

Capital Flows and Capital Account Management in Selected Asian Economies



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Rajeswari Sengupta and Abhijit Sen Gupta



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About the New Thinking and the New G20 Project

The project aims to promote policy and institutional innovation in global economic governance in two key areas: governance of international monetary and financial relations and international collaboration in financial regulation. Sponsored by CIGI and the Institute for New Economic Thinking, the project taps new research and next-generation scholars in the emerging economies, linking them to established networks of researchers in the industrialized world. The objective over the longer run is to create a more permanent and self-sustaining research network that will provide a continuing stream of new ideas, sustain international collaboration and integrate researchers from the emerging economies into global policy discussions.

Miles Kahler and Barry Eichengreen (principals in the original project) recruited C. Randall Henning (new principal, American University) and Andrew Walter (University of Melbourne) to lead two research teams devoted to macroeconomic and financial cooperation and to international financial regulation. Gathering authors from eight countries, the project consists of 11 CIGI papers that add to existing knowledge and offer original recommendations for international policy cooperation and institutional innovation. CIGI will also publish the final papers as an edited volume that addresses the global agenda in these issue-areas.

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Abhijit Sen Gupta is an economist with the Asian Development Bank in New Delhi. His research focuses on open economy macroeconomics, global financial architecture, public finance and monetary economics. In particular, he is interested in challenges that arise with volatile capital flows, exchange rate coordination among Asian economies and international financial regulation. His work has also focused on drivers of food inflation and suitability of an inflation targeting regime in emerging markets such as India. His work has appeared in journals such as *Oxford Economic Papers*, *International Economic Journal*, *Singapore Economic Review* and *Open Economies Review*, along with several edited volumes published by the Asian Development Bank, the Asian Development Bank Institute and the World Bank.

In the past, he has worked with the Indian Council for Research on International Economic Relations and the World Bank in New Delhi, and at the International Monetary Fund headquarters in Washington, DC. He has also taught at Jawaharlal Nehru University in New Delhi and the University of California Santa Cruz. He obtained his M.A. and Ph.D. in international economics from the University of California Santa Cruz. He also holds an M.A. and M.Phil. in economics from Jawaharlal Nehru University.

Acronyms

AFC	Asian financial crisis
BI	Bank of Indonesia
BOK	Bank of Korea
BOT	Bank of Thailand
EAE	emerging Asian economy
EME	emerging market economy
EMP	exchange market pressure
EMPI	Exchange Market Pressure Index
FDI	foreign direct investment
GFC	global financial crisis
GMM	generalized method of moments
IMF	International Monetary Fund
MSB	Monetary Stabilization Bonds
MSS	Market Stabilization Scheme
QE	quantitative easing
RBI	Reserve Bank of India
SBI	Bank of Indonesia certificates
URR	unremunerated reserve requirement

Executive Summary

Gross capital inflows and outflows to and from emerging market economies (EMEs) have witnessed a significant increase since the early 2000s. This rapid increase in the volume of flows, accompanied by sharp swings in volatility, has amplified the complexity of macroeconomic management in EMEs. While capital inflows provide additional financing for productive investment and offer avenues for risk diversification, unbridled flows could also exacerbate financial instability. This paper focuses on the evolution of capital flows in selected emerging Asian economies (EAEs), and analyzes surge and stop episodes as well as changes in the composition of flows across these episodes. Having identified the episodes, the paper evaluates the policy measures undertaken by these economies in response to the surge and stop of capital flows. These responses encompass negotiating the trilemma in the face of volatile capital flows, intervention in the foreign exchange market by the central bank, and imposing capital controls. This kind of analysis is highly relevant, especially at a time when EMEs around the world

are facing the repercussions of a potential monetary policy normalization in the United States and continuing quantitative easing (QE) measures by the European Central Bank, either of which could once again heighten the volatility of cross-border capital flows, thereby posing renewed macroeconomic challenges for major EMEs.

Introduction

Emerging economies witnessed a sharp increase in capital flows during the last two decades. From around 2.6 percent of GDP in 2000, gross capital inflows increased to a peak of 12.5 percent of GDP in the second quarter of 2007. During the same period, net capital inflows surged from 1.25 percent of GDP to over 6.5 percent of GDP. After collapsing during the 2008 global financial crisis (GFC), capital flows to emerging economies experienced a sharp rebound in late 2009 and 2010. These created a number of macroeconomic challenges and financial stability concerns for emerging markets, forcing them to undertake capital account management and macroprudential measures to stem the flow of capital. The situation reversed again by the end of 2011, with worsening of the global economic outlook driven by a sovereign debt rating downgrade of the United States in August 2011 and exacerbation of the euro-zone crisis. This resulted in capital flows receding rapidly, eroding the recent exchange rate gains and reserve accumulation.

This heightened volatility in capital flows reignited the debate on allocation of flows to emerging economies. The paper focuses on the trend of capital inflows and outflows in selected EAEs by analyzing the “waves” in capital flows. Moreover, the composition of these waves is also evaluated, i.e., whether the flows were driven by foreign direct investment (FDI) flows, portfolio flows, bank and non-bank flows, derivative flows or government flows. Subsequently, the response of the host countries to these waves of flows is analyzed, focusing both on the capital account management and macroprudential measures. These policy responses have involved: negotiating the trilemma or the impossible trinity in the face of rising and volatile capital flows; intervention in the foreign exchange market by the central banks to balance exchange rate management and monetary management; and imposing capital controls to stem the inflow of a particular type of foreign capital. Finally, the paper evaluates the efficacy of these measures by analyzing whether they achieved their desired goals.

Identifying Surge and Stop Episodes

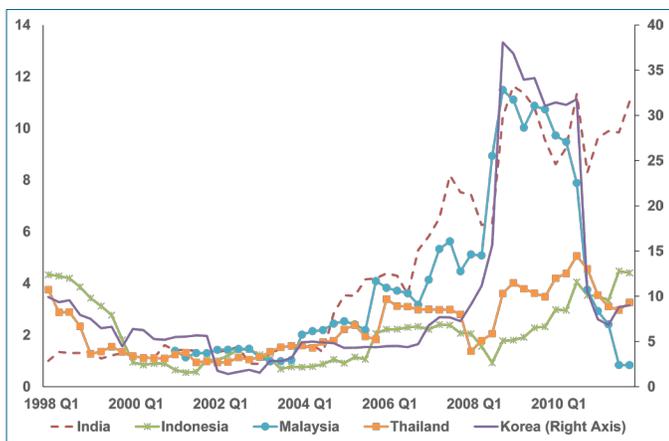
In this section, the broad trends in capital flows in selected Asian emerging markets are documented. The analysis focuses on five major emerging economies of the region, namely, India, Indonesia, the Republic of Korea (henceforth Korea), Malaysia and Thailand. The choice of these countries is driven

by the availability of the data and their economic importance. According to the International Monetary Fund's (IMF's) World Economic Outlook, barring China, these five EAEs accounted for 86 to 88 percent of GDP of emerging and developing Asia during the 2000s.

At the same time, these economies accounted for nearly 90 percent of capital flows into emerging and developing Asia. This paper covers the period from 1995 Q1 to 2011 Q4.

Gross capital inflows have been extremely volatile in recent years in these Asian economies. For example, inflow of foreign capital on account of net purchase of Korean assets by foreigners, through direct and portfolio investment, financial derivatives and other investment, reversed from +\$25.7 billion in 2007 Q2 to \$22.6 billion (net sales) in 2008 Q3.¹ Similarly, even in India, an economy with limited capital account integration, net purchase of assets decreased from +\$29.2 billion in 2007 Q4 to -\$1.6 billion in 2008 Q4. Following Kristin J. Forbes (2014) the increase in volatility is assessed by calculating the standard deviation of quarterly gross capital inflows over the last eight quarters for our sample of countries. The results are shown in Figure 1. Given Korea's significantly higher degree of volatility, compared to the other economies, it has been measured on a different axis. It is evident that in all these economies, the period of the GFC was characterized by significantly higher volatility in capital flows, compared to earlier years. There was a steady increase in volatility from early 2006, which peaked in the second half of 2008.

Figure 1: Volatility in Capital Inflows in Asia



Data sources: IMF's Balance of Payment Statistics and authors' estimates.

Volatility in the capital inflows has been driven by periods of waves of capital inflows. We use the methodology introduced in Kristin J. Forbes and Francis E. Warnock (2012) to identify periods of sharp changes in inflows. We focus on surges and stops. While a surge is defined as a sharp increase in gross capital inflows, a stop implies a sharp decline in gross inflows. Both

these events are driven by foreigners buying or selling domestic assets. Details of the calculations are provided in Section A.1 in the Appendix. The various episodes of surges and stops, with their start and end dates, are tabulated in Table 1.

Table 1: Surge and Stop Episodes for Selected Countries

	Surges			Stops		
	Start	End	Quarters	Start	End	Quarters
India	1996 Q2	1997 Q1	4	1998 Q2	1998 Q3	2
	2003 Q3	2004 Q2	4	2008 Q3	2009 Q3	5
	2004 Q4	2005 Q3	4			
	2006 Q4	2008 Q2	7			
	2010 Q1	2010 Q4	4			
Indonesia	1995 Q2	1996 Q3	6	1997 Q4	1998 Q3	4
	2005 Q4	2006 Q1	2	2006 Q4	2007 Q1	2
	2010 Q4	2011 Q2	3	2009 Q1	2009 Q3	3
Korea	1994 Q3	1995 Q4	6	1997 Q2	1998 Q3	6
				2008 Q1	2009 Q2	6
Malaysia				2005 Q4	2006 Q3	4
				2008 Q3	2009 Q2	4
Thailand	1995 Q2	1996 Q1	4	1996 Q3	1998 Q2	8
	2004 Q3	2006 Q1	7	2007 Q1	2007 Q4	4
	2010 Q3	2011 Q1	3	2008 Q3	2009 Q3	5

Data sources: Forbes (2014), IMF's International Financial Statistics and authors' estimates.

In addition, Figure 2 superimposes these episodes with the evolution of gross capital inflows and outflows as well as net inflows. Table 1 shows that these five EAEs experienced 12 surge and 12 stop episodes. While most of the surge episodes occurred in the years preceding the Asian financial crisis (AFC) and the GFC, the bulk of the stop episodes were confined to these two crisis periods. However, there were differences at the individual country level. While India experienced the greatest number of surge episodes (five), Malaysia did not witness any surge episodes. The stop episodes were more symmetrically distributed, with Indonesia and Thailand experiencing three episodes each and India, Korea and Malaysia encountering two episodes each. India and Thailand witnessed the longest surge episodes, spanning more than seven quarters during the period before the GFC, while Thailand witnessed the longest stop episode during the AFC.

