INTERNATIONAL MONETARY FUND

Asia and Pacific Department

Facing the Tides

Managing Capital Flows in Asia

Prepared by an IMF team led by Harald Finger and Pablo Lopez Murphy.

No. 19/17

Asia and Pacific Department

Facing the Tides
Managing Capital Flows in Asia

Prepared by a staff team led by Harald Finger and Pablo Lopez Murphy, and comprising R. Sean Craig, Niels-Jakob Hansen, Minsuk Kim, Sanaa Nadeem, Simon Paroutzoglou, Jay Peiris, Tahsin Saadi Sedik, Ananya Shukla, Nour Tawk, Jiae Yoo, and Qianqian Zhang, under the guidance of Jonathan D. Ostry. Alessandra Balestieri and Stephen Chukwumah supported the production of the paper

INTERNATIONAL MONETARY FUND

Cataloging-in-Publication Data
IMF Library

Names: Craig, R. Sean, author. | Hansen, Niels-Jakob Harbo, author. | Kim, Minsuk, author. | Nadeem, Sanaa, author. | Paroutzoglou, Simon, author. | Peiris, Jay, author. | Saadi-Sedik, Tahsin, author. | Shukla, Ananya, author. | Tawk, Nour, author. | Yoo, Jiae, author. | Zhang, Qianqian (Research Analyst), author. | Finger, Harald, project director. | Lopez Murphy, Pablo, project director. | Ostry, Jonathan David, 1962- | Balestieri, Alessandra. | Chukwumah, Stephen. | International Monetary Fund. Asia and Pacific Department, issuing body. | International Monetary Fund, publisher.
Title: Facing the tides : managing capital flows in Asia / Prepared by a staff team led by Harald Finger and Pablo Lopez Murphy, and comprising Sean Craig, Niels-Jakob Hansen, Minsuk Kim, Sanaa Nadeem, Simon Paroutzoglou, Jay Peiris, Tahsin Saadi Sedik, Ananya Shukla, Nour Tawk, Jiae Yoo, and Qianqian Zhang, under the guidance of Jonathan D. Ostry. Alessandra Balestieri and Stephen Chukwumah supported the production of the paper.
Other titles: Managing capital flows in Asia. | International Monetary Fund. Asia and Pacific Department (Series).
Description: Washington, DC : International Monetary Fund, 2019. | Departmental paper series. | At head of title: Asia and Pacific Department. | Includes bibliographical references.
Identifiers: ISBN 9781513512334 (paper)
Subjects: LCSH: Capital movements—Asia. | Foreign exchange rates—Asia. | Investments, Foreign—Asia.
Classification: LCC HG3891.C73 2019

Publication orders may be placed online, by fax, or through the mail:
International Monetary Fund, Publication Services
P.O. Box 92780, Washington, DC 20090, U.S.A.
Tel. (202) 623-7430 Fax: (202) 623-7201
E-mail: publications@imf.org
www.imfbookstore.org
www.elibrary.imf.org

Contents

Acknowledgments

The paper was prepared under the general guidance of Chang Yong Rhee, and supervised by Jonathan D. Ostry. The team was led by Harald Finger and Pablo Lopez Murphy and comprised R. Sean Craig, Niels-Jakob Hansen, Minsuk Kim, Sanaa Nadeem, Simon Paroutzoglou, Jay Peiris, Tahsin Saadi Sedik, Ananya Shukla, Nour Tawk, Jiae Yoo, and Qianqian Zhang (all from the Asia and Pacific Department (APD) of the International Monetary Fund). The authors are grateful for the production assistance provided by Alessandra Balestieri (APD), Stephen Chukwumah (APD), Houda Berrada (COM), and Linda Long (COM).

The team would like to express its thanks to colleagues in APD (Pragyan Deb, Eugenio Cerutti, Nada Choueiri, Thomas Helbling, Ken Kang, Dan Nyberg, Jochen Schmittmann, and Andy Swiston) for their helpful comments, advice, and insights throughout the process. The paper also benefited from excellent comments from our IMF colleagues in COM (Glenn Gottselig, Cristina Pagan, Keiko Utsunomiya, and Ting Yan), MCM (Purva Khera, Annamaria Kokenyne, Erlend Nier, Thorvadur Olafsson, and Ratna Sahay), RES (Suman Basu and Giovanni Dell'Ariccia), and SPR (Tam Bayoumi, Shakill Hassan, Vladimir Klyuev, Huidan Lin, Rui Mano, and Hui Tong).

Executive Summary

Managing large and volatile capital flows is a central economic challenge in Asian emerging market economies (EMEs) owing to the disruptions engendered by wide swings in the exchange rate and financial conditions. Although freely floating exchange rates have essential insulation properties, currency fluctuations in the presence of domestic financial frictions can also amplify external financial shocks and raise macro-financial stability risks. This paper looks empirically at some economic effects of volatile exchange rates and financial conditions and examines policy responses for managing such volatility.

Although exchange rate fluctuations can absorb shocks, they can in some cases aggravate corporate vulnerabilities and discourage investment, especially in the presence of foreign exchange (FX) liabilities and in countries with shallow financial markets. In addition, domestic financial conditions, partly driven by global factors and exchange rate fluctuations, can raise medium-term financial-stability risks. These findings are supported by firm-level and macro-level analysis indicating that exchange rate and domestic financial shocks have a significant impact on investment and growth, including higher left-tail risks.

Keeping in mind the diversity of policy approaches and frameworks, some common trends in policy reactions emerge. In a setting where exchange rate volatility and financial conditions have real economic consequences, Asian EMEs make extensive use of foreign exchange intervention (FXI) to moderate exchange rate fluctuations in response to volatile capital flows. FXI is used more intensively against more volatile types of flow (for example, portfolio flows), where unhedged balance sheet mismatches are more salient, and where financial markets are shallow.

Monetary policy in Asian EMEs responds to inflation as would be expected, but it also reacts to other variables—notably, the US interest rate (in line with global financial cycle considerations); the exchange rate (particularly when financial markets are relatively less developed); and credit growth. This finding is suggestive of policy interest rate movements responding to multiple objectives.

Macroprudential and capital flow management measures seem to react to external, domestic macro, and domestic financial-stability considerations: the US policy rate, capital flows, inflation, credit growth, and housing-related risks. Policies (often related to housing) are adjusted amid inflow surges as well as during more normal periods.

This paper sheds light on some economic costs that stem from volatile capital flows and exchange rates and analyzes how countries deploy their policy toolkits in response. The data-driven analysis should contribute to ongoing reflections about how to manage volatile capital flows and exchange rates both in Asian EMEs and more broadly.

Introduction

The global financial crisis (GFC) and its aftermath saw large gyrations in cross-border capital flows, rekindling debates on how to deal with these flows. While supporting global growth at a critical time after the GFC, the unconventional monetary policies in advanced economies (AEs) contributed to record amounts of liquidity in the international system, a large part of which was channeled to EMEs in Asia and elsewhere (Figure 1). During periods of tighter global financial conditions and rising risk-off sentiments, such as the "taper tantrum," the region faced large reversals of capital inflows.

Fluctuating tides of capital can be disruptive. While capital flows are generally beneficial for recipient economies, for many EMEs in Asia capital flows can be large compared to the size of domestic financial systems, creating challenges for the efficient allocation of capital. Capital inflow surges can lead to substantial increases in leverage, raising crisis risks (Gourinchas and Obstfeld 2012). Inflows are also often associated with real exchange rate appreciations and deteriorating current account balances, and can exacerbate economic cycles, deepening downturns when inflows reverse (Cardarelli, Elekdag, and Kose 2010).

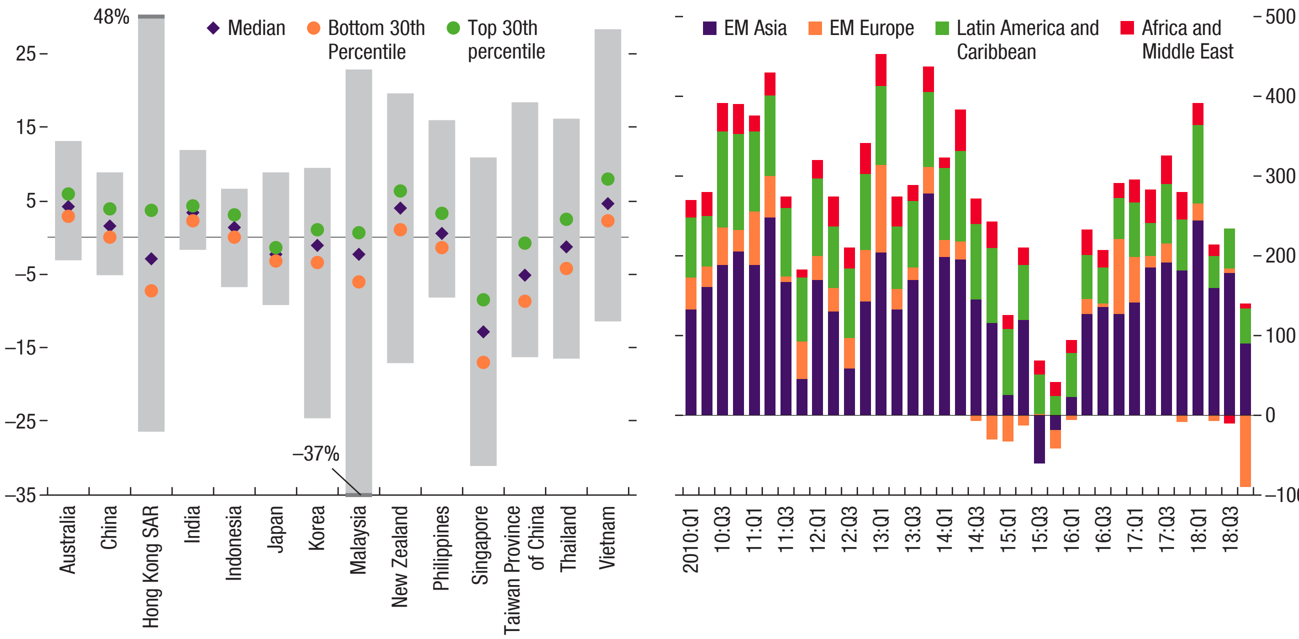
Large and volatile capital flows can weaken monetary policy as a stabilization tool. Portfolio flows driven by the global financial cycle can influence domestic financial conditions and weaken the ability of monetary policy to regulate the domestic economy (Figure 2; Ostry and others 2012; and Corbacho and Peiris 2018). This can undermine monetary policy independence and reduce the insulating properties of floating exchange rates (Rey 2015).

The impact of capital flows on the exchange rate is a central economic policy challenge for Asian EMEs. The exchange rate is a key variable influencing competitiveness, balance sheets, inflation, and the credibility of the monetary policy framework. Volatile flows contribute to exchange rate fluctuations that may become more disruptive in the presence of financial frictions (Figure 3).

Figure 1. Capital Flows Have Been Large in Relation to the Size of Recipient Economies

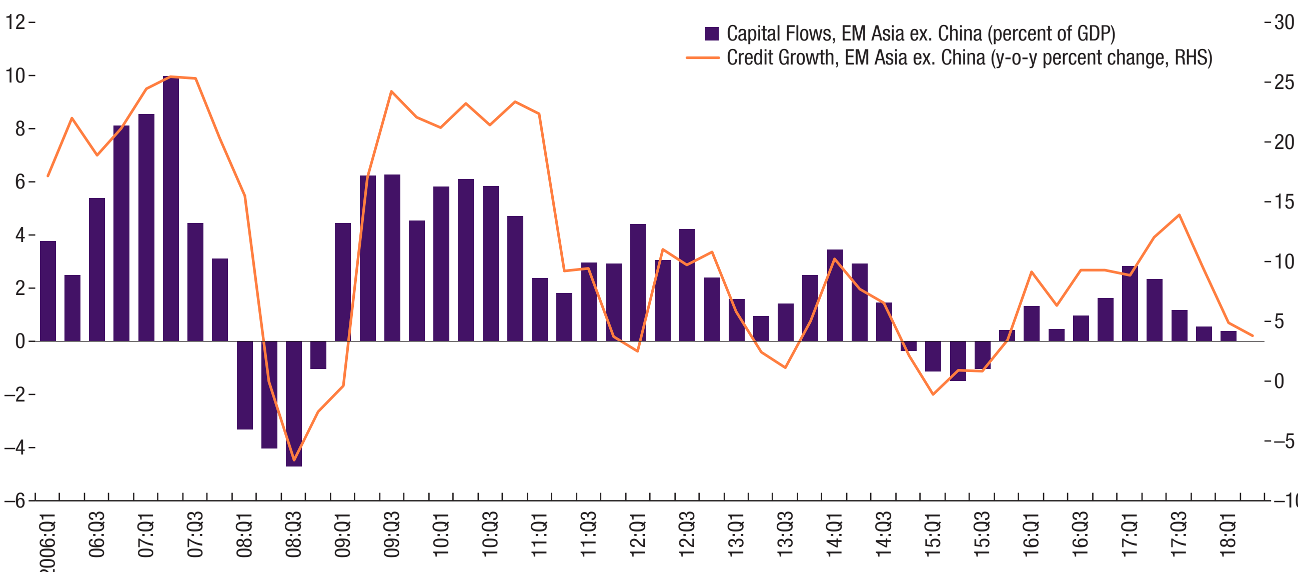
1. Total Net Capital Flows to Asia
(Percent of GDP; 2000:Q1–18:Q4)

2. Regional Capital Inflows
(In billions of US dollars)



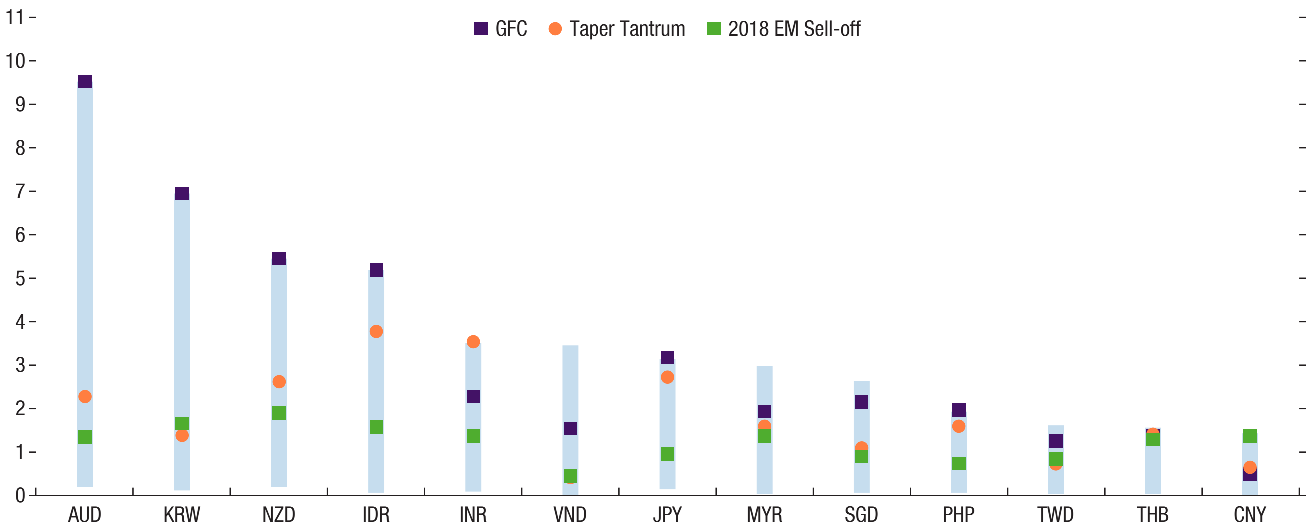
Sources: Balance of Payments Statistics and IMF staff estimates; IMF *Financial Flows Analytics* and staff calculations.
Note: The left figure shows quarterly net capital flows to Asian countries in percent of quarterly GDP. The gray bars represent the maximum and minimum values for quarterly net capital flows between 2000:Q1 and 2018:Q4, whereas the dots represent the median, top 30th, and bottom 30th percentiles for net capital flows. Maximum value for Hong Kong SAR (48) and minimum value for Malaysia (–37) are not fully visible on the chart. The right figure shows quarterly nonresident capital flows in billions of US dollars.

Figure 2. Capital Flows Can Drive Domestic Financial Conditions
(Percent of GDP, left scale; year-over-year percent change, right scale)



Sources: Haver Analytics; IMF, World Economic Outlook; and IMF staff calculations.
Note: Bars are calculated as a four-quarter moving average of portfolio capital inflows, weighted by GDP. Credit growth is calculated using a weighted average of year-on-year credit growth.

Figure 3. Capital Flows Can Lead to Exchange Rate Volatility
(Exchange rate volatilities, 2006–19, coefficient of variation, percent)



Source: IMF staff estimates.
Note: Realized exchange rate volatility is measured as the coefficient of variation for the daily bilateral exchange rate vis-à-vis the US dollar using three-week rolling windows. The blue bars show the maximum volatility for the period of 2006–19. The purple, orange, and green dots show volatility during episodes of financial turbulence.

Many Asian EMEs are de facto "flexible" inflation targeters with quasi-managed floats. While policy frameworks and policy approaches differ, in the face of shifts in global market sentiment these EMEs have often pursued simultaneously multiple objectives of price, growth, and financial stability, using multiple instruments.

Policymakers have used four main tools to address the challenges posed by capital flows: monetary (interest rate) policy; exchange rate policy; macroprudential measures (MPMs); and capital flow management measures (CFMs) (Ghosh, Ostry, and Qureshi 2017a). Fiscal policy is generally seen as an insufficiently nimble instrument to address volatile capital flows; its role is not discussed in this paper. In deploying the four main tools, some have claimed there is a "natural mapping" between instruments and objectives (Blanchard and others 2014; Ghosh, Ostry and Qureshi 2017b): monetary policy targets inflation, foreign exchange intervention (FXI) is geared to manage the currency's value in the exchanges, and macroprudential measures are used to control financial-stability risks (related to rapid credit growth and in sectors such as housing). CFMs can play a role when these other policies are constrained (Ostry and others 2011).[1] This mapping is not the only one

[1]The IMF's Institutional View on Capital Flow Management (IMF 2012) provides a framework for how CFMs can be used in combination with other policies, when the latter are constrained.

possible between targets and instruments, of course. Policymakers may follow a more eclectic approach, deploying instruments to multiple targets in a manner that is less-easily summarized.

This paper aims to shed light on how Asian countries deploy policies to manage external financial shocks. While recognizing the diversity of country experiences across Asia, it seeks to identify common trends in policy responses among Asian EMEs. It aims to document stylized facts about the impact of exchange rate fluctuations and changing domestic financial conditions driven by volatile capital flows, as well as countries' monetary, exchange rate, macroprudential, and capital flow management policy responses. By identifying common aspects of policy responses using panel estimation and other techniques, the paper aims to fill a gap in our understanding of how Asian countries tend to respond to external shocks, which can serve as a building block for developing a view on appropriate policies.

Main findings include the following:

- Large and volatile capital flows exert significant pressure on exchange rates in Asian EMEs.
- While the exchange rate is normally viewed as an absorber of economic shocks, under certain circumstances it can act as a shock amplifier. Exchange rate depreciation can aggravate corporate vulnerabilities and discourage firm-level investment, especially where FX debt is significant and financial markets are shallow, limiting hedging opportunities. This finding is mirrored at the macro level, where exchange rate depreciation is found to have a significant negative impact on investment and growth.
- Faced with a global capital flow cycle, Asian EMEs have deployed multiple policy instruments, often deviating from traditional policy frameworks.
- The management of currency fluctuations using FXI is widespread. FXI is used more heavily when financial markets are shallow and FX liabilities are larger and unhedged. FXI is used more intensely for types of flows that are inherently more volatile (for example, portfolio flows).
- Monetary policy reacts to standard Taylor rule variables, including inflation and the output gap, but also to an array of external and domestic influences, including the US policy rate, capital flows, the exchange rate, and credit growth.
- MPMs likewise are responsive to an array of domestic and external influences, including credit growth, inflation, the US policy rate, and capital flows. CFMs have been adjusted a limited number of times and in response mostly to large increases in domestic house prices, reflecting authorities' concerns that cross-border flows have materially impacted these prices.

CHAPTER

1 Exchange Rate: Shock Absorber or Amplifier?

Currency depreciations can have opposing effects on domestic economic activity through a variety of channels.

- **Competitiveness channel**. Depreciation makes exporting goods cheaper, improving international competitiveness and boosting economic activity. Fluctuations in the real exchange rate can also affect corporate investment and firm growth through an internal financing channel (Dao, Minoiu, and Ostry 2017). However, the short-term response of trade flows to exchange rate movements can be asymmetric, reducing imports but exerting little immediate effect on exports due to trade pricing in dominant currencies (Gopinath 2015, Casas and others 2016). Finally, the relationship between exchange rate adjustment and trade flows may have been weakened by the buildup of global value chains (Amiti, Itskhoki, and Konings 2012).
- **Financial channels**. Financial channels arise from financial frictions and balance sheet mismatches. Their role can generally be captured using financial conditions indices (FCIs) and balance sheet indicators. A key amplification mechanism results from currency mismatches, where depreciation makes borrowers' debt burdens heavier when the firm borrows in foreign currency. Similarly, when foreign investors hold a large fraction of local-currency debt, depreciation may tighten domestic financial conditions, exerting a contractionary effect on economic activity. Another channel (the aggregate lending channel) operates in the same direction—weaker balance sheets of banks impair their capacity to lend and reduce firms' access to finance (Bruno and Shin 2015; Chen, Nadeem, and Peiris forthcoming). Finally, depreciation can negatively affect global value chains (GVCs). A stronger dollar tightens credit conditions, impairing firms' ability to meet the often-significant financing requirements inherent in maintaining complex value chains, thereby potentially shortening them (Bruno, Kim, and Shin 2018).

