EXECUTIVE BOARD MEETING

EBS/20/18

March 11, 2020

To: Members of the Executive Board

From: The Secretary

Subject: **April 2020 World Economic Outlook—Analytical Chapter 3**

Board Action:	Executive Directors' **consideration** (Formal)
Tentative Board Date:	**Wednesday, April 1, 2020**
Publication:	Yes, it is intended that the full set of the World Economic Outlook documents will be released to the public at the time of the World Economic Outlook press conference, tentatively scheduled for **Tuesday, April 14, 2020**. The analytical chapters will be made available to the public on the IMF website in advance of the publication of the full document.
Questions:	Mr. Sandri, RES (ext. 37698) Mr. Grigoli, RES (ext. 34804) Ms. Bergant, RES (ext. 34667) Mr. Hansen, RES (ext. 39044)
Additional Information:	The paper will be revised for publication in light of the Executive Board discussion. If Executive Directors have additional comments, they should notify Mr. Sandri and Mr. Grigoli by **5:30 p.m. on Tuesday, March 24, 2020**.

CHAPTER 3

DAMPENING GLOBAL FINANCIAL SHOCKS IN EMERGING MARKETS: CAN MACROPRUDENTIAL REGULATION HELP?

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CHAPTER 3

DAMPENING GLOBAL FINANCIAL SHOCKS IN EMERGING MARKETS: CAN MACROPRUDENTIAL REGULATION HELP?

Global financial conditions can considerably influence credit markets and macroeconomic conditions in emerging markets. This chapter asks whether macroprudential regulation—which aims to buttress financial stability—can help emerging markets dampen the macroeconomic effects of global financial shocks. The analysis finds that a more stringent level of macroprudential regulation reduces the sensitivity of GDP growth in emerging markets to global financial shocks. Macroprudential regulation also tends to dampen the effects of global financial shocks on credit growth and the exchange rate. However, maintaining a tight level of macroprudential regulation is not costless. Although macroprudential regulation supports GDP growth in the face of adverse global financial shocks, it also lowers economic activity when global financial conditions are favorable. This symmetric effect calls for further research on how to adjust macroprudential regulation optimally. The analysis also finds that macroprudential regulation allows monetary policy to respond more countercyclically to global financial shocks, which could be an important channel through which macroprudential regulation enhances macroeconomic stability. Finally, the chapter examines potential side effects of macroprudential regulation on average GDP growth or through cross-country spillovers. The analysis finds no evidence of detrimental effects on average GDP growth, but more research is needed before definitive conclusions are drawn. Regarding spillovers, there is some evidence that macroprudential regulation in one country tends to enhance resilience in other countries as well, possibly because greater domestic stability supports more stable financial and trade flows.[1]

Introduction

Fluctuations in global financial markets significantly influence financial and macroeconomic conditions in emerging markets. Under buoyant global financial conditions, emerging markets tend to enjoy stronger economic growth supported by abundant foreign capital inflows. Conversely, a tightening in global financial conditions—for example, an unexpected policy rate hike in the United States or a spike in global risk aversion—can depress economic activity in emerging markets.[2]

According to conventional macroeconomic theory, emerging markets should be able to offset the impact of global financial shocks by relying on exchange rate flexibility. Indeed, exchange rate flexibility appears to soften the effects of foreign financial shocks (Obstfeld, Ostry, and Qureshi 2019), but it falls short of providing full insulation.[3] Global financial conditions affect credit markets and macroeconomic conditions even in countries with flexible exchange rates (Rey 2015, 2016).

The fact that exchange rate flexibility does not fully insulate emerging markets from global financial shocks has fueled recurring debates about whether policymakers should deploy

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[1] The authors of this chapter are Katharina Bergant, Francesco Grigoli, Niels-Jakob Hansen, and Damiano Sandri (lead), with support from Jungjin Lee and Xiaohui Sun. The chapter benefited from insightful comments by Sebnem Kalemli-Özcan and internal seminar participants.

[2] See, for example, Canova (2005), Dedola, Rivola, and Stracca (2017), Maćkowiak (2007), Georgiadis (2016), Choi and others (2017), Iacoviello and Navarro (2019), Bräuning and Ivashina (forthcoming), Vicondoa (2019), and Kirti (2018).

[3] Recent models show that exchange rate flexibility may not fully absorb foreign shocks in the presence of financial frictions (Ottonello 2015; Aoki, Benigno, and Kiyotaki 2018; Farhi and Werning 2016; Cavallino and Sandri 2018; Akinci and Queralto 2018) and trade invoicing in US dollars (Gopinath and others 2019; Egorov and Mukhin 2019).