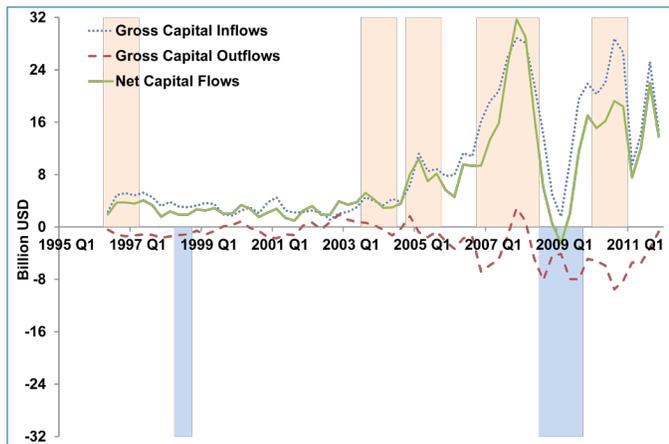
Figure 2 shows that during the longest surge episode experienced in India, between 2006 Q4 and 2008 Q2, there was an inflow in excess of \$150 billion or an average of 7.6 percent of GDP. Similarly, although the surge episode between 2004 Q3 and 2006 Q1 in Thailand was much more modest in volume, resulting in capital inflow of only \$30 billion, this capital flow accounted for nearly 9.3 percent of GDP. The stop episodes were equally diverse. While the longest stop episode among these five EAEs took place in Thailand during the AFC,

1 All dollar figures in this paper indicate US dollars.

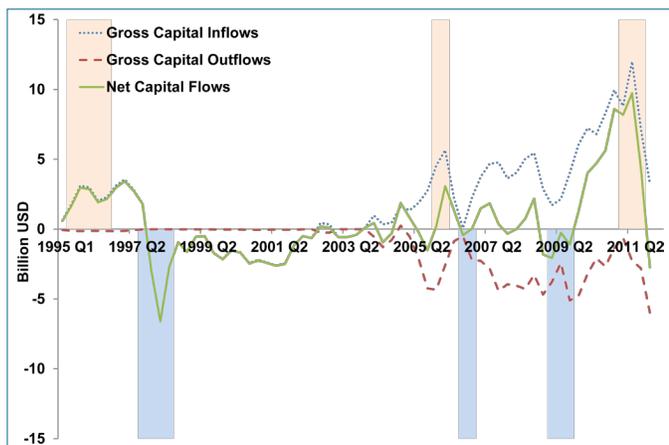
and led to sales of Thai assets by foreigners worth \$4 billion or 2.4 percent of GDP, Korea experienced sales of assets worth \$130 billion or 11.5 percent of GDP during the GFC.

Figure 2: Net and Gross Flows to Asian Economies along with Surge and Stop Episodes

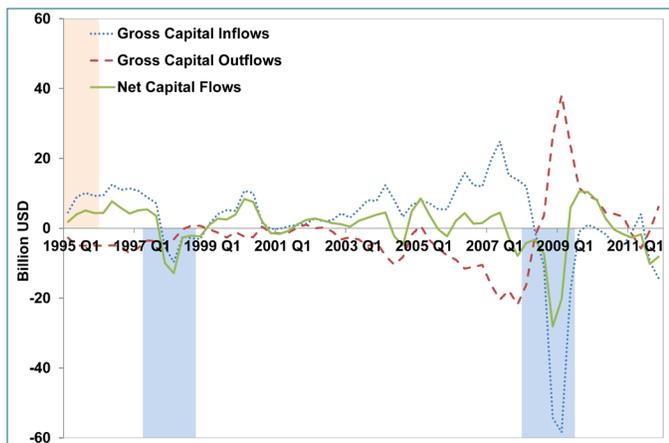
(a) India



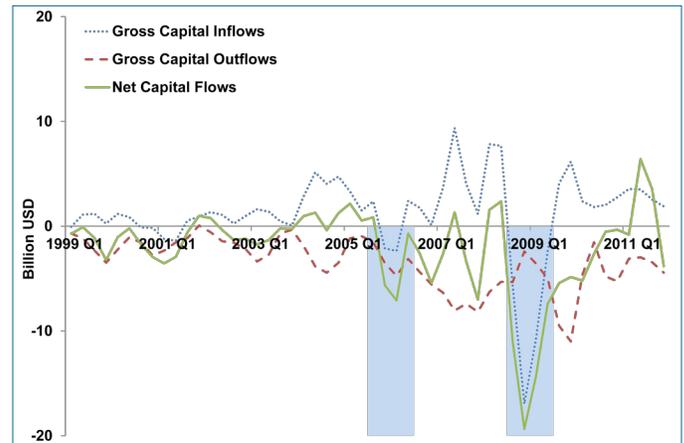
(b) Indonesia



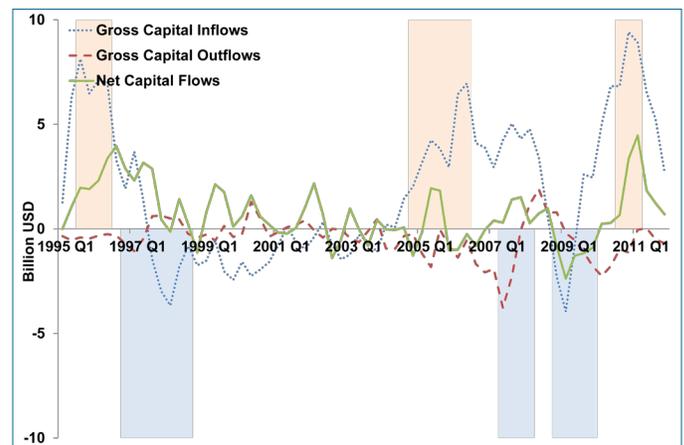
(c) Korea



(d) Malaysia



(e) Thailand



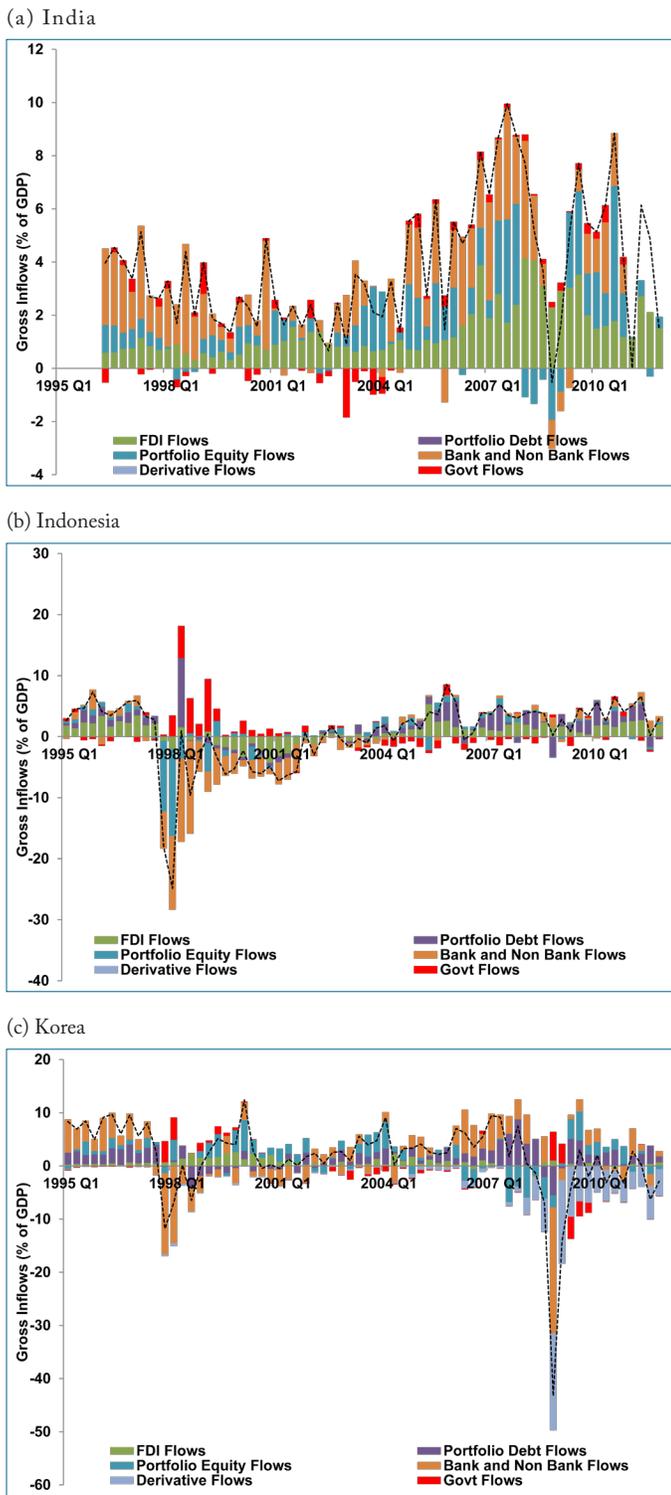
Sources: Forbes (2014), IMF's Balance of Payment Statistics and authors' estimates.

Next, we shift focus toward the composition of the gross inflows to get an idea of what kind of flows influenced the surge and stop episodes. Figure 3 decomposes the gross capital inflows (as a percentage of GDP) received into FDI flows, portfolio debt flows, portfolio equity flows, bank and non-bank flows, derivative flows and government flows. While data for Indonesia, Korea and Thailand is available for the period 1995 to 2011, the data begins in 1996 for India, and in 1999 for Malaysia.

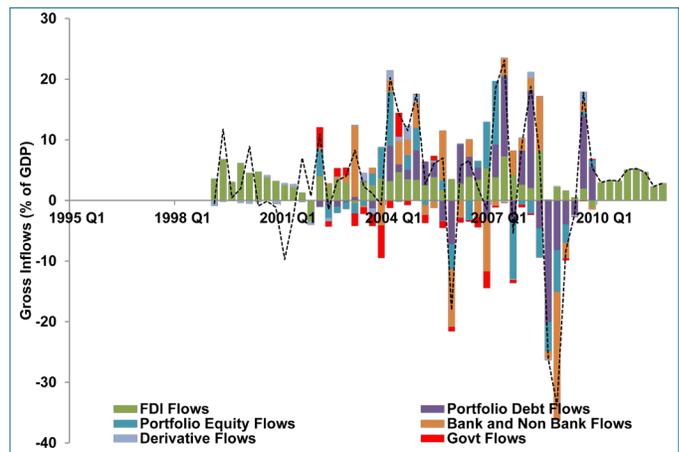
In India, the first surge episode in the mid-1990s was driven by bank and non-bank flows, which accounted for nearly 60 percent of the gross inflows. This was driven by commercial borrowings by the Indian corporate sector, short-term trade credits and deposits by non-resident Indians. These flows also played an important role during the surge episodes of 2004 Q4 to 2005 Q3 and 2006 Q4 to 2008 Q2, when they accounted for more than 40 percent of total inflows. These flows have been encouraged by the widening interest rate differential between India and the advanced economies, as well as liberalization of borrowing norms. The other two surge episodes in the 2000s were driven by portfolio equity flows, which accounted for 59.1 percent and 41 percent of the total flows. While FDI

inflows accounted for 25 to 30 percent of flows during these two episodes, its contribution peaked at 38 percent during the longest surge episode, which took place from 2006 Q4 to 2008 Q2.

