

Capital Flows and Reserve Management in Selected Asian Economies*

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Abstract

Gross capital inflows and outflows to and from emerging market economies (EMEs) have witnessed a significant increase since 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, and analyses 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 an analysis is highly relevant especially a time when EMEs around the world are about to face the repercussions of monetary policy normalisation by the developed countries which could once again heighten the volatility of cross-border capital flows thereby posing renewed macroeconomic challenges for major EMEs.

JEL Classification: F32, F38 and F41

Keywords: Capital flows, Impossible Trinity, Foreign exchange intervention, Capital controls, Global financial crisis, Exchange market pressure.

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1 Introduction

Emerging economies witnessed a sharp increase in capital flows during the last two and a half decades. After fluctuating between 2.0% and 4.0% of GDP during 2000 to 2002, gross capital inflows started to pick up from 2003 and reached a peak of 11.5% of GDP in the third quarter of 2007. These inflows collapsed dramatically with the onset of the Global Financial Crisis (GFC) and fell to -5.4% of GDP in the fourth quarter of 2008 (Bluedorn et al, 2013).¹ The slew of measures introduced by a number of countries in the aftermath of GFC to bolster aggregate demand, including the unconventional monetary policies adopted by a number of advanced economies resulted in a resurgence of capital into the emerging markets. Gross capital inflows rose rapidly in the second half of 2009 and 2010, and by third quarter of 2010 these inflows to emerging markets exceeded the pre crisis peak and reached almost 15% of GDP of their cumulative GDP. The situation reversed again by end of 2011, with worsening of the global economic outlook driven by sovereign debt rating downgrade of the United States in August 2011 and exacerbation of the Eurozone crisis. This resulted in capital flows receding rapidly, with gross inflows falling below 3.0% of GDP in the last quarter of 2011, and eroding the recent exchange rate gains and reserve accumulation. While there was some recovery in the subsequent quarters, the signal by the Federal Reserve Bank in May 2013 that it would taper its bond-buying program, again precipitated a sharp drop in capital flows.

This heightened volatility in capital flows created a number of macroeconomic challenges and financial stability concerns for emerging economies, and forced them to undertake capital account management and macroprudential measures to stem the flow of capital. These measures were adopted to address multiple objectives such as preventing excessive appreciation of the domestic currencies in order to preserve the competitiveness of exports, guarding against asset bubbles, maintaining monetary policy autonomy in the face of volatile capital flows and pressure on the exchange rate, and reducing financial sector vulnerability to contagion.

The paper focuses on the trend of capital inflows and outflows in selected Emerging Asian Economies (EAEs) by analyzing the “waves” in capital flows. The composition of these waves is also evaluated, i.e. were the flows driven by 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

¹Bluedorn et al (2013) define gross inflows in terms of sale and purchase of domestic assets by foreign residents. They are net sales of domestic assets to foreign residents. Gross outflows are net purchases of foreign assets by domestic residents. Net capital flows are basically net inflows, defined as gross inflows (change in domestic resident liabilities to foreigners) minus gross outflows (change in foreign assets owned by domestic residents).

management and macroprudential measures. These policy responses have involved (a) negotiating the trilemma or the impossible trinity in the face of rising and volatile capital flows; (b) intervening in the foreign exchange market by the central banks to stabilise the domestic currency; and (c) imposing capital controls to stem the inflow of particular types of foreign capital. Finally, the paper attempts to evaluate the efficacy of these measures by analyzing if these measures achieved their desired goals.

The rest of the paper is organised as follows. Section 2 documents the broad trends in capital flows in selected EAEs. Section 3 discusses the various capital account management and macroprudential measures adopted by the EAEs to balance the complex and diverse objectives of macroeconomic management. In this section we also attempt to analyse the impact of capital controls implemented by some of the EAEs. Section 4 explores the evolution of exchange market pressure in the EAEs. Finally, Section 5 concludes by summarising the main take aways of the paper.

2 Identifying Surge and Stop Episodes

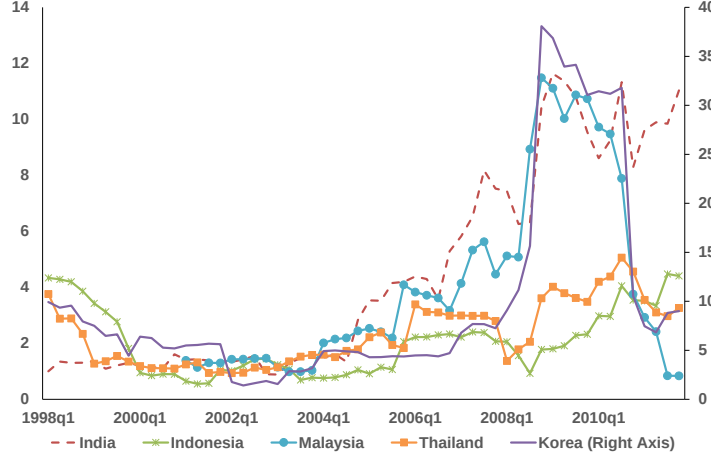
In this section, the broad trends in capital flows in selected Asian emerging markets is documented. The analysis focuses on five major emerging economies of the region viz. India, Indonesia, Republic of Korea (henceforth, Korea), Malaysia and Thailand. The choice of these countries is driven by the availability of the data and their economic importance. According to IMF's World Economic Outlook, barring China, these 5 EAEs accounted for 86% to 88% of GDP of emerging and developing Asia during the 2000s. At the same time, these economies accounted for nearly 90% of capital flows into emerging and developing Asia. The paper covers the period 1995q1 to 2015q4. However, for certain sections in the paper we are forced to look at a sub period owing to lack of data.

Gross capital inflows have been extremely volatile in recent years in these Asian economies. For example, gross capital inflow 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 Q2 2007 to -\$22.6 billion (net sales) in Q3 2008. Similarly, even in India, an economy with limited capital account integration, net purchase of assets went down from +\$29.2 billion in Q4 2007 to -\$1.6 billion in Q4 2008.²

Following Forbes (2014) the increase in volatility is assessed by calculating

²The statistics are based on authors' calculations using data from Bluedorn et al (2013). Their capital flows database contains panel data on international capital flows by country at annual and quarterly frequencies, covering years 1970 - 2011 and quarters 1970:Q1 - 2012:Q2.

Figure 1: Volatility in Capital Inflows in Asia



Source: IMF's Balance of Payment Statistics & Authors' Estimates

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 the volatility from early 2006, which peaked in the second half of 2008.

The volatility in the capital inflows have been driven by periods of “waves” of capital inflows. We use the methodology introduced in Forbes and Warnock (2012) to identify periods of sharp changes in inflows. According to this methodology let C_t be the four-quarter moving sum of gross capital inflows (GINFLOW), and compute annual year over year changes in C_t . Consequently,

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

and $\Delta C_t = C_t - C_{t-4}$. Next, we compute the rolling means and standard deviations of ΔC_t over the last 5 years or 20 quarters. Following Forbes and Warnock (2012), we identify surge as an episode, which starts in the month when ΔC_t increases more than one standard deviation above its rolling mean, provided it crosses two standard deviation above the rolling mean during this period. 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. and

again provided that it reaches two standard deviations below the rolling mean at some time during the period.