Micro-level Evidence

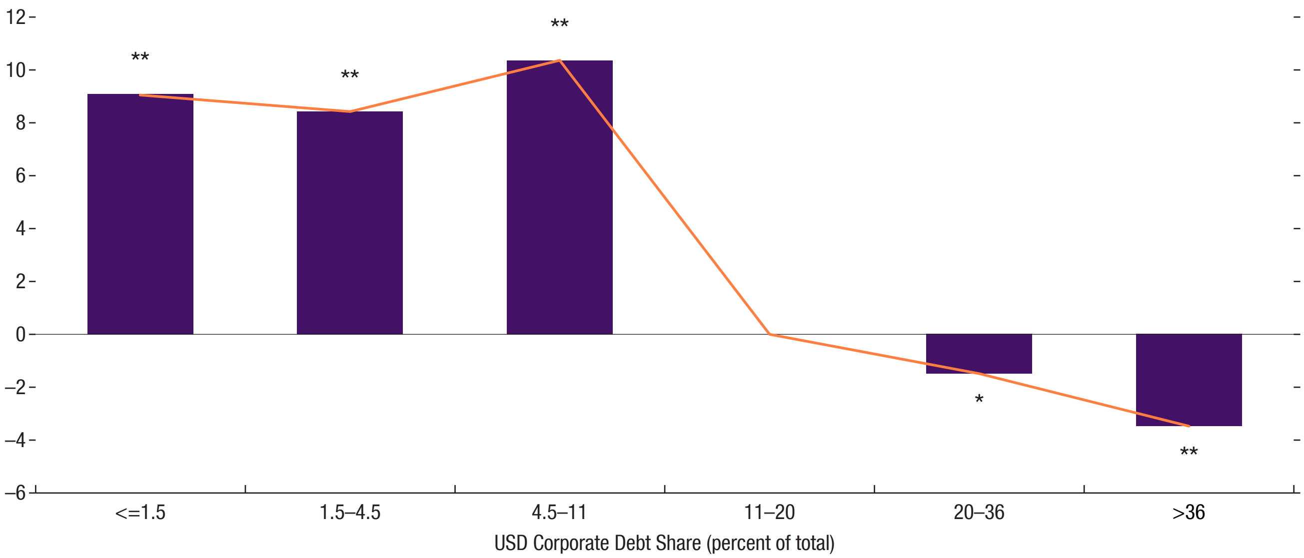
Currency depreciations can be an important driver of corporate financial vulnerabilities in Asian EMEs. Using a firm-level database of 12 Asian economies during 1994–2016, corporate vulnerability is estimated by computing a summary indicator based on financial ratios that encapsulate profitability, leverage, liquidity, and solvency (Annex 1, Jiang and Saadi Sedik 2019). This indicator can be interpreted as proxying for a firm's probability of default. The analysis shows that a 30 percent domestic currency depreciation against the US dollar is associated with 7 percent of firms in the sample moving into the category of high probability of default. The debt burden of firms with FX liabilities becomes heavier after the depreciation, which could generate financial distress in some of them. Moreover, the marginal impact of a currency depreciation on corporate vulnerability is stronger when the share of FX debt in firms' balance sheets is higher. Such corporate financial distress could spill over into the financial system by weakening banks' balance sheets.[1]

Currency depreciations discourage investment in firms with large FX liabilities. Although currency depreciation is associated with higher firm-level investment on average, the relationship reverses for firms with large FX liabilities, where investment contracts with a depreciation. As firms' FX liabilities increase, the financial channel of the exchange rate increasingly dominates the competitiveness channel. Figure 4 shows that when Asian EME firms' share of FX-denominated debt exceeds 20 percent, an exchange rate depreciation is associated with lower firm-level investment. The effect is more significant in firms that do not export, as they do not benefit from the positive impact of currency depreciation on competitiveness and do not have natural hedging (Annex 1).

The degree of financial development is an important driver of the transmission of exchange rate shocks to firms' investment decisions. A firm-level empirical analysis of 21 economies shows that the degree of financial development determines the extent to which exchange rate volatility is associated with lower investment (Annex 2, Kim 2019). In a depreciation, higher FX liabilities tend to weaken balance sheets of companies operating in countries with relatively less-developed financial markets, where hedging opportunities are more limited, constrained or costly. Through this financial channel, depreciation can act as a drag on firms' investment in countries with

[1]As the exchange rate is an endogenous variable, relationships discussed here may not necessarily be causal as some shocks (not controlled for in the estimation) may drive both the exchange rate and firm-level effects. Also, for purposes of exposition, we focus primarily on the impact of currency depreciation, but currency appreciation can also be detrimental to macro-financial stability as rapid appreciations relax firms' financing constraints and may attract additional capital flows, fueling a near-term boom that can end in a bust with large currency depreciation.

Figure 4. The Exchange Rate as a Shock Amplifier
(Impact of a 10 percent exchange rate depreciation on investment at the firm level, percent)



Source: IMF staff estimates.
Note: This chart shows the impact of 10 percent exchange rate depreciation on firm-level investment (in percent) for different levels of firms' foreign exchange debt as a share of total debt. The results are based on Annex Table 1.3.

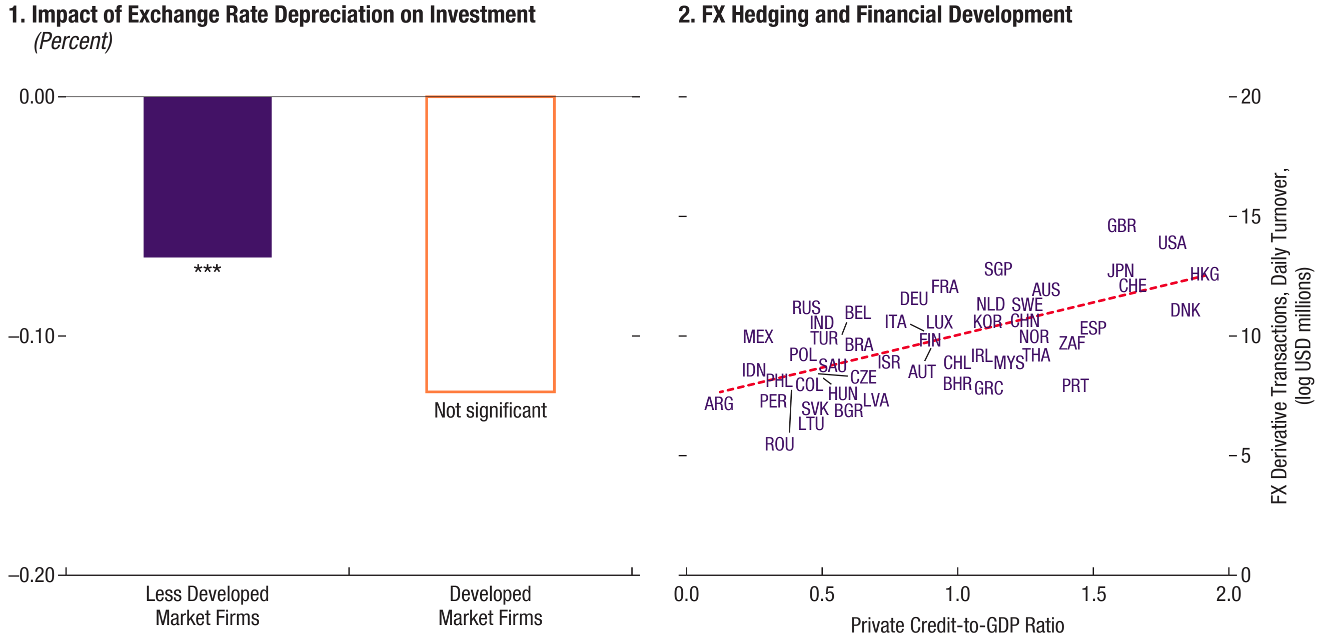
less-developed financial markets. In contrast, there is no statistically significant impact in countries with more-developed financial markets (Figure 5).[2]

Macro-level Evidence

Macroeconomic evidence is in line with the firm-level evidence on the transmission of exchange rate shocks and financial conditions to the real economy in Asian EMEs. The dynamic effects of exchange rate shocks on the investment-to-GDP ratio and growth are quantified using the Local Projection (LP) method (Jordà 2005, Annex 3). Results indicate that exchange rate depreciations have large effects on the investment ratio in Asian countries with less-developed financial markets but not in those with well-developed markets. Figure 6, Panel 2 shows that a 1 percent real depreciation lowers the investment ratio by 0.6 percent when markets are shallow (that is, for a credit-to-GDP ratio below 100 percent, which is the threshold identified above in the micro-level analysis), while the effect is not statistically significant otherwise (Panel 1). A similar pattern is observed in Panels 3 and 4, which portray GDP growth, though the impact in shallow financial markets is more short-lived for

[2]Hong and others (2019) find a similar result: the impact of a US dollar funding shock on domestic financial conditions depends on the degree of substitutability with domestic liabilities.

Figure 5. Financial Development Softens the Drag from Depreciation



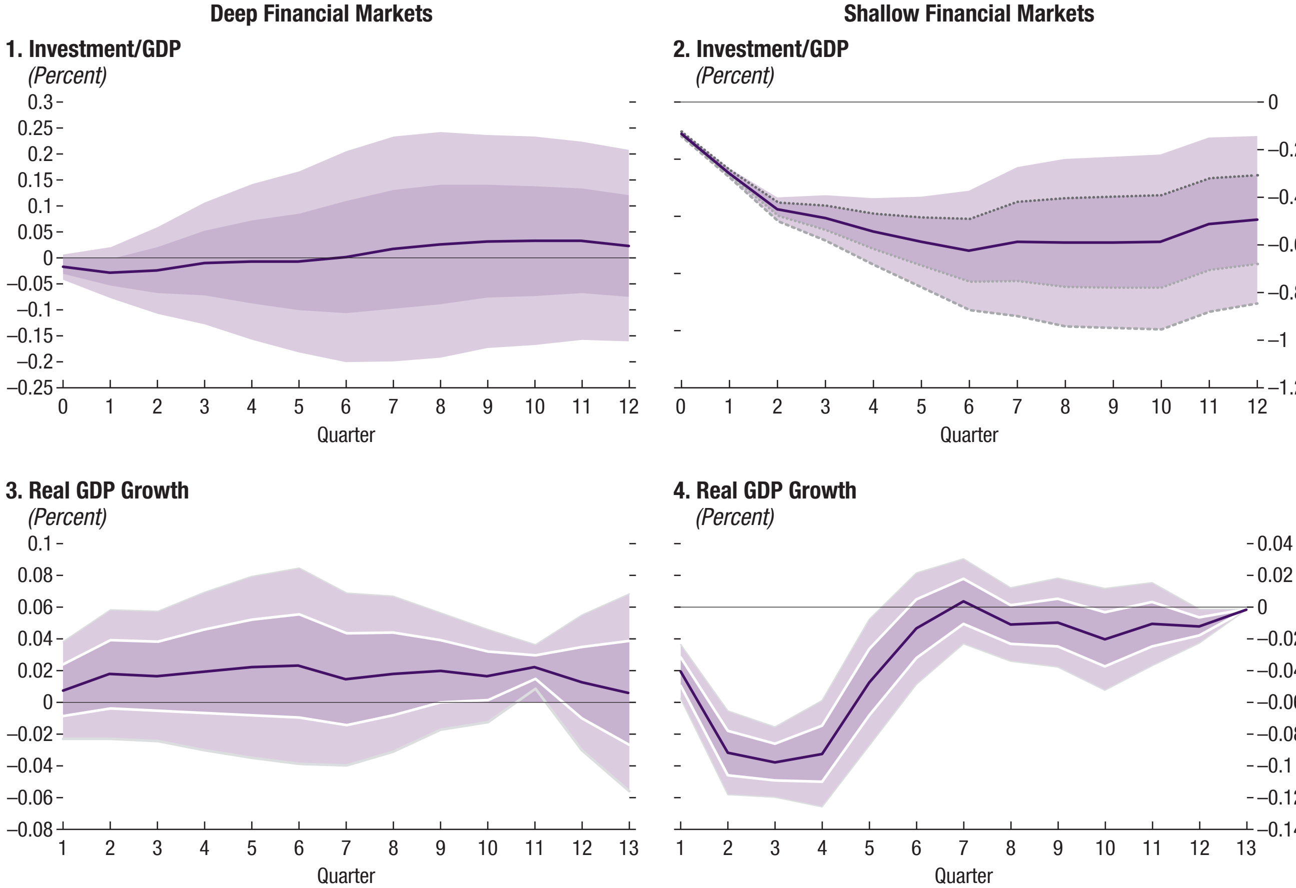
Source: Bank of International Settlements; and IMF staff estimates.
Note: Bars represent the estimated regression coefficients for the impact of real exchange rate depreciation on firms' investment in samples of companies in countries with less developed financial markets (credit-to-GDP ratio below 100 percent; left) and more developed financial markets (right).

GDP than for investment, as the competitiveness channel of depreciation gains traction through time (and offsets the balance sheet or financial channel). Consistent with the results for exchange rate depreciations, high nominal exchange rate volatility also exerts negative effects on investment and growth, particularly in countries with less-developed financial markets where hedging may not be readily available (Annex 3).

Growth-at-Risk

Exchange rate volatility affects the distribution of future GDP growth outcomes in Asian EMEs and growth-at-risk (left-tail growth). The impact of exchange rate changes on the conditional distribution of future GDP growth outcomes is assessed using an extended version of the growth-at-risk (GaR) framework (see Adrian, Boyarchenko, and Giannone 2019, IMF 2017a, and Annex 4). Exchange rate fluctuations are an important driver of the growth distribution, controlling for other financial conditions. Moreover, in many cases, for less-financially developed economies, the exchange rate affects the growth distribution more than domestic financial conditions (FCIs), which, in the GaR literature, are taken to be the key driver of the growth distribu-

Figure 6. Economic Loss from Depreciation Is Significant in Asian Countries with Less-Developed Financial Markets



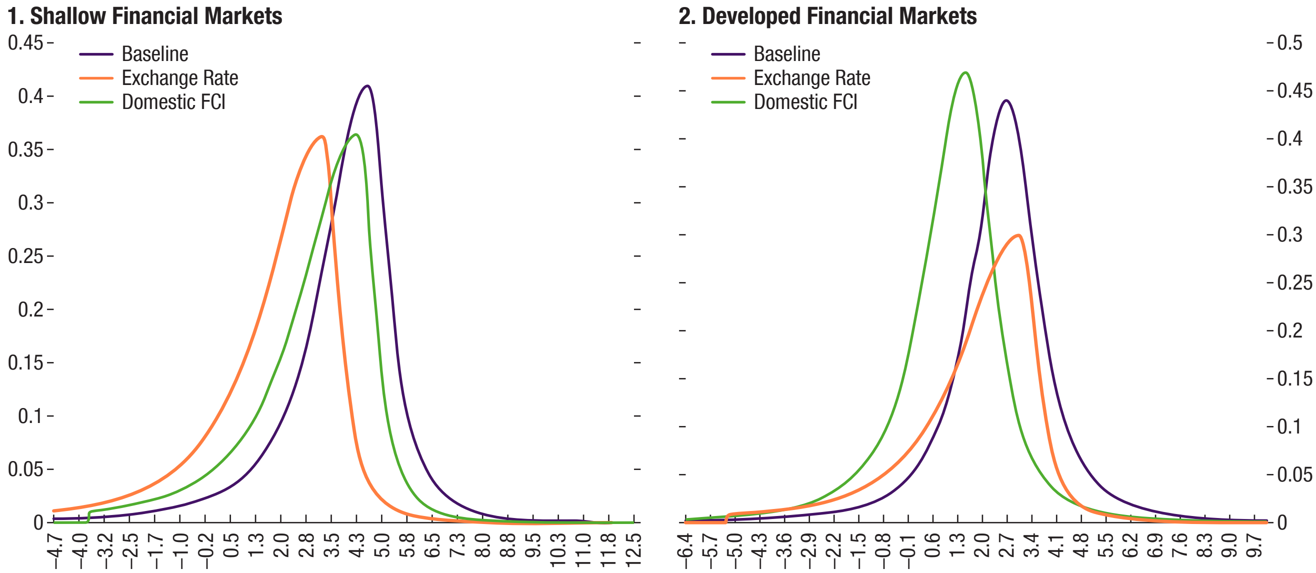
Source: IMF staff estimates.
Note: To isolate the impact of exchange rate changes on investment and growth, the impulse responses control for overall financial conditions (using the financial conditions index) and changes in the terms of trade.

tion. This is shown in Figure 7 by the larger leftward shift of the distribution as result of an exchange rate depreciation shock than a tightening of domestic conditions (Figure 7, Panel 1) for Indonesia. When financial markets are deep, such as in Korea, domestic FCI shocks have a much stronger effect on the growth distribution than exchange rate shocks (Panel 2).[3]

Global risk-on episodes amplify medium-term left-tail risks in Asia. An easing of financial conditions—through either a loosening in domestic financial conditions or an exchange rate appreciation and/or a reduction of exchange rate volatility—helps limit downside risks to growth in the near-term. How-

[3]Shifts in the growth distribution are not comparable between countries as the magnitude of shocks is country-specific.

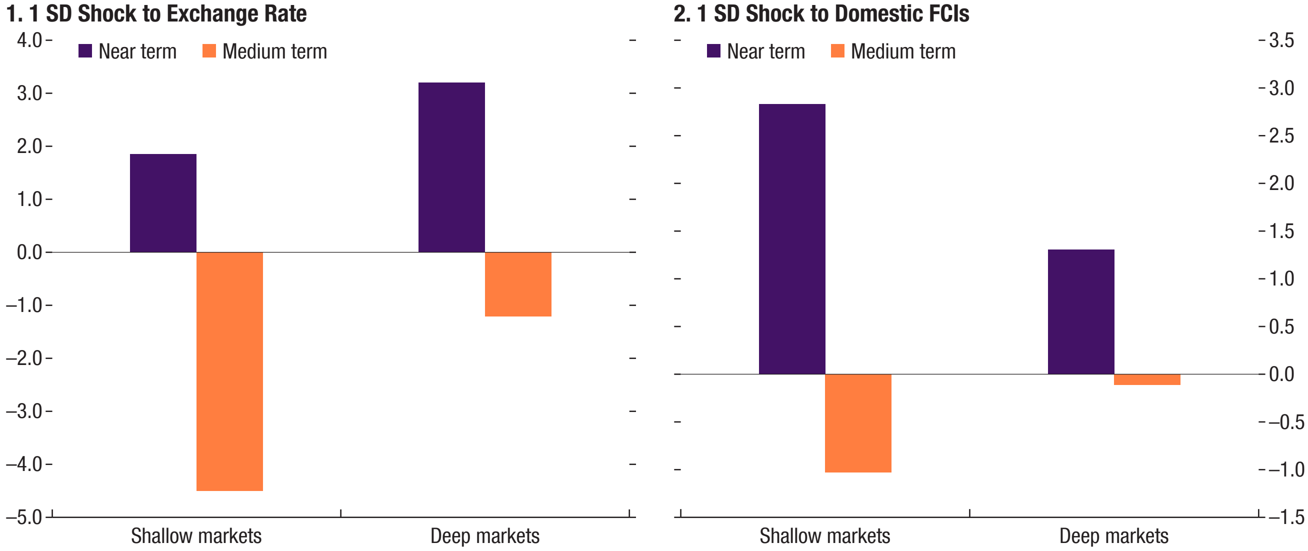
Figure 7. Growth-at-Risk: Exchange Rate Shocks Versus Domestic Financial Conditions Shocks in Asian Emerging Markets
(Growth distribution after a one-standard-deviation shock to the exchange rate or domestic FCI)



Source: IMF staff estimates.

ever, loose financial conditions and lower exchange rate volatility in the near term tend to amplify risks to growth over the medium term. Figure 8 shows the estimated 5th percentile of the growth distribution (that is, the left tail) in the near- and medium-term when subject to favorable near-term external and domestic financial shocks. There is a sizable decline in the 5th percentile of the growth distribution over the medium term, that is, a significant leftward shift of the left tail, indicating heightened risks to growth over the medium term.

Figure 8. Shifts in the Growth Distribution in Response to Easing Shocks



Source: IMF staff estimates.
Note: These charts plot changes in the 5th percentile of the estimated growth distribution (GAR5%) in response to favorable exchange rate and domestic financial conditions index (FCI) shocks in the near- and medium-term, compared to the initial baseline. A positive (negative) bar suggests that the GAR5% increased (decreased) relative to the initial near-term baseline distribution, that is, the distribution has shifted to the right (left). The purple bars are changes in the GAR5% in the near term, whereas the orange bars show the change over the medium term. The medium term refers to the number quarters ahead (8, 12, or 16) in which the decline in the GAR5% is the largest relative to the near term (four quarters ahead).

CHAPTER

2 Policy Responses in Asian EMEs

A Bird's Eye View

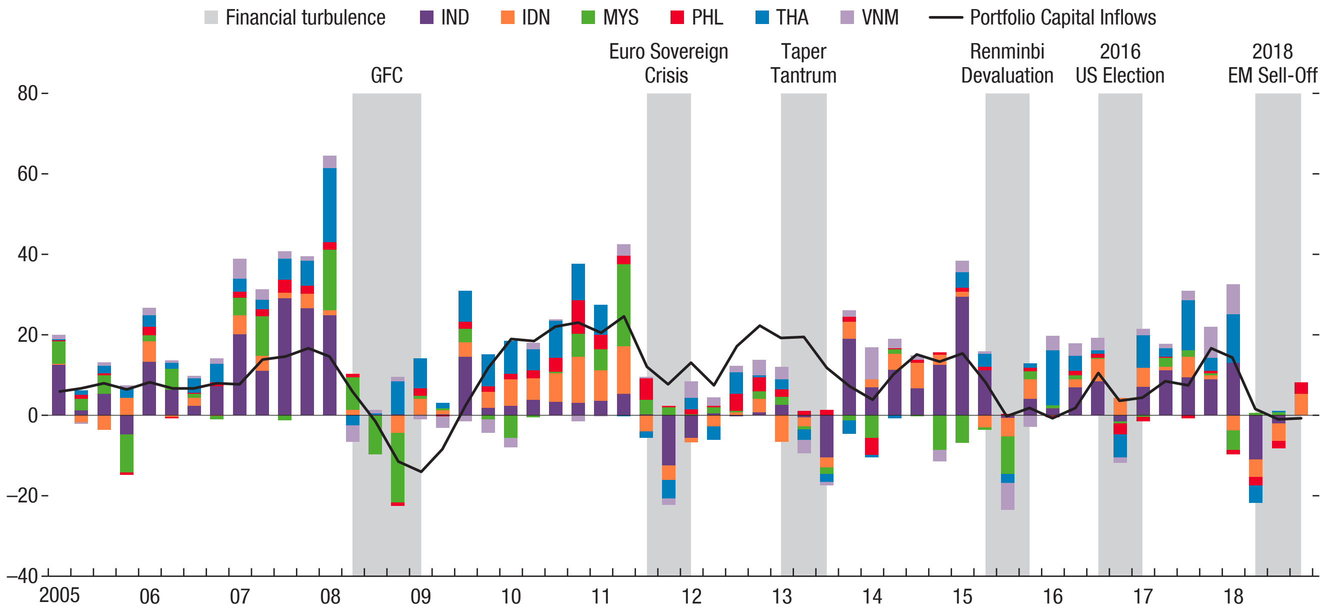
Asian EMEs rely substantially on FXI when responding to capital flows (Figure 9). Countries tend to accumulate foreign reserves when they are receiving capital inflows and decumulate during outflows.

Policy interest rates display considerable synchronization across Asian economies, in association with US policy rates (Figure 10). This could reflect a lack of policy autonomy even under floating exchange rates owing to the global financial cycle (Rey 2015), active management of exchange rates by Asian countries, or some combination. It could also reflect some degree of synchronization in business cycles.