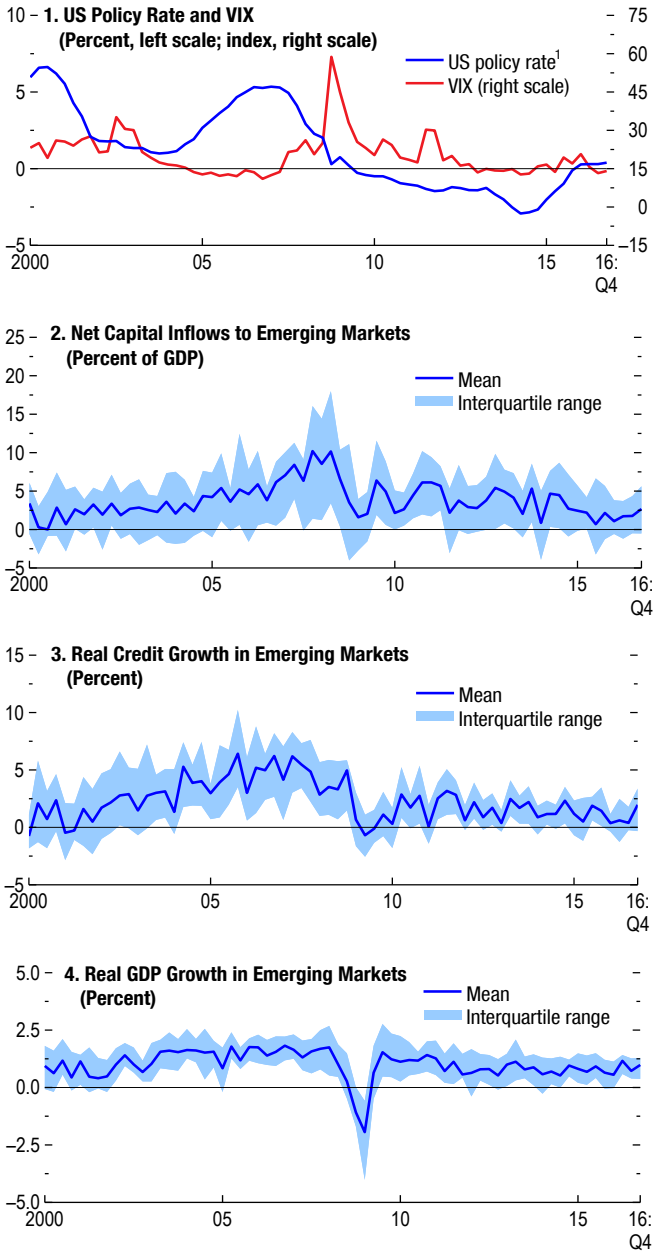
additional policy tools. The discussion often focuses on the role of capital flow management measures and foreign exchange intervention, because these tools directly target international financial transactions. However, awareness is growing that macroprudential policies can themselves play an important role in stabilizing credit markets, despite considerable heterogeneity in effectiveness among instruments (Box 3.1).

Considering this background, the chapter analyzes whether macroprudential regulation—which involves a broad range of policy measures to contain the buildup of systemic vulnerability and protect financial stability—may also dampen the macroeconomic impacts of global financial shocks on emerging markets. The premise underpinning the analysis is that by reinforcing balance sheets, restricting risk taking, and limiting foreign currency exposures, macroprudential regulation strengthens the domestic financial sector's resilience and thus enhances macroeconomic stability.

Ostry and others (2012) provides early evidence favoring this hypothesis, showing that macroprudential regulation enhanced resilience during the global financial crisis of 2008–09. Similarly, Neanidis (2019) finds that stronger bank supervision reduces the negative impact of volatile capital flows on economic growth.[4] This chapter examines the dampening effects of macroprudential regulation against global financial shocks

Figure 3.1. Global Financial Conditions and Emerging Markets

Global financial conditions can significantly influence credit markets and economic activity in emerging markets.



Sources: Bank for International Settlements; Haver Analytics; IMF, *Balance of Payments and International Investment Position Statistics*; IMF, *International Financial Statistics*; Wu and Xia (2015); and IMF staff calculations.
Note: VIX = Chicago Board Options Exchange Volatility Index.
[1]The US policy rate is the federal funds rate except during the zero lower bound period, which uses the implied rate from Wu and Xia (2015).

[4] Brandao-Marques and others (forthcoming) analyzes the role of macroprudential policies in affecting the full distribution of future GDP growth. Examining the effectiveness of changes in macroprudential regulation, their study finds that these policies can dampen downside risk to growth from external financial shocks.

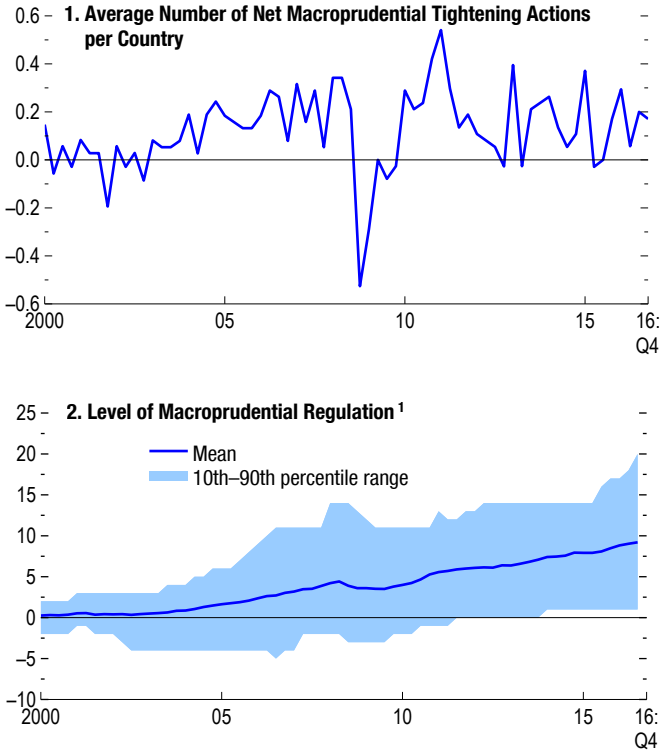
more systematically by analyzing the experience of 38 emerging markets between 2000 and 2016.[5]

During that period, emerging markets were exposed to highly volatile global financial conditions driven by large swings in US policy rates, global risk aversion, proxied here by the Chicago Board Options Exchange Volatility Index (VIX), and capital inflows (Figure 3.1, panels 1 and 2).[6] Global financial volatility significantly affected emerging markets. Panels 3 and 4 of Figure 3.1 show that domestic credit and GDP in emerging markets grew strongly during the buoyant years before the global financial crisis and sharply contracted during the crisis.

Meanwhile, emerging markets have gradually tightened macroprudential regulation. The IMF's integrated Macroprudential Policy (iMaPP) database records tightening and loosening actions for various macroprudential policy instruments between 1990 and 2016 (Alam and others 2019). These include measures to boost bank capital and liquidity, limit foreign exchange mismatches, and prevent risky lending to leveraged borrowers.