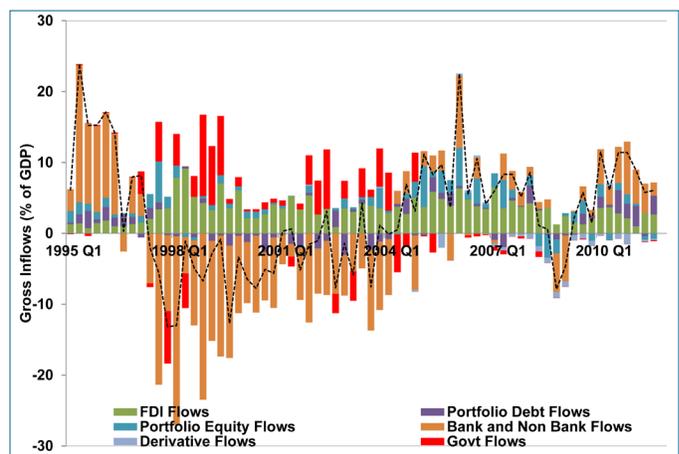
Figure 3: Composition of Gross Capital Inflows



(d) Malaysia



(e) Thailand



Data sources: Forbes (2014), IMF's Balance of Payment Statistics and authors' estimates.

In Indonesia, FDI inflows were the major driver of capital flows, explaining nearly 50 percent of the capital inflows during the surge episodes of 1995 Q2 to 1996 Q3 and 2010 Q4 to 2011 Q2. In comparison, FDI inflows accounted for only 30 percent of total inflows during the short episode from 2005 Q4 to 2006 Q1. Indonesia experienced a boom in FDI during 1995 and 1996, with FDI doubling over previous years. Portfolio debt flows also played an important role, accounting for between 25 percent and 50 percent of the capital inflows. Again, with domestic interest rates trending at higher levels than foreign interest rates, there were inducements for foreign borrowing and capital inflows. However, expected depreciation of the currency and country risk considerations tempered some of the inflows. The post-GFC period saw private investors engaging in purchases of government bonds and Bank of Indonesia (BI) securities, with portfolio debt flows accounting for 38 percent of aggregate capital inflows.

The only surge episode witnessed in Korea took place prior to the onset of the AFC. This was driven mainly by bank and non-bank flows and portfolio debt flows, which explained 56.9 percent and 28.3 percent of capital inflows. The worsening

of the current account deficit in the early 1990s, along with the requirements to join the Organisation of Economic Co-operation and Development, resulted in the Korean government relaxing its control over the financial sector and liberalizing the capital account. Foreign investors were allowed to invest directly in stock markets, foreigners were allowed to purchase government bonds, and small and medium firms were allowed to issue equity-linked bonds. Norms for foreign commercial loans were significantly eased, which led to an increase in short-term borrowing.

While Malaysia did not experience a surge episode during the period of the study, Thailand witnessed three such episodes. The first one, in the mid-1990s, was driven exclusively by bank and non-bank flows. This was a result of progressive capital account liberalization in the early 1990s, with measures such as increasing commercial banks' net foreign liabilities from 20 to 25 percent and allowing residents to undertake foreign exchange transactions directly with commercial banks. In the second surge episode, FDI inflows accounted for nearly half the inflows, while another 40 percent of inflows were in the form of portfolio equity flows. The final episode was driven by bank and non-bank flows and portfolio debt flows.

The stop episodes were primarily concentrated during the periods of the AFC and GFC. Barring India, all the other Asian economies witnessed a significant sale of assets by foreigners during the AFC. Steven Radelet and Jeffrey Sachs (2000) point out that these four EAEs, along with the Philippines, witnessed net private flows dropping from \$93 billion in 1996 to -\$12 billion in 1997, a swing of \$105 billion or nine percent of GDP. Out of this decline of \$105 billion, more than \$77 billion was due to commercial bank lending, while portfolio equity and non-bank lending accounted for \$24 billion and \$5 billion respectively.

Unlike the AFC, India was significantly impacted by the GFC, along with the other EAEs. From \$100.6 billion in 2007, private capital inflows dropped to \$33.2 billion in 2008. Cumulatively, these five economies witnessed private capital inflows declining from \$223.7 billion to -\$15.6 billion. Of the reversal of \$239.3 billion between 2007 and 2008, nearly \$150 billion was on account of bank lending, while portfolio equity witnessed a reversal of \$67 billion. Non-bank lending also experienced a reversal of \$23 billion.

Thus, during both the AFC and GFC, bank and non-bank inflows as well as portfolio equity inflows were the major channels of capital flow reversal. FDI inflows remained fairly constant during these two crises. The increase in global liquidity in the aftermath of the GFC, as well as initial signs of decoupling of emerging economies of Asia from the advanced economies, led to a revival of capital flows in the latter part of 2009, which continued until 2011. From a cumulative negative inflow of -\$15.6 billion in 2008, private inflows to these five

EAEs jumped to \$1.94 trillion in 2009, and further to \$2.15 trillion in 2010, before dropping to \$1.89 trillion in 2012.

Policy Response to Manage Capital Inflows

Policy makers' desire to prevent sharp surges in capital inflows stems from the myriad risks associated with these surges. These include macroeconomic risks, financial stability risks and finally risks associated with capital flow reversal. Arvind Subramanian and Raghuram Rajan (2005) and Esvar S. Prasad, Raghuram G. Rajan and Arvind Subramanian (2007) show that excessive capital inflows result in rapid exchange rate appreciation, which can hurt exports of emerging markets. Thus capital flow surges can influence macroeconomic variables in a way that is inconsistent with policy objectives such as price stability, exchange rate stability and export promotion. Capital inflows can also push up asset prices, reduce the quality of assets and adversely affect maturity and currency composition of corporate balance sheets, contributing to enhanced financial fragility. Prasad and Rajan (2008) contend that in an underdeveloped financial system, foreign capital is channelled toward easily collateralized, non-tradable investments, leading to asset price booms, with subsequent busts severely disrupting the economy. Foreign portfolio investment into shallow equity markets also causes sharp valuation swings. Finally, capital inflows can reverse themselves, leading to a costly balance of payments crisis. Susan Schadler (2010) shows that about 15 percent of capital inflow episodes over the past two decades have resulted in a crisis.

In the case where capital flows are being driven largely by economic fundamentals, policy makers need to be reconciled to the inevitability of allowing a real exchange rate appreciation as it would result in a fundamental revaluation of domestic assets relative to foreign assets. However, policy makers tend to be reluctant to allow the real exchange rate to appreciate, for a variety of reasons. The most important concern tends to be loss of international price competitiveness resulting in an adverse balance-of-payments situations.

In general, policy makers can resort to three broad macroeconomic measures to counter the surge in capital inflows. These involve: enhancing exchange rate flexibility to manage the trilemma; undertaking sterilized intervention; and imposing controls on capital inflows. Below, we analyze the experience of the five selected EAEs on these measures.

Enhancing Exchange Rate Flexibility

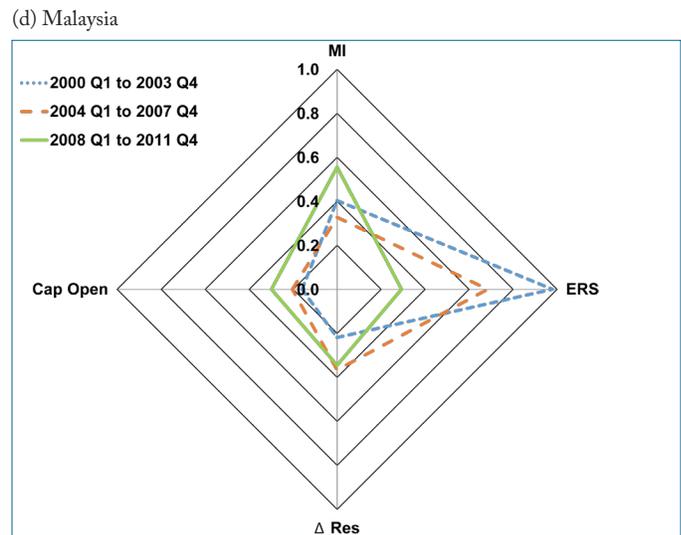
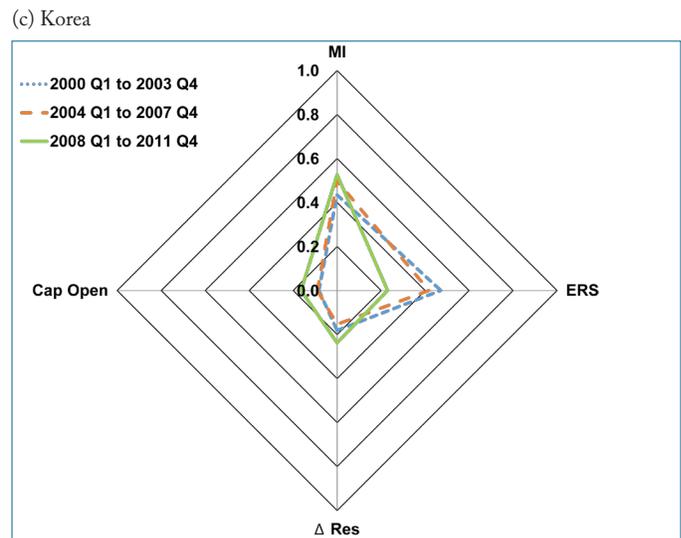
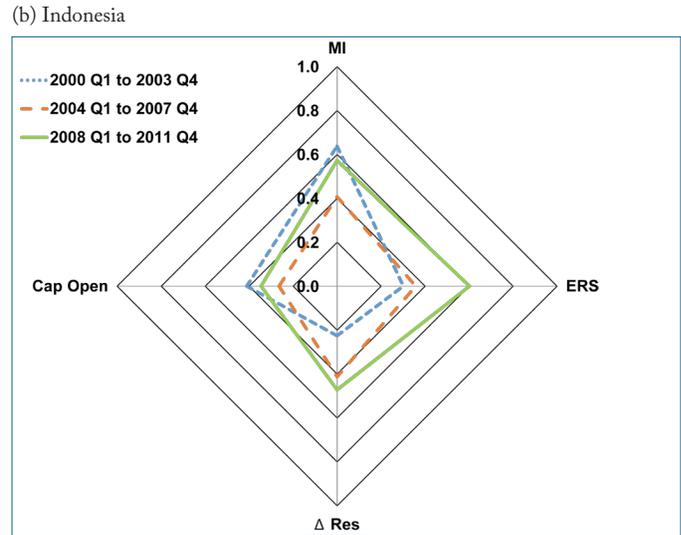
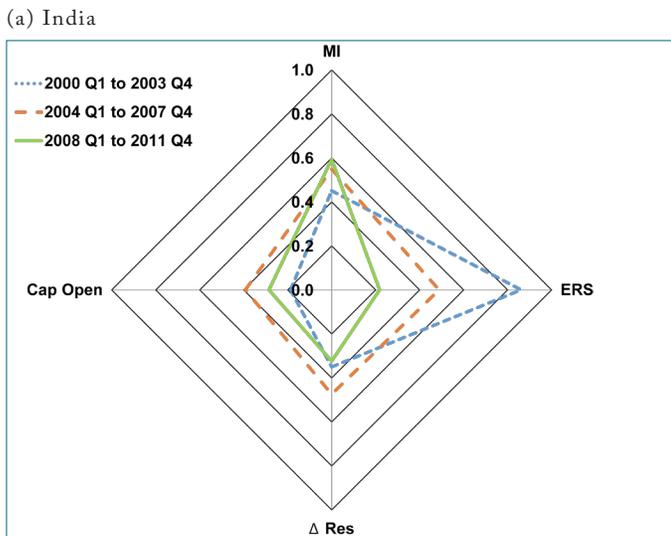
Enhancing exchange rate flexibility does not necessarily imply nominal exchange rate appreciation, something that the policy makers are reluctant to allow. It refers to introducing two-way

risks, thereby discouraging speculative capital inflows. If a central bank responds to capital inflows over a period of time by continuing to intervene in the foreign exchange market, it encourages more capital flows by introducing a one-way bet. It signals investors that the domestic currency will appreciate in the near future when the central bank cannot afford further intervention and allows freer movement of the currency. At the same time, a large stockpile of reserves provides an assurance that a major depreciation will not take place.