Macroprudential policy appears to respond to the global financial cycle (Figure 11). During risk-on episodes, such as in the years before the GFC and again when capital flows resumed in 2010/11, tightening was more aggressive and concentrated in instruments targeting liquidity and credit demand. In the post-GFC period when capital inflows slowed, the pace of MPM tightening actions eased and shifted toward MPMs aimed at strengthening banking system capitalization (Figure 11).

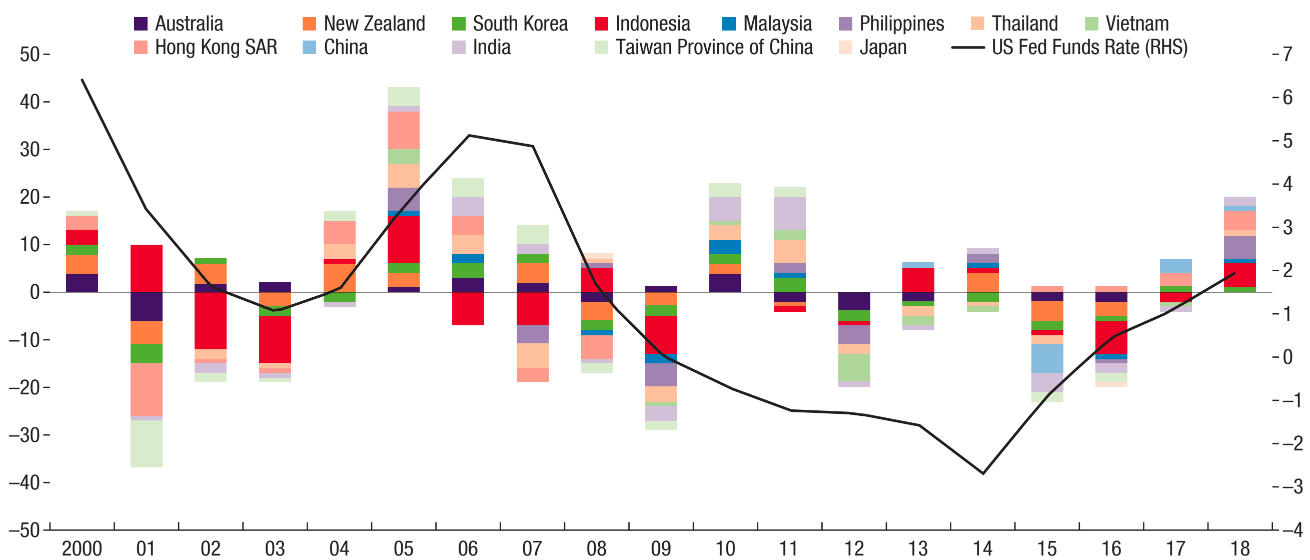
CFMs generally have been used to a limited extent. CFMs adopted by Asian economies since 2013 can be classified in nine distinct types (Figure 12). They have been used less frequently than MPMs and applied more often to inflows than to outflows. Stamp duties to curb rising property prices have been a favored measure, particularly in advanced economies. CFMs on inflows and outflows have generally been used in a complementary way. While easing of CFMs on outflows can be associated with capital account liberalization, countries tightening inflow CFMs tend to loosen outflow CFMs in tandem, which also helps mitigate net inflows.

Figure 9. Foreign Exchange Intervention Absorbs Significant Amounts of Capital Flows
(Foreign exchange reserve flows, emerging Asia, billions of USD)



Sources: IMF, Balance of Payments database; and IMF staff calculations.
Note: Episodes of financial turbulence are identified using a composite index of indicators of financial conditions. Data on foreign exchange reserve flows (as proxy for foreign exchange intervention) are obtained from the balance of payments statistics, which exclude valuation changes (changes in positions due to exchange rate and other price changes). These data do not cover intervention in derivative markets or by entities other than the central bank. Data labels in the figure use International Organization for Standardization (ISO) country codes.

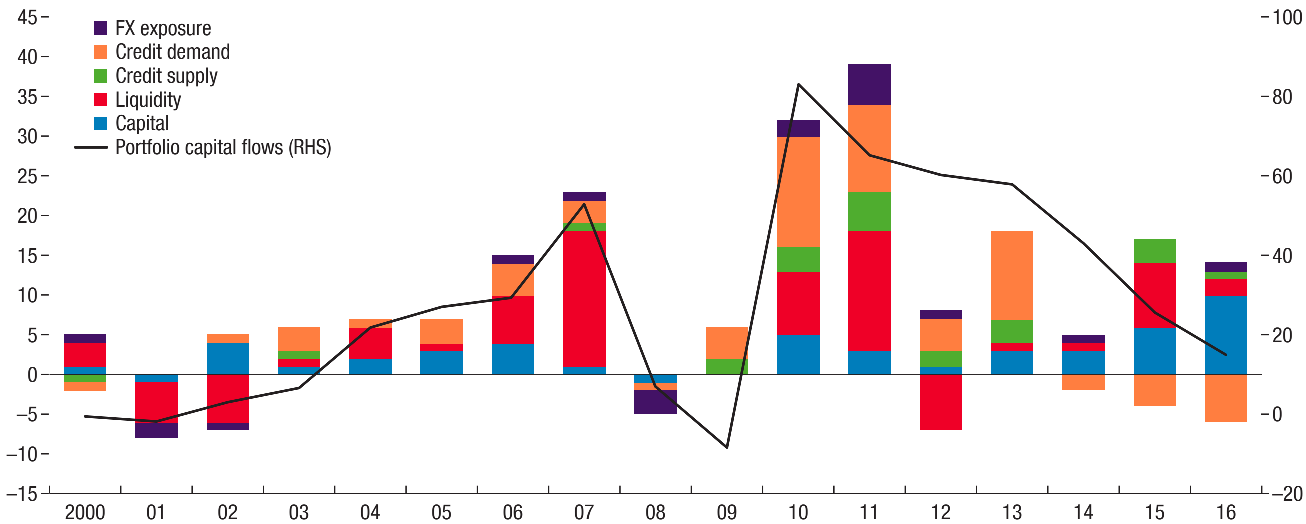
Figure 10. Asian Monetary Policy Action Often Follows the United States
(Frequency of policy rate actions, 2000–18)



Sources: Bloomerg L.P., Haver Analytics and IMF staff estimates.
Note: The US interest rate is combined with the Wu-Xia shadow rate for the period during which it was at the zero-lower-bound. Bars indicate the cumulative number of monetary policy actions (tightening = 1, loosening = –1, and holding = 0).

Figure 11. Macroprudential Measures Were Tightened in Periods of Strong Capital Inflows

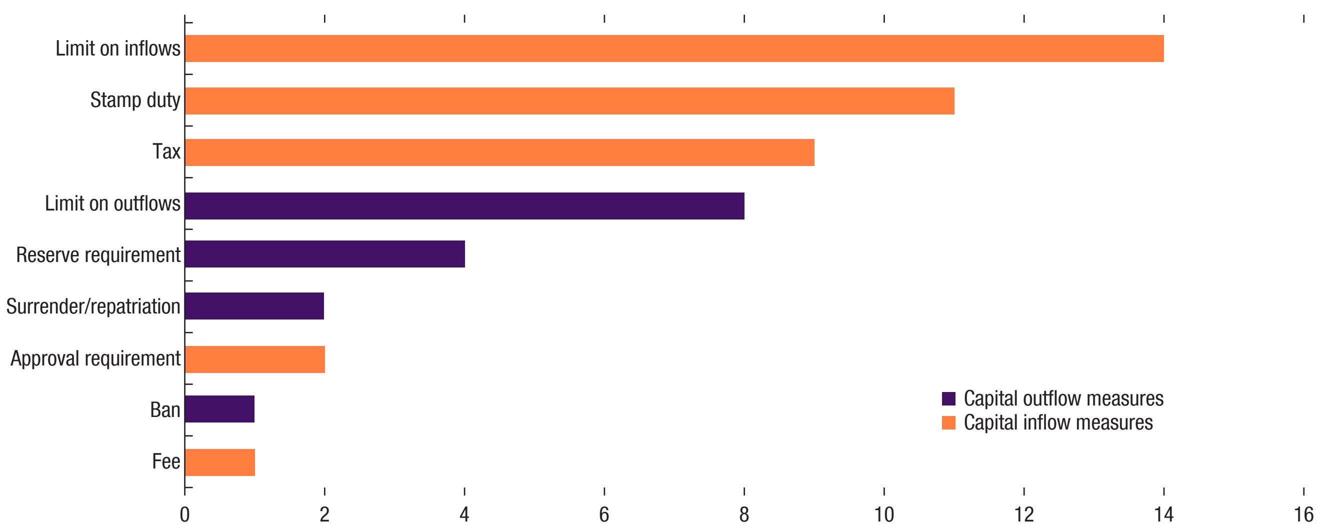
(Use of MPMs in Asia, 2000–16)



Sources: IMF MPM database and staff calculations.
Note: The chart shows the net sum of macroprudential measure (MPM) tightening and loosening actions in each year for 17 different types of MPMs. These have been grouped into five categories that reflect how the different MPMs affect the financial system.

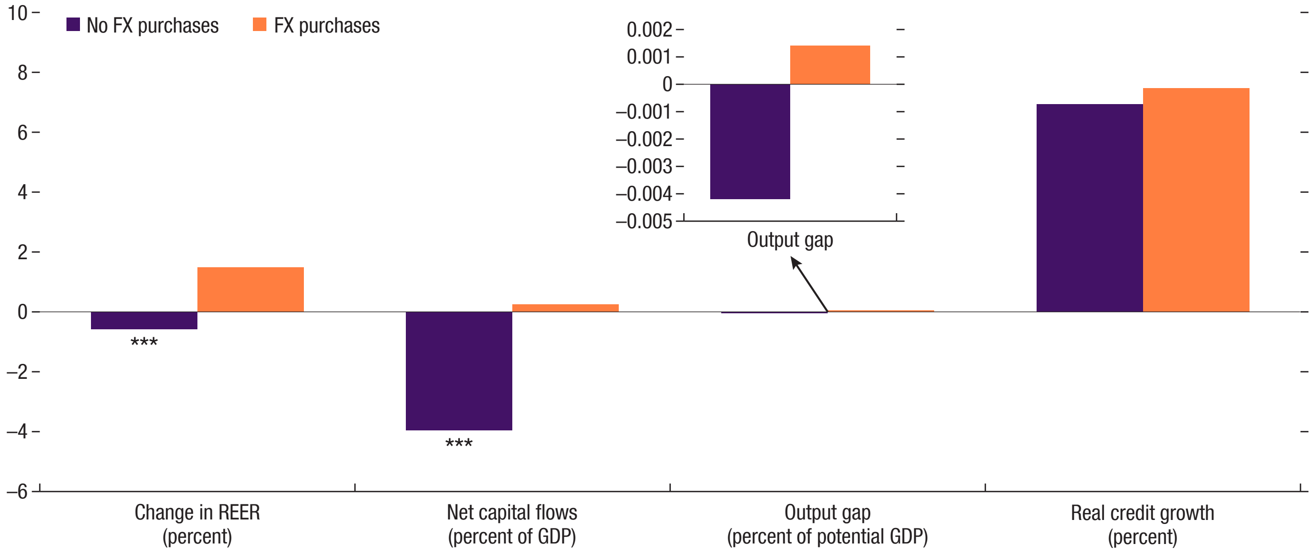
Figure 12. Capital Flow Management Measures Are Dominated by Inflow Measures, Often Targeting Real Estate

(Capital flow management measures in Asia, 2010–8, number of measures per type)



Source: IMF 2018 Taxonomy of CFMs.

Figure 13. Foreign Exchange Intervention Is Responsive to Exchange Rates and Capital Flows
(Macroeconomic developments and foreign exchange intervention, 2000–18)



Source: IMF staff estimates.
Note: Bars show the average year-on-year change in the real effective exchange rate (percent), net capital flows (percent of GDP), output gap (percent of potential GDP), and real credit growth (percent) when central banks purchase foreign exchange (FX; orange bars) and when they do not (purple bars). Stars indicate a statistically significant difference between the FX purchase and no FX purchase cases.

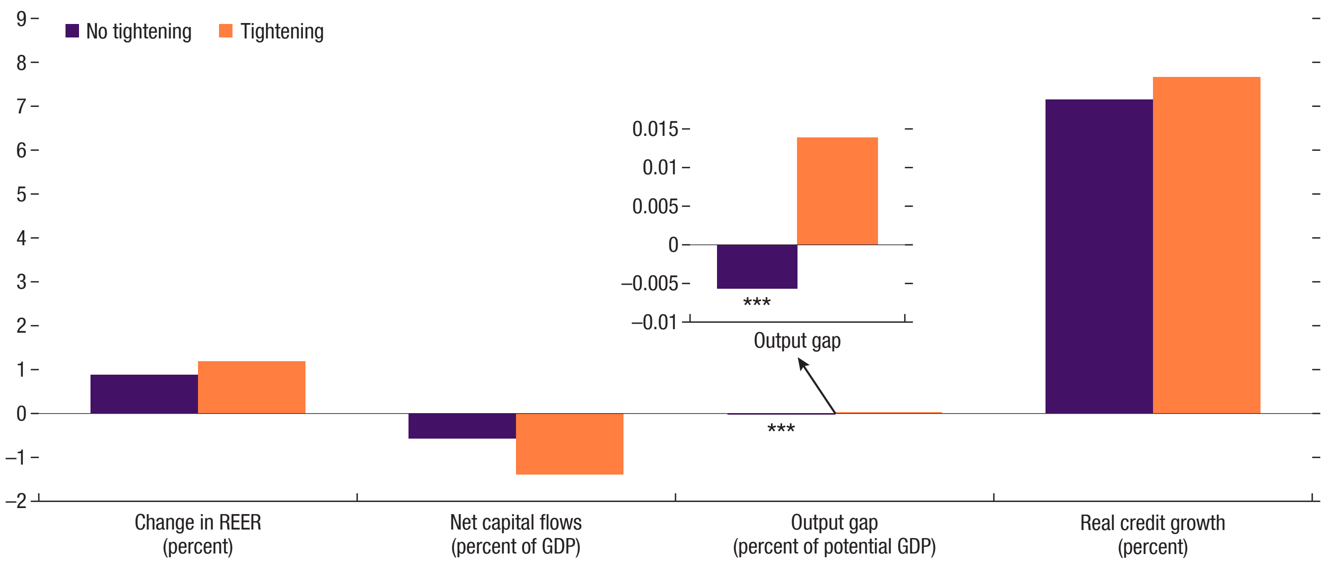
Links Between Instruments and Risks

There is a mapping between instruments and risks. This mapping can be gleaned by examining differences in the behavior of real exchange rates, capital flows, output gaps, and credit growth when certain policy instruments are used relative to when they are not used. Before estimating policy reaction functions that capture this link and control for different variables, we take a look at broad insights from the data in a model-free setting.

Foreign exchange intervention is employed in periods of exchange rate appreciation and capital inflows. Figure 13 shows macroeconomic developments (that is, the real exchange rate, capital inflows, the output gap, and credit growth) during times when central banks accumulate reserves (orange bars) versus when they do not (purple bars). There is a statistically significant difference in real exchange rate dynamics and net capital inflows during reserve accumulation periods versus non-accumulation periods.

Monetary policy reacts somewhat to output gaps. Figure 14 shows the macroeconomic environment when central banks increase policy rates (orange bars) and when they do not (purple bars). Output gaps tend to be slightly more positive when policy is tightened.

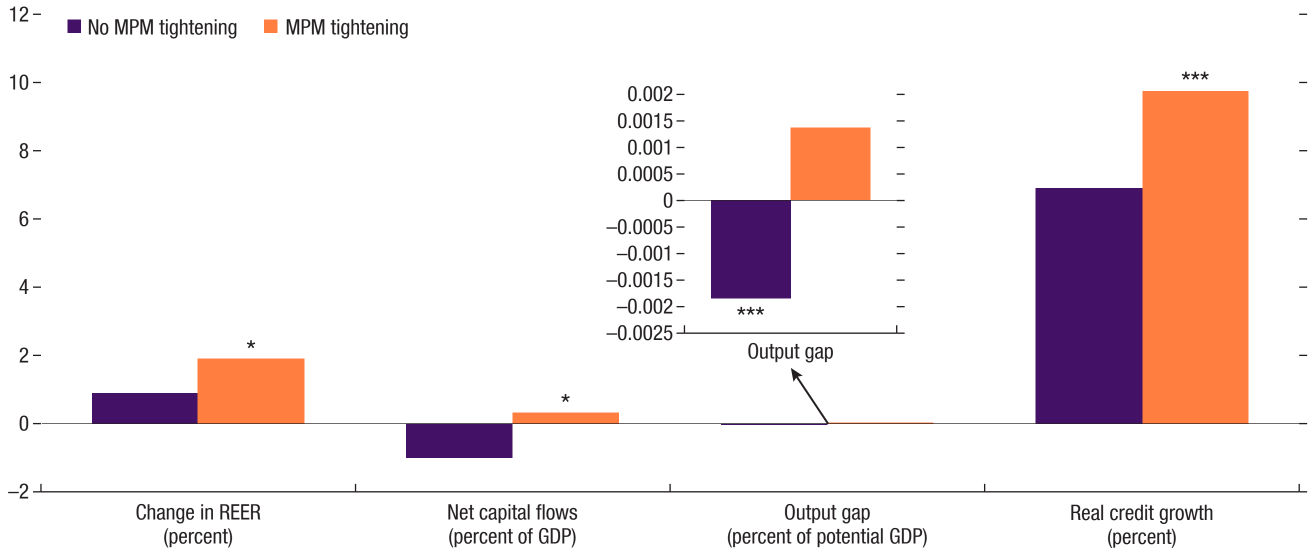
Figure 14. Monetary Policy Reacts to the Output Gap
(Macroeconomic developments and policy rate tightening, 2000–18)



Source: IMF staff estimates.
Note: Bars show the average year-on-year change in the real effective exchange rate (percent), net capital flows (percent of GDP), output gap (percent of potential GDP), and real credit growth (percent) when central banks tighten the policy rate (orange bars) and when they do not (purple bars). Stars indicate a statistically significant difference between when policy rate are increased and when they are not.

Macroprudential policy appears to respond to domestic and external financial developments. Figure 15 shows the macroeconomic environment when MPMs are tightened (orange bars) or not (purple bars). MPMs are tightened in periods of more rapid domestic credit growth, when the real exchange rate is appreciating, and when net capital inflows are positive. They are less likely to be tightened when there is a negative output gap.

Figure 15. Macroprudential Measures Are Prompted by Financial Stability and External Drivers
(Macroeconomic developments and MPM tightening, 2000–16)



Source: IMF staff estimates.
Note: Bars show the average year-on-year change in the real effective exchange rate (percent), net capital flows (percent of GDP), output gap (percent of potential GDP), and real credit growth (percent) when central banks tighten macroprudential measures (MPMs; orange bars) and when they do not (purple bars). Stars indicate a statistically significant difference between when MPMs are tightened or not.

Chapter

3 Estimated Policy Reaction Functions

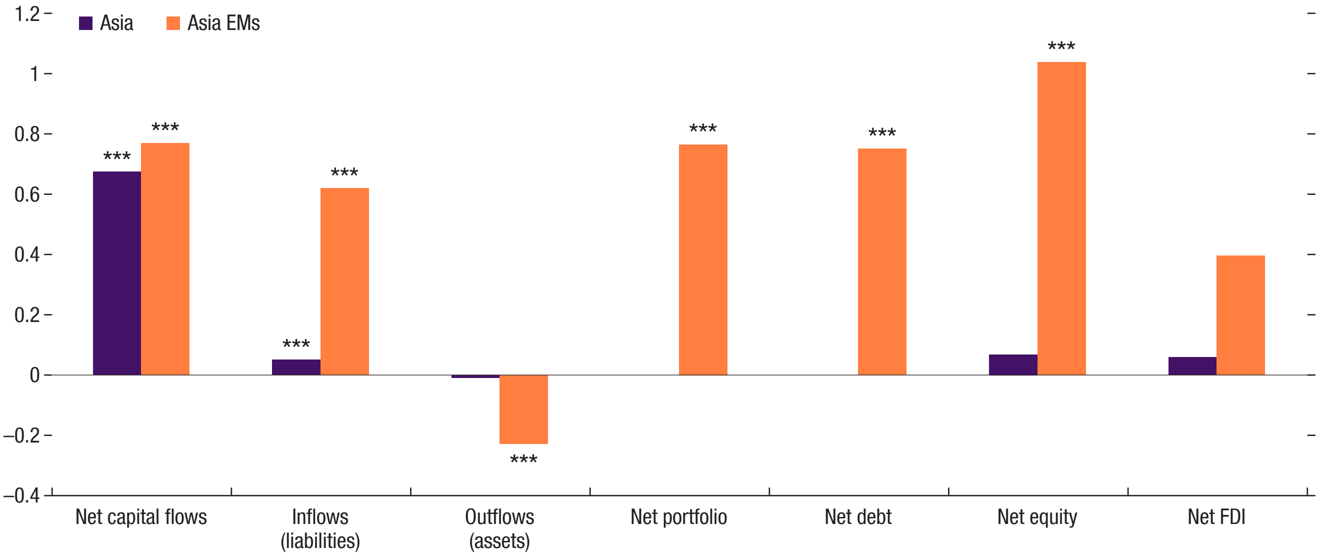
Policy reaction functions are estimated for the main policy instruments: policy interest rates, FXI, and MPMs. Their purpose is to go beyond the data analysis in the previous section by controlling for a variety of possible determinants of policy changes. Reaction functions can be thought of as "augmented" Taylor rules, covering not only interest rate responses, but also the other policy instruments. Policy reactions functions—in the tradition of the established empirical monetary policy literature on Taylor rules—are estimated following the approach in Ghosh, Ostry, and Qureshi (2017) for Asia as a whole and a common set of EMEs. The regressions are run for 13 Asian economies using quarterly data during 2000–18. Policy responses are regressed on: net capital flows or its components (percent of GDP); global factors (such as global market uncertainty proxied by the VIX index, commodity prices, and the US policy interest rate); and relevant domestic control variables (such as the output gap, inflation, credit growth, etc.). Annex 5 presents detailed results, including variations of the reaction function specifications that confirm the robustness of the presented findings.

FXI Absorbs a Large Share of Capital Flows

Estimation of a policy reaction function for FXI confirms that intervention reacts strongly to net capital flows. On average, FXI absorbs about 70 percent of net capital inflows, mainly driven by the EME part of the sample and by the response to nonresident liability flows more than resident asset flows.