Figure 3.2. Macroprudential Regulation in Emerging Markets

Emerging markets have tightened macroprudential regulation over the years, but considerable variation remains across countries.



Sources: IMF, integrated Macroprudential Policy (iMaPP) database; and IMF staff calculations.
[1]The level of macroprudential regulation is calculated by cumulating the net tightening actions for each country since 1990, the first year in the iMaPP database.

Panel 1 of Figure 3.2 shows the average number of macroprudential tightening actions per country in emerging markets since 2000. By cumulating the tightening and loosening actions for each country since 1990, it is possible to construct an approximate measure of the stringency of macroprudential regulation. Panel 2 of the figure shows that macroprudential regulation in emerging markets has tightened considerably over the years, especially since 2005. The global

[5] The country sample includes Albania, Argentina, Belarus, Bosnia and Herzegovina, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, the Dominican Republic, Ecuador, El Salvador, Georgia, Hungary, India, Indonesia, Jamaica, Jordan, Kazakhstan, Malaysia, Mexico, Morocco, North Macedonia, Pakistan, Paraguay, Peru, the Philippines, Poland, Romania, Russia, Serbia, South Africa, Thailand, Turkey, Ukraine, and Uruguay. The sample period ends in 2016—the last year in the iMaPP database—and excludes extreme crises characterized by a "freely falling" exchange rate, according to the classification of Ilzetzki, Reinhart, and Rogoff (2019). For details on the sample selection and all data sources used in the analysis, see Online Annex 3.1. All annexes are available at http://www.imf.org/en/Publications/WEO.

[6] Emerging markets' cross-border financial positions increased considerably as a share of GDP until the global financial crisis, and they have remained broadly stable since then (Lane and Milesi-Ferretti 2018). The VIX captures the market's expected volatility in the Standard & Poor's 500 index over the coming 30 days.

financial crisis led to a temporary loosening in macroprudential regulation, but emerging markets returned to tightening macroprudential regulation during the subsequent recovery. Panel 2 also illustrates a substantial dispersion in the level of macroprudential regulation across countries.

In this context, this chapter asks three main questions:

- Can a more stringent level of macroprudential regulation dampen the effects of global financial shocks on macroeconomic conditions in emerging markets?
- Regarding possible channels through which macroprudential regulation affects resilience, does monetary policy respond more countercyclically to global financial shocks when macroprudential regulation is tighter?
- Does macroprudential regulation have side effects on average economic growth and via cross-country spillovers?

By exploiting the time-series and cross-country variation in macroprudential regulation, the analysis first shows that macroprudential regulation can strengthen emerging markets' resilience to swings in global financial conditions. Specifically, a more stringent level of macroprudential regulation reduces the sensitivity of GDP growth in emerging markets to global financial shocks.[7] These results are robust to a broad set of endogeneity tests to alleviate concerns about reverse causality and omitted variables.

The dampening effects of macroprudential regulation show decreasing marginal returns. Therefore, when regulation is already more stringent, further macroprudential tightening becomes less effective in strengthening resilience. This decrease in effectiveness is consistent with concerns about circumvention, whereby excessive macroprudential regulation may push financial activities outside the regulatory perimeter and increase cross-border lending.[8]

No particular set of tools seems to drive the dampening effects of macroprudential regulation. A broad range of macroprudential measures can contribute to enhancing resilience to global financial shocks, including macroprudential tools that boost bank capital and liquidity, limit foreign exchange exposures, and prevent forms of credit that are too risky. However, these tools have heterogeneous dampening effects that depend on the type of global financial shock hitting the economy.

Macroprudential regulation also appears to reduce domestic credit's sensitivity to global financial shocks, in line with the hypothesis that stronger bank balance sheets lead to steadier credit supply. Furthermore, macroprudential regulation tends to stabilize nominal and real exchange rates, possibly because a safer financial system reduces the volatility of currency risk premia.

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[7] It is important to emphasize that the analysis does not examine how *changes* in macroprudential regulation affect macroeconomic conditions, which is the focus of most of the existing literature. It instead investigates whether a tighter *level* of macroprudential regulation—which is expected to strengthen financial resilience—dampens the effects of global financial shocks on domestic macroeconomic conditions.

[8] See, for example, Aiyar and others (2014), Reinhardt and Sowerbutts (2015), Cerutti and others (2017), Anhert and others (2018), Bengui and Bianchi (2018), Braggion and others (2018), and Cizel and others (2019).

However, maintaining a high level of macroprudential regulation at all times is not costless, because regulation involves symmetric dampening effects. A higher level of macroprudential regulation supports GDP growth when global financial shocks are adverse, but it lowers levels of economic activity when global financial conditions are favorable. This observation calls for further analysis on how to adjust macroprudential policies optimally to dampen the effects of negative global financial shocks without unduly constraining economic activity when financial conditions are supportive.[9] Such analysis should also take into account the need to adjust macroprudential policies based on domestic systemic vulnerabilities (IMF 2014).

The chapter also examines whether macroprudential policies may strengthen macroeconomic resilience by allowing central banks to respond more countercyclically to global financial shocks. This question is important because emerging markets often respond procyclically by increasing policy rates when global financial conditions tighten, possibly to stabilize exchange rates and capital flows.[10] The empirical results show that macroprudential regulation indeed leads monetary policy to respond more countercyclically to global financial shocks. A possible interpretation is that macroprudential regulation alleviates concerns about financial stability and thus allows monetary policy to focus more squarely on macroeconomic stabilization.

Finally, the chapter studies potential side effects of macroprudential regulation. As mentioned previously, macroprudential regulation has symmetric dampening effects, thus reducing economic growth when global financial conditions are favorable. Besides those negative effects, there could be a deeper concern that a more stringent level of macroprudential regulation may reduce the average level of economic growth throughout the economic cycle. The analysis finds no evidence of such a negative impact. However, since endogeneity concerns are more severe in this context, more research is needed to reach definitive conclusions.