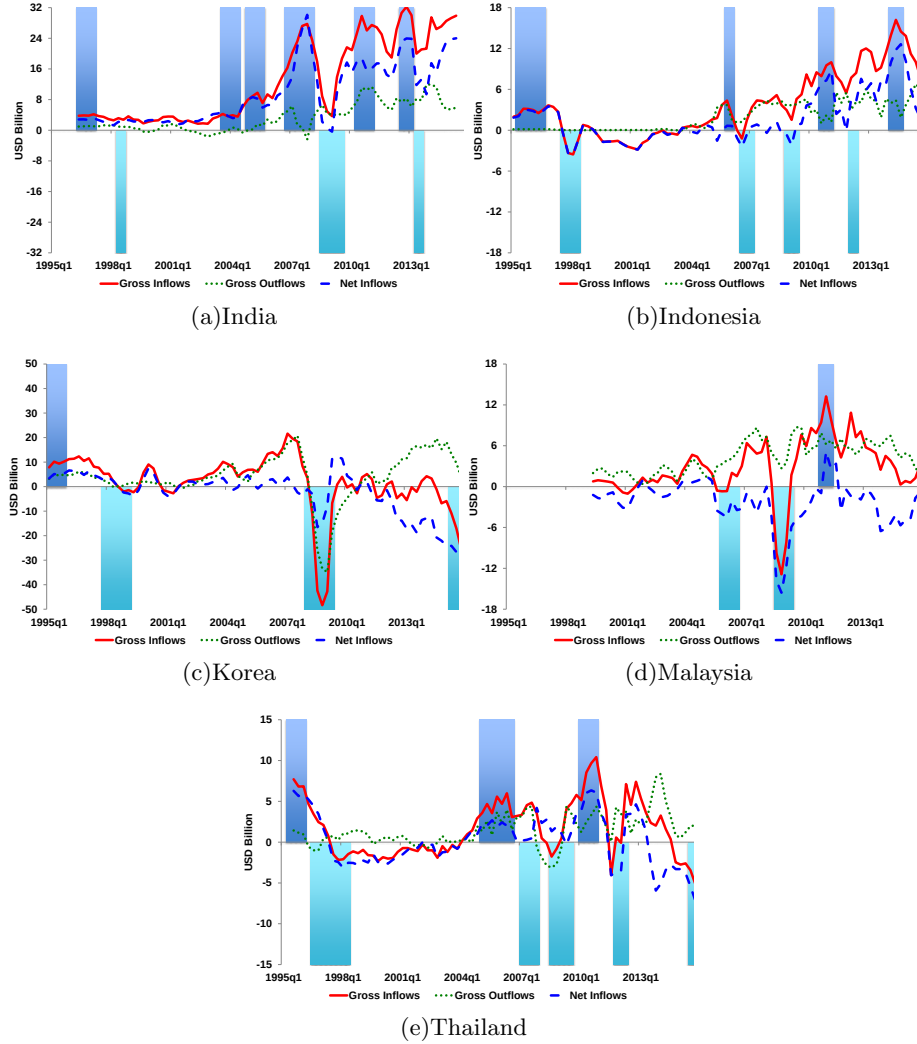
Using this methodology we are able to identify numerous surge and stop episodes across the 5 EAEs. Figure 2 highlights these episodes, along with the evolution of gross capital inflows and outflows as well as net inflows. Overall, these 5 EAEs experienced 15 surge and 18 stop episodes. Most of the surge episodes occurred in the years preceding the Asian financial crisis (AFC) and the GFC, and the post-GFC period when many of the advanced economies were practicing unconventional monetary policies. In contrast, majority of the stop episodes were confined to the AFC and the GFC periods, with some countries being impacted with the US signalling a tapering of its quantitative easing in mid-2013. The stop episodes around the GFC were during the period 2008Q3 - 2009Q3 for all the EAEs.

There are significant differences at the individual country level. While, at six, India experienced the most number of surge episodes, Malaysia and Korea witnessed only one surge episode each. The stop episodes were a little more symmetrically distributed with Indonesia and Thailand experiencing five episodes each while India and Korea witnessed three episodes and Malaysia encountered only two episodes. While Indonesia and Korea experienced the longest surge in capital inflows during the pre-AFC period (1994-1996), India and Thailand recorded the longest surge episodes during the pre-GFC period. Figure 2 shows that during the longest surge episode experienced in India between Q4 2006 and Q2 2008, there was a gross inflow in excess of \$150 billion or an average of 7.9% of GDP and net capital inflows of 6.7% of GDP. Similarly, though the surge episode between Q3 2004 and Q1 2006 in Thailand was much more modest in volume, resulting in gross capital inflow of only \$30 billion, these capital flows accounted for nearly 8.9% of GDP. Both Indonesia and Korea received net capital inflows of roughly 5% of GDP during their pre-AFC surge episodes. The stop episodes were equally diverse. The longest stop episode among these 5 EAEs took place in Thailand during the AFC (1996Q3 - 1998Q2), and led to sale of Thai assets by foreigners worth \$4 billion or 2.4% of GDP. Korea experienced sale of assets worth \$130 billion or 11.5% of GDP during the GFC.

Next, we focus on the particular type of flows that influenced these surge and stop episodes. We differentiate between FDI flows, portfolio equity flows, portfolio debt 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. We do not have access to this data for our sample EAEs beyond 2011.