FXI is used more actively in response to volatile, riskier types of flows. FXI absorbs a greater proportion of portfolio flows compared to total flows. Asian EMEs purchase about 75 percent of portfolio debt flows and 100 percent of portfolio equity flows. In contrast, FXI is not systematically used to absorb

Figure 16. Foreign Exchange Intervention Response by Type of Capital Flow
(Coefficient, percent)



Source: IMF staff estimates.
Note: The chart shows the response of foreign exchange intervention by type of capital flow. The *y* axis shows the coefficient in the reaction function for each type of capital flow (Annex Table 5.2). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

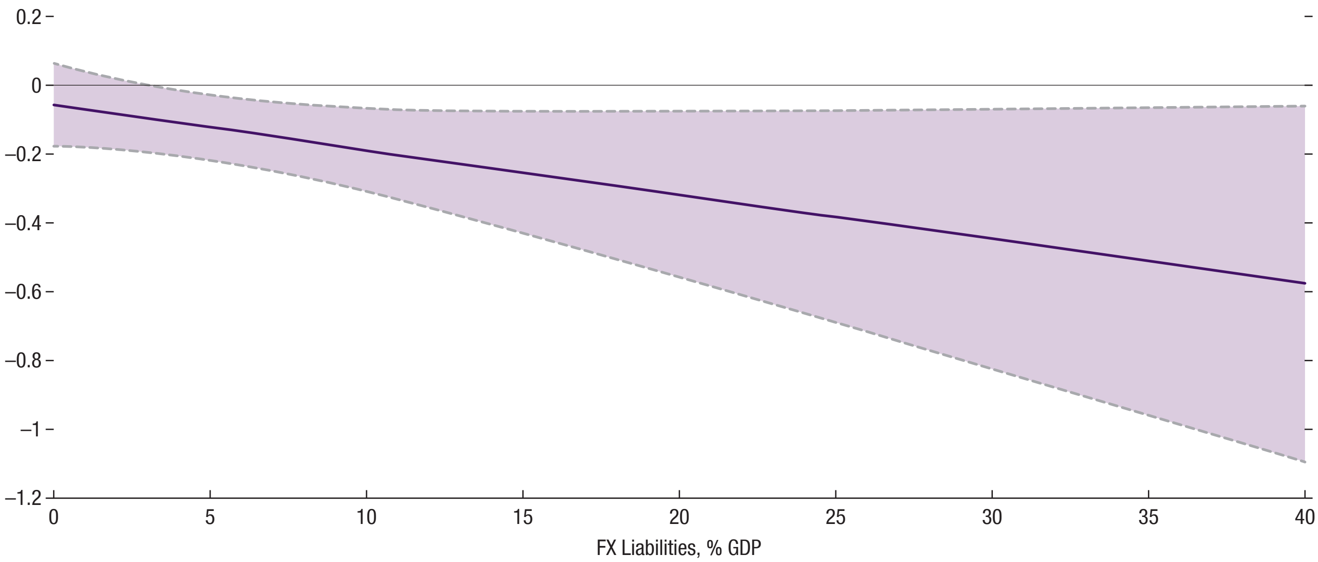
FDI flows, which are less volatile and thus less likely to flee in a risk-off episode (Figure 16).

FXI responds more forcefully where (unhedged) corporate FX liabilities are relatively large. In some Asian countries, corporates have relied significantly on external foreign currency borrowing, contributing to balance-sheet mismatches. This may motivate the authorities to dampen depreciation pressures during risk-off episodes. Reaction function estimates confirm provision of FX liquidity in response to outflows is more pronounced where corporate FX liabilities are relatively large, that is, the interaction term in the reaction function between FX liabilities and depreciation is significantly negative (Annex Table 5.3). Put differently, FXI responds more strongly to exchange rate depreciation when FX liabilities are higher, suggesting that balance sheet FX mismatches are an important consideration in intervention policy (Figure 17).

Asian countries with greater financial depth rely less on FXI. The addition of a proxy for financial depth—the private credit-to-GDP ratio—to the reaction function suggests that greater depth is associated with significantly lower FXI by central banks. Financial depth is associated with more liquid and robust financial markets that can absorb capital flows more easily, reduce the likelihood of disorderly market conditions, and provide hedging opportunities for corporates, which reduces the need for intervention (Annex Table 5.3).

Figure 17. Foreign Exchange Intervention Response to Exchange Rate Depreciation Is Stronger Where Foreign Exchange Liabilities Are High

(Impact of exchange rate depreciation on foreign exchange intervention conditional on the level of foreign exchange liabilities, percent)



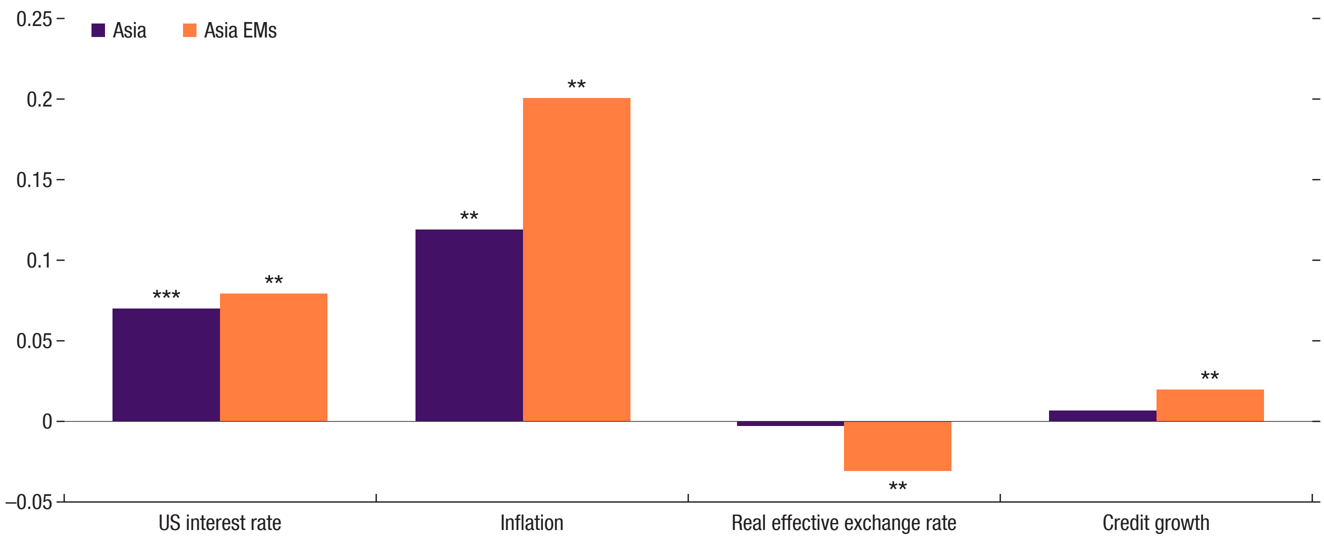
Source: IMF staff estimates.
Note: The chart shows the marginal effect of an exchange rate depreciation on foreign exchange intervention, conditional on the level of foreign exchange liabilities (as a share of GDP). The shaded area represents the 95 percent confidence interval.

Monetary Policy Reaction Functions Reflect Multiple Objectives

Reaction functions for the policy interest rate highlight the relevance of multiple factors beyond a standard Taylor rule (inflation, output gap). Inflation significantly influences the policy rate for both Asia as a whole and the EME subsample (Figure 18). Monetary policy also reacts to the output gap in the Asia sample. Global monetary conditions also matter: the US policy rate is found to be significant in explaining Asian monetary policy rate responses. This is consistent with limited monetary independence when monetary conditions are affected by a global financial cycle (Rey 2015).

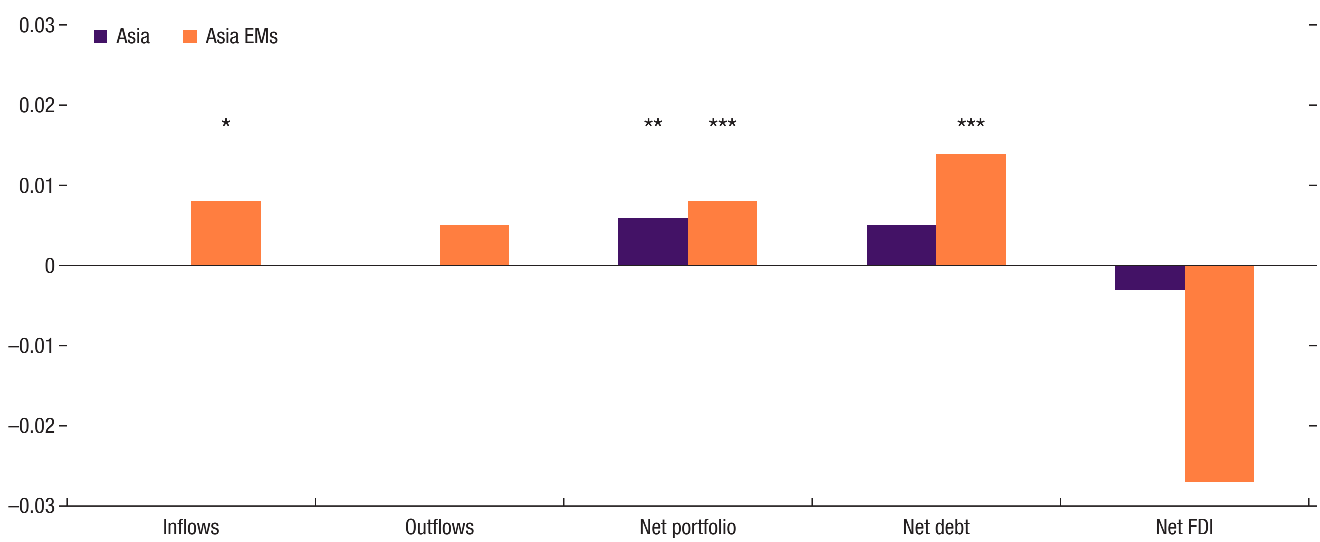
Monetary policy also reacts somewhat to capital flows, particularly more volatile types of flows. Among different types of capital flow, this finding is stronger for net portfolio capital flows, especially portfolio debt flows into EMEs (Figure 19). Positive coefficients indicate that central banks tighten monetary policy in response to—potentially expansionary—capital inflows, although the effect is small, for example, a net inflow surge of 10 percent of GDP is associated with a 10 basis point monetary tightening.

Figure 18. Monetary Policy Reaction Function
(Coefficient, percent)



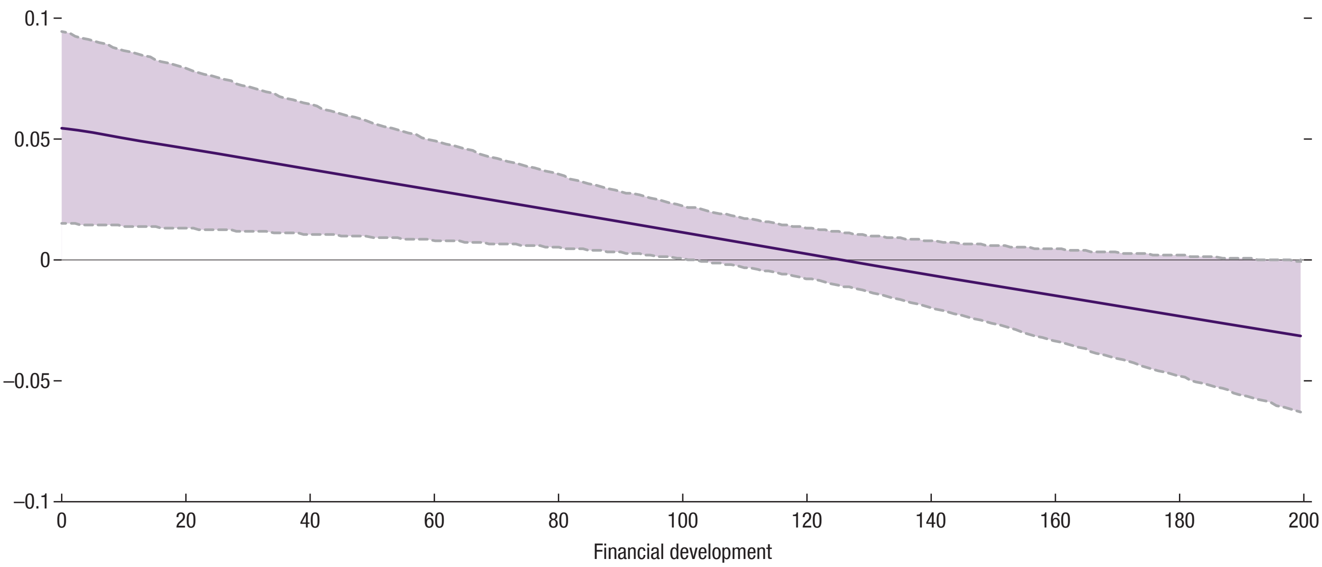
Source: IMF staff estimates.
Note: The chart shows the response of monetary policy to domestic and global factors. The *y* axis shows the coefficient of each variable for the monetary policy reaction function (Annex Tables 5.4 and 5.6). Note that the specification includes the lagged dependent variable. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 19. Monetary Policy Response and Composition of Capital Flows
(Coefficient, percent)



Source: IMF staff calculations.
Note: The chart shows the response of monetary policy to components of capital flows. The *y* axis shows the coefficient of each variable for the monetary policy reaction function (Annex Table 5.5). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 20. Exchange Rate Depreciation Tends to Induce Monetary Tightening in Shallow Financial Markets
(Effect of exchange rate depreciation on monetary policy, through financial development, percent)



Source: IMF staff estimates.
Note: The chart shows the average marginal effect of an exchange rate depreciation on monetary policy, conditional on the country's financial development (proxied as private credit as a share of GDP). The shaded area represents the 95 percent confidence interval.

Monetary policy reacts to exchange rate movements in Asian EMEs. Other things equal, Asian EMEs tend to raise the policy rate when the real exchange rate depreciates, and to lower the policy rate when the real exchange rate appreciates. Since we control for inflation, this effect is over and above the effect that the exchange rate has on current inflation. We also find that exchange rate depreciation is associated with greater tightening of monetary policy in countries with lower financial development. In contrast, the policy rate does not respond to exchange rate fluctuations in countries with well-developed financial markets (Figure 20).

Policy rates also react to financial-stability considerations, notably rapid credit growth in Asian EMEs. The estimated reaction functions highlight that faster credit growth is associated with a tightening of policy interest rates, underscoring the multiplicity of objectives influencing monetary policy.

MPMs Respond to Domestic Macro-Financial Risks and Global Factors

Macroprudential policy involves a wide range of tools. Building on Alam and others (2019), they can be grouped into five categories: bank capital, bank liquidity, credit demand, credit supply, and foreign-currency exposures, as illustrated in Figure 21 (Annex 5). Loan-to-value ratios (LTVs) and reserve requirements have been the most popular MPMs in Asian economies.

Estimated reaction functions suggest that macroprudential policy responds to global and domestic developments as follows (Figure 22):

- **Net capital inflows**. A net capital inflow surge raises the probability of MPM tightening in Asia. MPMs tend to be tightened with nonresident inflows while tightening actions tend to be reversed with resident outflows. The MPM response to capital inflows is stronger for Asian EMEs than for AEs. This underscores the important role of targeted macroprudential measures to contain FX risks (IMF 2017b).
- **Global financial shocks**. Lower US policy rates are generally associated with MPM tightening in Asia. The reaction to US rates could indicate that countries use MPMs to address domestic macroeconomic risks at times where monetary policy cannot adequately respond to domestic macroeconomic conditions due to limited policy autonomy.
- **Inflation and growth**. An increase in inflation raises the probability of MPM tightening. This illustrates the role MPMs may play in supporting other policies to stabilize the macroeconomy. There is also some evidence (albeit weaker) of a response of MPMs to growth. These findings may in part reflect the overlap between macroprudential and monetary policy instruments, notably through the widely used reserve requirement (Figure 21).
- **Real credit growth**. An acceleration in credit growth raises the probability of MPM tightening in Asian EMEs. This is consistent with the result in Figure 15. While only marginally significant in the reaction function estimation for Figure 22, credit growth is generally significant across a variety of specifications for Asia EMEs (Annex 5).

Housing Risks Appear to be an Important Driver of CFM Use

CFMs are often tightened outside of major capital flow surge episodes.[1] CFM actions since 2013 have complemented use of MPMs and mostly targeted the housing market. CFMs that are broad-based enough to significantly reduce capital inflows have been used infrequently by Asian countries. CFMs have often been used outside of capital flow surge episodes, defined as quarters when net capital inflows for a country are in the top three deciles of their distribution in 2000–18 (Figure 23), though CFMs may have been implemented to contend with sectoral risks (such as in the real estate market; see below).

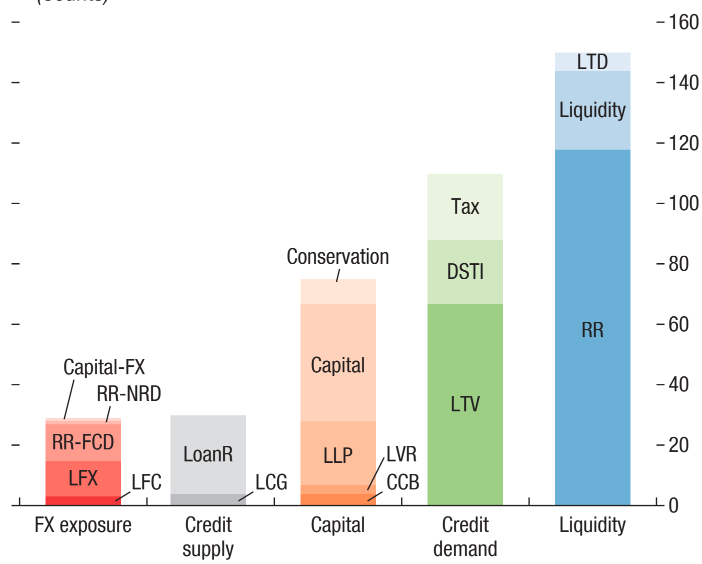
[1]The IMF's Institutional View on Capital Flow Management (IMF 2012) does not provide a specific definition of a capital flow surge when use of CFMs may be appropriate.

Figure 21. Use of Macroprudential Measures Has Centered on Liquidity and Credit Demand Measures

1. Main types of MPMs

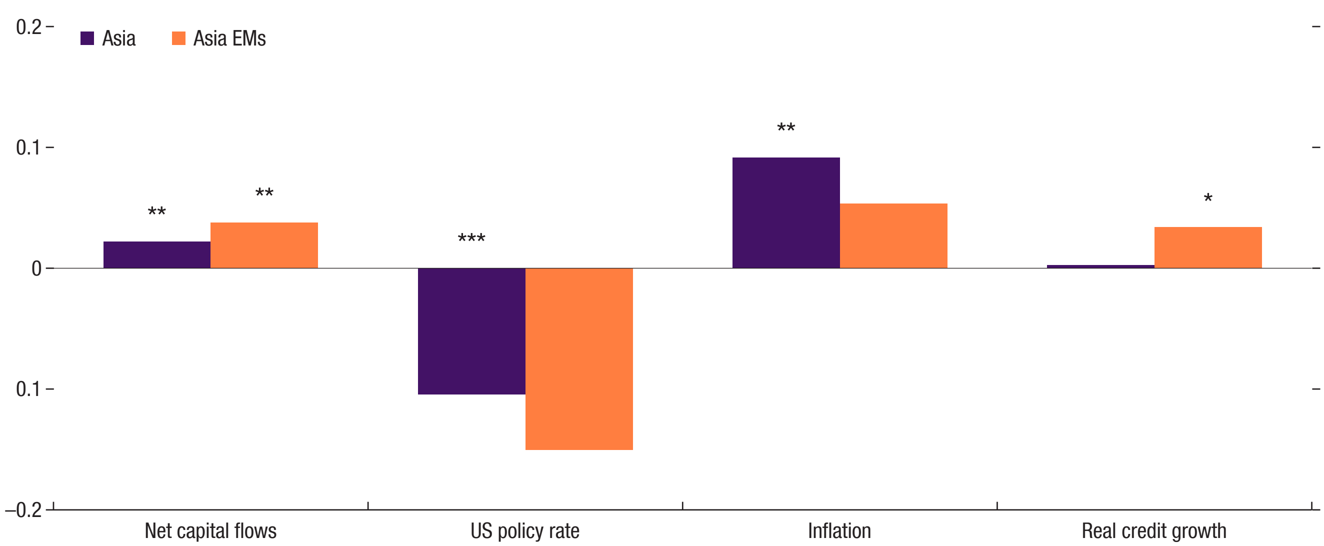
Capital	Countercyclical + SIFI capital buffers **(CCB + SIFI)** Leverage Limit **(Leverage)** Loan loss provisions **(LLP)** Regulatory capital requirement **(Capital)** Capital conservation buffer **(Conservation)**
Credit demand	Loan-to-value ratio **(LTV)** Debt-service-to-income ratio **(DSTI)** Tax on loans **(Tax)**
FX exposure	Limits on foreign currency lending **(LFC)** FX open position limits **(LFX)** Reserve requirement on FX deposits **(RR-FCD)**
Liquidity	Reserve requirement **(RR)** Liquidity coverage ratio, NSFR **(Liquidity)** Loan-to-deposit ratio limits **(LTD)**
Credit supply	Credit growth limits **(LCG)** Loan restrictions **(LoanR)**

2. Use of MPMs by Type in Asia, 2000–2016
(Counts)



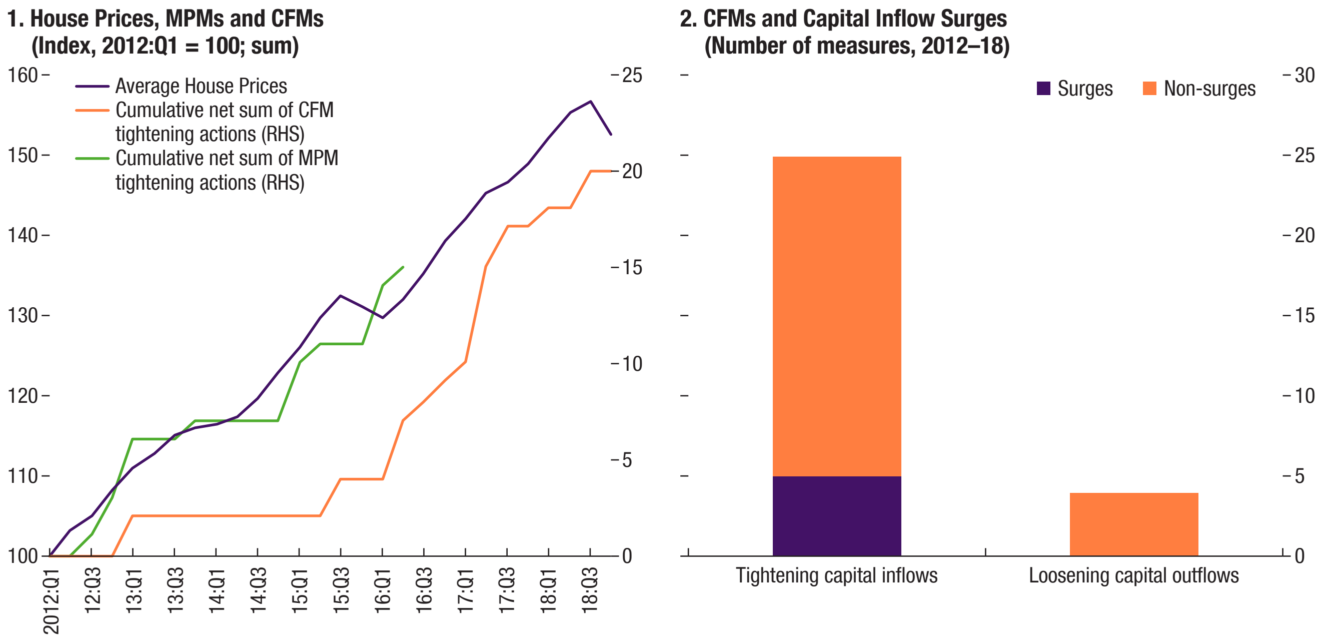
Sources: IMF Macroprudential Measure database; and staff calculations.
Note: Asia includes 14 major economies.