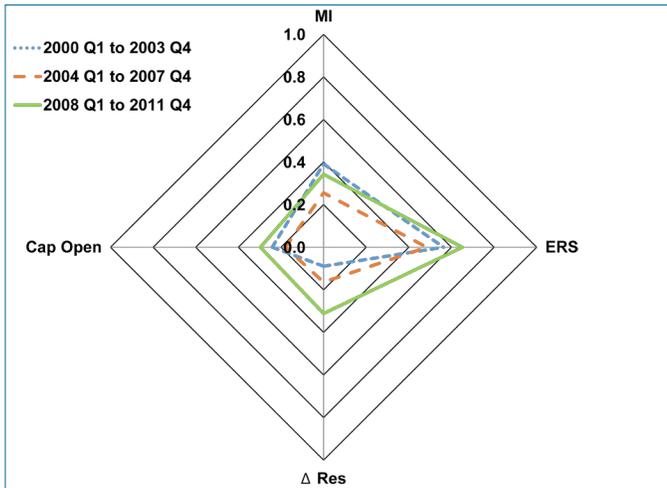
Introduction of two-way risks involves widening the band of fluctuation in the case of a de facto peg or a tightly managed float. The need to allow greater freedom to the exchange rate in the face of enhanced capital inflows is driven by the desire to retain monetary autonomy to be able to stabilize the economy in the event of adverse shocks. This trade-off stems from the classic open economy trilemma, which argues that it is impossible to simultaneously attain monetary policy independence, exchange rate stability and capital market integration. Only two of the three objectives can be obtained at a particular point in time. We use empirical methods following Joshua Aizenman, Menzie D. Chinn and Hiro Ito (2010) to briefly describe the experience of the EAEs with the impossible trinity, using quarterly data from 2000 Q1 to 2013 Q4. Details of the calculations are given in Section A.2 of the Appendix.

With three indices across five countries, it is difficult to identify events that would have resulted in a structural shift in these indices across all the economies. Hence, to better understand the evolution of these indices, the entire sample is broken into three equal periods. Period 1 lasts from 2000 Q1 to 2003 Q4, Period 2 covers 2004 Q1 to 2007 Q4 and Period 3 includes 2008 Q1 to 2011 Q4. Figure 4 plots the means of the indices across these periods.

Figure 4: Configuration of the Trilemma Objectives and International Reserves



(c) Thailand



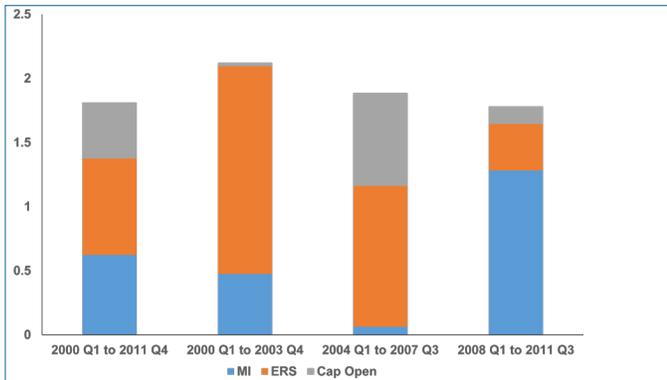
Source: Authors' estimates.

Next, the validity of the trilemma framework is examined by testing whether the weighted sum of the three trilemma policy variables adds up to a constant, here set to be 2. The results are given in Table 6.² The relationship is estimated for the entire period (2000 Q1 to 2011 Q4), as well as for the three sub-periods. While the estimates for exchange rate stability and capital account openness are significant across all the specifications, it is not the case with monetary independence.

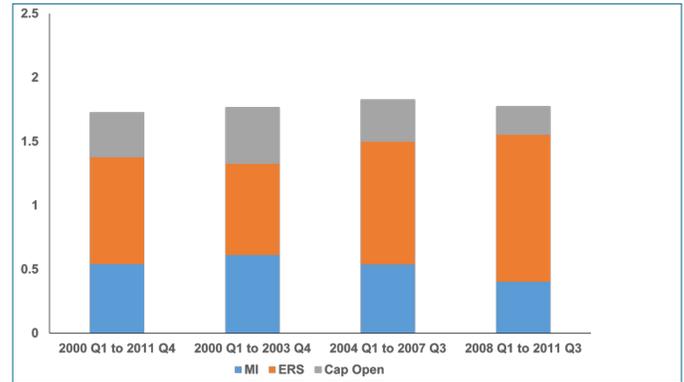
To obtain the contribution of each trilemma policy orientation the coefficients are multiplied with the average for each phase. The results are outlined in Figure 5.

Figure 5: Configuration of the Trilemma Objectives and International Reserves

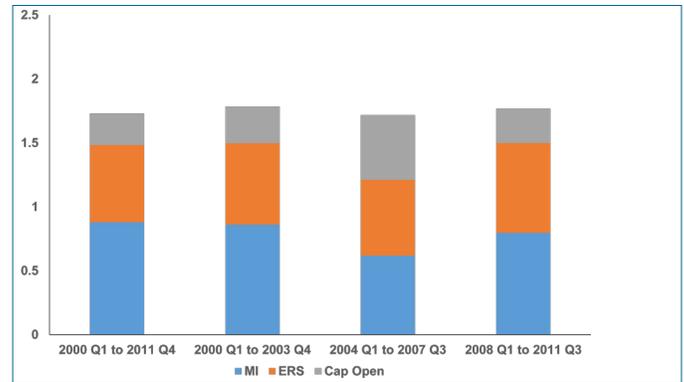
(a) India



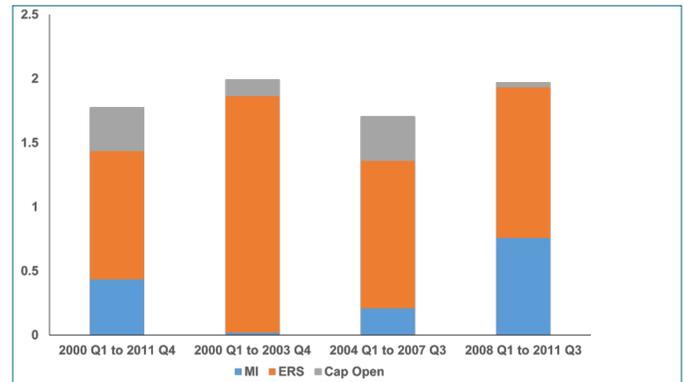
(b) Indonesia



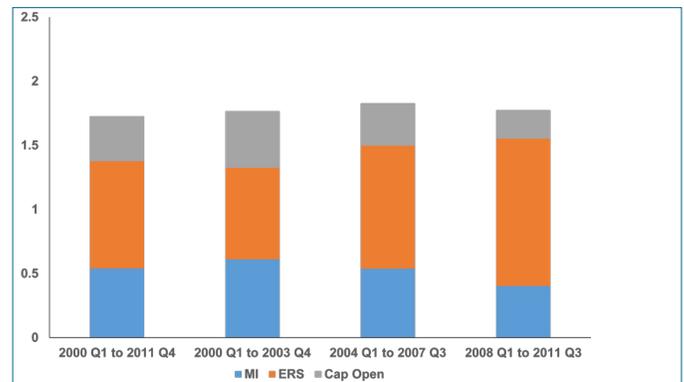
(c) Korea



(d) Malaysia



(e) Thailand



Source: Authors' estimates.

2 If the trilemma is indeed binding, then a country that chooses to implement any two of the three policy objectives perfectly will have to completely forego the third objective. Hence, in the analysis where all the trilemma objectives are normalized to lie between 0 and 1, the maximum combined value of the trilemma indices is 2.

In Malaysia and India, capital account openness witnessed an increase in Period 2, helped by loose global liquidity and strong domestic macro fundamentals. However, the GFC, followed by the sovereign debt crisis in Europe and deterioration in domestic macro indicators, led to a slump in capital flows in Period 3. Both these economies put greater emphasis on monetary independence across the periods. While in India the weight on monetary independence increased from 22.4 percent in Period 1 to more than 70 percent in Period 3 as monetary policy was calibrated to manage domestic inflationary pressures, in Malaysia it increased from one percent to 38 percent. Both these economies significantly reduced the weight on exchange rate stability to manage the trilemma. In Malaysia, the weight declined from 92.6 percent in Period 1, when the ringgit was pegged to the US dollar, the weight on exchange rate stability declined to below 60 percent in Period 3, while in India it dropped from 76.3 percent to 20.3 percent.

By contrast, in Indonesia policy makers imparted greater weight to exchange rate over time with a view to retain competitiveness, despite BI's committing to an inflation targeting framework in 2005. The dichotomy between monetary and exchange rate management was achieved through BI's intervention in the foreign exchange market to keep its exchange rate near what the central bank perceived to be equilibrium. This is evidenced from the Δ Res index, which is highest for Indonesia among the five EAEs. This was associated with a declining weight on monetary independence across the period. In Thailand, there was a decline in the weight given to exchange rate stability in Period 2 compared to Period 1, but the weight assigned to exchange rate stability increased considerably thereafter. These shifts were offset by weights on monetary independence moving in the opposite directions. While the weight on capital account openness declined over time in Indonesia, it remained fairly constant in Thailand.

Finally, Korea has consistently put the highest weight on monetary independence, followed by exchange rate stability. There was some decline in the emphasis given to monetary independence in Period 2, when the economy experienced a rush of capital inflows prior to the GFC, resulting in an increase in capital account openness. The emphasis on exchange rate stability was fairly consistent across the periods.