In India, the first surge episode in the mid-1990s was driven by bank and

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

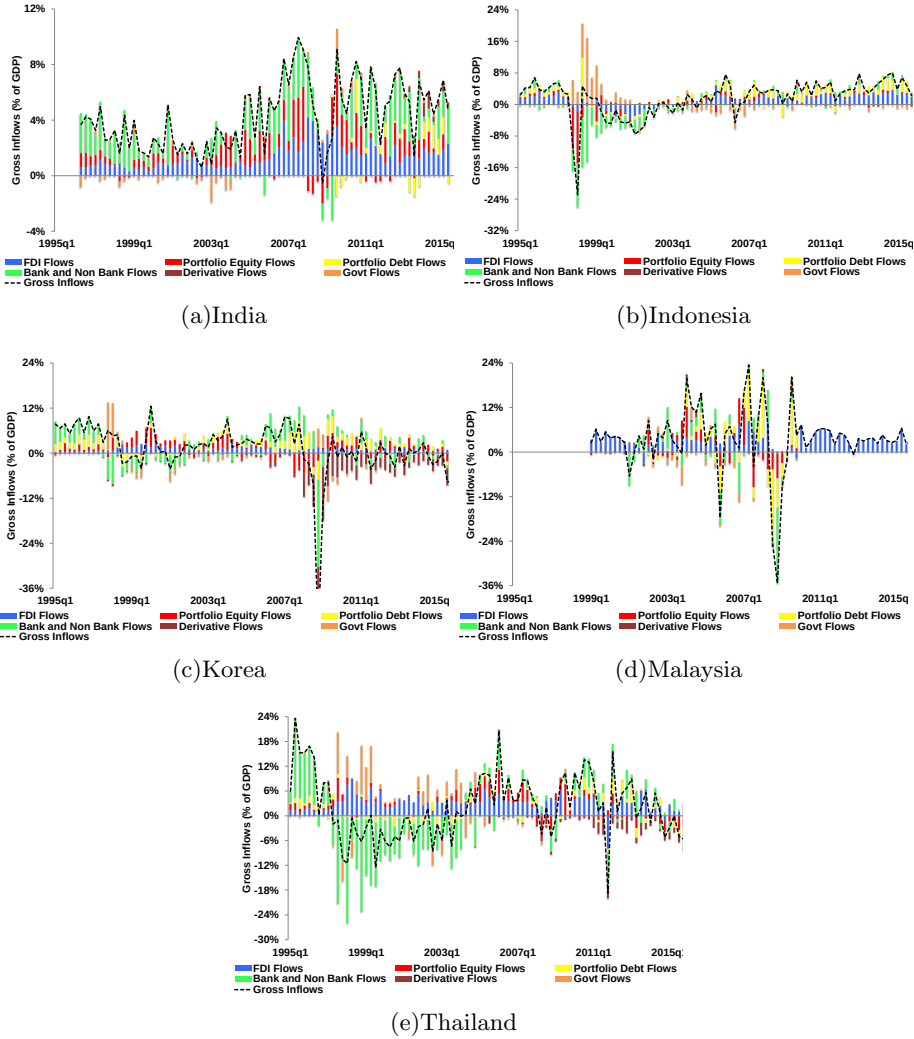


Source: Forbes (2014), IMF's Balance of Payment Statistics and Authors' Estimates.

non-bank flows, which accounted for nearly 60% of the gross inflows coming into the country. This was driven by commercial borrowings by 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 Q4 2004 to Q3 2005 and Q4 2006 to Q2 2008, when they accounted for more than 40% of total inflows. These flows have been encouraged by widening interest rate differential between India and the advanced economies as well as liberalization of borrowing norms. The other two surge episodes in 2000s, were driven by portfolio equity flows, which accounted for 59.1% and 41% of the total flows. While FDI inflows accounted for 25% to 30% of flows dur-

ing these two episodes, its contribution peaked at 38% during the longest surge episode that took place from Q4 2006 to Q2 2008. In the both the surge episodes occurring after GFC, bank and non-bank flows and FDI flows accounted for tw-third of the gross inflows.

Figure 3: Composition of Gross Capital Inflows



Source: 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% of the capital inflows during the surge episodes occurring during Q2 1995 to Q3 1996, Q3 2010 to Q1 2011 and Q1 2014 to Q3 2014. In comparison, FDI inflows accounted for only 30% of total inflows during the short episode from Q4 2005 to Q1 2006. Portfolio debt flows also played an important role, accounting between 25% to 50% of the capital inflows during these episodes. Again, with domestic interest rates trending at higher level

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 Indonesia securities, with portfolio debt flows accounting for 38% 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% and 28.3% of capital inflows. The worsening of the current account deficit in the early 1990s along with the requirements to join OECD 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.

During Malaysia's only surge episode from Q4 2010 to Q2 2011, it was driven entirely by FDI inflows. 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% and allowing residents to undertake foreign exchange transactions directly with commercial banks. In the second episode, FDI inflows accounted for nearly half of the inflows, while another 40% 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. Radelet and Sachs (2000) point out that these 4 EAEs, along with Philippines, witnessed net private flows dropping from \$93 billion in 1996 to -\$12 billion in 1997, a swing of \$105 billion or 9% of GDP. Out of this decline of \$105 billion, over \$77 billion was due to commercial bank lending, while portfolio equity and non-bank lending accounted for \$24 billion and \$5 billion.

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 both during 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 later part of 2009, which continued till 2011. From a cumulative negative inflow of -\$15.6 billion in 2008, private inflows to these 5 EAEs jumped to \$1.94 trillion in 2009, and further to \$2.15 trillion in 2010, before dropping to \$1.89 trillion in 2012.

India experienced a stop episode in 2013 as a result of the US signalling a tapering of its quantitative easing. Korea and Thailand also witnessed a stop episode in 2015. During this episode, barring FDI flows, all other flows witnessed a reversal.

3 Policy Response to Manage Capital Inflows

Policymakers' 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. Subramanian and Rajan (2005) and Prasad et al. (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 channeled towards 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 cause sharp valuation swings. Finally, capital inflows can reverse themselves leading to a costly balance of payments crisis. Schadler (2010) shows that about 15% 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, policymakers need to reconcile 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, policymakers 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 adverse balance of payments situation.

In general, policymakers can resort to three broad macroeconomic measures to counter the surge in capital inflows. These involve (i) enhancing exchange rate flexibility to manage the trilemma in order to retain monetary autonomy, (ii) undertaking foreign exchange intervention to stabilise the domestic currency and maintain competitiveness of exports but sacrificing monetary policy independence, and (iii) imposing controls on capital inflows and/or relaxing controls on capital outflows. Below, we analyse the experience of the 5 selected EAEs on these measures.

3.1 Enhancing Exchange Rate Flexibility

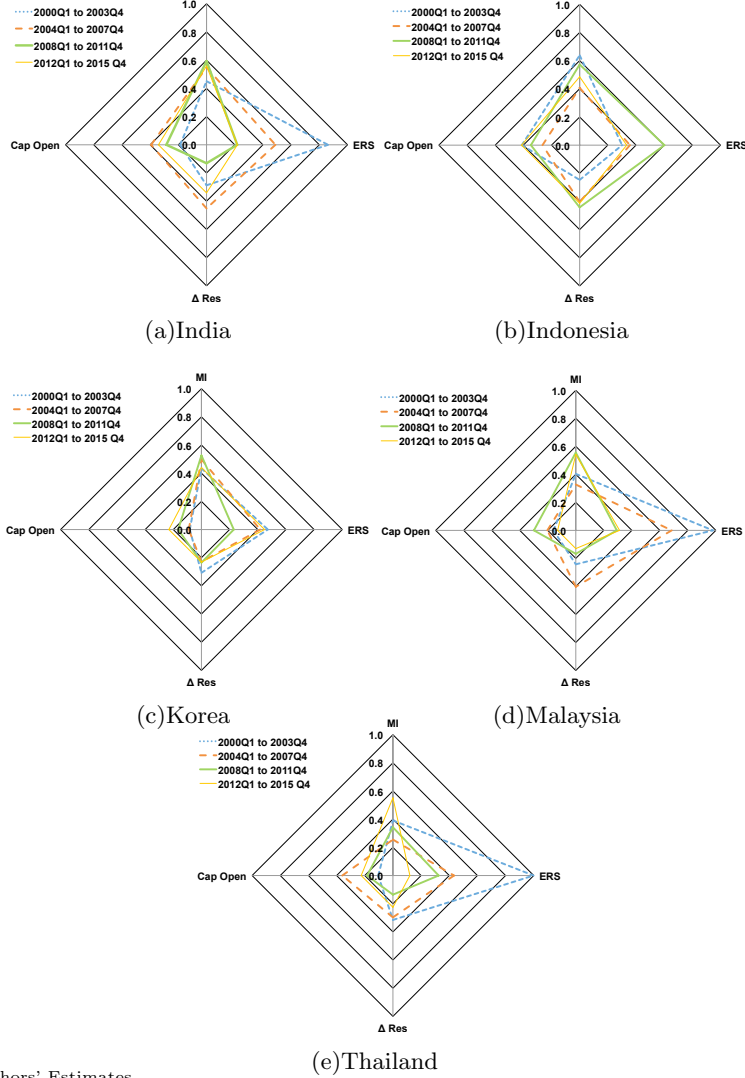
Enhancing exchange rate flexibility does not necessarily imply nominal exchange rate appreciation, something which the policymakers are reluctant to allow. It refers to introducing two-way risks, and thereby discourage speculative capital inflows. If a central bank responds to a capital inflows over 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, large stockpile of reserves provides an assurance that large depreciation will not take place.