Figure 22. Macroprudential Policy Reaction Function
(Coefficients, probability)



Source: IMF staff calculations.
Note: Probit coefficient estimates show the marginal probability of a tightening of macroprudential policies associated with each variable.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 23. Capital Flow Management Measures Have Been Used Largely Outside of Surges



Sources: Haver Analytics, CFM Database and IMF staff calculations; IMF 2018 Taxonomy of CFMs and IMF Staff estimates.
Note: The sample in the panel 1 covers Australia, Hong Kong SAR, New Zealand, and Singapore.

CFMs have been frequently used in response to rising housing prices, including through stamp duties and taxes on nonresident property buyers. The measures have been concentrated among AEs in Asia (Figure 23), partly reflecting concerns about the social impact of rising housing prices. The cumulative tightening of CFMs is correlated with the average rise in house prices in the countries using them. The tightening of CFMs targeting housing has often involved frequent, but small, policy actions (the data identify the number of policy actions, without differentiating by their size or impact).

CFMs targeting housing tend to be used in combination with MPMs. MPMs targeting housing, such as loan-to-value ratios and debt-service-to-income limits, work by constraining financing for house purchases. This makes them less effective in deterring demand by nonresidents who are less likely to raise financing domestically. This is illustrated by the fact that countries that tightened housing-related CFMs did so after already tightening MPMs (Figure 23). In some countries, housing prices continued to rise after credit growth had peaked following the tightening of MPMs, with CFMs continuing to be tightened as the divergence between housing prices and credit growth persisted.

Chapter

4 Potential Costs of Policy Approaches

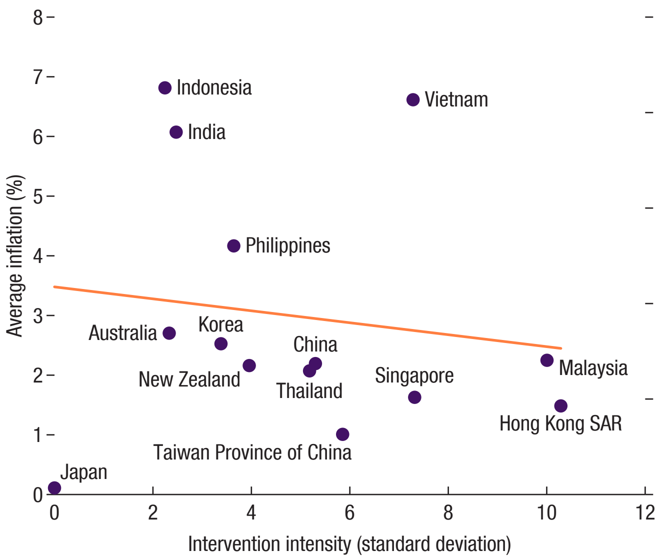
The policy responses to capital flows revealed by the reaction functions involve potential costs related to both coordination and communication. Coordinating and communicating policy frameworks that internalize how all the instruments are jointly calibrated to reach multiple objectives is much more challenging than a framework in which each instrument is focused on a single objective.

One concern is that FXI could signal a lack of commitment to the inflation target (Freedman and Otker-Robe 2010). This could de-anchor inflation expectations and worsen inflation outcomes. From a theoretical perspective, however, the effect of FXI on credibility is unclear since relying on an additional instrument could, in principle, help to achieve the inflation target (Ostry, Ghosh, and Chamon 2012). Having said that, in Asian economies, the intensity of FXI does not appear to be associated with worse inflation outcomes (Ostry and others 2019, Figure 24).

FXI may give rise to sterilization costs that need to be taken into account. The magnitude of the costs depends on the size of accumulated reserves and the gap between the yield of foreign and domestic assets. Moreover, sterilized intervention may aggravate the challenge posed by capital inflows by preventing domestic interest rates from declining and restoring portfolio equilibrium.

Extensive use of MPMs, CFMs, and FXI may hamper the development and use of domestic financial markets. MPMs can inhibit the expansion of financial intermediation that supports economic growth. FXI suppresses FX volatility, which may reduce incentives to hedge foreign-currency risk and make the economy more vulnerable to exchange rate fluctuations (Burnside, Eichenbaum, and Rebelo 2001). CFMs can also hamper cross-border financing that supports more robust and liquid domestic financial markets. If CFMs and FXI result in the central bank becoming a dominant player in

Figure 24. Inflation Outcomes Not Obviously Affected by Foreign Exchange Intervention



Source: IMF staff estimates.
Note: Intervention intensity (standard deviation) is based on foreign exchange reserve flows (as proxy for foreign exchange intervention), obtained from the balance of payments statistics, which exclude valuation changes (changes in positions due to exchange rate and other price changes). The sample covers 2000:Q1–18:Q4.

the foreign exchange market, this can prevent the development of FX derivative markets needed to manage exchange rate risk.

FX purchases could be interpreted by some as being motivated to gain unfair competitive advantage in export markets. Particularly in countries with substantial current account surpluses and, correspondingly, undervalued exchange rates, FX purchases that lean against strong appreciation pressures associated with large capital inflows could be seen as an attempt to maintain or gain advantage over trading partners.

CHAPTER

5 Conclusion

Managing capital flows in a way that internalizes multiple macroeconomic and financial-stability objectives poses a difficult challenge for emerging market economies, including in Asia. Although capital flows are generally beneficial for recipient economies, for many EMEs in Asia, they can be large and volatile, often driven by external developments and shifts in investor sentiment originating in major advanced economies. Capital flows tend to be expansionary, fueling domestic credit growth and amplifying vulnerabilities, notably from high corporate leverage and unhedged currency exposures. Importantly, capital flows can induce large exchange rate swings which can be macro-financially disruptive.

In Asian EMEs, the exchange rate can sometimes act as an amplifier, rather than an absorber, of shocks. Currency depreciations can increase corporate financial vulnerability where firms have large FX liabilities, particularly in economies with less-developed financial markets and limited hedging opportunities, and thereby weaken investment and growth. Conversely, currency appreciation can also be detrimental to macro-financial stability by relaxing firms' financing constraints and fueling a financing boom that increases their vulnerability to shocks. These and other financial channels make the exchange rate a relevant concern for policymakers.

Estimated policy reaction functions suggest that Asian economies use multiple instruments to manage capital flows in an attempt to achieve an array of macro-financial objectives. Despite the diversity in policy approaches and frameworks, some common trends emerge. FXI reacts strongly to capital flows; more so where FX exposures are high and financial markets are shallow. Monetary policy reacts to inflation developments as one would expect. However, when other influences—including the US interest rate, capital flows, and the exchange rate—are allowed to enter an augmented Taylor rule for Asian EMEs, the data suggest that these additional variables also influence domestic policy interest rates. MPMs likewise seem to respond to an array of domestic macro-financial risks and external influences, including capital flows and US policy rates, and combine with monetary policy to support achievement of multiple policy objectives. CFMs have generally been used less frequently in Asian EMEs and deployed mainly against specific, real estate-related risks.

The multitude of policy responses reflects the complexity of the challenges Asian EMEs face in managing volatile capital flows. The data-driven analysis presented in this paper will hopefully contribute to ongoing reflections about how to manage volatile capital flows and exchange rates both in Asian EMEs and more broadly.

Annex 1. Corporate Vulnerability in Asian Firms

This Annex explores the effect of the exchange rate on corporate vulnerabilities and firm-level investment, focusing on the impact of the exchange rate conditional on firms' leverage of foreign currency.[1]

A newly constructed firm-level data set with comprehensive information on Asian firms' FX liabilities is used to estimate the effect of the exchange rate on corporate financial vulnerability and investment. In particular, the focus is on the impact of the exchange rate conditional on leverage in foreign currency. The firm-level empirical literature on corporate vulnerability with respect to the exchange rate is scarce and inconclusive, especially for EMEs, owing to the paucity of data on the currency decomposition of corporate debt. This gap is filled by constructing a new firm-level database with comprehensive information on the FX liabilities of firms in 12 Asian economies during 1994–2016. This allows for assessing the effect of exchange rate on corporate vulnerability conditional on leverage in foreign currency at the firm level.

Previous works such as Serena and Sousa (2017) and Bruno and Shin (2017, 2018) used only bond issuance denominated in US dollars as a measure of US dollar debt portion at corporate level. Although corporate bond issuance in US dollar has increased rapidly in recent years, syndicated loans are still the dominant source of foreign currency debt issuance for not only larger firms but also medium- and small-sized firms. Excluding syndicated loans from firms' FX liability would miss an important factor of corporate vulnerability. Finally, including the period prior to the Asian financial crisis provides a crucial benchmark for comparison.

[1]This annex is based on Jiang and Saadi Sedik (2019).

First, corporate vulnerability is defined following Alfaro and others (2017), by constructing an aggregate measure of corporate financial vulnerability at the firm level (the Altman Emerging Market Z"-score) for a large sample of Asian firms. The Altman Z"-score is a summary measure of corporate vulnerability based on financial ratios of profitability, leverage, liquidity, and solvency. Lower Z"-scores are associated with a higher probability of corporate bankruptcy. In other words, instead of assessing different ratios in isolation (single dimension), we combine them into an overall indicator (multiple dimensions). Methodologically, this multivariate approach has proven to be superior to univariate approaches in predicting corporate distress (Altman and others 2016). Economically, using, for example, high corporate leverage alone as an indicator of corporate distress may be misleading, as it could indicate both the availability of profitable projects and high risk, and it misses other dimensions of corporate vulnerability. More importantly, Altman (2005) establishes a correspondence between the Z"-score and corporate bond ratings in EMEs, so this aggregate measure could be interpreted as an indicator of firms' probability of default.

Then, a firm-level database of firms in 12 Asian economies during 1994–2016 is constructed, for the currency decomposition of corporate debt, including corporate bond issuance and syndicated loans. The data set covers the period prior to the Asian financial crisis, to provide a benchmark for comparison.

As a first step, using Z"-scores as a measure of overall corporate vulnerability, the following regression specification looks at the impact of the exchange rate on corporate vulnerability, conditional on the level of FX-denominated corporate debt:

$$Z_{i,j,t} = \alpha + \beta_1 F_{i,j,t} + \beta_2 M_{j,t} + \beta_3 S_{i,j,t} * ER_{j,t} + \beta_4 S_{i,j,t} * IR_t + \mu_i + \varepsilon_{i,j,t} \qquad (1)$$

where

- $Z_{i,j,t}$ is the firm-level Altman Z"-score of company *i*, in country *j*, at time *t*;
- α is the constant;
- $F_{i,j,t}$ is a vector of firm-level variables;
- $M_{j,t}$ is a vector of macroeconomic variables for country j;
- $ER_{j,t}$ is a change in the exchange rate at time t, where a positive increase signals an appreciation;
- IR_t is a measure of global interest rates (or domestic short-term interest rate);

- $S_{i,j,t}$ is the share of US-dollar denominated debt on the firm *i*'s balance sheet; and
- μ_i is the company fixed effect.

Then, the following specification estimates the impact of the exchange rate on firm-level investment:

$$Y_{i,j,t} = \alpha + \beta_1 F_{i,j,t} + \beta_2 M_{j,t} + \beta_3 S_{i,j,t} * ER_{j,t} + \mu_i + \varepsilon_{i,j,t} \quad (2)$$

Where $Y_{i,j,t}$ is capital expenditure as the share of total assets and acts as a proxy for a firm's investment. The explanatory variables are the same as equation (1).

The results suggest that the exchange rate may act as a shock amplifier—not a shock absorber—for the Asian corporate sector (Annex Table 1.1, equations 1–4). Specifically, exchange rate depreciation is associated with a higher probability of default of Asian firms. We find both statistically and economically significant associations between corporate sector vulnerability in Asia and local currency depreciation against the US dollar, both in nominal and real terms. A 30 percent domestic currency depreciation against the US dollar is associated with a 0.4 decrease in the Z"-score, which corresponds, on average, to a two-notch downgrade in the corporate credit rating (for example, from A to BBB+). Such a shock will result in 7 percent of firms in our sample falling into D-rating bucket (or falling into bankruptcy). These results remain robust when the bilateral exchange rate is replaced by the NEER or REER, and after controlling for other factors such as the VIX.

The effect of the exchange rate on corporate vulnerability is conditional on the level of foreign currency debt (Annex Table 1.1, equations 4–6). The result of the interaction regression can be interpreted as follows: the marginal impact of local currency depreciation is stronger when the share of US-dollar denominated debt on firms' balance sheets is higher.

The impact of an exchange rate depreciation could increase firm-level investment on average (Annex Table 1.2, equations 1–2): the results show a positive impact for the exchange rate depreciation on investment, capturing the real-side competitiveness channel. But the interaction regressions show that the impact of the exchange rate depreciation on investment is conditional on the level of corporate debt: as FX liabilities increase, the positive impact of the exchange rate depreciation declines, and the financial channel offsets gains from the competitiveness channel (Annex Table 1.2, equations 3–5).

Annex Table 1.1. Currency Decomposition—Nominal Exchange Rate

VARIABLES	(1) Z-score	(2) Z-score	(3) Z-score	(4) Z-score	(5) Z-score	(6) Z-score	(7) Z-score	(8) Z-score	(9) Z-score	(10) Z-score
ΔNominal ER	2.369***			1.329	1.219**	1.273	2.339***	2.151***	2.469***	2.109***
	(0.805)			(0.893)	(0.605)	(0.915)	(0.819)	(0.822)	(0.829)	(0.545)
U.S. dollar Debt Portion	−0.045	−0.016	−0.045	−0.165*	−0.083*	−0.124	0.0089	0.0077	−0.0055	−0.0055
	(0.0886)	(0.0394)	(0.0906)	(0.0992)	(0.0444)	(0.102)	(0.0914)	(0.0913)	(0.0421)	(0.0420)
ΔShort-term Interest Rate		0.00143				−0.0067	0.0120	0.00336		
		(0.0150)				(0.015)	(0.0159)	(0.0162)		
ΔU.S. Shadow Rate			−0.111***		−0.104***				−0.086***	−0.099***
			(0.0165)		(0.0167)				(0.016)	(0.0174)
U.S. dollar Debt Portion* ΔNominal ER				3.949***	3.322***	3.417**				
				(1.471)	(0.985)	(1.524)				
VIX					−0.021***	−0.026**		−0.027***		−0.021***
					(0.0068)	(0.010)		(0.0103)		(0.0068)
U.S. dollar Debt Portion* ΔShort-term Interest Rate							−0.114*	−0.114**		
							(0.0581)	(0.0580)		
U.S. dollar Debt Portion* ΔU.S. Shadow Rate									−0.0296	−0.0316
									(0.0564)	(0.0564)
Constant	5.906***	5.902***	4.892***	5.919***	5.343***	6.46***	5.915***	6.455***	4.910***	5.330***
	(0.0584)	(0.0608)	(0.0412)	(0.0586)	(0.141)	(0.217)	(0.0610)	(0.217)	(0.0409)	(0.141)
Observations	15,614	15,047	14,545	15,614	14,545	15,047	15,047	15,046	14,545	14,545
R-squared	0.306	0.304	0.306	0.307	0.307	0.305	0.305	0.305	0.306	0.306
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Annex Table 1.2. Investment—Nominal Exchange Rate

VARIABLES	(1) Investment	(2) Investment	(3) Investment	(4) Investment	(5) Investment
U.S. dollar Debt Portion	−0.00031	−0.00034	−0.0011	−0.00096	−0.0011
	(0.00138)	(0.00140)	(0.00144)	(0.00146)	(0.00147)
ΔNominal Exchange Rate	−0.02	−0.0281*	−0.0357**	−0.0458***	−0.0520***
	(0.0167)	(0.0169)	(0.0172)	(0.0175)	(0.0181)
U.S.D. Debt Portion* ΔNominal ER			0.0312**	0.0297**	0.0307**
			(0.0151)	(0.0152)	(0.0153)
Leverage				−0.00526***	−0.00509***
				(0.00103)	(0.00105)
Tobin's Q				0.0120***	0.0117***
				(0.00106)	(0.00108)
Cash					0.0672***
					(0.0215)
ΔShort-term Interest Rate		0.000470	0.000472	0.000440	0.000401
		(0.000340)	(0.000340)	(0.000363)	(0.000367)
Constant	0.0765***	0.0764***	0.0765***	0.0677***	0.0626***
	(0.00125)	(0.00130)	(0.00130)	(0.00202)	(0.00256)
Observations	19,960	19,202	19,202	18,395	17,527
R-squared	0.157	0.166	0.166	0.163	0.163
Firm FE	Yes	Yes	Yes	Yes	Yes

Note: This table uses the subsample of corporates that we have concrete measures of firms' USD debt proportion; there are in total 1,420 firms in our sample covering both tradable industries and nontradable industries. Investment is the capital expenditure divided by lagged total assets; leverage is total debt divided by lagged total assets; cash is cash holding divided by lagged total assets. Tobin's Q is total market value of firm divided by total book value of firm and then lagged by one period. USD debt portion is (USD loans + USD bond) *Exchange Rate/Total Asset. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The regressions (Annex Table 1.3, equations 1–3), show that if the share of US dollar debt is less than 10 percent, the competitiveness channel dominates the financial channel, while the financial channel offsets the competitiveness channel if the share of US dollar debt is between 10 and 20 percent (Annex Table 1.3, equation 4). If US dollar debt is higher than 20 percent, the financial channel dominates (Annex Table 1.3, equations 5–6).

Annex Table 1.3. Regressions by USD Debt Proportion

VARIABLES	(1) Investment	(2) Investment	(3) Investment	(4) Investment	(5) Investment	(6) Investment
USD debt portion	1.207	0.159	0.257*	0.0328	−0.166	−0.640
	(1.253)	(0.238)	(0.134)	(0.0957)	(0.159)	(0.561)
ΔNominal Exchange Rate	−0.064**	−0.059**	−0.072**	0.041	0.011*	0.024**
	(0.0318)	(0.0243)	(0.0298)	(0.0396)	(0.00504)	(0.00841)
Leverage	−0.00440**	−0.0063***	−0.0118***	−0.00425**	−0.013***	−0.009***
	(0.00171)	(0.00162)	(0.00220)	(0.00215)	(0.00422)	(0.00210)
Tobin's Q	0.00870***	0.0316***	0.0392***	0.0437***	0.0476***	0.0319***
	(0.00141)	(0.00399)	(0.00473)	(0.00545)	(0.00788)	(0.00460)
Cash	0.0744**	0.0586	0.0834*	0.153***	0.0754	0.0562
	(0.0332)	(0.0442)	(0.0455)	(0.0483)	(0.0842)	(0.0602)
Constant	0.0582***	0.0413***	0.0335***	0.0291*	0.00367	0.0598***
	(0.00389)	(0.00882)	(0.0116)	(0.0158)	(0.0403)	(0.00793)
Observations	10,579	1,381	2,081	1,789	837	1,482
R-squared	0.157	0.707	0.653	0.639	0.681	0.526
USD Debt Proportion	<=1.5%	[1.5%, 4.5%]	[4.5%, 10.8%]	[10.8%, 20.3%]	[20.3, 35.9]	>35.9%
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Annex 2. Financial Development, Exchange Rate Fluctuations, and Debt Dollarization

This annex investigates the effects of exchange rate volatility on the debt currency composition of nonfinancial firms, as well as the impact on their investment following large depreciations, using a panel data of more than 9,000 nonfinancial firms from 21 advanced and emerging market economies from 2009 to 2017.[1]

The firm-level data set is constructed from the corporate balance sheet database provided by S&P Capital IQ. The data set contains direct and comprehensive information on the currency composition of outstanding balance sheet liabilities, including foreign currency loans from local banks, in contrast to other commercial firm-level databases. The sample comprises both listed and nonlisted firms, all owned by the private sector.

The effect of exchange rate volatility on firms' debt currency composition is examined using the following Tobit specification:

$$Y_{i,j,k,t} = Y^{*}_{i,j,k,t} 1[Y^{*}_{i,j,k,t} \geq 0],$$

$$Y^{*}_{i,j,k,t} = \alpha X_{k,t-1} + \beta F_{i,j,k,t-1} + \gamma Q_{k,t-1} + \mu_j + \mu_k + \mu_t + \varepsilon_{i,j,k,t}, \quad (1)$$

$$\varepsilon_{i,j,k,t} \overset{iid}{\sim} \mathcal{N}(0, \sigma^2_{\varepsilon}),$$

[1]This annex is based on Kim (2019).

Where the dependent variable $Y_{i,j,k,t}$ denotes the ratio of dollar debt to total debt (DDR), bounded between 0 and 1 by definition. This ratio is regressed over the following explanatory variables:

- $X_{k,t-1}$, a vector of macroeconomic variables;
- $F_{i,j,k,t-1}$, a vector of variables for each firm *i* in industry *j* and economy *k*;
- $Q_{k,t-1}$, a vector of additional control variables;
- μ_j, μ_k, μ_t, which denote industry, country and time fixed effects, respectively.

The theoretical framework developed in Kim (2019) produces two empirically testable hypotheses. First, the dollar debt ratio should be negatively related with exchange rate volatility. The regression results shown in Annex Table 2.1 are consistent with this hypothesis. The coefficient for exchange rate volatility is negative, implying that higher exchange rate volatility reduces the dollar debt ratio. Furthermore, the coefficient of the interaction term between exchange volatility and financial depth (measured by the private credit-to-GDP ratio) is positive, implying that the negative effect of exchange rate volatility on firms' dollar borrowing becomes weaker in more developed financial market economies. In fact, in economies with the private credit-to-GDP ratio greater than 1, the influence of exchange rate volatility in determining firms' debt currency composition becomes statistically insignificant. This interrelationship between financial depth, exchange rate volatility, and the dollar debt ratio is shown in Annex Figure 2.1.[2]

The results above could be explained by the greater availability of FX hedging instruments in more- developed financial markets. If this is the case, it should also hold that firms in developed financial markets are better hedged against unexpected exchange rate shocks. In the absence of information on firms' derivative hedging, the taper tantrum is used as a natural experiment to confirm this second hypothesis. Specifically, the analysis examines whether corporate investment in less-developed financial markets (defined as those with the private credit-to-GDP ratio less than 1) is more susceptible to depreciation shocks due to the balance sheet channel.