Thus, the five EAEs negotiated the trilemma in very different manners as they were confronted with rising and volatile capital flows. Instead of adopting the extreme solutions, all five EAEs adopted an intermediate approach in negotiating the conflicting approaches of the trilemma. While India and Malaysia chose to sacrifice exchange rate stability in more recent years to have greater freedom to exercise monetary policy, Indonesia and Thailand put greater emphasis on managing the exchange rate at the cost of monetary policy. Korea has remained fairly consistent in managing the trilemma, focusing on monetary independence followed by exchange rate stability.

Sterilized Intervention

One of the most commonly used instruments to counter a surge in capital flows is sterilized intervention. This involves the central bank intervening in the foreign exchange market to resist an appreciation of the domestic currency, and then exchanging domestic assets with foreign assets to neutralize the increase in monetary base due to the intervention. Carmen Reinhart and Vincent Reinhart (1998) refer to sterilized intervention as the “policy of first recourse.”

The central banks of the five EAEs also resorted to intervention in the face of surges in inflows. The surge episodes identified in Table 1 were associated with significant accumulation of reserves. Focusing on the episodes during the 2000s, Table 2 indicates the extent of reserve accumulation or decumulation during these episodes.³ All the surge episodes were associated with accumulation of reserves. While India had built 78 percent of its end-2011 reserve holdings during these surge episodes, Indonesia and Thailand accumulated 39.5 percent and 26.7 percent of their reserves during such episodes.

Table 2 shows that the stop episodes were not universally associated with depletion of reserves. In fact, the EAEs used reserves to counter the stop of capital inflow in only four out of the eight stop episodes. This raises a question as to whether the EAE central banks have been intervening in an asymmetric manner in the foreign exchange market (i.e., accumulating reserves during surges of capital flows to stem appreciation of the domestic currency), but adopting a hands-off approach during stops of capital flows and allowing the currency to depreciate. The plausible reasons for central banks to pursue such an asymmetric intervention policy could either be adherence to a mercantilist approach of keeping exchange rates depreciated in order to promote exports, or the fear of losing international reserves that are now considered a crucial indicator of the overall macroeconomic stability of a country. In order to empirically investigate this, a loss function of the central bank is modelled following Victor Pontines and Ramkishan S. Rajan (2011) and Abhijit Sen Gupta and Rajeswari Sengupta (2014), and generalized method of moments (GMM) methodology is used to estimate the asymmetric preference parameter for the EAEs for the period from 2000 to 2011. Details of the model, estimation strategy and results are described in Section A.3 in the Appendix. The parameter θ indicates the extent of asymmetric intervention in the foreign exchange market. The results, outlined in Table 3, indicate across all five EAEs that central banks intervened asymmetrically in the foreign exchange market.

3 Data on actual intervention by the central bank would be a better indicator to exclude valuation change; however, such data is not available for all the economies in our sample. Hence, we use the change in reserves as a proxy for intervention.

Table 2: Reserve Accumulation During Surge and Stop Episodes

	Surge				Stop			
	Episode		Reserve Accumulation		Episode		Reserve Accumulation	
	Start	End	Growth (%)	Absolute (\$ Billion)	Start	End	Growth (%)	Absolute (\$ Billion)
India	2003 Q3	2004 Q2	45.2	35.93	2008 Q3	2009 Q3	-10.6	-32.02
	2004 Q4	2005 Q3	19.9	22.96				
	2006 Q4	2008 Q2	90.4	143.77				
	2010 Q1	2010 Q4	3.8	10.09				
Indonesia	2005 Q4	2006 Q1	32.8	9.47	2006 Q4	2007 Q1	11.9	4.84
	2010 Q4	2011 Q2	39.1	32.64	2009 Q1	2009 Q3	20.9	10.38
Korea					2008 Q1	2009 Q2	-11.6	-30.49
Malaysia					2005 Q4	2006 Q3	-0.5	-0.44
					2008 Q3	2009 Q2	-27.4	-34.33
Thailand	2004 Q3	2006 Q1	27.1	11.45	2007 Q1	2007 Q4	30.5	19.93
	2010 Q3	2011 Q1	23.1	33.15	2008 Q3	2009 Q3	25.1	25.90

Data sources: IMF's International Financial Statistics and authors' estimates.

Table 3: Extent of Asymmetric Intervention in EAEs

	India	Indonesia	Korea	Malaysia	Thailand
β_0	2.112*** [18.964]	1.137*** [11.939]	1.021*** [16.156]	2.176*** [22.499]	0.846*** [9.476]
β_1	-0.419*** [-9.997]	-0.357*** [-11.403]	-0.425*** [-14.106]	-1.169*** [-21.311]	-0.772*** [-15.443]
β_2	-0.205*** [-9.934]	-0.014*** [-4.307]	-0.027*** [-6.359]	-0.864*** [-22.753]	-0.124** [2.348]
θ	0.978***	0.078***	0.127***	1.478***	0.321**
Number of Observations	128	128	128	128	128

Source: Authors' estimates. NOTES: Robust t-statistics in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.

The asymmetric intervention resulted in the central banks acquiring significant volumes of foreign assets, which threatened to disrupt the monetary base. Central banks sought to limit the impact on the monetary base by sterilizing these interventions, albeit with varying results. The Reserve Bank of India (RBI) initially conducted open market sales of government securities to neutralize the effect of reserve accretion on the monetary base. However, by the end of 2003, the RBI had exhausted its stock of government securities, and in January 2004 introduced the Market Stabilization Scheme (MSS) bonds. As a share of GDP, outstanding MSS bonds reached a peak of nearly four percent in 2007. However, during the GFC, the amount of outstanding MSS bonds was drawn down rapidly to inject liquidity. Apart from these bonds, the RBI also raised the reserve requirements to restrain the expansion of money supply.

Korea also used its central bank's own Monetary Stabilization Bonds (MSBs) to offset the impact of intervention in the

foreign exchange market. However, a rising stock of MSBs due to several years of intervention made these interventions more and more costly. The Korean government assisted in the sterilization of the capital inflows by selling the government securities and depositing the proceeds with the Bank of Korea (BOK). The ratio of outstanding MSBs to GDP reached a peak of 20 percent in 2005 before declining to around 11 percent in 2011. Like the RBI in India, the BOK also raised reserve requirements for the commercial banks to contain the growth in money supply.

Indonesia also attempted to sterilize its interventions in the foreign currency market. It used the one-month and three-month BI certificates (Bank Sentral Republik Indonesia certificates or SBIs) to sterilize the interventions. However, the high interest rate on these SBIs made them an attractive instrument, especially as non-residents were allowed to invest in SBIs. Thus, sterilized intervention in Indonesia resulted in attracting more portfolio inflows. The share of central bank securities to GDP reached a peak of two percent in 2007. However, during the GFC, the stock of these bonds were quickly drawn down. In 2010 and 2011 there was again some increase in issuance of such bonds.

Both Malaysia and Thailand resorted to a number of instruments for liquidity management. Massive inflow of foreign capital through portfolio investment also necessitated Bank Negara Malaysia conducting sterilization to prevent inflationary pressures. In Malaysia, the interventions were sterilized using direct borrowing, repos (repurchase agreements) and the issuance of Bank Negara Monetary Notes. As a share of GDP, the volume of outstanding central bank securities reached a peak of 13 percent just before the onset of the GFC. As in most other EAEs, in Malaysia there was a decline in the ratio during

the GFC, before a sharp increase in 2010 and 2011 to pre-crisis peak levels.

The Bank of Thailand (BOT) had also been intervening in the foreign exchange market intensively during the 2000s to resist appreciation of the domestic currency. The principal absorption instrument used by Thailand is the BOT bond. Thailand used these bonds along with repo transactions and foreign exchange swaps to manage overall liquidity. The stock of central bank securities has steadily increased as a share of GDP and stood close to 10 percent in 2011.

Capital Controls and Impact

One of the most common macroeconomic policy tools to deal with surges in capital inflows is imposing capital controls, for example, residency-based restrictions on the cross-border movement of capital. In recent times emerging economies have begun using controls — both on inflows and outflows — to manage volatile and potentially disruptive capital flows. The recent GFC has been a turning point in the world view on capital controls, just as a similar reassessment was done in the aftermath of the AFC of 1997-1998. The issue of regulation of capital flows has slowly but steadily moved to the centre stage from earlier being confined to the periphery of mainstream policy discourse. *Ex ante* management of capital flows is now accepted as a legitimate instrument of countries' macroeconomic policy tool kits. The IMF, at one time a proponent of complete liberalization of the capital account, has also shifted in favour of the idea that capital controls can be useful as a last resort when a country faces a net capital inflow surge and after other macroeconomic policy options have been exhausted (Ostry et al. 2011). The IMF position (Ostry et al. 2010a) goes further in suggesting that capital controls be used in the pursuit of macroeconomic management. The impact of controls on the magnitude and composition of capital flows, on transactional frictions, monetary policy, rates in different financial markets, asset prices, etc., have been a subject of enormous debate with very little consensus on the issue. Effectiveness of capital controls varies with initial conditions as well as across countries and time periods. To the extent that there are country-specific characteristics that make capital controls effective, understanding individual country experiences with capital controls gains significance (Patnaik and Shah 2012).

There was significant heterogeneity across the four Southeast Asian EAEs in their policy responses to the AFC of 1997-1998. While Malaysia imposed a series of comprehensive capital controls on short-term capital inflows as well as outflows, and pegged the ringgit to the US dollar, Korea went to the other extreme by lifting various capital account and foreign exchange restrictions in a "big-bang" move, thereby taking the capital account openness of the country to the same level as that of advanced economies.

In Malaysia, the capital controls introduced after the AFC were progressively relaxed and eventually removed by the early 2000s, and the transition was made to a managed floating exchange rate regime by July 2005 (Athukorala and Jongwanich 2012). Over the next several years, the central bank further liberalized restrictions on capital flows. In 2004, residents with foreign currency funds were allowed to invest in any foreign currency product offered by onshore licensed banks and the limit for banking institutions on loans to non-residents was raised five-fold. In 2005, another series of outflow controls was relaxed. Residents could invest abroad in foreign currency and those with domestic credit facilities were permitted to convert ringgit, up to RM 100,000 per annum. Corporations were allowed to convert ringgit up to RM 10 million per annum for investment in foreign currency assets. Residents were also free to open a foreign currency account onshore or offshore, without any prior permission and with no limit on the amount of foreign currency funds to be retained (*ibid.*).

In contrast, Korea adopted measures to completely liberalize capital flows. The extensive capital market opening undertaken by the Korean government resulted in inflows increasing significantly from 1999 onward. In the early 2000s, there was a surge in short-term borrowing by foreign banks and in 2003, foreign investment in the domestic stock market reached a record high of \$14.4 billion (Kim and Yang 2012). In order to mitigate the adverse impact of the massive inflows of short-term capital, the Korean government liberalized capital outflows. In 2006, for instance, the limit on outward FDI by domestic residents was relaxed to include purchase of real estate and, in 2007, a temporary tax exemption for three years was applied to capital gains generated from overseas stock investment by domestic companies.