Introduction of two-way risks involve widening the band of fluctuation in the case of *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 Aizenman et al. (2010) to briefly describe the experience of the EAEs with the impossible trinity, using quarterly data from 2000 Q1 to 2015 Q4. Details of the calculations are given in Section A.1 in Appendix.

With three indices across 5 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 four equal periods. While Period I lasts from 2000 Q1 to 2003 Q4, Period II covers 2004 Q1 to 2007 Q4, Period III encompasses 2008 Q1 to 2011 Q4 and Period IV covers 2012 Q1 to 2015 Q4. Figure 4 plots the means of the indices across these periods.

Next, we test the extent to which the trilemma was binding across these

Figure 4: Configuration of the Trilemma Objectives



Source: Authors' Estimates.

5 EAEs. The methodology is outlined in Section A.2 in Appendix. The relationship is estimated for the entire period 2000 Q1 to 2015 Q4 as well as the four 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.

In case of both India and Malaysia, the importance of exchange rate stability has decreased over time while the weight attached to monetary policy independence has gone up. In India capital account openness witnessed an

increase in Period II, boosted by abundant global liquidity and strong domestic macroeconomic fundamentals. However, the GFC, followed by the sovereign debt crisis in Europe, and concomitant deterioration in domestic macroeconomic indicators resulted in a slump in capital flows in Period III. The weight on monetary independence increased from 22.4% in Period I to over 70% in Period III as monetary policy was calibrated to manage rising domestic inflationary pressures. In Malaysia, it increased from 1% to 38% during this period. Both these economies significantly reduced the weight on exchange rate stability to manage the trilemma. In Malaysia, the weight declined from 92.6% in Period I, when the Ringgit was pegged to the US Dollar, the weight on exchange rate stability declined to below 60% in Period III, while in India it dropped from 76.3% to 20.3%. Finally, in Period IV, both Malaysia and India came close to adopting corner solutions focusing only on monetary independence and capital account openness and allowing the exchange rate to remain completely adjustable.

In Thailand also, there has been a decline in the weight given to stabilizing the exchange rate across the periods, barring Period III when there was a slight uptick in ERS index. The decline in ERS index was associated with rising focus on monetary independence. In fact, in Period IV, Thailand, like, India and Malaysia, came close to adopting a corner solution comprising monetary independence and capital account openness, with a very small weight on stabilizing exchange rate.

In contrast, in Indonesia policymakers imparted greater weight to exchange rate in the first three periods with a view to retain competitiveness, despite BI 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 ΔRes index, which is highest for Indonesia among the 5 EAEs. This was associated with a declining weight on monetary independence across the period. However, this policy configuration changed in the fourth period when Indonesia significantly increased the weight on monetary independence and capital account openness and allowed the exchange rate to fluctuate.

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

Thus, the 5 EAEs negotiated the trilemma in very different manner as they were confronted with rising and volatile capital flows. During the first three periods, instead of adopting corner solutions, all the 5 EAEs adopted inter-

mediate approach in negotiating the conflicting approaches of the trilemma. While India, Malaysia and Thailand chose to sacrifice exchange rate stability in more recent years to have greater freedom to exercise monetary policy in the face of rising capital account openness, Indonesia and Korea have continued to put emphasis on managing the exchange rate. Korea has remained fairly consistent in managing the Trilemma in a more balance manner emphasising both exchange rate stability and monetary independence. In recent years, three economies viz. India, Malaysia and Thailand have nearly adopted corner solutions focusing on monetary independence and capital account openness, and allowing exchange rate to fluctuate. Indonesia also increased its weight on monetary independence and reduce the weight on exchange rate stability. Korea was the only outlier, which continued to focus on exchange rate stability with a view to retain competitiveness.

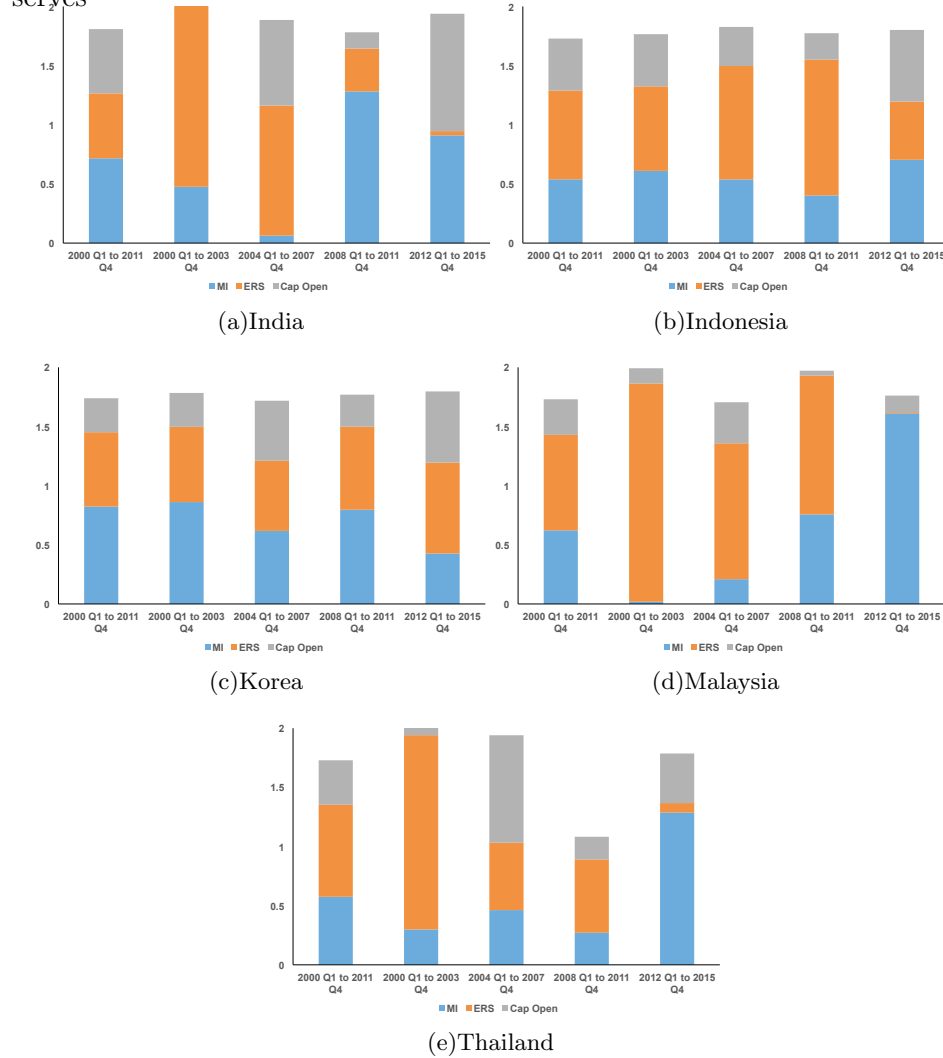
3.2 FX Intervention

One of the most commonly used instruments to counter a surge in capital flows is foreign exchange intervention. This involves the central bank intervening in the foreign exchange market to resist an appreciation of the domestic currency. In case of sterilised intervention, the central bank exchanges the domestic assets with foreign assets to neutralise the increase in monetary base resulting from the intervention. Reinhart and Reinhart (1998) refer to sterilised intervention as the “policy of first recourse”.