Macroprudential regulation may also raise concerns about negative cross-country spillovers. If a country shields itself against global financial volatility, other countries may face more exposure to such volatility. The analysis finds no evidence of such negative spillovers. Rather, it finds some evidence of positive spillovers, since a higher level of macroprudential regulation in one country tends to enhance macroeconomic stability in other countries in the face of capital flow shocks. Macroprudential regulation may thus reduce the propagation of global financial shocks, possibly because enhanced resilience at the level of individual countries leads to more stable cross-border trade and financial flows, even though more research is needed to better understand these transmission channels.

An important caveat to the analysis is that current indicators of macroprudential regulation are subject to several measurement drawbacks, for example, because they do not account for the intensity of changes in regulation. Further efforts are needed to improve the measurement of macroprudential regulation and assess the robustness of the findings presented in the chapter.

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[9] Box 3.2 shows that policymakers in emerging markets tend to adjust macroprudential regulation in response to global financial shocks, but more research is needed to understand whether these responses are optimal.

[10] Obstfeld, Shambaugh, and Taylor (2005), Aizenman, Chinn, and Ito (2016, 2017), Han and Wei (2018), Cavallino and Sandri (2018), and Bhattarai, Chatterjee, and Park (forthcoming) document similar findings. Monetary policy appears to respond procyclically even after controlling for expected inflation.

The empirical findings presented in the chapter will also need to be tested in richer empirical frameworks that allow for dynamic effects and a fuller interplay between policy tools. This is particularly important since policy tools can interact in complex and nontrivial ways.

Can Macroprudential Regulation Dampen the Effects of Global Financial Shocks?

Macroprudential regulation involves a broad set of policy tools that aim to contain the buildup of systemic vulnerabilities and strengthen financial sector resilience, including measures to increase bank capital and liquidity, reduce leverage in the household and corporate sectors, and prevent currency mismatches. The hypothesis motivating this chapter's analysis is that by buttressing financial sector stability, macroprudential regulation should also enhance macroeconomic resilience to global financial shocks. For example, a banking sector that is better capitalized and more liquid should cope more easily with a sudden withdrawal of foreign capital; firms that are less leveraged should better withstand a sudden increase in foreign borrowing costs; and bank and corporate balance sheets that are less exposed to currency mismatches should be less vulnerable to swings in exchange rates.[11] Does the empirical evidence support this logic?

To address this question, the empirical framework uses a panel regression of real GDP growth in emerging markets over a vector of global financial shocks and their interactions with the stringency of macroprudential regulation. The regression coefficients on the interaction terms capture whether the level of macroprudential regulation mediates the impact of global financial shocks on emerging markets' GDP. The regression also includes interaction terms of the global financial shocks with the squared level of macroprudential regulation to account for possible nonlinear effects. Furthermore, the regression includes country fixed effects to capture time-invariant country-specific factors and various controls, similar to the approach of Obstfeld, Ostry, and Qureshi (2019).[12]

The analysis considers three sources of global financial shocks: US monetary policy shocks to measure variations in international risk-free rates, the VIX to capture changes in global risk premia, and net capital inflows (in percent of GDP) to account for changes in the quantity supply of foreign funds.[13] Following Blanchard and others (2017), net capital inflows to a given country are instrumented using the sum of gross capital inflows to the other emerging markets.

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[11] While this chapter examines whether the level of regulation affects the transmission of global financial shocks to GDP, there is also a large literature that analyzes the effects of changes in macroprudential regulation on the economy. As discussed in the recent review of the literature by Galati and Moessner (2018) "the transmission mechanisms of macroprudential policy tools are not yet well understood". However, there is growing evidence that borrower-based tools transmit to the economy by affecting household credit and house prices.

[12] These include lagged GDP growth, the lagged log of real GDP per capita, institutional quality, and a linear trend. The regression also controls for the lagged output gap, to capture growth dynamics over the business cycle, and commodity terms of trade, because several emerging markets are large importers or exporters of commodities. Online Annex 3.2 reports the econometric specification and details of the analysis.

[13] Most studies in the literature analyze only one of these three shocks. Including all shocks at once helps in considering all major sources of global financial shocks and trying to disentangle the components associated with risk-free rates, risk premia, or the quantity supply of foreign capital. The monetary policy shocks are the ones in Iacoviello and Navarro (2019), extended to the end of 2016 and computed as the residuals from a regression of the federal funds rate on US inflation, US log GDP, US corporate spreads, and the log of foreign GDP. The regression uses net capital flows, since gross outflows offset part of the volatility in gross inflows (Broner and others 2013; Jeanne and Sandri 2020). Capital flows are normalized by the Hodrick-Prescott-trend component of GDP to avoid introducing volatility due to high-frequency movements in GDP. See the April 2020 *Global Financial Stability Report* for an analysis of the sensitivity of capital flows to global and domestic factors.

This is to isolate the component of capital flows driven by global push factors rather than domestic developments.

