock leads to the constraint binding in advanced countries, the real return (benefit) on bond instruments of advanced countries decreases. This makes riskless assets of advanced countries unattractive and alters the capital inflows searching for the safe stores of values from outside of the advanced countries. This can explain the suspended capital inflows to the advanced countries which have persistently grown for many years and the repatriation of (or weakly reversed) capital outflows from the advanced countries. Since ρ_t can be a function of foreign debt-to-asset ratio and EMEs hold large contingent claims on advanced countries, ρ_t for EMEs are close to 1. This makes no difference on EFPD for them even if the same aggregate shock also hits the countries, so the return on EME claims will not change. Therefore, the lower return on bond assets of advanced countries and unchanged return for EMEs bonds make the gap between interest rates of two countries shrinks compared to the gap when the liquidity constraint was not

binding. Global imbalances of net foreign asset position of riskless assets between two countries also shrink.

In addition to the financing premium on debt, there is also a endogenous credit channel mechanism. When the liquidity constraint binds, the premium initiates the first round of capital outflows or lower borrowing, and then ρ_t adjust by going up little bit because the leverage ratio is improved. If ρ_t goes up, the chance for the constraint to bind is higher given that other conditions are the same. Thus, agents in advanced countries will still have the barrier in borrowing and this forces them to borrow less due to existence of discount rate on the next period debts. This causes another round of capital outflows or reduced borrowing, but with decreasing margin, because ρ_t goes up so the next period claims are not as much as diminished compared to the previous period. In this way, passing through several rounds of outflows, the value of ρ_t will keep adjusting until the benefits of borrowing and financial loss by the discount rate are equalized. This can also be explained similarly by using the return on the bond assets. Existence of ρ_t will make the assets unattractive but as ρ_t increases, return will drop less and reach some value. Thus capital outflows will stop at some stage where all the adjustment process of the values is completed.

The impact of liquidity constraint on productive capital can be analyzed by the Euler equation for k_{t+1}, and the return on capital is:

$$1 + R_t = \frac{U'(c_t) - \psi_t}{\beta E U'(c(w_{t+1}^1, w_{t+1}^2) - E\psi(w_{t+1}^1, w_{t+1}^2) + E\lambda(w_{t+1}^1, w_{t+1}^2)}$$

where also $\psi(w_{t+1}^1, w_{t+1}^2)$ and $\lambda(w_{t+1}^1, w_{t+1}^2)$ are Lagrange multiplier associated with the liquidity constraint and the limited liability constraint respectively. Also equity

premium can be obtained by combining the Euler equations for bonds and capital, thus the expected excess return on capital relative to r_t :

$$E[R_{t+1} - r_t] \quad = \quad \frac{\gamma_t E\psi(w^1_{t+1}, w^2_{t+1}) - \rho_t \psi_t E\gamma(w^1_{t+1}, w^2_{t+1})}{E\gamma(w^1_{t+1}, w^2_{t+1})\{E\gamma(w^1_{t+1}, w^2_{t+1}) + E\psi(w^1_{t+1}, w^2_{t+1})\}}$$

where $\gamma(w^1_{t+1}, w^2_{t+1})$ is Lagrange multiplier associated with the budget constraint. For simplicity under autarky $\lambda(w^1_{t+1}, w^2_{t+1})$ will be zero. Then if the liquidity constraint does not bind either at t or t+1, ψ_t and ψ_{t+1} are zero, the equity premium disappears. However, with the liquidity constraint binding, because the premium in steady state collapses to $\frac{(1-\rho_t)\psi^{ss}}{\gamma^{ss} + \psi^{ss}}$, which is greater than zero for $\rho_t < 1$, the equity premium should also be greater than zero. Thus an aggregate liquidity shock also creates risk premium in advanced countries. Similar to the discussion on riskless assets above, under autarky without the liquidity constraint, advanced countries with sufficient high ϕ will have no marginal premium for investing productive assets, because next period's consumption is not stochastic, so the return on productive assets and interest rate are equalized. However, as we show, the liquidity constraint also generates risk premium in advanced countries and this attracts capital flows to productive assets from outside of the countries. This explains the reversed capital flows to risky assets in advanced countries from the rest of the world and capital outflows from risky assets in emerging markets during the global financial crises. However, since the equity premium is still higher in EMEs than in advanced countries, EMEs still maintain a negative NFA position in risky assets.