The central banks of the 5 EAEs also resorted to intervention in the face of surge in inflows. The surge episodes identified in Figure 2 were associated with significant accumulation of reserves. Focusing on the episodes during the 2000s, Table 1 indicates the extent of reserve accumulation or decumulation during the these episodes.³ All the surge episodes were associated with accumulation of reserves. While India had built 78% of its end-2011 reserve holdings during these surge episodes, Indonesia and Thailand accumulated 39.5% and 26.7% of their reserves during such episodes.

³Data 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.

Figure 5: Configuration of the Trilemma Objectives and International Reserves



Source: Authors' Estimates.

Table 1: Reserve Accumulation During Surge and Stop Episodes

	Surge			Stop		
	Start	End	Reserve Accumulation (\$ Billion)	Start	End	Reserve Accumulation (\$ Billion)
India	2003 Q3	2004 Q2	18.9	2008 Q3	2009 Q3	-30.81
	2004 Q4	2005 Q3	23.5	2013 Q2	2013 Q3	-14.81
	2006 Q4	2008 Q1	146.8			
	2010 Q2	2011 Q1	25.8			
	2012 Q3	2013 Q1	2.3			
Indonesia	2005 Q4	2006 Q1	9.8	2006 Q3	2007 Q1	7.11
	2010 Q3	2011 Q1	24.4	2008 Q4	2009 Q2	0.47
	2014 Q1	2014 Q3	17.9	2012 Q1	2012 Q2	5.98
				2015 Q3	2015 Q4	-6.79
Malaysia	2010 Q4	2011 Q2	14.7	2005 Q4	2006 Q3	-0.44
Korea				2008 Q3	2009 Q2	-34.24
				2008 Q1	2009 Q2	-30.49
Thailand	2005 Q1	2006 Q3	11.8	2015 Q1	2015 Q3	4.52
	2010 Q1	2010 Q4	33.7	2007 Q1	2007 Q4	20.47
				2008 Q3	2009 Q3	26.08
				2011 Q4	2012 Q2	-5.42
				2015 Q3	2015 Q4	-3.76

Source: IMF's International Financial Statistics and Authors' Estimates.

Table 1 shows that the stop episodes were not universally associated with depletion of reserves. In fact, in only 8 out of the 14 stop episodes the EAEs used reserves to counter the stop of capital inflow. 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 as to why central banks would 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 modeled following Pontines and Rajan (2011) and Sen Gupta and Sengupta (2014) and GMM methodology is used to estimate the asymmetric preference parameter for the EAEs for the periods 2000-2011 and 2007-2016. Details of the model, estimation strategy and results are described in Section A.3 in Appendix. The parameter θ indicates the extent of asymmetric intervention in the foreign exchange market. The results, outlined in Tables 2 and 3 indicate across all 5 EAEs the central banks intervened asymmetrically in the foreign exchange market during the 2000-2011 period. During the 2007-2016 period, Malaysia and Thailand do not seem to have engaged in asymmetric intervention while the other three EAEs continued the trend though the magnitude of asymmetric intervention seems to have decreased.

Table 2: Extent of Asymmetric Intervention in EAEs: 2000-2011

	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

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

The asymmetric intervention resulted in the central banks acquiring significant volume of foreign assets, which threatened to disrupt the monetary base. Central banks sought to limit the impact on the monetary base by sterilising these interventions albeit with varying results. In India, the Reserve Bank of India (RBI) initially conducted open market sales of government securities to neutralize the effect of reserve accretion on monetary base. However, by end of 2003, the RBI had exhausted its stock of govern-

Table 3: Extent of Asymmetric Intervention in EAEs: 2007-2016

	India	Indonesia	Korea	Malaysia	Thailand
β_0	1.016*** [11.10]	1.063*** [12.47]	0.539*** [16.69]	0.223 [1.31]	-0.024 [-0.19]
β_1	0.495*** [10.35]	0.505*** [26.77]	0.486*** [60.46]	0.987*** [7.42]	0.731*** [5.84]
β_2	-0.144*** [-7.07]	-0.019*** [-12.48]	-0.020*** [-23.25]	-0.046 [-1.04]	0.341 [4.60]
θ	0.582***	0.075***	0.082***	0.093	0.933
Number of observations	111	111	111	111	111

Note: Robust z-statistics in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% respectively. Source: Authors' Estimates.

ment 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 4% 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 the 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% in 2005 before declining to around 11% in 2011. Like RBI in India, 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 Bank Indonesia Certificates (SBI) 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 2% in 2007. However, during the GFC, the stock of these bonds were quickly drawn down. In 2010 and 2011 there has been 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 and the issuance of Bank Negara Malaysia Monetary Notes (BNMNs). As a share of GDP, the volume of outstanding central bank securities reached a peak of 13% just before the onset of the

GFC. Like most other EAEs, 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 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 in the Bank of Thailand (BOT) bond. Thailand used these bonds along with repo transactions and foreign exchange swaps to manage overall liquidity. The stock of central bank securities have steadily increased as a share of GDP, and stood close to 10% in 2011.

3.3 Capital Controls and Impact

One of the most common macroeconomic policy tool to deal with surges in capital inflows is imposing capital controls i.e. 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 1997-98. The issue of regulation of capital flows has slowly but steadily moved to the center 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 in countries macroeconomic policy toolkit.

The IMF, a one-time proponent of complete liberalization of the capital account, has also shifted in favor 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 South East Asian EAEs in their policy responses to the AFC of 1997-98. While Malaysia imposed a series of comprehensive capital controls on short-term capital inflows as well as outflows, and pegged the Ringgit to the 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 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 restriction 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 folds. In 2005, another series of outflow controls were relaxed. Residents could invest abroad in foreign currency and those with domestic credit facilities were permitted to convert Ringgit up to RM100,000 per annum. Corporations were allowed to convert Ringgit up to RM10 million per annum for investment in foreign currency assets. Residents were also free to open a foreign currency account (FCA) onshore or offshore, without any prior permission and no limit on the amount of foreign currency funds to be retained (Athukorala and Jongwanich, 2012).

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 onwards. In 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, Korean government liberalized capital outflows. For instance in 2006, the limit on outward FDI by domestic residents was relaxed to include purchase of real estate and in 2007, a temporary tax exemption for 3 years was applied to capital gains generated from overseas stock investment by domestic companies.