To test this hypothesis, the following equation is estimated using a sample of firms holding a positive amount of dollar debt during the period from 2012 to 2014.

$$I_{i,j,k,t} = \beta_1 DDR_{i,j,k,t-1} * \Delta ER_{k,t} + \beta_2 \Delta ER_{k,t} + \beta_3 F_{i,j,k,t-1} + \beta_4 X_{k,t} + \beta_5 Q_{k,t-1} + \mu_i + \mu_t + \mu_{j,t} + \varepsilon_{i,j,k,t},$$

[2]The results are robust to reverse causality and alternate estimation methods.

Annex Table 2.1. Macroeconomic Determinants of Corporate Dollar Debt Ratios

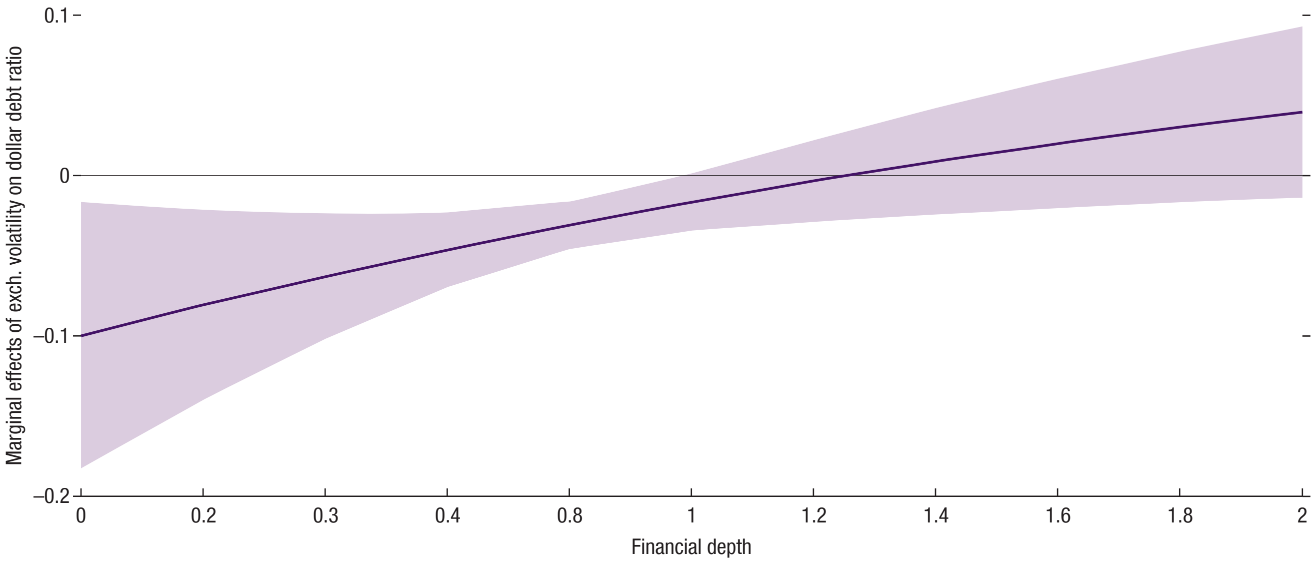
	(1)	(2)	(3)	(4)
Exch. Volatility	–0.096***	–0.269***	–0.092***	–0.273***
	(0.032)	(0.065)	(0.031)	(0.066)
Exch. Volatility × Financial Depth		0.230***		0.242***
		(0.082)		(0.083)
Interest Diff.	0.724**	0.760***	0.985*	1.089**
	(0.338)	(0.280)	(0.540)	(0.444)
Interest Diff. × Financial depth			–0.566	–0.708
			(0.727)	(0.608)
Inflation Volatility	0.006**	0.005**	0.005**	0.005**
	(0.002)	(0.002)	(0.002)	(0.002)
Inflation	–0.173	–0.118	–0.149	–0.085
	(0.115)	(0.116)	(0.110)	(0.120)
ΔReal Exch. Rate	–0.230***	–0.228***	–0.240***	–0.240***
	(0.077)	(0.067)	(0.081)	(0.070)
ΔGDP	0.246	0.257	0.239	0.249
	(0.201)	(0.173)	(0.203)	(0.176)
Financial Depth	0.000	–0.000	0.004	0.005
	(0.050)	(0.052)	(0.048)	(0.050)
Tradable (=1)	0.179***	0.178***	0.179***	0.178***
	(0.044)	(0.044)	(0.044)	(0.044)
Number of observations	33,905	33,905	33,905	33,905
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes

Note: This table presents the Tobit regression results with the ratio of the dollar-denominated debt to the total debt as the dependent variable. The displayed explanatory variables are defined as follows: Exch. volatility is the annualized standard deviation of the monthly real exchange rate changes (y/y) against the US dollar over 12 months; Interest diff. is the difference between short-term local interest rates and the US dollar three-month LIBOR; Financial depth is the private credit-to-GDP ratio; Inflation volatility is the annualized standard deviation of the monthly CPI inflation (y/y) over 12 months; Inflation is the average CPI inflation rate over 12 months; ΔReal exch. rate is the end-of-year real exchange rate depreciation against the US dollar (y/y), in which a negative value indicates a local currency depreciation; and ΔGDP is the real GDP growth rate. Tradable(=1) is a dummy variable that takes a value of 1 if a firm belongs to the tradable sector and 0 otherwise. The other control variables, although not shown to save space, include: the logarithm of total assets, the debt-to-total assets ratio, the tangible assets-to-total assets ratio, the cash-to-total assets ratio, the return on assets, real GDP per capita (PPP, 2011 international dollars), the exports-to-GDP ratio, the composite country risk rating from the International Country Risk Guide Database, as well as the country, year, and industry fixed effects. All explanatory variables are lagged by one year. The standard errors, shown in brackets, are robust to clustering at the country level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Where $I_{i,j,k,t}$ denotes the ratio of capital expenditure in year t to total assets in year $t-1$ for firm i in industry j and economy k. This ratio is regressed on the change in the bilateral exchange rate, an interaction term between the dollar debt ratio and the change in the exchange rate, and the control variables described in equation (1), with the exception that μ_i, μ_t, and $\mu_{j,t}$ here denote the firm, year, and industry-year interaction fixed effects.

The main variable of interest is the interaction term between the dollar debt ratio and the change in the exchange rate ($DDR_{i,j,k,t-1} * \Delta ER_{k,t}$), which is aimed to capture the balance sheet effect of depreciation. The variable $\Delta ER_{k,t}$ is defined to take a positive value if the local currency appreciates

Annex Figure 2.1. Average Marginal Effects of Exchange Rate Volatility on Dollar Debt Ratio



Source: IMF staff estimates.
Note: The shaded area represents the 95 percent confidence interval.

against the US dollar. If depreciation negatively affects a firm's investment by inflating the local currency value of its unhedged dollar debt, the coefficient of this interaction term should be positive. Finally, to check whether this balance sheet channel is more prominent in less-developed financial markets, the sample is divided into two groups: those firms from economies with the private credit-to-GDP ratio less than 1 ("Low FD") and greater than 1 ("High FD").

The results in Annex Table 2.2 are consistent with the prediction that the dollar debt held by low FD economies are less hedged against exchange rate shocks. The results show that it is only the firms in the low FD economies that are hit from depreciation, as indicated by the significant and positive coefficient for the interaction term between the dollar debt ratio and exchange rate (column 2). In contrast, depreciation is found not to have a significant negative impact on investment for firms in high FD economies (column 3).

The results in column (5) and (6) further show that, even in the absence of significant depreciation on a year-to-year annual basis, large exchange rate volatility within a year—greater than one standard deviation—can have a negative impact on investment, captured by the squared exchange rate volatility variable, in the case of low FD firms (the uncertainty channel).

Annex Table 2.2. Firms' Capital Expenditure and Exchange Rate Shocks

	Model 1			Model 2		
	(1) All	(2) Low FD	(3) High FD	(4) All	(5) Low FD	(6) High FD
ΔReal Exch. Rate × Dollar debt ratio	0.232***	0.246***	0.455	0.220***	0.216**	0.452
	(0.072)	(0.090)	(0.301)	(0.070)	(0.088)	(0.298)
ΔReal Exch. Rate	−0.107**	−0.169***	−0.241	−0.123***	−0.156***	0.507
	(0.042)	(0.057)	(0.169)	(0.043)	(0.059)	(0.950)
Exch. Volatility				0.288***	0.320***	−0.247
				(0.067)	(0.088)	(0.984)
Exch. Volatility × Exch. Volatility				−0.906***	−0.982***	−2.207
				(0.200)	(0.236)	(7.129)
Number of observations	3,549	2,072	1,477	3,549	2,072	1,477
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year X Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table presents the fixed-effects panel regression results for the sample firms with a positive amount of dollar-denominated debt over the period of 2012–2014. The dependent variable is the ratio of capital expenditure in year t to total assets in year t-1. Columns (1) and (4) show the regression results for the full sample, columns (2) and (5) for the sample in economies with the private credit-to-GDP ratio less than 1 (Low FD), and columns (3) and (6) for the sample with the ratio greater than 1 (High FD). ΔReal Exch. Rate is the real exchange rate depreciation against the US dollar in year t, in which a negative value denotes a local currency depreciation. Dollar debt ratio denotes the ratio of dollar-denominated debt to total debt at the end of year t-1. Exch. volatility is calculated as the annualized standard deviation of monthly real exchange rate changes (y/y) against the US dollar over 12 months. Although not shown to conserve space, all regressions also include a set of lagged firm-level variables (the logarithm of total assets, debt-to-total assets ratio, tangible assets-to-total assets ratio, cash-to-total assets ratio, dollar denominated debt-to-total debt, and sales growth), contemporaneous macroeconomic variables (real GDP growth, inflation, inflation volatility, country risk rating from the International Country Risk Guide Database, and the logarithm of real GDP per capita (PPP-based, in 2011 international dollars)), as well as the year, country, and the industry-year fixed effects. The standard errors, shown in brackets, are robust to clustering at the country level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Annex 3. Investment and GDP Growth Response to Exchange Rate Shocks

To quantify the dynamic effects of exchange rate shocks on the investment-to-GDP ratio and growth, we utilize the Local Projection (LP) method (Jordà 2005).[1] This method is now standard in the literature when examining the impact of shocks on macroeconomic variables. A key advantage of the LP technique is that it can estimate non-linear effects where the size and persistence of the effects can depend on the severity of the shocks.

The estimation aims to measure the time-varying correlation between the real exchange rate and changes in the investment-to-GDP ratio or GDP growth, while controlling for basic determinants, cyclical conditions, country fixed effects, and quarterly fixed effects. More formally, the LP specification is as follows:

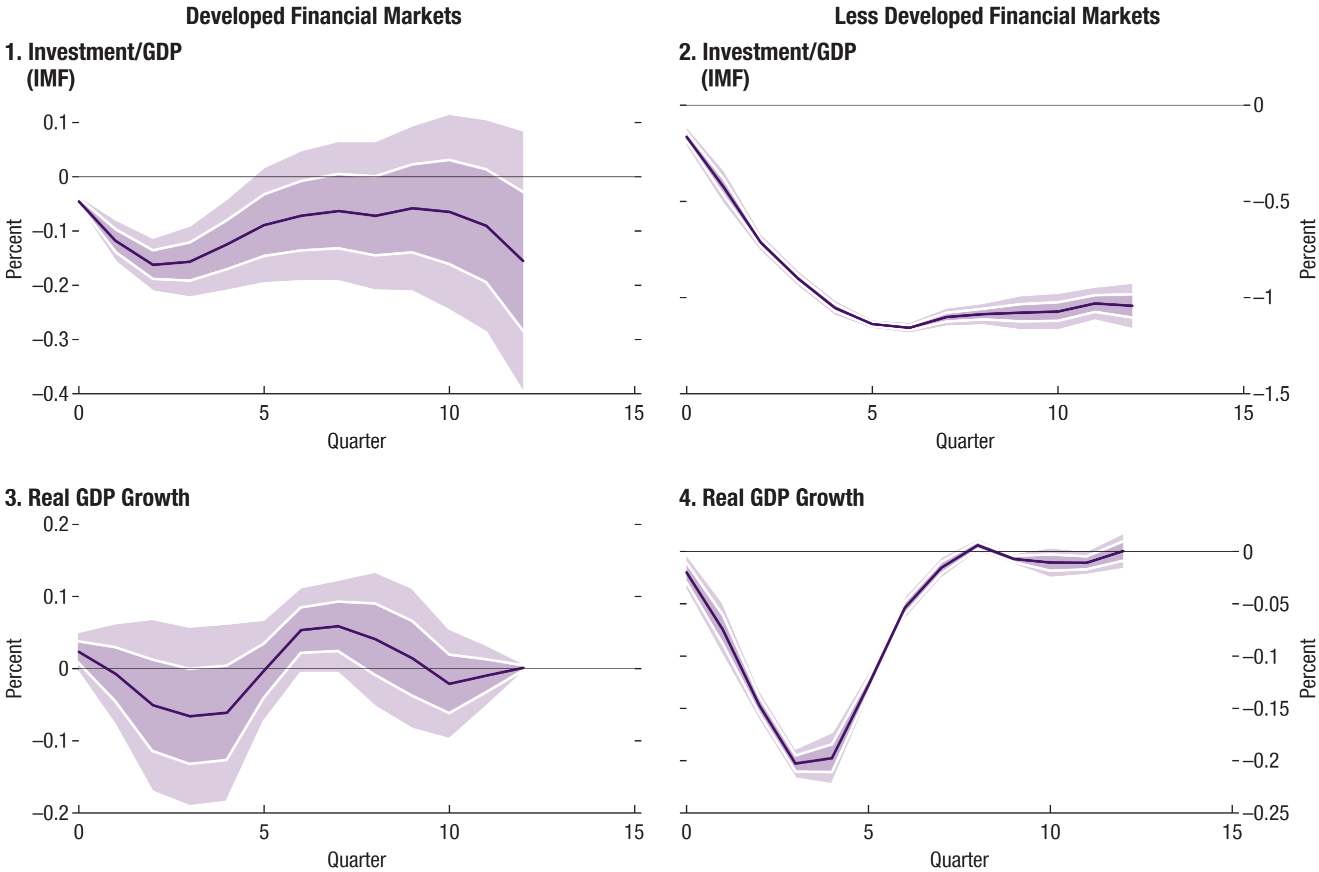
$$y_{i,t+h} = u_i + \mu_t + \mu_h (REER_{it-q}) + \Psi_h (L)\, y_{i,t+h-1} + X'_{i,t}\Gamma_h + \varepsilon_{i,t+h} \quad [1]$$

Where $y_{i,t+h} = I_{i,t+h} - I_{i,t-1}$, and $I_{i,t}$ is the logarithm of gross fixed capital formation divided by GDP in country i observed at quarter t.[2] The model is estimated at each horizon $h = 0,1,\ldots,H$. REER is the logarithmic level or standard deviation of the real exchange rate. X is a matrix of control variables, considered in the literature to be the standard determinants of the investment ratio, including GDP growth and financial conditions.

The models are estimated using a sample of 14 Asia-Pacific countries during first quarter of 1995 to fourth quarter of 2018. To trace the impact of REER shocks on investment and growth over time, the section presents the associ-

[1]This is based on De and others (forthcoming).
[2]The specification is shown for the investment ratio but can be generalized to GDP growth.

Annex Figure 3.1. Impact of Real Effective Exchange Rate Volatility on Investment and Growth in Asia



Source: IMF staff estimates.

ated impulse response functions of the investment ratio and growth following a 1 percent change in the REER or exchange rate volatility (measured as the standard deviation of daily exchange rate changes in the quarter).

The impact of shocks to the level of the real exchange and volatility are significant in countries with less-developed financial markets, and less so in countries with well-developed financial markets. In less-developed financial markets in emerging Asia, REER depreciation (Figure 6) and volatility (Annex Figure 3.1) have a large statistically significant negative impact on the investment ratio. A similar response is observed for growth, though the negative impact is more short-lived, as the competitiveness or net exports channel increasingly supports growth. In more financially developed markets, the impact of changes in the level of the REER on investment is not statistically significant (Figure 6), but volatility shocks have a small statistically significant impact suggesting that an uncertainty channel on investment may still operate. However, the balance sheet channel observed in less-developed financial markets appears to be present.

The regression specification used for the analysis includes the FCI to isolate the impact of exchange rate shocks from financial tightening (for example, global financial crisis). While the baseline specification includes the FCI, other measures of financial conditions such as the US 10-year yield also give similar results. In addition, to ensure that results are not driven by real terms of trade shocks, we check the robustness of our results using terms of trade changes in the regression specification as well as purging changes in REER due to terms of trade shocks. In both cases, the results continue to hold.

Annex 4. Exchange Rate Volatility and Growth at Risk

Using the Growth at Risk (GaR) framework, this analysis explores the impact of exchange rate volatility on the probability distribution of future GDP growth in Asian economies.[1] The nonlinear role of financial conditions in determining the conditional distribution of real GDP growth has been well documented (for the United States, see Adrian, Boyarchenko and Giannone 2019, for other advanced and emerging market economies, see IMF 2017a; Adrian, Grinberg, and Malik 2018). This analysis disaggregates financial conditions to compare the impact of exchange rate-related variables relative to domestic financial conditions on growth to better explore the role of exchange rate changes on the real economy.

Quantile regressions for growth y_t (equation 1) are estimated using quarterly data from the first quarter of 1995 to the fourth quarter of 2018 for individual Asian economies, *n* quarters ahead:

$$y_{t+n} = \beta_y^q y_t + \beta_e^q ER_t + \beta_f^q domfci_t + \beta_g^q global_t + \varepsilon_{t+n}^q \quad (1)$$

Three regressor groups are considered: exchange rate variables, domestic financial conditions, and global conditions; principal components are used to reduce the dimensionality of each regressor group:

- *Exchange rate* (*ER*), comprising exchange rate volatility, change in the real effective exchange rate, and external debt;
- *Domestic financial conditions* comprising real short-term interest rate, interbank spread, term spread, sovereign local and dollar debt spreads, the

[1]This is based on De and others (forthcoming).

corporate local and dollar debt spreads, equity prices and volatility, growth in domestic credit to the private sector, and real house prices; and,

- *Global conditions* (*global*), comprising VIX, the US federal funds rate, the US 10-year bond rate, and the dollar index.

The estimated quantile regression coefficients from (1) are then used to generate a *t*-skew distribution for growth for each country.

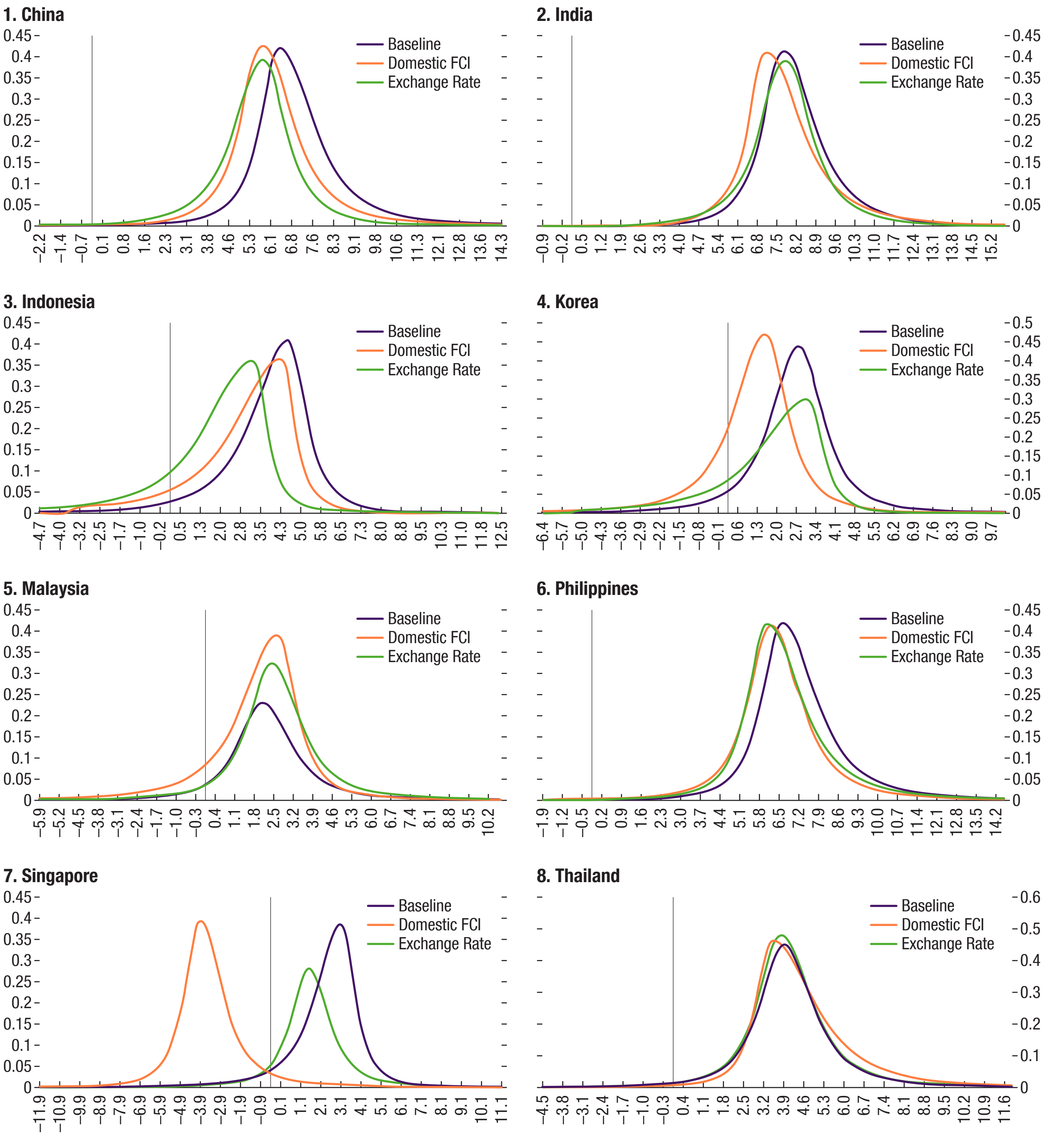
Results confirm that, as a whole, changes in financial conditions shift the distribution of future GDP growth, highlighting the nonlinear impact of financial conditions on GDP growth. However, the disaggregation of financial conditions to domestic financial conditions and exchange rate related factors reveals several important findings.