Analytical results derived from the model is consistent with the recent moderate

current account reversals in qualitative term. However, comparison of dynamics of interest rates between two countries after integration and imposing aggregate shocks, needs to be done to achieve further accuracy. Thus after integration, two countries share the optimized dynamic equilibria with introducing different shocks, and I need to investigate further from those equilibria how the liquidity constraint affects the next dynamic equilibria. Specifically, the reduced interest rate for the advanced countries after the liquidity shocks is still higher than world interest rate after capital mobility or the one for emerging economies is still lower than the world interest rate. However, quantitative analysis with proper values of parameters can show this.

3.5 Quantitative Analysis

3.5.1 Calibration

All the values of parameters in the model followed the ones in Mendoza, Quadrini, Rios-Rull (2009). In order to accommodate aggregate liquidity shocks, which were not the concerns in the base model, parameters will be properly modified for the new dynamic equilibria.

The population size of the advanced country (country 1) is 0.3 so as to match the U.S. share of world GDP, which is about 30 percent. Interpreting w as labor income and y as net capital income, $\overline{w}$ is set as 0.85, and the production function is parameterized so that $y = \overline{z}k^{\nu} = 0.15$. Because per capita assets are $k = 1$, this requires $\overline{z} = 0.15$. The return to scale parameter is set to $\nu = 0.75$, implying a share of managerial capital of 0.25. This generates managerial rents as a fraction of total net income that are relatively small, about

3.75 percent.

ϕ^1 is assumed as 0.35 and ϕ^2 is put as 0. Thus, contingent claims are partially available in country 1 and unavailable in country 2. The utility function is constant relative risk aversion (CRRA), with the coefficient of risk aversion set to $\sigma = 2$. The intertemporal discount factor is $\beta = 0.925$. With this discount factor, the wealth-to-income ratios in the steady state with capital mobility are 2.86 in country 1 and 3.45 in country 2. The worldwide wealth-to-income ratio is about 3.3.

3.5.2 Results in Steady States

This section reports the values for agents' policy functions, value functions, multipliers of the constraints, and returns on riskless and risky assets, and compares the values between economies where the liquidity constraint does bind and does not.

Regarding riskless assets, from the result the liquidity constraint actually lowers the interest rate to 1.0746, compared to 1.0811 in the economy without binding liquidity constraint. This lower return in riskless assets can deter from investing in advanced countries and reverse the capital flows from advanced countries to EMEs. For risky assets, the liquidity constraint also reduces capital return but more importantly it generates equity premium of 0.0002 relative to zero in the economy without liquidity constraint, so this can attract the capital flows to risky assets in the advanced countries on the contrary to the case of riskless assets. When the liquidity constraint is binding, γ_t , Lagrangian multiplier of budget constraint, is reduced due to the existence of liquidity constraint associated with the Lagrangian multiplier, ψ_t.

As for policy functions, with binding liquidity constraint, the economy holds

more bond assets, 0.023, relative to -2.347 in the economy without binding liquidity constraint, and hold less productive assets, 0.991 relative to 1 in the economy without binding liquidity constraint. This is also consistent with the empirical features that the decline in huge negative NFA in riskless assets and the decrease in strong positive NFA in productive assets in advanced economies.

The achieved results is consistent with the data in terms of asset holdings and returns on the assets, but for the consumption, the complete market consumes smaller, 0.824, than constrained economy, 0.938, and value function is also lower.

Table 3.1: Steady State values by Matlab

Unknowns	c_t	γ_t	Value	k_t	b_t	ψ_t	r_t	R_t
no liquid. const.	0.824	1.473	-16.182	1	-2.347	.	1.081	1.081
liquid. const.	0.938	1.056	-14.215	0.991	0.023	0.077	1.075	1.075

3.6   Conclusion

International capital mobility between countries has been increased dramatically since the middle of 1980's. A variety of existing literature argues that international financial integration allows to take advantage of sharing uncorrelated risk between countries, and for domestic savings to generate more profits in countries with productive investment opportunities. However, as the model suggests, this trend can also be affected by market frictions originated from the characteristics of the financial markets itself, combining with an aggregate shock. Thus, countries with highly developed financial markets, which borrow heavily from abroad and invest in high-return foreign risky asset will induce the lack of riskless assets and create a market friction associated with those assets. Then, when it is hit

by an aggregate shock specific to those assets, foreign investors will abruptly cut funding or put some punishment on the next period borrowing, which causes 'sudden stops'(current account reversals) periods for those countries. This is very similar to the 'sudden stops' usually affect less financially developed countries, in terms of reversals of international capital flows, reflected in sudden increases in the current account, huge drops in production and absorption, and corrections in asset prices. However, on a closer view, the objects of reversals are exactly opposite, specifically one is riskless assets and the other one is risky assets, and this is because the big discrepancies of asset holdings between heterogeneous groups. This can be explained by putting a proper financial friction specific to those assets, so collateral constraint has a limit in explaining recent global crisis.

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