In 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 mid 2000s, the country was experiencing major macroeconomic turbulence, persistent capital outflows, high currency volatility, and inflationary pressures. From the mid 2000s, favorable 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, BI introduced new prudential regulations on net open foreign exchange positions of commercial banks hindered their ability to speculate in the swap market. Around the same time, deposit accounts in Rupiah were subjected to reserve requirements. In 2005Q1, short-term

borrowings by banks were limited to 20% 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 2010Q4. Once again, restrictions were imposed on speculative transactions and new capital controls (prudential regulations) were introduced to redirect the inflows towards longer maturity assets (Jayasuriya and Chen-Yu Leu, 2012).

Like other EAEs, Thailand also experienced a surge in capital inflows in the middle of 2000s. A fairly long surge episode was recorded starting 2004, and there was a noticeable appreciation of the. Bank of Thailand (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, BOT implemented a market-based restriction in December 2006. This involved a requirement to deposit 30% of foreign exchange as unremunerated reserve requirement (URR) for most foreign transactions. If funds remained within Thailand for 1 year, then the full amount of capital would be refunded and if funds were repatriated earlier, only two-thirds would be refunded. Imposition of the URR immediately caused panic amongst foreign investor, and a stop episode was recorded in 2007Q1. With capital inflows reacting adversely to the URR imposition, foreign capital inflows were increasingly exempted from the URR and eventually the URR measures were lifted in March 2008 (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 also to 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 towards financial integration with 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 amongst the highest capital inflows, recording 3 surge episodes in the run up to the GFC. Abiad et al. (2010) show that restrictions on the capital account were eased between 1999 and 2004, though 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 3rd surge episode was recorded in 2006Q4. These took the form of reduction in the ceiling on interest rates on non-resident bank deposits, restriction portfolio investment inflows by banning ‘participatory notes’ and prohibiting external commercial borrowings (ECB) by real estate

companies and reducing interest rate ceiling on ECB.

To formally assess the impact of capital controls on the exchange rate and stock market, 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 are 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 slowdown the rate of appreciation and increase in stock prices observed prior to their introduction.

The paper focuses on 4 selected measures aimed to curb inflow of foreign capital. These include

- India – Restrictions on ‘participatory notes’ in October 2007 to curb portfolio investment inflows. These are over-the-counter derivatives sold by a Foreign Institutional Investment registered financial 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 were increased to 1 month, and central banks instruments with longer maturity of 6 months and 9 months were introduced (Magud et al. 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 Bank of Thailand required all foreign transactions, barring those related to trade in goods and services, repatriation of investment abroad by residents, and FDI, had to deposit 30% of foreign exchange with the BOT as URR. If these funds remained within Thailand for one year, 30% of capital was refunded. If funds repatriated before a year, only two-thirds of the amount was refunded (Jongwanich and Kohpaiboon, 2012).

Table 4 highlight the efficacy of the capital controls in restricting exchange rate appreciation and stock price increase for 4 out of the 5 EAEs in our sample. We do not have the required data for Malaysia. To evaluate the short-term and longer term effect 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: Efficacy of the Capital Flow Measures

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

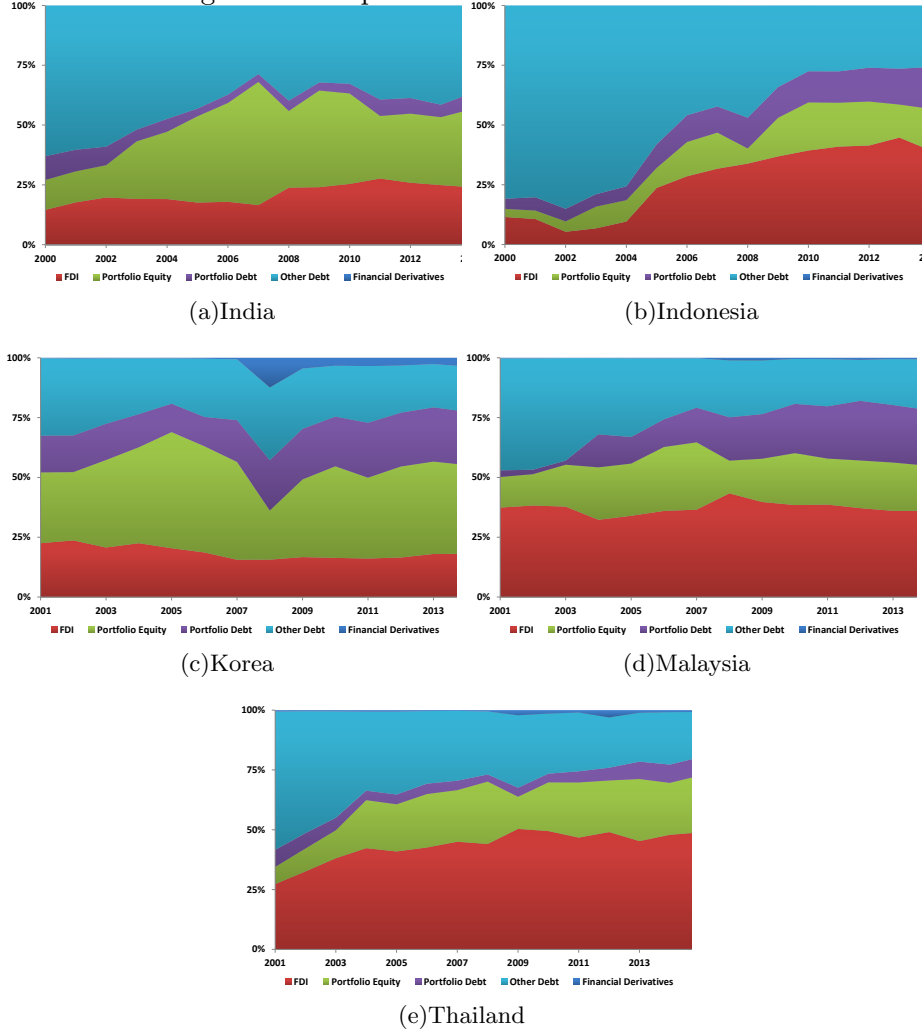
Notes: Robust t-statistics in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% respectively
Source: Authors' calculations.

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 increase over a window of one-month. However, when the period under study is increased to six months the difference is significant only in case of Korea.

Thus, by and large for these 5 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-term and disappeared over a longer horizon.

The limited success of capital controls is in line with other studies such as Forbes and Warnock (2012), who conclude that controls on inflows do not significantly affect surges of gross capital inflows. These findings are also consistent with 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

Figure 6: Composition of External Liabilities



Source: Authors' Estimates.

have some effect. Figure 6 highlights the change in composition of liabilities over the past 4 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.

However, the subsequent liberalization of capital flows involved dismantling of the “walls” in a manner consistent with the “pecking order” of capital flows.⁴ Table 5 highlights the evolution of capital controls across the 5

⁴Ostry 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, consumer price indexed debt inflows.