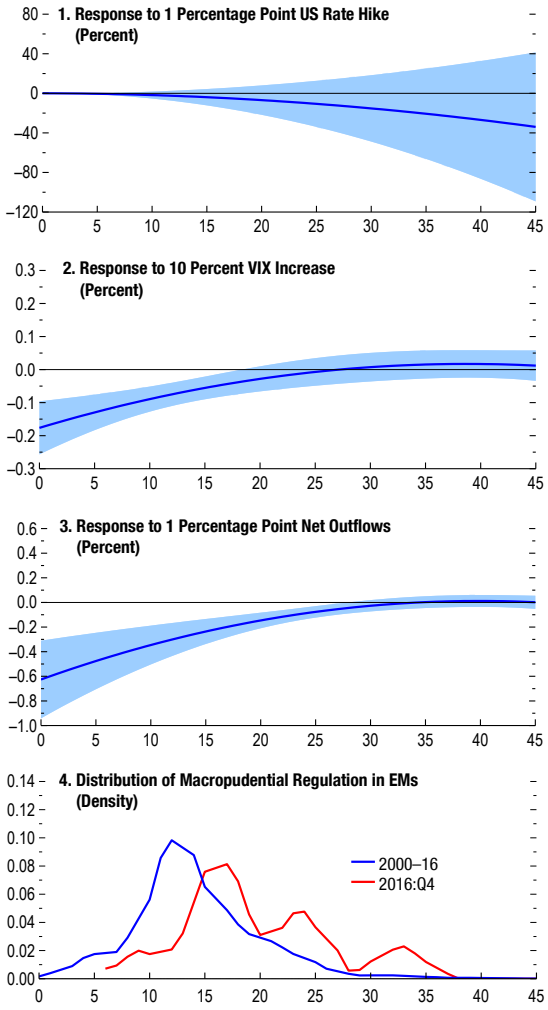
The stringency of macroprudential regulation is measured by cumulating the net tightening actions for each country since 1990, the first year in the iMaPP database, as panel 2 of Figure 3.2 illustrates.[14]

The first three panels in Figure 3.3 illustrate the impact of global financial shocks on GDP in emerging markets as a function of the stringency of macroprudential regulation on the horizontal axis. At a low level of macroprudential regulation, an increase in global risk aversion (proxied by the VIX) or an outflow of capital considerably reduces economic growth in emerging markets. Given that quarterly GDP growth in the sample of analysis averages 1 percent, a 60 percent spike in the VIX or a capital outflow equal to 2 percent of GDP can push emerging markets with the lowest levels of macroprudential regulation into a recession. Once the VIX and net capital flows are controlled for, shocks to US policy rates appear not to have statistically significant effects on emerging markets' economic growth.[15]

The figure further illustrates that the VIX and capital outflows have less damaging effects in countries with tighter macroprudential regulation. Therefore, macroprudential regulation dampens the impact of global financial shocks on economic activity in emerging markets. If the level of regulation is sufficiently tight, the VIX and net capital outflows no longer have statistically significant effects on emerging markets' GDP.

Figure 3.3. GDP Response in Emerging Markets to Global Financial Shocks

A higher level of macroprudential regulation dampens the impact of global financial shocks on GDP in emerging markets.



Source: IMF staff calculations.
Notes: The *x*-axis denotes the level of macroprudential regulation. See Online Annex 3.1 for data sources and country coverage. Panels 1 to 3 show the GDP response to global financial shocks for different levels of macroprudential regulation; panel 4 shows the probability density function of macroprudential regulation in the sample; see Online Annex 3.2 for details. Net capital outflows are scaled by the HP-trend of GDP. The coefficients on the interaction terms between the shock and macroprudential regulation are statistically significant in panel 2 and panel 3, but not in panel 1. The shaded areas correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. EMs = emerging markets.

[14] The econometric analysis rescales the cumulated macroprudential indices across all countries so that values are always positive, because the regression specification includes squared values of these indices.

[15] This lack of a statistically significant effect does not imply that US monetary policy has no impact on emerging markets, but it does imply that the effects materialize through changes in risk premia and capital flows rather than in risk-free rates. Indeed, if the regression does not control for the VIX and capital flows, a tightening in US monetary policy negatively affects economic growth in emerging markets. Kalemli-Özcan (2020) also documents the importance of risk premia in affecting emerging markets.

Panel 4 in Figure 3.3 shows the distribution of macroprudential regulation in emerging markets during 2000–16 and at the end of 2016. Emerging markets have generally tightened macroprudential policies over time, as evident by the shift of the distribution to the right. Yet various countries are still at levels of macroprudential regulation at which further tightening can strengthen resilience to global financial shocks. Nonetheless, gains from further tightening appear modest. Panels 2 and 3 in Figure 3.3 point to nonlinearities in the dampening effects of macroprudential regulation: a tightening in macroprudential regulation becomes progressively less effective in strengthening resilience to global financial shocks.

These nonlinearities may be consistent with problems of circumvention. As the stringency of regulation increases, domestic borrowers have stronger incentives to seek credit in the unregulated shadow financial market or from international lenders. Credit from these sources is likely more sensitive to global financial conditions and thus could weaken the dampening effects of macroprudential regulation.

Robustness Tests

The analysis has an important caveat: the index of macroprudential regulation constructed by cumulating net tightening actions is subject to several measurement concerns. First, countries may have started with a different level of macroprudential regulation in 1990 (the first year in the iMaPP database), thus confounding cross-country rankings. Second, the iMaPP database records when macroprudential policies are tightened or loosened, but not the intensity of those changes (except in the case of loan-to-value limits). Third, the cumulated index used in the baseline analysis gives equal weight to tightening actions across a broad range of different macroprudential measures recorded in the iMaPP database, even though they may have heterogeneous effects on resilience.

These measurement problems could affect the estimates' accuracy but are unlikely to drive the results on the dampening effects of macroprudential regulation. In fact, they should bias the analysis against finding significant effects associated with macroprudential policies, as Akinci and Olmstead-Rumsey (2018) and Forbes (2018), for example, discuss. It is also reassuring that the results are robust to using different time-series and cross-sectional variation in the data and considering subcomponents of the macroprudential index, as the rest of the chapter describes. Nonetheless, the chapter's findings will need to be reexamined when more precise measures of macroprudential regulation become available.