Along somewhat similar lines, Indonesia, instead of adopting strict capital controls to counter the capital flight during the AFC, relaxed restrictions on FDI inflows and shifted to a managed floating exchange rate regime. Until the mid-2000s, the country was experiencing major macroeconomic turbulence, persistent capital outflows, high currency volatility and inflationary pressures. From the mid-2000s, favourable changes in the political climate and reforms in financial and banking institutions triggered a process of economic recovery (Jayasuriya and Chen-Yu Leu 2012) and capital inflows began increasing.

Several measures were adopted to check the influx of short-term capital flows. In 2004, the BI introduced new prudential regulations on net open foreign exchange positions of commercial banks, which hindered their ability to speculate in the swap market. Around the same time, deposit accounts in rupiah were subjected to reserve requirements. In 2005 Q1, short-term borrowings by banks were limited to 20 percent of bank capital. Once the economy recovered from the initial shock of the GFC in 2008-2009, large portfolio inflows resumed again; excessive short-term inflows resulted in real exchange rate

appreciation. Indonesia experienced a second surge episode in 2010 Q4. Once again, restrictions were imposed on speculative transactions, and new capital controls (prudential regulations) were introduced to redirect the inflows toward longer-maturity assets (*ibid.*).

Like other EAEs, Thailand also experienced a surge in capital inflows in the mid-2000s. A fairly long surge episode was recorded starting in 2004, and there was a noticeable appreciation of the Thai baht. The BOT announced a series of controls to curb speculative capital inflows, primarily in debt securities. When, in spite of these measures, short-term inflows continued unabated and appreciation pressures on the Thai baht still did not subside, the BOT implemented a market-based restriction in December 2006. This involved a requirement to deposit 30 percent of foreign exchange as an unremunerated reserve requirement (URR) for most foreign transactions. If funds remained within Thailand for one year, then the full amount of capital would be refunded; if funds were repatriated earlier, only two-thirds would be refunded. Imposition of the URR immediately caused panic among foreign investors, and a stop episode was recorded in 2007 Q1. With capital inflows reacting adversely to the URR imposition, foreign capital inflows were increasingly exempted from the URR and eventually, in March 2008, the URR measures were lifted (Jongwanich and Kohpaiboon 2012). During the early and mid-2000s, capital outflows were also progressively liberalized in FDI, equity and debt, in order to promote domestic residents' foreign investments, open up alternative investment opportunities and ease the rising appreciation pressure on the baht. The relaxation of outflow controls continued during the GFC as well as after the crisis.

India had a complex and extensive system of administrative controls to deal with volatile capital flows. During the last two decades India followed a gradual approach toward financial integration with the rest of the world, prioritizing non-debt-creating flows such as portfolio investment flows over debt flows (Sen Gupta and Sengupta 2014). When emerging economies witnessed a capital surge in the 2000s, India received among the highest capital inflows, recording three surge episodes in the run-up to the GFC. Abdul Abiad, Enrica Detragiache and Thierry Tresselt (2010) show that restrictions on the capital account were eased between 1999 and 2004, although since then the process of liberalization seems to have slowed down (Patnaik and Shah 2012). While controls on capital outflows were eased after 2006, restrictions on inflows were further tightened, especially after the third surge episode was recorded in 2006 Q4. These took the form of a reduction in the ceiling on interest rates on non-resident bank deposits, restriction on portfolio investment inflows by banning “participatory notes,” and prohibiting external commercial borrowings by real estate companies and reducing the interest rate ceiling on such borrowings.

To formally assess the impact of capital controls on the exchange rate and stock market, a means comparison test is undertaken before and after the introduction of capital controls. This involves comparing the means of the variables before and after the introduction of controls. In particular, the impact on movements in exchange rate and stock prices is evaluated, as controls are meant to restrain appreciation of the domestic currency and increase in asset prices. To be deemed effective, these measures must reverse or at least slow down the rate of appreciation and increase in stock prices observed prior to their introduction.

This paper focuses on four selected measures aimed to curb inflow of foreign capital. These include:

- India — Restrictions on “participatory notes” were introduced in October 2007 to curb portfolio investment inflows. These are over-the-counter derivatives sold by a registered foreign institutional investment firm to an investor who is not registered (Patnaik and Shah 2012).
- Indonesia — The required holding period on foreign capital inflows and central bank notes in July 2010 was increased to one month, and central bank instruments with longer maturity of six months and nine months were introduced (Magud, Reinhart and Rogoff 2013).
- Korea — In August 2007 the government restricted the use of foreign borrowings by allowing such funds only for real demand and investment in the manufacturing sector (Kim and Yang 2012).
- Thailand — In December 2006, the BOT required all foreign transactions — barring those related to trade in goods and services, repatriation of investment abroad by residents, and FDI — to deposit 30 percent of foreign exchange with the BOT as URR. If these funds remained within Thailand for one year, 30 percent of capital was refunded. If funds were repatriated before a year, only two-thirds of the amount was refunded (Jongwanich and Kohpaiboon 2012).

Table 4 highlights the efficacy of the capital controls in restricting exchange rate appreciation and stock price increase. To evaluate the short-term and longer-term effects of these measures, the difference in average rates of daily currency appreciation and stock price increase is evaluated, using the mean-comparison test during one month, as well as six months before and after the imposition of these measures.

Table 4: Testing the Validity of the Trilemma Framework

	Exchange Rate					
	One Month			Six Months		
	Before	After	Difference	Before	After	Difference
India (October 2007)	0.169%	-0.101%	0.179%*	0.591%	-0.013%	0.023%
			[1.652]			[1.546]
Indonesia (July 2010)	0.123%	0.043%	0.080%	0.029%	0.006%	0.023%
			[0.551]			[0.355]
Korea (July 2007)	0.073%	-0.123%	0.195%**	0.019%	-0.028%	0.047%
			[1.832]			[1.255]
Thailand (December 2006)	0.174%	0.003%	0.171%	0.069%	0.077%	-0.008%
			[0.847]			[-0.076]
	Stock Market					
	One Month			Six Months		
	Before	After	Difference	Before	After	Difference
India (October 2007)	1.050%	-0.066%	1.116%*	0.269%	-0.089%	0.358%
			[1.793]			[1.494]
Indonesia (July 2010)	0.274%	0.111%	0.163%	0.107%	0.222%	-0.115%
			[0.581]			[-0.711]
Korea (July 2007)	0.632%	-0.494%	1.123%*	0.304%	-0.119%	0.423%**
			[1.692]			[2.218]
Thailand (December 2006)						

Source: Authors' calculations. NOTES: Robust t-statistics in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% respectively.

In the short term there is some evidence for the efficacy of capital controls in restraining exchange rate appreciation in India and Korea. The trend of exchange rate appreciation prior to the imposition of the control was reversed after the measures were introduced. However, no such evidence is forthcoming in Thailand and Indonesia. Moreover, when the window is extended to six months, there is no significant difference in exchange rate movements before and after the imposition of these measures. Again, in both India and Korea, the measures reversed the trend of stock price increases over a window of one month. However, when the period under study is increased to six months, the difference is significant only in the case of Korea.

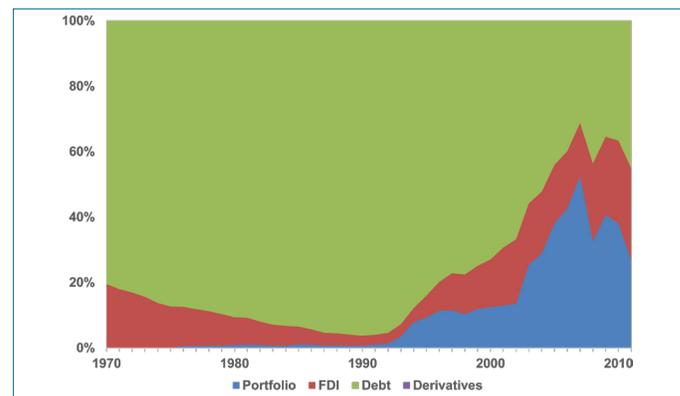
Thus, by and large for these five EAEs, while capital controls did not succeed in controlling surge episodes, once the surge was recorded and new capital controls were implemented, there

was moderate success in lowering the volume of gross inflows in some cases, such as in Thailand and Indonesia, but the success was not evident in other cases. Moreover, these controls reversed the trend of strengthening currency and rising stock prices only in a couple of countries. Furthermore, the effect lasted only for a short time and disappeared over a longer horizon.

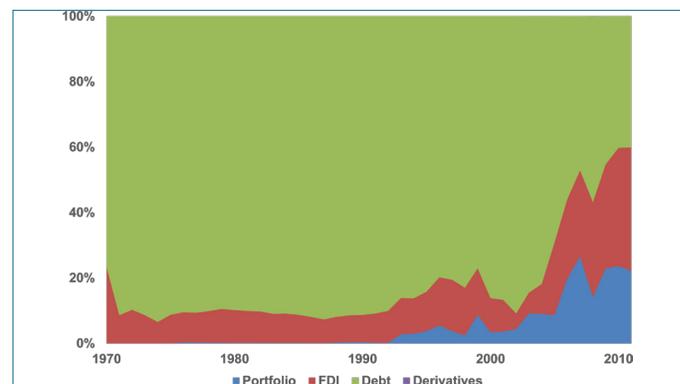
The limited success of capital controls is in line with other studies, such as Forbes and Warnock (2012), which conclude that controls on inflows do not significantly affect surges of gross capital inflows. These findings are also consistent with Michael W. Klein (2012), who finds that episodic capital controls (“gates”) have limited impact in reducing financial vulnerabilities and moderating exchange rate appreciations, while long-standing capital controls (“walls”) may have some effect. Figure 6 highlights the change in composition of liabilities over the past four decades. Barring Malaysia, in all the other EAEs, in the 1970s and 1980s, an overwhelming flow of foreign capital took the form of debt flows.