EAEs.⁵ Across most of these EAEs, “walls” on FDI inflows were liberalized the most, followed by equities. Debt flows continued to be a 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

Notes: Based on data from Fernandez et al. (2014). The intensity of controls are based on information provided in IMF’s Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The narrative description in the AREAER is used to determine whether or not there are restrictions on international transactions, with a 1 representing the presence of a restriction and a 0 representing no restriction. Each value represents the average over the past three years.

4 Exchange Market Pressure

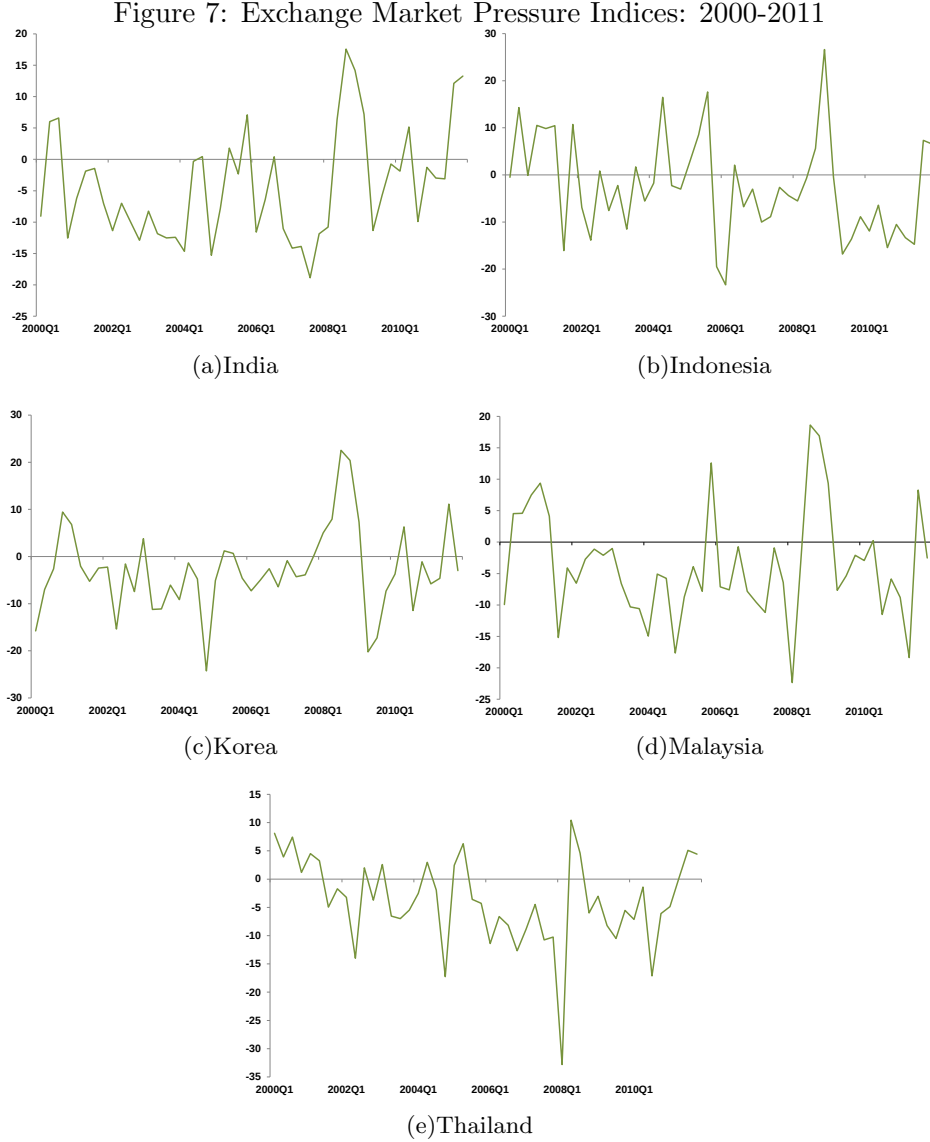
In this section we discuss the evolution of the Exchange Market Pressure Index (EMPI) in the 5 EAEs in our sample. A central bank’s management of capital account could be driven by a desire to moderate certain types of capital inflows or to manage exchange rate stability. In the context of the trilemma trade offs 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 Girton and 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 Aizenman et al. (2012) who investigate the factors explaining EMP in emerging markets during the 2000s. The simplest measure of EMP is the un-weighted 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

Foreign currency debt inflows are categorized as the most risky class of assets.

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

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 and Figure 8 shows the same for the period 2007 to 2016.⁶

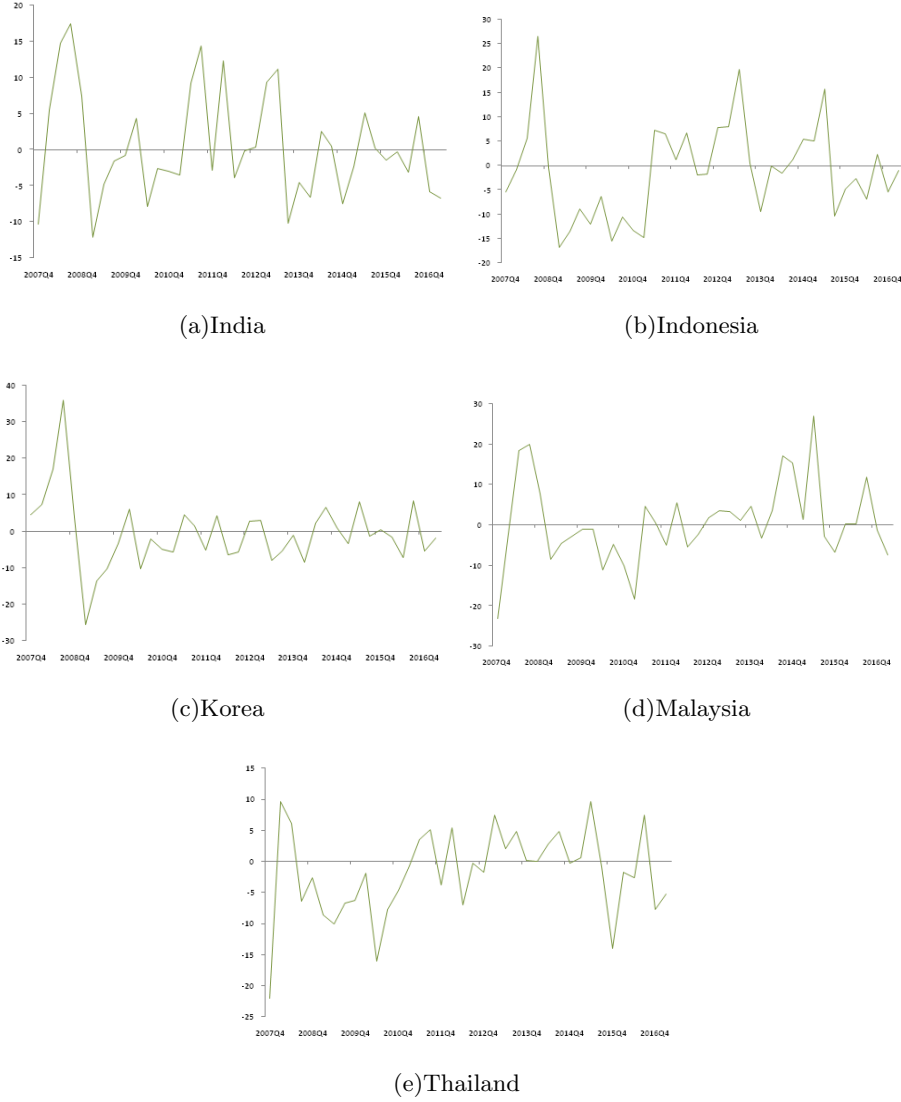


Source: Authors' Estimates.