Another possible concern with the analysis is that the level of macroprudential regulation may respond to changes in GDP growth, in which case reverse causality would bias the results. This concern is partly attenuated by the fact that the level of macroprudential regulation is persistent and much less volatile than quarterly fluctuations in GDP growth. In fact, because the level of macroprudential regulation is obtained by cumulating all past tightening and loosening macroprudential actions, it is largely predetermined with respect to the realization of global financial shocks and the associated GDP response. Besides, macroprudential policies seem not

to be systemically adjusted in reference to GDP growth developments, as Richter, Schularick, and Shim (2019) document in the case of loan-to-value ratios.[16]

Nonetheless, to alleviate concerns about reverse causality further, the dampening effects of macroprudential regulation are reestimated under various robustness tests. These tests include excluding periods with negative GDP growth—when macroprudential policies are more likely to be adjusted in reference to domestic macroeconomic developments—and lagging the level of macroprudential regulation by one quarter and one year. Furthermore, to rule out reverse causality concerns, the regression is estimated using the average level of macroprudential regulation for each country during 2000–16. In this specification, the dampening effects of macroprudential regulation are identified by exclusively relying on cross-country heterogeneity in the stringency of macroprudential regulation. Table 3.1 shows that the dampening effects of macroprudential regulation on GDP vis-à-vis VIX and capital flow shocks remain statistically significant in each of the robustness tests. Online Annex 3.2 reports details of the underlying analysis.

Table 3.1. Robustness to Reverse Causality: Dampening Effects on GDP

	Global Financial Shocks		
	US rate	Ln VIX	Net outflows
Baseline	n.s.	√	√
Excluding Negative GDP Growth	n.s.	√	√
Macroprudential Regulation, One Quarter Lagged	n.s.	√	√
Macroprudential Regulation, One Year Lagged	n.s.	√	√
Average Macroprudential Regulation	n.s.	√	√

Source: IMF staff calculations.

Note: See Online Annex 3.1 for data sources and country coverage. Check marks denote a statistically significant dampening effect (captured by the coefficient on the interaction term between the shock and the level of macroprudential regulation) at the 10 percent significance level, computed with Driscoll-Kraay standard errors. The columns denote the shocks, and the rows list the test performed; see Online Annex 3.2 for details. n.s. = nonsignificant dampening effect. VIX = Chicago Board Options Exchange Volatility Index.

Finally, omitted-variable bias could affect the results. More precisely, the dampening effects identified in the regression could be driven by country characteristics or policy actions that are correlated with macroprudential regulation and have been omitted from the analysis. To address these concerns, the regression specification is augmented with interaction terms between global financial shocks and various factors that may affect resilience. These factors include country structural characteristics such as institutional quality and financial development;[17] fiscal variables such as gross public debt (in percent of GDP), gross public debt in foreign currency (in percent of total public debt), and the cyclically adjusted fiscal balance (in percent of GDP); and monetary policy variables such as the monetary policy rate and the anchoring of inflation expectations

[16] Using a narrative approach, Richter, Schularick, and Shim (2019) finds that of 92 changes in loan-to-value ratios in a sample of 56 economies during 1990 and 2012, only 3 were motivated by developments in GDP, inflation, or other real variables.

[17] The analysis uses the IMF's Financial Development Index, which measures the development of financial institutions and financial markets in terms of depth, access, and efficiency. The data display no significant cross-country correlation between financial development and macroprudential regulation. Furthermore, during the period of analysis, most emerging markets experienced both gradual financial deepening and macroprudential tightening. These observations suggest that tighter macroprudential regulation does not undermine financial development. Online Annex 3.1 provides additional details on the definition and data sources of the other variables used in the robustness tests.

(Bems and others 2018). The omitted-variable tests also control for the exchange rate regime, distinguishing between fixed and floating exchange rates (Ilzetzki, Reinhart, and Rogoff 2019). Finally, the regression is augmented to include the stringency of capital controls (Fernandez and others 2016) and the stock of official reserves (in percent of GDP), which can allow countries to directly affect capital flows and the exchange rate. However, a systematic analysis of the interplay among macroprudential measures, capital controls, and foreign exchange intervention is left for future research.

Table 3.2 shows that the dampening effects of macroprudential regulation remain significant after including any of the additional interaction terms previously described above, thus alleviating concerns about omitted-variable bias. Furthermore, the results are robust to the inclusion of time fixed effects, which absorb any comovement in GDP growth among emerging markets.[18] Even though these tests alleviate concerns about omitted-variable bias, it will be important to test for the robustness of the results using empirical frameworks that allow for dynamic effects and a richer interplay between policy tools and country characteristics.

Table 3.2. Robustness to Omitted Variables: Dampening Effects on GDP

	Global Financial Shocks		
	US rate	Ln VIX	Net outflows
Baseline	n.s.	√	√
Institutional Quality	n.s.	√	√
Financial Development	n.s.	√	√
Gross Public Debt	n.s.	√	√
Gross Public Debt in Foreign Currency	n.s.	√	√
Cyclically Adjusted Balance	n.s.	√	√
Monetary Policy Rate	n.s.	√	√
Inflation Expectation Anchoring	n.s.	√	√
Fixed Exchange Rate Regime	n.s.	√	√
Capital Controls	n.s.	√	√
Official Reserves	n.s.	√	√
Time Fixed Effects	n.s.	√	√

Source: IMF staff calculations.

Note: See Online Annex 3.1 for data sources and country coverage. Check marks denote a statistically significant dampening effect (captured by the coefficient on the interaction term between the shock and the level of macroprudential regulation) at the 10 percent significance level, computed with Driscoll-Kraay standard errors. The columns denote the shocks, and the rows list the additional controls that enter the specification, along with their interactions with the shocks; see Online Annex 3.2 for details. n.s. = nonsignificant dampening effect. VIX = Chicago Board Options Exchange Volatility Index.