Figure 6: Composition of External Liabilities

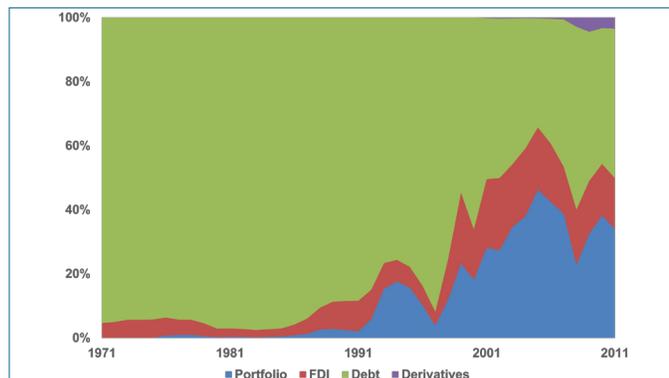
(a) India



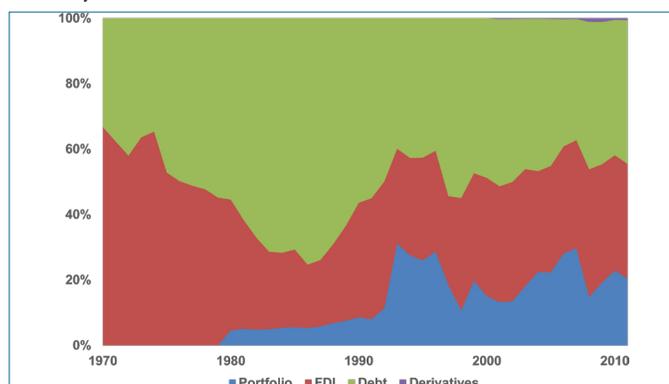
(b) Indonesia



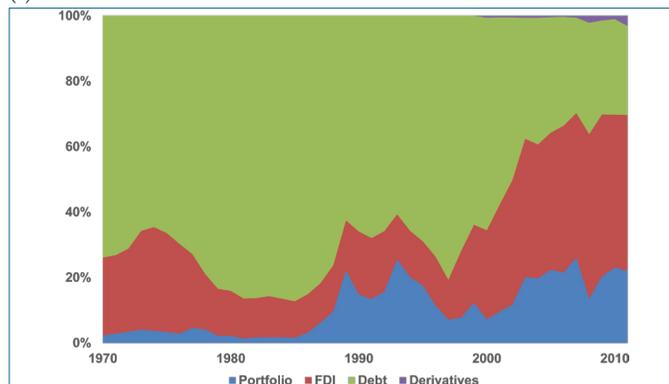
(c) Korea



(d) Malaysia



(e) Thailand



Source: Authors' estimates.

However, the subsequent liberalization of capital flows involved dismantling the walls in a manner consistent with the “pecking order” of capital flows.⁴ Table 5 highlights the evolution of capital controls across the five EAEs.⁵ Across most of these EAEs, walls on FDI inflows were liberalized the most, followed

by equities. Debt flows continued to be restricted across most of these EAEs, and in some instances there was an increase in restrictions on debt flows in recent years. This prioritization of liberalization of capital flows clearly had an impact on the composition of liabilities highlighted in Figure 6.

Table 5: Controls on Types of Capital Flows

	Debt Inflows	Equity Inflows	FDI Inflows
1997	0.55	0.77	0.57
2000	0.42	0.60	0.50
2003	0.58	0.60	0.50
2006	0.67	0.60	0.57
2009	0.68	0.60	0.53
2012	0.70	0.60	0.53

Source: Based on data from Fernandez et al. (2014). NOTES: The intensity of controls is based on information provided in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. The narrative description in the report is used to determine whether there are restrictions on international transactions, with 1 representing the presence of a restriction and 0 representing no restriction. Each value represents the average over the past three years.

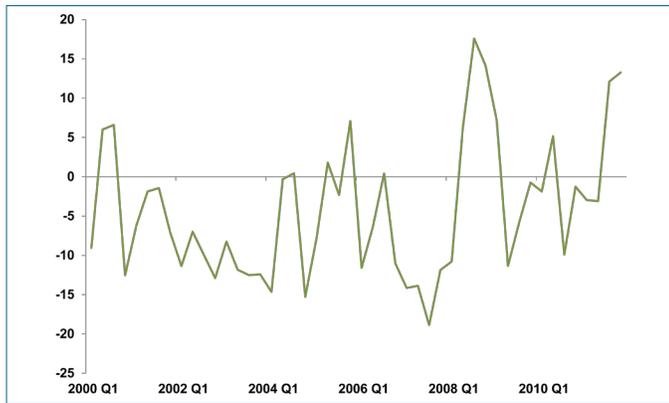
Finally, this paper focuses on the evolution of the Exchange Market Pressure Index (EMPI) in these five EAEs. A central bank's management of capital account could be driven by a desire to moderate certain types of capital inflows or to manage exchange rate stability. In the context of the trilemma tradeoffs faced by these EAEs during the period under consideration, it may be reasonable to conjecture that the goal was the latter. Accordingly in this section we measure the exchange market pressure (EMP) for all five EAEs, and discuss the evolution of the series over time. EMP is a combination of exchange rate depreciation and international reserves loss — a concept pioneered by Lance Gorton and Don Roper (1977), and applied frequently in the analysis of EMEs (Frankel 2009). A positive (negative) EMP indicates a net excess demand (supply) for foreign currency, accompanied by a combination of reserve loss (gain) and currency depreciation (appreciation). In order to measure EMP, we follow the methodology of Joshua Aizenman, Jaewoo Lee and Vladyslav Sushko (2012), who investigate the factors explaining EMP in emerging markets during the 2000s. The simplest measure of EMP is the unweighted sum of percentage nominal depreciation and percentage loss of reserves. For this we use the nominal bilateral exchange rate of each country against the US dollar and international reserves, minus gold. Figure 7 shows the evolution of the EMP series in each of the five EAEs from 2000 to 2011.

4 Ostry et al. (2010b) prescribes a pecking order of capital flows in decreasing order of riskiness, with short-term instruments being more risky than long-term instruments. According to this approach, FDI inflows are the least risky flows, followed by portfolio equity investment inflows, local currency debt inflows, and consumer price indexed debt inflows. Foreign currency debt inflows are categorized as the most risky class of assets.

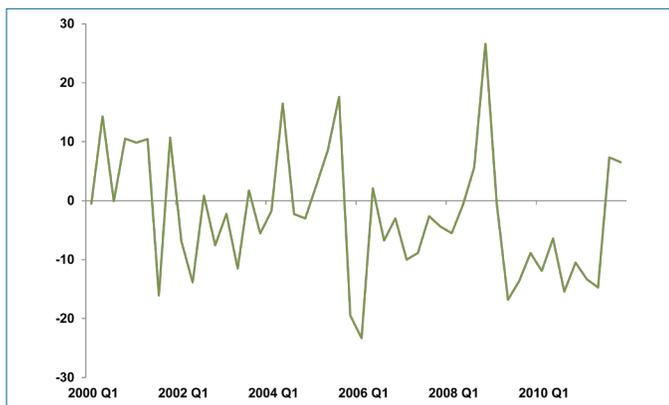
5 We are grateful to Michael W. Klein for providing us the data.

Figure 7: Exchange Market Pressure Indices

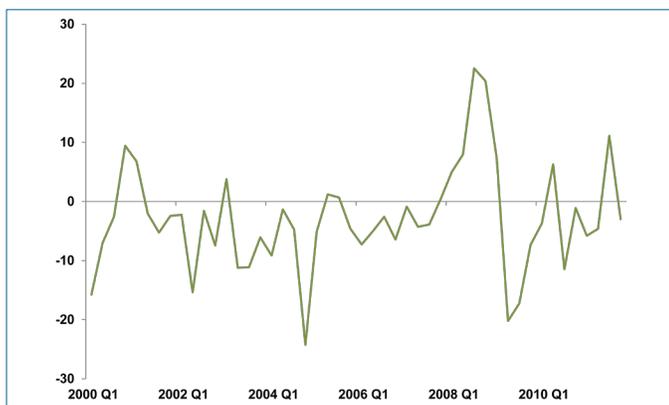
(a) India



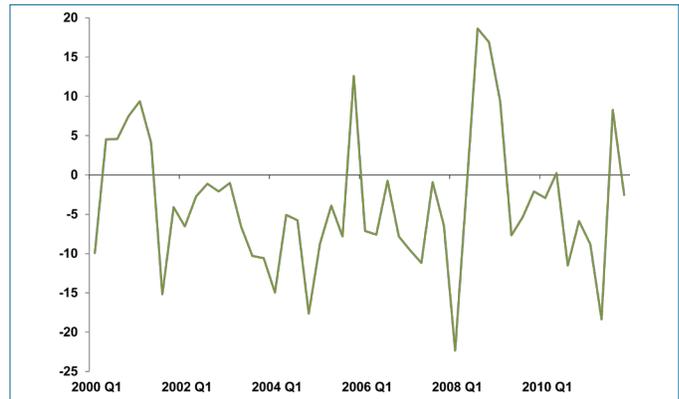
(b) Indonesia



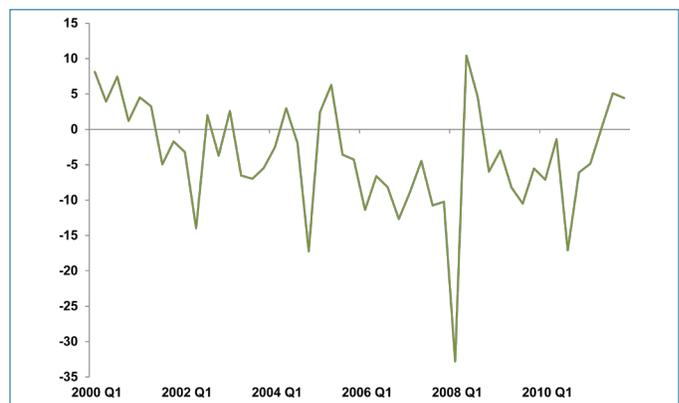
(c) Korea



(d) Malaysia



(e) Thailand



Source: Authors' estimates.

The crisis and post-crisis trends in EMP between 2008 Q3 and 2011 Q4 are quite similar across the countries in our sample. For instance, the EMP series of Korea is very similar to that of India, reflecting the common phenomenon these economies experienced during the first decade of the 2000s. Their negative EMP implies net excess supply of foreign currency, consistent with a surge in capital inflows experienced by the economies during this period, accompanied by exchange rate appreciation and a remarkable rise in the stock of international reserves. In the case of all the EAEs, this trend was interrupted by the GFC and the associated worldwide liquidity crunch, worsening risk perceptions and capital flight, all of which resulted in a sharp upward movement in the EMP index. Once the economies recovered from the initial shock, capital inflows resumed and the EMP improved somewhat until the domestic currencies came under renewed strains owing to the euro-zone crisis toward the end of our sample period. Thus, one could say that even though some of these EAEs experimented with capital controls from time to time to prevent capital inflow surges, the impact of these controls on the EMP index was hardly significant. The EMP indices of all five EAEs display a remarkably symmetric trend during this time period.

Conclusion

Gross capital inflows and outflows to and from EMEs have witnessed a significant increase since the early 2000s. This rapid increase in the volume of flows, accompanied by sharp swings in volatility, has amplified the complexity of macroeconomic management in EMEs. While capital inflows provide additional financing for productive investment and offer avenues for risk diversification, unbridled and volatile flows could also inflate asset price bubbles and lead to exchange rate overshooting (contributing to financial fragilities), and pose serious macroeconomic challenges.