- First, for most Asian economies, the exchange rate shifts the expected real GDP growth distribution controlling for other domestic and global financial conditions. Specifically, a depreciation and higher exchange rate volatility increase the downside risk to growth in the near term. This underscores the importance of the exchange rate or balance sheet channel on real GDP growth.
- Second, the relative impact of the exchange rate and domestic financial conditions appears to correlate with the extent of the economy's financial development. Specifically, exchange rate variables tend to have a stronger impact than domestic financial variables on the future growth distribution in shallower financial markets.
- Third, for some Asian EMEs, the exchange rate plays an important role both at the lower and upper tails of the growth distribution, while domestic financial conditions matter more at the left tail.

The following estimated one-year-ahead real GDP growth distributions for different Asian economies (Annex Figure 4.1) highlight the differential impact of exchange rate versus domestic financial conditions. We examine the effect on the estimated growth distribution of an adverse shock (1 standard deviation) to the exchange rate (associated with depreciation and higher volatility) and domestic financial conditions (a tightening).

The results suggest three main observations. First, for many countries with lower levels of financial development (such as Indonesia), an exchange rate shock tends to shift the growth distribution more than domestic financial conditions shock or by an equal amount. Second, by contrast, a country with more-developed financial markets, such as Korea, an adverse shock to exchange rates shifts the distribution less than one to domestic financial conditions. Third, for some emerging market economies, such as India, however,

Annex Figure 4.1. One-Year-Ahead Growth Distributions: Quarterly GDP
(Compound annual growth rate)



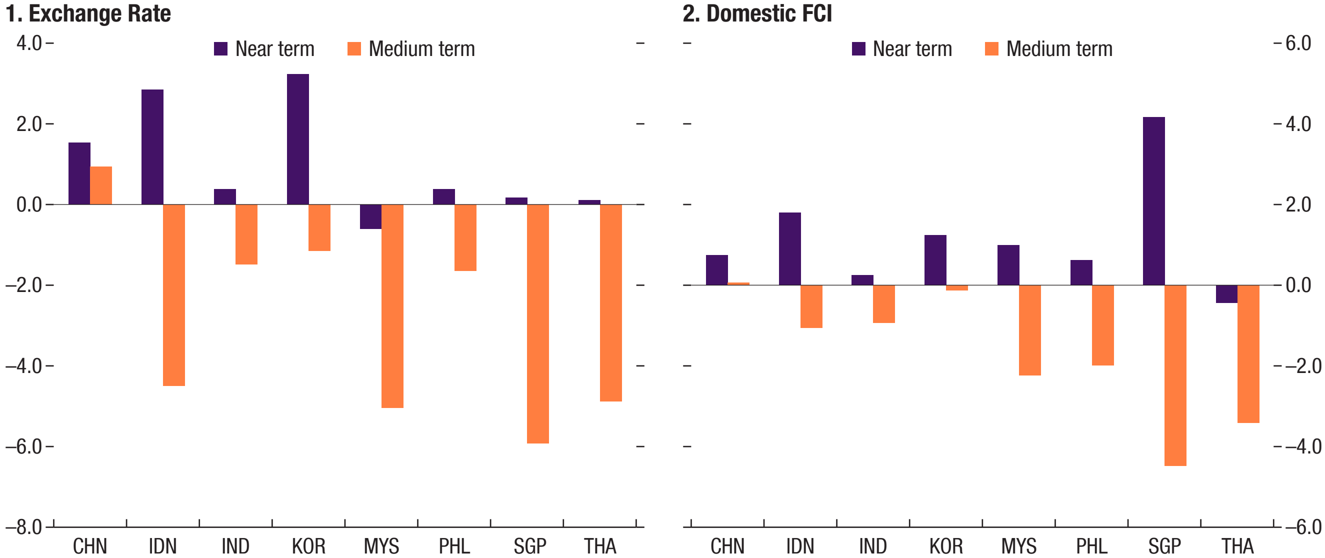
Source: IMF staff estimates.

the exchange rate shock does not shift the distribution as much as a domestic financial conditions shock.

These heterogenous country effects could reflect the relative importance of the different channels through which the exchange rate plays a role. Some channels explain why the exchange rate has a larger effect than the domestic FCI: this includes the corporate balance sheet and uncertainty channels, where countries with high unhedged FX liabilities or higher aversion to exchange rate volatility could see lower investment and growth in the face of adverse shocks. This could explain the finding that the growth distributions of countries with shallower financial markets shift more in response to exchange rate shocks than domestic FCI shocks. Other channels would move in the opposite direction. This includes the competitiveness channel, where a more depreciated and flexible exchange rate may make exports more competitive, providing a lift to future growth; this could explain the rightward shift the distribution in response to adverse exchange rate shocks in Malaysia. Another channel could be a capital flows channel, where tighter domestic financial conditions could attract capital flows, temporarily boosting growth. Further analysis is needed to parse out the relative importance of these different transmission channels.

Over the medium term, we see a different impact of exchange rate dynamics and financial conditions on the future distribution on growth. As discussed in the October 2017 and April 2018 IMF *Global Financial Stability Report*, an easing in financial conditions could boost growth in the short run; but over the medium term, financial vulnerabilities could build up, which would raise the downside risks to growth. For the sample, for most countries, the GaR 5 percent indicator, which measures the position of left tail (5^{th} percentile) of the growth distribution, declines over the medium term in response to easing of domestic financial conditions and lower exchange rate volatility/depreciation pressures (Annex Figure 4.2). This suggests that easing of financial conditions through both an exchange rate or balance sheet channel as well as domestic financial conditions related to bank credit growth, for example, could build vulnerabilities over the medium term and raise tail risks to growth.

Annex Figure 4.2. Short-Term versus Medium-Term Impact of an Easing in Financial Conditions on the Left Tail of the Growth Distribution



Source: IMF staff estimates.
Note: This panel shows changes in the left tail of the growth distribution compared to the initial near-term baseline. The chart compares how the GAR5%, a measure of the left tail of the distribution, has changed in response to easing shocks. A positive (negative) bar suggests that the GAR5% increased (decreased) relative to the initial near-term baseline distribution, that is, the distribution has shifted to the right (left). The blue bars are changes in the GAR5% in the near term, whereas the gray bars show the change over the medium term. The medium term refers to the number quarters ahead (8, 12, or 16) in which the decline in the GAR5% is the largest relative to the near term (four quarters ahead).

Annex 5. Estimating Policy Reaction Functions

Policy reactions functions are estimated following Ghosh, Ostry, and Qureshi (2017a). The regressions are run on a data set of 13 Asian economies: Australia, China, Hong Kong SAR, India, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, Taiwan Province of China, and Thailand. The data are on a quarterly basis, from the first quarter of 2000 to the fourth quarter of 2018.

The baseline reaction functions are depicted as follows:

$$Y_{it} = \alpha + \beta KF_{it} + \sum_{j=1}^{J} \delta_j Z_{jt} + \sum_{k=1}^{K} \gamma_k X_{kit} + \mu_i + \varepsilon_{it} \tag{1}$$

$$\Pr(Policy\ change = 1)_{it} = F\left(\alpha + \beta KF_{it} + \sum_{j=1}^{J} \delta_j Z_{jt} + \sum_{k=1}^{K} \gamma_k X_{kit} + \mu_i + \varepsilon_{it}\right) \tag{2}$$

Where the first equation analyses the response of FXI and monetary policy, and the second equation is for MPMs. In regressions for equation (2), the policy change (MPMs) variable is a dummy equal to 1 when policy is tightened. In both sets of equations, the variables used are the following (Box 1):

- Y represents the policy response (FX intervention, central bank policy rate, MPM) in country i in period t;
- KF is net capital flows (in percent of GDP) or its components;
- Z are the global factors (such as global market uncertainty proxied by the VIX index, commodity prices, U.S. real interest rates) that may influence the policy response of EMEs through channels other than capital flows;

Box 1. Main Variables Used in the Policy Reaction Functions

The policy reaction functions for the policy rate, foreign exchange intervention (FXI), and macroprudential measures (MPMs) include a common set of variables to capture domestic and external influences on policy.

Global Factors

- **Net capital flows** that capture one channel through which global financial shocks impact Asia. Policymakers can respond by allowing the exchange rate to adjust flexibly, or by managing the effect on the exchange rate and domestic financial conditions with FXI, policy rate changes, MPMs, and capital flow management measures (CFMs).
- **The US policy interest rate** to capture global monetary shocks. These can impact financial conditions in countries directly through financial market linkages (Rey 2015).
- **The VIX** to capture the impact of shifts in global risk appetite. Such shifts can trigger capital flow surges and financial market repricing that can prompt policy responses.
- **A global financial crisis dummy variable.**

Domestic Factors

- **Real GDP growth** to capture real domestic economic conditions.
- **Inflation** to capture the response of policies to inflationary pressures.
- **Real credit growth** to capture the buildup of risks to financial stability from excessive credit growth.
- **Real housing price increase** to capture the risks to financial stability from excessive house prices valuations.
- **Output gap** to capture the responses of policies to slack.
- **Financial development** to capture how policy responses change depending on the financial depth of the country.
- **Foreign currency liabilities** which can contribute to "fear of floating" is influencing policy decisions.
- **Country fixed effects** to control for differences in country characteristics in panel regressions.

- *X* reflects relevant domestic control variables (such as the output gap, inflation, currency appreciation, etc.). Regressions include a constant, fixed effects, and seasonal dummies.

Equation (1)

Regressions for equation (1) (FXI and monetary policy) are initially estimated using OLS with fixed and seasonal dummies, and then with 2SLS to address any endogeneity issues. For instrumentation, the estimates follow Blanchard, Adler, and de Carvalho Filho (2015) and, for each country, use net flows to the other regional countries as instruments, on the maintained assumption that these global flows are unlikely to be correlated with country-specific shocks. This provides as many instruments as there are categories of flows and allows us to estimate the effects of different types of flows on policy reactions. Since flows to different countries can be sensitive to global flows (for example, some are safer and less dependent on the global flow cycle), global flow variables are interacted with country specific dummies.

For each of the FXI and monetary policy reaction functions, the response of FXI and monetary policy is investigated with respect to:

- Type of capital flow (net, inflow, outflow, portfolio, debt, equity, FDI, etc.)
- FX denominated corporate debt, financial development (private credit to GDP), and private credit growth.

The countries for the FXI and monetary policy regressions are grouped into three subgroupings. The first group, Asia, includes all the 13 countries in our sample. The second group excludes all advanced economies and focuses on Asian EMEs (China, India, Indonesia, Malaysia, the Philippines, and Thailand). The last group corresponds to EMEs excluding China.

Equation (2)

For the regressions based on equation 2 (MPMs), to allow aggregation, MPMs are coded as “1” for a tightening action by a country in a quarter and “0” otherwise. Thus, a probit panel estimator is used on a panel of 12 advanced and emerging market Asian economies from the first quarter of 2000 to the fourth quarter of 2016. This allows the estimated coefficients to be interpreted as the marginal probability of MPM tightening. Next, the countries are grouped into different 2 subgroupings. The first subgroup includes the advanced economies only (Australia, Japan, Hong Kong SAR, Korea, New Zealand, Singapore), while the second subgroup, EMEs, includes six countries (China, India, Indonesia, Malaysia, Philippines, Thailand).

FXI Results

FXI absorbs on average 70 percent of net inflows. The coefficient is largest for the EM subgroups, suggesting that EM central banks react stronger to net capital flows (Annex Table 5.1, equations 1–4).

Asian EMEs' central banks use FXI more actively. This finding is highlighted in the regressions by inflows (nonresidents) and outflows (residents), where the coefficient of capital flows is larger and significant for EMEs compared to the entire sample (Annex Table 5.2, equations 1–4). The regressions show that EMEs purchase 60 percent of inflows (nonresidents) but sell less than 20 percent of outflows (residents), which suggests that EMEs are more concerned about nonresident flows.

Asian EMEs purchase more of capital flows that are volatile. The regression results show that the coefficients for portfolio, debt, and equity flows are higher than for total flows. For instance, EMEs purchase about 75 percent of portfolio debt flows, and nearly 100 percent of equity flows (Annex Table 5.2, equations 5–10). However, we do not find evidence of purchasing of FDI flows (Annex Table 5.2, equations 11 and 12), as the coefficient is not significant. This suggests that FXI is used more for capital flows that are fickle.

In the event of a depreciation, countries with a high load of FX debt intervene more. This finding is highlighted in a regression where an interaction term between FXL and the exchange rate is added (Annex Table 5.3, equations 4–6). The interaction term is negative and statistically significant for the Asia and EMEs excluding China sample.[1] This suggests that when the corporate sector has a high load of FX debt, countries will sell more reserves to stem currency depreciation so that the impact of the exchange rate does not amplify corporate vulnerabilities.

Asian countries with financially deep markets rely less on FXI. Using private sector credit (scaled to GDP) as a measure of financial depth, the results show that for higher financial development, FXI levels are lower (Annex Table 5.3, equations 7–9). The intuition is that countries with deeper financial markets do not need to intervene as much, as financial markets are better able to absorb inflows and corporates are more readily able to hedge their FX positions, rendering them less exposed to currency depreciation.

[1]The lower significance for EM excluding China in Annex Table 5.3 does not mean that results are mainly driven by China. This is indicated by statistical significance of the regression for the entire sample excluding China (not reported). Similarly, regression results for the monetary policy reaction function for EMEs (Annex Table 5.6) are not much affected by China.

We do not find evidence that Asian central banks rely on FXI in the face of high credit growth. The reaction function results when adding credit growth as an explanatory variable, show that it is not statistically significant in the FXI regression for the general sample, or any of the subgroups. This suggests that FXI does not react in response to higher credit growth.

Monetary Policy Results

The estimated reaction functions confirm that monetary policy in Asia responds to inflation and the output gap. Results show that policy rates respond to inflation in both advanced economies and EMEs: the coefficient is statistically significant for the Asia sample and for the EM sample (Annex Table 5.4, equations 1–4). Meanwhile, the output gap coefficient is statistically significant for the Asia sample but not for the EM sample, perhaps suggesting that monetary policy in more-advanced economies is more likely to be tightened in response to a rising output gap. Moreover, this may reflect the limited quality of output gap data for emerging markets. Overall, the analysis thus confirms that policy rates react to standard inflation targeting variables.

Monetary policy in Asia responds to the US interest rate and, in EMEs, to the exchange rate. Regression results show that the coefficient for the US interest rate is statistically significant in explaining policy rates in Asia (Annex Table 5.4, equations 1–4). This finding suggests that monetary policy independence is restricted by US interest rates (Rey 2015), as central banks are mindful of the impact of a changing interest differential to the US on capital flows. In Asian EMEs, policy rates also respond to changes in the real effective exchange rate, where an appreciation (depreciation) of the exchange rate is likely to be met with a loosening (tightening) of monetary policy. Since we control for inflation, this effect is over and above the effect on current inflation, possibly because exchange rate depreciation reflects concerns about future inflation.

Monetary policy in EMEs responds to volatile types of capital flows especially. Although the policy rate's reaction to capital flows is quantitatively small, the results do show that EM central banks react to nonresident (liability) inflows and net portfolio flows (especially net portfolio debt flows), but not to FDI flows (Annex Table 5.5, equations 1–8). These findings suggest that monetary policy is reacting more to volatile types of capital flows, in line with the results for the FXI reaction functions.

Countries with low financial development are more likely to tighten monetary policy during a depreciation episode. The interaction regressions (Annex Table 5.6, equations 4–6) show that the marginal impact of the exchange rate's depreciation on policy rate actions is stronger when countries are less-financially developed.

Asian EM central banks tighten monetary policy in response to credit growth. For EMEs, the effect of the private sector's credit growth on policy rates is positive and statistically significant (Annex Table 5.6, equations 7–9). This finding also suggests that EM central banks employ monetary policy to respond to financial stability issues, in addition to their standard mandate (inflation, exchange rate stability, etc.).

MPM Reaction Function Estimation

The MPM reaction function is estimated using a measure that aggregates changes in all MPMs. It is created using a database presented by Alam and others (2019), which contains tightening and loosening actions for 17 individual macroprudential policy instruments and their subcategories. This allows an aggregate MPM measure to be created by summing these actions across these different types of instruments for each quarter.

The reaction function is estimated with this aggregate MPM measure as the dependent variable for a panel of 13 Asian countries. The regressors are the set of explanatory variables in Box 1 (and listed below in Annex Table 5.7) that capture global and domestic influences on policy decisions. Dummy variables control for seasonal and country fixed effects. Panel regressions are run for all Asian countries, and for Asian AEs and EMEs separately. This is done using a probit panel estimator as the dependent variable is discrete (Annex Table 5.7, Columns 1–6). In addition, regressions are estimated using Instrumental Variables to correct for potential endogeneity bias (Columns 7–9). Differences in the estimated coefficients between the two sets of regressions are small, implying that this source of bias is relatively unimportant. The reaction functions presented in this Annex are probit estimates for tightening actions (that is, "+1" and "0") only. Estimation using a logit estimator and with both tightening and loosening actions produced similar but weaker results and are not reported. The statistically stronger results for just tightening actions may reflect the fact that most MPM policy actions were tightenings over the sample period. This reflects the fact that MPMs are a newer policy instrument that has been phased in by many countries over the sample period.

Reaction function estimation results provide insights into how Asian policymakers use MPMs in response to the following global and domestic developments:

- **Capital inflows.** A net capital inflow surge raises the probability of an MPM tightening in Asia (Columns 1 and 7). However, this response to net inflows is significant for EMEs only and not for AEs (Columns 2, 3, 8, and 9). Moreover, disaggregation of net inflows into gross liability and asset flows reveals that EMEs significantly tighten MPMs only in response to an increase in external liabilities (Column 6).

- **Global monetary shocks**. MPMs are tightened with an easing of global monetary policy, proxied by cuts in the US policy rate (Column 1). However, this response is significant only for AEs (in Columns 2 and 5, although not in the Instrumental Variables regression in Columns 8). It contrasts with the finding that EMEs respond significantly to net capital inflows, suggesting that AEs and EMEs respond differently to global financial shocks (which can have effects through both capital flows and interest rates). This response of macroprudential policy to spillovers from looser global monetary conditions may reflect the reduced domestic monetary policy independence associated with these spillovers. This can occur even under flexible exchange rates, as Rey (2015) argues, and leads authorities to tighten MPMs to help contain the effect of these spillovers on aggregate demand.
- **The global financial crisis.** The GFC significantly reduced the probability of a tightening of MPMs, but only in AEs (as indicated by a significant crisis dummy variable in Columns 2 and 5).
- **Inflation, the REER, and growth.** Inflationary pressures raise the probability of MPM tightening in Asia (Columns 1 and 4). This response reflects the role that MPMs can play in curbing aggregate demand and, hence, inflation. The effect is significant for AEs (Columns 2, 5, and 8), with evidence of a significant response in EMEs in the case of Instrumental Variables estimation (Column 9). MPMs respond only to contemporary inflation and not to the REER (not shown in the regression tables) in contrast to the monetary policy reaction, where the REER may be proxying for expected future inflation. Evidence of a direct response of MPMs to real GDP growth is weaker (and is significant only in Column 7 for Instrumental Variables).
- **Real credit growth.** An acceleration in credit growth raises the probability of MPM tightening in EMEs (Columns 3, 6, and 9). However, this response is relatively weak and is significant only at the 10 percent level. The data analysis in Figure 15 shows a stronger effect. Also, credit growth was generally found to be more highly significant in longer sample periods. A credit gap variable was also significant in many specifications, but these data are available only for a subset of countries so results for the credit gap are not reported.