Further Analysis on the Dampening Effects of Macroprudential Regulation

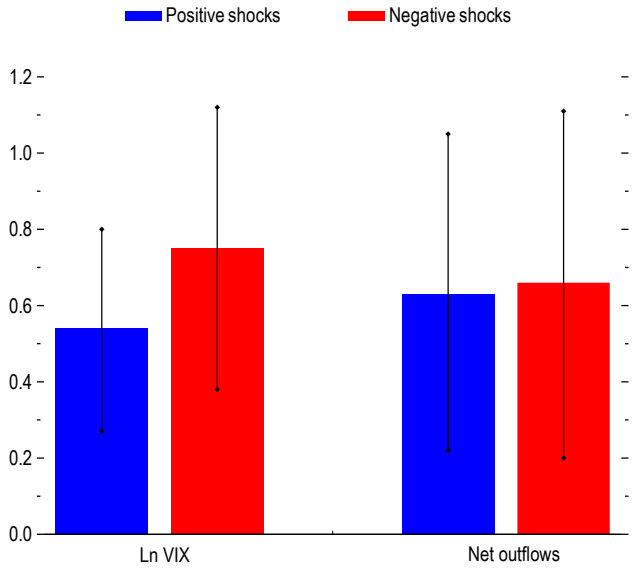
The previous analysis found that macroprudential regulation reduces the sensitivity of GDP growth in emerging markets to global financial shocks. Are these dampening effects at play against both positive and negative shocks? To address this question, the regression specification is extended to include dummies that differentiate between an increase and a decrease in the shock variables.

[18] When time fixed effects are included, the regression must exclude US monetary shocks and the VIX (because they are common to all countries) but can retain their interactions with macroprudential regulation. This specification makes it impossible to estimate these shocks' overall impact on GDP (as illustrated in Figure 3.3) but still allows measurement of the dampening effects of macroprudential regulation.

Figure 3.4 plots the regression coefficients on the interaction terms between the global financial shocks and the level of macroprudential regulation, distinguishing between positive and negative shocks. It shows that macroprudential regulation entails symmetric dampening effects of a similar magnitude. A Wald test confirms that the dampening effects against positive and negative global financial shocks are not statistically different from one another. This lack of a statistically significant difference implies that although a tighter level of regulation supports economic growth in cases of negative financial shocks, it also lowers economic activity when global financial shocks are positive.

Figure 3.4. Symmetric Dampening Effects of Macroprudential Regulation on GDP Growth
(Percent)

Macroprudential regulation dampens the effects of both positive and negative global financial shocks.



Source: IMF staff calculations.
Notes: See Online Annex 3.1 for data sources and country coverage. The blue (red) bars show the point estimate for the coefficient on the triple interaction term among the shock, the level of macroprudential regulation, and a dummy that identifies positive (negative) shocks, respectively; see Online Annex 3.2 for details. The level of macroprudential regulation is divided by 10 to make visualization of the coefficients easier. In the case of ln VIX, the shock is a 1 percent increase in the VIX; for net outflows, the shock consists of a 5 percentage point increase in net outflows. The *x*-axis depicts the shocks. The vertical lines correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. VIX = Chicago Board Options Exchange Volatility Index.

Maintaining a high level of macroprudential regulation is thus not costless, because it implies forgoing growth opportunities when global financial conditions are favorable. This does not imply that policymakers should wait to tighten macroprudential regulation until global financial conditions deteriorate. Constraining excessive risk taking and credit provision when financial conditions are loose is indeed a key channel through which macroprudential regulation ensures greater resilience at times of financial distress. Nonetheless, the symmetric dampening effects of macroprudential regulation call for further analysis on how to adjust regulation optimally to dampen the effects of negative shocks without excessively constraining economic activity when financial conditions are supportive.

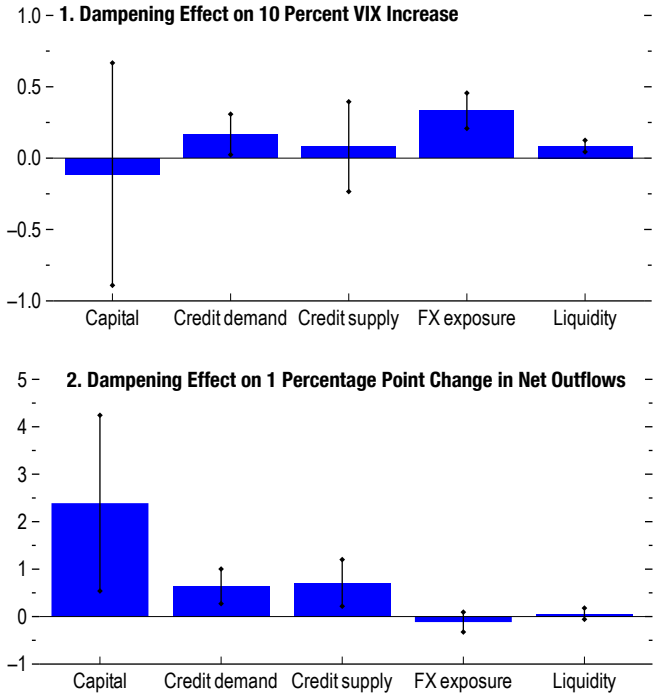
Up to this point, the analysis has used an overall index of macroprudential regulation that combines a broad range of specific measures recorded in the iMaPP database. Do any of these specific measures drive the dampening effects of macroprudential regulation? To shed light on this issue, the analysis is replicated using more disaggregated groups of macroprudential regulation, including measures targeted at bank capital and liquidity, credit demand (such as loan-to-value ratios), credit supply (such as limits on credit growth), and foreign currency exposure.[19]

[19] See Annex Table 3.1.3 (in Online Annex 3.1) for a description of each category. The analysis estimates different regressions for each group of macroprudential measures. It is not advisable to include all groups in the regression at once, since each group has to be interacted with three global financial shocks and the interaction terms with net capital inflows have to be instrumented.