This paper focuses on five major EAs, and evaluates the role and effectiveness of the various measures and policies implemented by these countries to manage capital flow surges and stops over the period 2000–2011. The analysis reveals that countries are bound by the trilemma, and have managed it by juggling the competing policy objectives to meet macroeconomic demands. Management of the trilemma has been accompanied by asymmetric intervention in the foreign exchange market, and sterilization of the intervention. This has helped economies to resist appreciation to protect their exports as well as retain monetary independence. Finally, capital controls imposed in response to a surge episode in capital inflows, or relaxed in response to a stop episode, are unlikely to be effective in achieving their purpose. On the other hand, when controls are imposed *ex ante* in a more systematic manner in order to restrict certain kinds of flows, irrespective of surge episodes, they succeed in altering the composition of capital flows. This kind of analysis is highly relevant, especially at a time when EMEs are about to face the repercussions of a potential monetary policy normalization in the United States and continuing QE measures by the European Central Bank, either or a combination of which could exacerbate the volatility of cross-border capital flows, thereby resulting in renewed complexities in macroeconomic management in major EMEs.

Appendix

A.1 Computing Surge and Stop Episodes

Let C_t be the four-quarter moving sum of gross capital inflows (GINFLOW), and compute annual year over year changes in C_t . Thus

$$C_t = \sum_{i=0}^3 \text{GINFLOW}_{t-i} \quad (1)$$

and $\Delta C_t = C_t - C_{t-4}$. Next, we compute the rolling means and standard deviations of ΔC_t over the last five years. Forbes and Warnock (2012) identify a surge as an episode that starts in the month when ΔC_t increases more than one standard deviation above its rolling mean. The episode ends once ΔC_t falls below one standard deviation above its mean. Similarly, a stop episode covers the period when gross inflows decline one standard deviation below its mean. Furthermore, for the period to qualify as a surge episode, there must be at least one quarter when ΔC_t increases by a minimum of two standard deviations above its rolling mean. Similarly, a stop episode is defined as the period over which gross capital inflows fall one standard deviation below its rolling mean, and provided it reaches two standard deviations below at some time during the period.

A.2 Computing Trilemma Indices

Monetary Independence: The extent of monetary independence is measured as the inverse of the quarterly correlation of the interest rates between EAEs and their base country. Here, the base country is defined as the country that a home country's monetary policy is most closely linked with. Aizenman, Lee and Sushko (2010) indicate that the base country for all five EAEs is the United States. The quarterly indices are calculated using weekly three-month Treasury bill yields for India and the United States. The index of monetary independence is given by

$$MI = 1 - \frac{\text{corr}(i_j, i^{US}) - (-1)}{1 - (-1)} \quad (2)$$

where i_j refers to the interest rate prevailing in the EAEs, i^{US} refers to the US interest rates and $\text{corr}(i_j, i^*)$, refers to the correlation of these interest rates over a quarter, and provides evidence on co-movement of domestic and foreign interest rates. By definition, $\text{corr}(i_j, i^{US})$, can take a maximum value of +1 and a minimum value of -1. Thus the monetary independence index can theoretically take a value between 0 and 1 with a higher value indicating a greater degree of monetary independence.

Exchange Rate Stability: We make use of the methodology introduced by Jeffrey A. Frankel and Shang-Jin Wei (1994) to create an index of exchange rate stability. The degree of influence that major global currencies have on the Indian rupee can be estimated using the following estimation model:

$$\Delta \log \epsilon_{j,t}^{SDR} = \alpha_0 + \beta_{j,USD} \Delta \log \epsilon_{USD,t}^{SDR} + \beta_{j,EUR} \Delta \log \epsilon_{EUR,t}^{SDR} + \beta_{j,JPY} \Delta \log \epsilon_{JPY,t}^{SDR} + \nu_t \quad (3)$$

where $\epsilon_{j,t}^{SDR}$ is the value of the five EAEs' currency j against the numeraire currency, which in this case is the IMF's Special Drawing Rights. The three major global currencies — the US dollar, Japanese yen and the euro — can be viewed as making up the implicit currency basket, which the different EAEs are targeting to a different degree. Here $\hat{\beta}_{j,k}$ where $k = \text{USD, EUR and JPY}$ (which is the estimated coefficient on the rate of change in the exchange rate for major global currency), represents the weight of currency k in the implicit basket. In the case where the EAE currency is pegged to a particular currency or a basket of currencies, either $\hat{\beta}_{j,k}=1$ or $\sum_{k=1}^K \hat{\beta}_{j,k}=1$ for K currencies that are a part of the basket. Moreover, pegging to an individual currency or a basket of currencies implies a higher goodness of fit. The estimation is applied over a quarter and the goodness of fit, or the adjusted R^2 , is taken as the measure of exchange rate stability. A higher R^2 indicates greater pegging to an individual currency or a basket of currencies.

Capital Account Openness: A de facto measure of capital account openness is employed as it is the actual volume of flows that creates a conflict between monetary independence and exchange rate stability, as opposed to controls governing the movement of capital. A country with high de jure openness can have low capital flows and hence can simultaneously stabilize the exchange rate and retain monetary autonomy. Alternatively, a country with low de jure openness can experience large flows due to low enforcement of controls, and face a trade-off between ensuring monetary independence and exchange rate stability. Hence, the index is based on net capital flows. The index is constructed as the ratio of absolute value of net capital flows to GDP. The index is normalized to lie between 0 and 1.

$$CapOpen = \frac{|NKF|}{GDP} \quad (4)$$

Finally, policy makers can garner greater flexibility vis-à-vis monetary and exchange rate management in the short run by accumulating or depleting reserves. Consequently, ΔRes , the absolute change in reserves (as a share of GDP) is also computed, and normalized to lie between 0 and 1.

A.2.1 Testing the Validity of the Trilemma Framework

$$2 = \alpha MI_t + \beta ERS_t = \gamma CapOpen_t + \mu_t \quad (5)$$

Table 6: Testing the Validity of the Trilemma Framework

	2000 Q1 to 2011 Q4	2000 Q1 to 2003 Q4	2004 Q1 to 2007 Q4	2008 Q1 to 2011 Q4
India				
Monetary Independence	1.174*** [3.560]	1.055* [1.774]	0.115* [1.661]	2.159*** [3.645]
Exchange Rate Stability	1.439*** [7.608]	1.880*** [12.002]	2.250*** [6.458]	1.662 [0.892]
Capital Account Openness	1.512*** [3.065]	0.145*** [1.993]	1.844*** [3.472]	0.484 [0.545]
Observations	48	16	16	16
R-squared	0.906	0.983	0.943	0.891
Indonesia				
Monetary Independence	1.003*** [4.687]	0.957*** [2.302]	1.321*** [5.106]	0.703* [1.785]
Exchange Rate Stability	1.989*** [8.557]	2.372*** [6.803]	2.685*** [4.885]	1.909*** [4.204]
Capital Account Openness	1.026*** [3.538]	1.073* [2.088]	1.250** [2.518]	0.642* [1.887]
Observations	48	16	16	16
R-squared	0.863	0.883	0.914	0.887
Korea				
Monetary Independence	1.809*** [8.006]	1.983*** [5.536]	1.239* [1.699]	1.514*** [3.669]
Exchange Rate Stability	1.618*** [5.041]	1.349** [2.896]	1.422* [1.775]	3.058** [2.446]
Capital Account Openness	2.204*** [4.780]	3.459** [2.770]	5.631** [2.242]	1.641*** [6.942]
Observations	48	16	16	16
R-squared	0.865	0.892	0.859	0.884
Malaysia				
Monetary Independence	1.013*** [4.712]	0.047* [1.677]	0.638* [1.764]	1.362*** [9.250]
Exchange Rate Stability	1.535*** [12.049]	1.885*** [20.586]	1.679*** [4.766]	4.012*** [6.859]
Capital Account Openness	1.547*** [4.178]	0.807* [1.743]	1.705** [1.987]	0.134* [1.738]
Observations	48	16	16	16
R-squared	0.888	0.996	0.852	0.946
Thailand				
Monetary Independence	1.039*** [3.788]	0.765* [1.709]	1.812*** [4.836]	0.792* [1.795]
Exchange Rate Stability	1.901*** [11.268]	1.644*** [7.111]	1.314** [2.944]	1.909*** [6.627]
Capital Account Openness	1.445*** [4.335]	1.533*** [3.076]	2.525*** [3.854]	1.044 [1.755]
Observations	48	16	16	16
R-squared	0.882	0.938	0.865	0.912

Source: Authors' calculations. NOTES: Standard errors in parentheses. *, ** and *** indicate correlations significant at 10%, 5% and 1% respectively.

A.3 Estimating Asymmetric Intervention by Central Banks

A representative central bank's loss function is given as follows:

$$L_t = \frac{1}{2}(R_t - R^*)^2 + \frac{\theta}{2}((\tilde{\varepsilon}_t - \varepsilon^*)^2 + \frac{\theta}{3}(\tilde{\varepsilon}_t - \varepsilon^*)^3) \quad (6)$$

Here $\tilde{\varepsilon}_t$ is the percent change in exchange rate with the exchange rate being defined as the foreign currency price of the domestic currency while R_t is the reserves level. The central bank aims to minimize the deviation of reserves as well as the exchange rate from their respective target values ε^* and R^* . Moreover, θ is the relative weight on stabilizing exchange rate vis-à-vis reserves. The right-most term introduces the asymmetry in the loss function. With $\theta > 0$, an appreciation ($\tilde{\varepsilon} > 0$) increases the central bank's loss while depreciation ($\tilde{\varepsilon} < 0$) reduces the extent of loss. Thus, a positive θ implies asymmetric intervention.

There is a trade-off between stabilizing reserves and exchange rate as interventions can reduce the extent of exchange rate deviation.

$$\tilde{\varepsilon}_t - \varepsilon^* = \alpha_0 + \alpha_1 R_t + \eta_t \quad (7)$$

Here α_1 is positive. Minimizing Equation (6) by choosing R_t , subject to the constraint given in Equation (7) yields the optimality condition

$$R_t = R^* - (\theta \alpha_1) \tilde{\varepsilon}_t - \frac{\theta}{2} \alpha_1 \tilde{\varepsilon}_t^2 \quad (8)$$

This can be reduced to an empirically testable formulation

$$R_t = \beta_0 + \beta_1 \tilde{\varepsilon}_t + \beta_2 \tilde{\varepsilon}_t^2 + v_t \quad (9)$$

where $\beta_1 = -\theta \alpha_1$ and $\beta_2 = -\frac{\theta}{2} \alpha_1$. These parameters provide information on the degree of asymmetry in exchange rate stabilization with $\theta = -\frac{2\beta_2}{\beta_1}$.

Equation (9) is empirically estimated by using monthly data on nominal exchange rate and reserves (minus gold) over the period 2000 to 2011. The GMM methodology is employed to estimate Equation (9). Here, 1 to 12 and 15 lags of R_t and $\tilde{\varepsilon}_t$, as well as the current value of federal funds rate and its four lags, are used as instruments. The estimates of the intervention reaction function and the asymmetric preference parameter are reported in Table 3. θ is found to be positive and significant for all five EAEs, implying that the central banks did pursue asymmetric intervention in the foreign exchange market to counter surges and stops of capital flows.

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