Annex Table 5.1. Foreign Exchange Intervention Response and Net Capital Flows, 2000:Q1–18:Q4

	Asia		Emerging Market Economies	
	(1) FE	(2) IV	(3) FE	(4) IV
Net capital flows, % GDP	0.67***	0.66***	0.77***	0.99***
	(0.067)	(0.044)	(0.118)	(0.091)
US interest rate	0.135	0.465	0.416*	0.972
	(0.153)	(3.280)	(0.170)	(5.092)
VIX	0.182	0.392	1.155*	−0.410
	(0.395)	(2.581)	(0.561)	(4.112)
Commodity prices	0.418	2.035	0.561	−0.432
	(0.698)	(14.767)	(1.144)	(22.987)
GFC dummy	0.635	6.346	0.426	10.597
	(0.921)	(7.863)	(0.898)	(12.121)
Constant	0.863	−10.741	−4.165	0.116
	(3.966)	(85.062)	(6.322)	(132.69)
Observations	981	981	453	453
R-squared	0.623		0.571	
No. of countries	13	13	6	6

Annex Table 5.2. Foreign Exchange Intervention Response and the Composition of Flows, 2000:Q1–18:Q4

	Inflows (liabilities)		Outflows (assets)		Net portfolio		Net debt		Net equity		Net FDI	
VARIABLES	(1) Asia	(2) Asia EMs	(3) Asia	(4) Asia EMs	(5) Asia	(6) Asia EMs	(7) Asia	(8) Asia EMs	(9) Asia	(10) Asia EMs	(11) Asia	(12) Asia EMs
Capital flows	0.050**	0.622***	−0.008	−0.230***	0.082	0.770***	0.108	0.754***	0.069	1.040**	0.059	0.399
	(0.022)	(0.114)	(0.018)	(0.049)	(0.076)	(0.028)	(0.105)	(0.056)	(0.073)	(0.291)	(0.038)	(0.233)
US interest rate	0.126	0.355**	0.185	0.403*	0.155	0.395*	0.121	0.505*	0.159	0.365*	0.177	0.349**
	(0.120)	(0.112)	(0.122)	(0.171)	(0.132)	(0.178)	(0.150)	(0.205)	(0.136)	(0.181)	(0.124)	(0.121)
VIX	1.073	1.970***	0.982*	0.442	1.062*	1.404***	1.056	1.060**	1.236*	1.499*	1.095*	0.973
	(0.627)	(0.405)	(0.551)	(0.522)	(0.571)	(0.302)	(0.711)	(0.336)	(0.622)	(0.736)	(0.582)	(0.538)
Commodity prices	0.599	−0.757	1.158	2.191*	0.943	1.265	0.532	1.415	0.741	1.900*	1.148	1.825
	(0.865)	(1.362)	(0.899)	(0.927)	(0.922)	(0.897)	(1.005)	(1.099)	(0.818)	(0.870)	(0.904)	(0.935)
GFC dummy	−2.000	0.868	−3.138*	−3.973	−3.022	−0.988	−2.064	−2.013	−2.698	−2.413	−3.110*	−3.647
	(1.457)	(1.354)	(1.640)	(3.299)	(1.703)	(1.181)	(1.521)	(1.675)	(1.857)	(2.441)	(1.707)	(3.085)
Constant	−3.759	−1.889	−5.687	−9.563	−4.745	−8.669	−3.198	−8.316	−4.776	−12.020	−6.108	−10.245
	(4.561)	(7.156)	(4.928)	(5.422)	(5.099)	(4.880)	(5.970)	(5.709)	(4.636)	(6.163)	(4.954)	(5.867)
Observations	981	453	981	453	981	453	869	417	897	445	981	453
R-squared	0.180	0.413	0.151	0.121	0.165	0.334	0.154	0.270	0.141	0.215	0.153	0.114
No. of countries	13	6	13	6	13	6	12	6	12	6	13	6

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Annex Table 5.3. Foreign Exchange Intervention Response and Foreign Exchange Liabilities, and Financial Development

	FXI and FXL			FXL and FXL X Bilateral ER			FXI and Financial Development		
VARIABLES	(1) Asia	(2) EMs	(3) EMs Ex China	(4) Asia	(5) EMs	(6) EMs Ex China	(7) Asia	(8) EMs	(9) EMs Ex China
Net capital flows (% of GDP)	0.684***	0.729***	0.710***	0.682***	0.759***	0.738***	0.676***	0.727***	0.729***
	(0.071)	(0.097)	(0.102)	(0.072)	(0.126)	(0.138)	(0.083)	(0.138)	(0.155)
US interest rate	0.114	0.203	0.079	0.113	0.393*	0.268	0.077	0.132	0.086
	(0.151)	(0.232)	(0.231)	(0.150)	(0.174)	(0.158)	(0.077)	(0.077)	(0.079)
VIX	0.197	0.740	0.714	0.224	1.264**	1.300*	−0.210	0.009	0.396
	(0.357)	(0.602)	(0.703)	(0.349)	(0.459)	(0.606)	(0.422)	(0.465)	(0.323)
Commodity prices	0.364	−0.142	−0.794	0.377	0.424	−0.266	0.681	−0.136	−0.721
	(0.674)	(1.132)	(1.113)	(0.672)	(1.172)	(1.194)	(0.580)	(0.899)	(0.891)
GFC dummy	0.759	1.262	0.878	0.900	0.984	0.462	0.839	0.844	0.493
	(1.020)	(0.673)	(0.688)	(0.983)	(0.702)	(0.533)	(1.051)	(0.622)	(0.587)
Exchange rate change (increase = depreciation)	−0.110**	−0.212**	−0.188*	−0.056	−0.143	−0.044	−0.095*	−0.165*	−0.153
	(0.045)	(0.084)	(0.082)	(0.054)	(0.130)	(0.073)	(0.045)	(0.078)	(0.087)
FX Liabilities (FXL), % GDP	−0.050***	−0.342	−0.363	−0.048***	−0.149	−0.174			
	(0.014)	(0.299)	(0.298)	(0.014)	(0.274)	(0.276)			
FXL X exchange rate				−0.013*	−0.016	−0.035**			
				(0.007)	(0.021)	(0.012)			
Credit (% of GDP)							−6.062**	−13.923**	−14.622
							(2.301)	(3.965)	(9.634)
Constant	1.489	2.815	6.375	1.309	−3.210	0.113	6.407**	13.131**	13.684
	(3.820)	(8.010)	(8.653)	(3.800)	(7.494)	(8.496)	(2.616)	(3.933)	(8.079)
Observations	969	522	447	969	447	372	894	447	372
R-squared	0.638	0.601	0.604	0.639	0.593	0.583	0.651	0.641	0.612
No. of countries	13	7	6	13	6	5	12	6	5

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Annex Table 5.4. Monetary Policy Response and Net Capital Flows, 2000:Q1–18:Q4

	Asia		EMEs	
	(1) FE	(2) IV	(3) FE	(4) IV
Net capital flows, % of GDP	−0.002 (0.006)	0.009 (0.008)	0.006 (0.007)	0.031* (0.017)
US interest rate	0.072*** (0.018)	0.522 (0.543)	0.078** (0.026)	0.501 (0.888)
VIX	−0.162 (0.104)	0.327 (0.495)	−0.043 (0.136)	0.186 (0.835)
Commodity prices	−0.180 (0.412)	2.618 (3.395)	−1.339** (0.460)	2.234 (5.577)
GFC dummy	−0.871*** (0.187)	−0.961 (1.444)	−1.102** (0.335)	−0.985 (2.349)
Lagged dependent variable	0.812*** (0.036)	0.833*** (0.017)	0.741*** (0.045)	0.780*** (0.030)
Output gap	1.935** (0.753)	0.708 (0.616)	1.704 (1.323)	−1.411 (1.296)
CPI	0.119** (0.049)	0.086*** (0.013)	0.200** (0.073)	0.148*** (0.020)
REER	−0.002 (0.011)	−0.003 (0.004)	−0.029* (0.012)	−0.027*** (0.008)
Constant	0.797** (0.327)	−14.810 (19.227)	0.731 (0.548)	−12.110 (31.640)
Observations	956	956	441	441
R-squared	0.947		0.938	
No. of countries	13	13	6	6

Annex Table 5.5. Monetary Policy Response and the Composition of Flows, 2000:Q1–18:Q4

	Inflows (liabilities)		Outflows (assets)		Net portfolio		Net debt		Net FDI	
VARIABLES	(1) Asia	(2) Asia EMs	(3) Asia	(4) Asia EMs	(5) Asia	(6) Asia EMs	(7) Asia	(8) Asia EMs	(9) Asia	(10) Asia EMs
Capital flows	−0.000 (0.002)	0.008* (0.004)	−0.000 (0.002)	0.005 (0.007)	0.006** (0.002)	0.008*** (0.002)	0.005 (0.003)	0.014*** (0.003)	−0.003 (0.002)	−0.027 (0.032)
US interest rate	0.072*** (0.018)	0.079** (0.026)	0.072*** (0.018)	0.077** (0.027)	0.078*** (0.022)	0.077** (0.027)	0.075*** (0.020)	0.069** (0.024)	0.073*** (0.019)	0.081** (0.030)
VIX	−0.166 (0.110)	−0.024 (0.133)	−0.165 (0.109)	−0.036 (0.143)	−0.246* (0.114)	−0.041 (0.137)	−0.099 (0.100)	−0.054 (0.163)	−0.168 (0.108)	−0.050 (0.134)
Commodity prices	−0.192 (0.394)	−1.372** (0.451)	−0.195 (0.396)	−1.325** (0.491)	−0.571 (0.477)	−1.328** (0.483)	−0.177 (0.443)	−1.332** (0.514)	−0.199 (0.399)	−1.327** (0.498)
GFC dummy	−0.866*** (0.184)	−1.094** (0.329)	−0.863*** (0.185)	−1.120** (0.314)	−0.868*** (0.244)	−1.098** (0.316)	−0.936*** (0.159)	−1.100** (0.332)	−0.861*** (0.187)	−1.132** (0.318)
Lagged dep Variable	0.813*** (0.036)	0.742*** (0.045)	0.813*** (0.035)	0.740*** (0.045)	0.791*** (0.031)	0.740*** (0.045)	0.807*** (0.041)	0.739*** (0.045)	0.812*** (0.036)	0.735*** (0.047)
Output gap	1.937** (0.745)	1.703 (1.317)	1.930** (0.755)	1.746 (1.321)	1.794 (1.047)	1.779 (1.321)	2.313*** (0.717)	1.860 (1.506)	1.931** (0.758)	1.686 (1.343)
CPI	0.119** (0.050)	0.200** (0.073)	0.119** (0.050)	0.201** (0.073)	0.131* (0.060)	0.201** (0.073)	0.134** (0.055)	0.213** (0.071)	0.119** (0.050)	0.202** (0.073)
REER	−0.003 (0.011)	−0.030* (0.012)	−0.003 (0.011)	−0.029* (0.012)	−0.021* (0.011)	−0.029* (0.012)	−0.003 (0.011)	−0.032* (0.013)	−0.003 (0.011)	−0.029* (0.011)
Constant	0.811** (0.346)	0.649 (0.538)	0.808** (0.346)	0.704 (0.582)	1.148** (0.392)	0.726 (0.553)	0.623* (0.303)	0.728 (0.621)	0.820** (0.337)	0.793 (0.511)
Observations	956	441	956	441	736	441	848	407	956	441
R-squared	0.947	0.939	0.947	0.938	0.945	0.938	0.945	0.937	0.947	0.939
No. of countries	13	6	13	6	10	6	12	6	13	6

Annex Table 5.6. Monetary Policy Response and Financial Development, Credit Growth

	Monetary policy and Financial Development (FD)			Monetary policy and FD X Bilateral ER			Monetary policy and Credit Growth		
VARIABLES	(1) Asia	(2) EMs	(3) EMs ex China	(4) Asia	(5) EMs	(6) EMs ex China	(7) Asia	(8) EMs	(9) EMs ex China
Net capital flows (% of GDP)	−0.003 (0.006)	0.003 (0.007)	0.002 (0.008)	−0.002 (0.006)	0.002 (0.008)	0.001 (0.008)	−0.003 (0.006)	0.004 (0.006)	0.002 (0.007)
US interest rate	0.062*** (0.020)	0.041 (0.033)	0.040 (0.040)	0.063*** (0.019)	0.039 (0.032)	0.038 (0.039)	0.075*** (0.021)	0.059* (0.027)	0.054 (0.033)
VIX	−0.229* (0.120)	−0.102 (0.164)	−0.136 (0.209)	−0.226* (0.121)	−0.100 (0.166)	−0.133 (0.212)	−0.168 (0.112)	−0.056 (0.145)	−0.086 (0.183)
Commodity prices	0.023 (0.099)	−0.141 (0.204)	−0.223 (0.231)	0.029 (0.095)	−0.144 (0.198)	−0.223 (0.226)	−0.012 (0.106)	−0.190 (0.181)	−0.291 (0.190)
GFC dummy	−0.805*** (0.227)	−0.854* (0.376)	−0.801 (0.484)	−0.873*** (0.254)	−0.864* (0.379)	−0.812 (0.488)	−0.871*** (0.219)	−0.928** (0.311)	−0.917* (0.416)
Δexchange rate (increase= depreciation)	0.013 (0.008)	0.027 (0.016)	0.028 (0.017)	0.055** (0.018)	0.050* (0.022)	0.048 (0.023)	0.012 (0.008)	0.022 (0.016)	0.023 (0.017)
Credit (% of GDP)	−0.694*** (0.166)	−0.852** (0.302)	−0.840 (0.559)	−0.666*** (0.168)	−0.835** (0.285)	−0.857 (0.534)			
Δexchange rate # Credit (% GDP)				−0.043** (0.015)	−0.039* (0.019)	−0.038 (0.022)			
lagged dependent variable	0.794*** (0.034)	0.716*** (0.068)	0.704*** (0.077)	0.799*** (0.033)	0.719*** (0.068)	0.707*** (0.077)	0.815*** (0.036)	0.733*** (0.066)	0.716*** (0.074)
Output gap	1.538 (0.868)	0.429 (1.340)	0.729 (1.563)	1.456 (0.841)	0.481 (1.304)	0.774 (1.521)	1.608 (0.925)	0.403 (1.346)	0.610 (1.595)
CPI	0.120** (0.048)	0.194** (0.073)	0.207* (0.083)	0.120** (0.048)	0.193** (0.074)	0.206* (0.084)	0.112** (0.047)	0.185** (0.068)	0.197* (0.079)
credit growth, yoy							0.007 (0.005)	0.020*** (0.001)	0.020*** (0.002)
Constant	1.645* (0.802)	2.360 (1.543)	2.708 (1.876)	1.567* (0.811)	2.346 (1.529)	2.702 (1.859)	0.823 (0.654)	1.535 (1.164)	2.097 (1.273)
Observations	882	441	367	882	441	367	882	441	367
R-squared	0.947	0.935	0.936	0.948	0.935	0.936	0.946	0.936	0.937
No. of countries	12	6	5	12	6	5	12	6	5

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Annex Table 5.7. Macroprudential Measure Reaction Function Estimations

	MPM Reaction Function Estimations								
Variables	1 Baseline Asia	2 Baseline AEs	3 Baseline EMs	4 Baseline Asia	5 Baseline AEs	6 Baseline EMs	7 Probit IV - Asia	8 Probit IV - Advanced Asia	9 Probit IV - EM Asia
Net capital flows	0.022**	0.017	0.038**				0.062**	−0.021	0.124***
(/GDP)	(0.010)	(0.011)	(0.019)				(0.026)	(0.061)	(0.039)
External liability flows				0.022**	0.018	0.060***			
(/GDP)				(0.010)	(0.012)	(0.020)			
External asset flows				−0.022**	−0.019**	−0.000			
(/GDP)				(0.009)	(0.009)	(0.019)			
US interest rate	−0.105***	−0.150**	−0.024	−0.105***	−0.150**	−0.013	−0.062	0.138	−0.347
	(0.038)	(0.060)	(0.054)	(0.038)	(0.060)	(0.053)	(0.484)	(1.516)	(0.588)
VIX	0.001	0.019	−0.020	0.001	0.018	−0.013	0.100	−0.094	0.055
	(0.010)	(0.014)	(0.016)	(0.010)	(0.012)	(0.016)	(0.236)	(0.959)	(0.265)
GFC dummy	−1.101*	−5.305***	−0.814	−1.104	−5.351***	−0.812	−0.765		1.588
	(0.665)	(0.576)	(0.774)	(0.675)	(0.653)	(0.768)	(3.007)		(2.307)
Real GDP growth	0.046	−0.065	0.085	0.046	−0.064	0.066	0.163***	0.142	0.131*
	(0.047)	(0.040)	(0.065)	(0.046)	(0.042)	(0.058)	(0.054)	(0.131)	(0.072)
Inflation	0.092**	0.062**	0.054	0.092**	0.063**	0.049	−0.004	0.375**	−0.074**
	(0.040)	(0.028)	(0.059)	(0.039)	(0.025)	(0.058)	(0.032)	(0.151)	(0.038)
Credit growth	0.003	−0.009	0.034*	0.003	−0.008	0.035*	0.014	0.007	0.023*
	(0.009)	(0.008)	(0.020)	(0.009)	(0.010)	(0.019)	(0.009)	(0.017)	(0.014)
House price growth	0.001	0.024		0.001	0.025		0.001	0.002	
	(0.011)	(0.016)		(0.010)	(0.016)		(0.008)	(0.022)	
Constant	−1.340***	−1.049**	−1.156***	−1.338***	−0.982***	−1.482***	−2.712	−0.279	−1.326
	(0.209)	(0.461)	(0.391)	(0.205)	(0.334)	(0.362)	(3.699)	(16.754)	(4.022)
Observations	784	408	408	784	408	408	636	186	294
Pseudo R2	0.176	0.228	0.152	0.176	0.228	0.170			

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

References

Adrian, T., N. Boyarchenko, and D. Giannone. 2019. "Vulnerable Growth." *American Economic Review* 109: 1263–89.

Adrian, T. F., N. L. Grinberg, and S. Malik. 2018. "The Term Structure of Growth-at-Risk." IMF Working Paper WP/18/180, International Monetary Fund, Washington, DC.

Alam, Z., A. Alter, J. Eiseman, G. Gelos, H. Kang, M. Narita, E. Nier, and N. Wang. 2019. "Digging Deeper – Evidence on the Effects of Macroprudential Policies from a New Database." IMF Working Paper WP/19/66, International Monetary Fund, Washington, DC.

Alfaro, L., G. Asis, A. Chari, and U. Panizza, 2017. "Lessons Unlearned? Corporate Debt in Emerging Markets" NBER Working Paper No. 23407, National Bureau of Economic Research, Cambridge, MA.

Altman, E. 2005. "An Emerging Market Credit Scoring System for Corporate Bonds." *Emerging Market Review* 6 (4): 311–23.

Altman, E., Iwanicz Drozdowska, M., Laitinen, E., and Suvas, A. 2016. "Financial Distress Prediction in an International Context: A Review and Empirical Analysis of Altman's Z Score Model." *Journal of International Financial Accounting and Management*, Volume 28, Issue 2, June 2017, Pages 131–171.

Amiti, M, O. Itskhoki, and J. Konings. 2012. "Importers, Exporter, and Exchange Rate Disconnect." CEPR Discussion Paper No. 9260, Center for Economic and Policy Research, Washington, DC.

Blanchard, O., G. Adler, and I. de Carvalho Filho. 2015. "Can Foreign Exchange Intervention Stem Exchange Rate Pressures from Global Capital Flows Shocks?" IMF Working Paper WP/15/159, International Monetary Fund, Washington, DC.

Blanchard, O., J. Ostry, A. Ghosh, and M. Chamon. 2014. "Dealing with Capital Inflows." Keynote remarks at the Central Bank of Chile's Conference, The Role of Central Banks in Modern Times: Twenty-Five Years into the Central Bank of Chile's Independence. Santiago, October 24.

Bruno V., S. Kim, and H. Shin. 2018. "Exchange Rates and the Working Capital Channel of Trade Fluctuations." *AEA Papers and Proceedings* 108 (May): 531–36.

Bruno, V., and H. Shin. 2015. "Cross-Border Banking and Global Liquidity." *Review of Economic Studies* 82 (2): 535–64.

———. 2017. "Global Dollar Credit and Carry Trades: A Firm-level Analysis." *Review of Financial Studies* 30: 703–49.

———. 2018. "Currency Depreciation and Emerging Market Corporate Distress." BIS Working Papers No 753, Bank for International Settlements, Basel.

Burnside, C., M. Eichenbaum, and S. Rebelo. 2001. "Hedging and Financial Fragility in Fixed Exchange Rate Regimes." *European Economic Review* 45: 1151–193.

Cardarelli, R., S. Elekdag, and A. Kose. 2010. "Capital Inflows: Macroeconomic Implications and Policy Responses." *Economic Systems* 34: 336–56.

Casas, C., F. Diez, G. Gopinath. and P-O. Gourinchas. 2016. "Dominant currency paradigm." NBER Working Paper 22943. National Bureau of Economic Research, Cambridge, MA.

Chen, Z., S. Nadeem, and S. Peiris. Forthcoming. "Bank Balance Sheets and External Shocks: The Role of Foreign Exchange Intervention and CFMs." IMF Working Paper, International Monetary Fund, Washington, DC.

Corbacho, A., and S. Peiris, eds. 2018. *The ASEAN Way: Sustaining Growth and Stability*. Washington, DC: International Monetary Fund.

Dao, M., C. Minoiu, and J. Ostry. 2017. Corporate Investment and the Real Exchange Rate. IMF Working Paper WP/17/183, International Monetary Fund, Washington, DC.

De, J., P. Deb, S. Nadeem and S. Peiris. Forthcoming. "The Transmission of International Financial Cycles in Asia: Country Characteristics and Policy Responses."

Freedman, C. and I. Otker-Robe. 2010. "Important Elements for Inflation Targeting for Emerging Economies." IMF Working Paper WP/10/113, International Monetary Fund, Washington, DC.

Gadanecz, B., and A. Mehrotra. 2013. "The Exchange Rate, Real Economy and Financial Markets." BIS Papers No. 73, Bank for International Settlements, Basel.

Georgiadis, G., and F. Zhu. 2019. "Monetary Policy Spillovers, Capital Controls and Exchange Rate Flexibility, and The Financial Channel of Exchange Rates." BIS Working Papers No. 797, Bank for International Settlements, Basel.

Ghosh, A., J. Ostry, and M. Qureshi. 2017a. "Managing the Tide: How Do Emerging Markets Respond to Capital Flows?" IMF Working Paper WP/17/69, International Monetary Fund, Washington, DC.

———. 2017b. *Taming the Tide of Capital Flows: A Policy Guide*. Cambridge, MA: MIT Press.

Gopinath, G. 2015. "The International Price System." In *Jackson Hole Symposium, Volume 27*. Kansas City: Federal Reserve Bank at Kansas City.

Gourinchas, P., and M. Obstfeld. 2012. "Stories of the Twentieth Century for the Twenty-First." *American Economic Journal: Macroeconomics* 4: 226–65.

Hofmann, B., I. Shim, and H. Shin. "Bond Risk Premia and The Exchange Rate." BIS Working Papers No. 775, Bank for International Settlements, Basel.

Hong, G. H., A. Oeking, K. H. Kang, and C. Rhee. 2019. "What Do Deviations from Covered Interest Parity and Higher FX Hedging Costs Mean for Asia." IMF Working Paper No. 19/169, International Monetary Fund, Washington, DC.

International Monetary Fund (IMF). 2012. "The Liberalization and Management of Capital Flows: An Institutional View." IMF Policy Paper, Washington, DC.

———. 2017a. *Global Financial Stability Review*. Washington, DC, October.

———. 2017b. "Increasing Resilience to Large and Volatile Capital Flows—The Role of Macroprudential Policy." IMF Policy Paper, Washington, DC.

Jiang, B., and T. Saadi Sedik. 2019. "The Turning Tide: How Vulnerable are Asian Corporates?" IMF Working Paper No. 19/93, International Monetary Fund, Washington, DC.

Jordà, Ò. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95: 161–82.

Kim, M. 2019. "Financial Development, Exchange Rate Fluctuations, and Debt Dollarization: A Firm-Level Evidence." IMF Working Paper No. 19/168, International Monetary Fund, Washington, DC.

Montiel, P. 2014. "Capital Flows. "Issues and Policies." *Open Economic Review* 25: 595–633.

Nier, E., T. Olafsson, and Y. Rollinson. Forthcoming. "Exchange Rates, Domestic Credit, and Macroprudential Policy." IMF Working Paper, International Monetary Fund, Washington, DC.

Ostry, J., S. Basu, M. Chamon, and U. Wiriadinata. 2019. "FX Intervention and Monetary Policy Credibility in Inflation Targeting Emerging Markets." Unpublished.

Ostry, J., A. Ghosh, and M. Chamon. 2012. "Two Targets, Two Instruments; Monetary and Exchange Rate Policies in Emerging Market Economies." IMF Staff Discussion Note 12/01, International Monetary Fund, Washington, DC.

Ostry, J., A. Ghosh, M. Chamon, and M. Qureshi. 2011. "Capital Controls: When and Why?" *IMF Economic Review* 59 (3): 562–80.

———. 2012. "Tools for Managing Financial-Stability Risks from Capital Inflows." *Journal of International Economics* 88 (2): 407–21.

Rey, H. 2015. "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence." NBER Working Paper 21162, National Bureau of Economic Research, Cambridge, MA.

Serena, J., and R. Sousa. 2017. "Does Exchange Rate Depreciation Have Contractionary Effects on Firm-Level Investment?" BIS Working Paper No. 624, Bank for International Settlements, Basel.

Vegh, C., L. Morano, D. Friedheim, and D. Rojas. 2017. *Between a Rock and a Hard Place: The Monetary Policy Dilemma in Latin America and the Caribbean*. Washington, DC: World Bank.