During the 2000-2011 period, the EMP series of all 5 EAEs appear similar reflecting the common phenomenon that these economies experienced during the decade of the 2000s. Their negative EMP implies net excess supply

⁶ An earlier version of the paper used data only till 2011. Subsequently we updated the analysis using more recent data. In case of the EMP, we look at the pre-GFC and post-GFC samples.

Figure 8: Exchange Market Pressure Indices: 2007-2016



Source: Authors' Estimates.

of foreign currency. This is consistent with the 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 case of all the EAEs this trend was interrupted by the GFC of 2008 and associated liquidity crunch world-wide, 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 towards the end

of 2011. 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.

There are some country-wise differences during the 2011-2016 period. For example, India, Indonesia, and Malaysia experienced a spike in EMP around the taper-tantrum episode of 2013. The same is not observed for Korea or Thailand. In general the volatility in the EMP index seems to have decreased with increasing time lapse from the GFC especially for Korea while it has persisted to some extent for the other 4 EAEs. So it appears that despite the use of capital controls, the EAEs other than Korea were not successful in managing the EMP resulting from taper tantrum related volatilities or from the Euro zone debt crisis.

5 Conclusion

Gross capital inflows and outflows to and from emerging market economies (EMEs) have witnessed a significant increase since 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 EAEs, 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 2000-2015. The analysis reveals that countries are bound by the trilemma, and have managed the trilemma by juggling the competing policy objectives to manage the demands of macroeconomy.

The management of the trilemma has been accompanied by asymmetric intervention in the foreign exchange market. 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 an analysis is highly relevant especially at a time when EMEs are about to face the repercussions of a normalisation in monetary policy by the US, which could once again exacerbate the volatility of cross-border capital flows thereby

resulting in renewed complexities in macroeconomic management in major EMEs.

A Appendix

A.1 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 countrys monetary policy is most closely linked with. ? indicate that the base country for all these 5 EAEs is the United States. The quarterly indices are calculated using weekly 3-month Treasury Bill yields for India and the US. The index of Monetary Independence is given by

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

where i_j refers to the interest rate prevailing in the EAEs, i^{US} refers to the US interest rates and $corr(i_j, i^*)$, 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, $corr(i_j, i^{US})$, 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 greater degree of monetary independence.

Exchange Rate Stability: We make use of the methodology introduced by ? to create an index of exchange rate stability. The degree of influence that major global currencies have on Indian Rupee can be estimated using the following estimation model.

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

Where $\epsilon_{j,t}^{SDR}$ is the value of the 5 EAEs' currency j against the numeraire currency, which in this case is the IMF's Special Drawing Rights. The three major global currencies, 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 currency, 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 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 (ERS). A higher R^2 indicates greater pegging to an individual 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 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, policymakers can garner greater flexibility vis-a-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 Testing Validity of Trilemma Framework

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. If the Trilemma is indeed binding then a country, which chooses to implement any 2 of the 3 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 can be 2.

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

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	2012 Q1 to 2015 Q4
India					
Monetary Independence	1.332*** [4.639]	1.055* [1.774]	0.115* [1.661]	2.159*** [3.645]	2.965*** [8.652]
Exchange Rate Stability	1.229*** [7.036]	1.880*** [12.002]	2.250*** [6.458]	1.662 [0.892]	0.023** [2.038]
Capital Account Openness	1.801*** [3.556]	0.145** [1.993]	1.844*** [3.472]	0.484 [0.545]	1.139 [2.084]
Observations	62	16	16	16	16
R-squared	0.903	0.983	0.943	0.891	0.881
Indonesia					
Monetary Independence	1.025*** [5.815]	0.957** [2.302]	1.321*** [5.106]	0.703* [1.785]	0.765** [2.009]
Exchange Rate Stability	1.883*** [8.981]	2.372*** [6.803]	2.685*** [4.885]	1.909*** [4.204]	2.144*** [7.111]
Capital Account Openness	1.225*** [5.250]	1.073* [2.088]	1.250** [2.518]	0.642* [1.887]	1.533*** [3.076]
Observations	63	16	16	16	16
R-squared	0.866	0.883	0.914	0.887	0.938
Korea					
Monetary Independence	1.734*** [8.268]	1.983*** [5.536]	1.239* [1.699]	1.514*** [3.669]	1.812*** [4.836]
Exchange Rate Stability	1.604*** [5.639]	1.349** [2.896]	1.422* [1.775]	3.058** [2.446]	1.314** [2.944]
Capital Account Openness	2.021*** [5.453]	3.459** [2.770]	5.631** [2.242]	1.641*** [6.942]	3.525*** [3.854]
Observations	64	16	16	16	16
R-squared	0.870	0.892	0.859	0.884	0.865
Malaysia					
Monetary Independence	1.360*** [7.670]	0.047* [1.677]	0.638* [1.764]	1.362*** [9.250]	0.792* [1.830]
Exchange Rate Stability	1.424*** [10.322]	1.885*** [20.586]	1.679*** [4.766]	4.012*** [6.859]	1.909*** [6.627]
Capital Account Openness	1.520*** [4.171]	0.807* [1.743]	1.705** [1.987]	0.134* [1.738]	1.044** [1.755]
Observations	64	16	16	16	16
R-squared	0.865	0.996	0.852	0.946	0.912
Thailand					
Monetary Independence	1.4949*** [8.018]	0.765* [1.709]	1.812*** [4.836]	0.792* [1.795]	2.334*** [4.189]
Exchange Rate Stability	1.656*** [10.179]	1.644*** [7.111]	1.314** [2.944]	1.909*** [6.627]	0.662 [0.318]
Capital Account Openness	1.723*** [5.378]	1.533*** [3.076]	2.525*** [3.854]	1.044 [1.755]	1.860* [1.927]
Observations	64	16	16	16	16
R-squared	0.867	0.938	0.865	0.893	

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

A.3 Estimating Asymmetric Intervention by Central Banks

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

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

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's aims to minimize the deviation of reserves as well as the exchange rate from their respective target values ε^* and R^* . Moreover, ϕ is the relative weight on stabilizing exchange rate vis-a-vis reserves. The right most term introduces the asymmetry in the loss function. With $\theta > 0$, an appreciation ($\tilde{\varepsilon} > 0$) increases the central banks 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.

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

where $\alpha_1 > 0$. Minimizing equation (6) by choosing R_t , subject to the constraint given in equation (7) yields the optimality condition

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

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 $\beta_1 = -\phi\alpha_1$ and $\beta_2 = -\frac{\phi\theta}{2}\alpha_1$. 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 Generalized Method of Moments (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 2. θ is found to be positive and significant across for all 5 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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