Figure 3.5 displays the dampening properties of each of these macroprudential categories in reference to the VIX (panel 1) and net capital outflows (panel 2). All macroprudential components play some role in dampening the effects of global financial shocks, but the effects are heterogeneous and depend on the type of shock. Measures targeted at credit demand, foreign currency exposure, and liquidity offer protection against fluctuations in the VIX. Macroprudential regulation targeted at bank capital, credit demand, and credit supply protects against shocks to net capital flows.

Figure 3.5. Dampening Effects on GDP Growth by Categories of Macroprudential Measures
(Percent)

A broad range of macroprudential measures contribute to dampening the effects of global financial shocks.



Source: IMF staff calculations.
Note: See Online Annex 3.1 for data sources and country coverage. The bars show the point estimate for the coefficient on the interaction term between the shock and the level of macroprudential regulation; see Online Annex 3.2 for details. The level of macroprudential regulation is divided by 10 to make visualization of the coefficients easier. The *x*-axis depicts five categories of macroprudential measures. The vertical lines correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. FX = foreign exchange; VIX = Chicago Board Options Exchange Volatility Index.

These results suggest that enhancing resilience to global financial shocks requires a well-rounded macroprudential framework rather than a narrow focus on a few specific tools. Furthermore, the analysis shows that the dampening effects of macroprudential regulation are not limited to measures targeted at foreign currency exposures that could operate similarly to capital flow management measures.[20] Macroprudential regulation that ensures adequate capital and liquidity and prevents excessive risk taking in credit provision also plays an important role in fostering resilience to global financial shocks.

Finally, the dampening properties of macroprudential regulation are not limited to the effects on GDP growth. Figure 3.6 shows that macroprudential policies also weaken the effects of capital flow shocks on the real growth of bank credit.[21] This finding is consistent with the idea that by boosting bank capital and liquidity as well as reducing currency mismatches, macroprudential regulation makes the banking sector less susceptible to fluctuations in the supply of foreign funds.

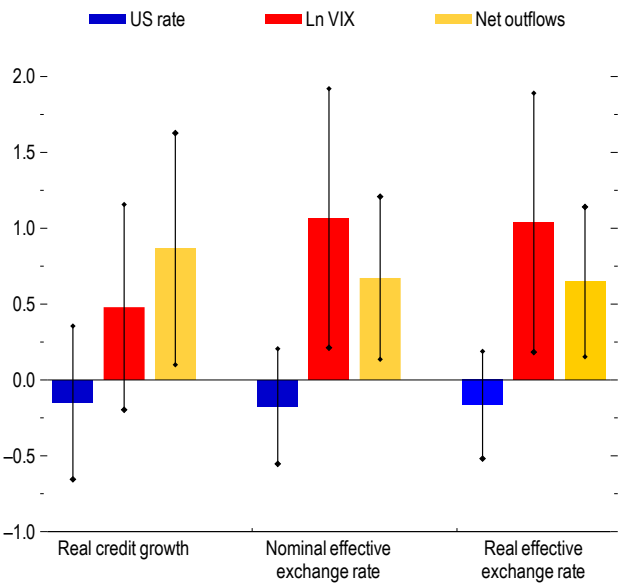
[20] For the country sample used in the analysis, the IMF 2019 Taxonomy of Capital Flow Management Measures identifies only nine macroprudential tightening or loosening actions that are also classified as capital flow management measures because they are designed to limit capital flows. Out of these, the iMaPP database records seven. The results in the chapter are robust to excluding those measures.

[21] The regression finds that shocks to US monetary policy and the VIX do not influence credit growth once capital flow shocks are controlled for, regardless of the level of macroprudential regulation.

The analysis also finds that macroprudential regulation tends to dampen the effects of VIX and capital flow shocks on the nominal and real effective exchange rates.[22] A possible interpretation is that by curbing risk taking in the domestic economy, macroprudential regulation reduces the volatility of currency risk premia. Lower volatility in currency risk premia, in turn, may contribute to more stable economic growth by weakening the damaging effects of currency mismatches and allowing monetary policy to respond more countercyclically, as the next section analyzes.

Figure 3.6. Dampening Effects of Macroprudential Regulation on Credit and Exchange Rates
(Percent)

Macroprudential regulation tends to dampen the effects of global financial shocks on domestic credit and exchange rates as well.



Source: IMF staff estimates.
Notes: See Online Annex 3.1 for data sources and country coverage. The bars show the point estimate for the coefficient on the interaction term between the shock and the level of macroprudential regulation; see Online Annex 3.2 for details. In the case of net outflows, the shock is equal to a 5 percentage point increase in net outflows. The level of macroprudential regulation is divided by 10 to make visualization of the coefficients easier. The *x*-axis depicts three dependent variables. The vertical lines correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. VIX = Chicago Board Options Exchange Volatility Index.

Can Macroprudential Regulation Support a More Countercyclical Monetary Policy Response?

According to the Mundell-Fleming trilemma, countries open to capital flows can retain monetary independence if they have a flexible exchange rate (Fleming 1962; Mundell 1963). Monetary independence is broadly interpreted as monetary policy's ability to set interest rates and stabilize domestic macroeconomic conditions independent of swings in global monetary and financial conditions. In line with the trilemma, the empirical literature documents that policy rates in countries with flexible exchange rates respond less to US monetary policy and the VIX than those in countries with fixed exchange rates (Obstfeld 2015).

However, even among emerging markets with flexible exchange rates, several central banks tend to increase policy rates in response to a US monetary tightening or a spike in the VIX, even after expected inflation is controlled for (Obstfeld, Shambaugh, and Taylor 2005; Aizenman, Chinn, and Ito 2016, 2017; Han and Wei 2018; Cavallino and Sandri 2018; Bhattarai, Chatterjee, and Park, forthcoming). This is possibly to limit fluctuations in exchange rates and capital flows

[22] Once the VIX and capital flow shocks are controlled for, emerging markets' exchange rates are not sensitive to US monetary policy shocks. The dampening effects of macroprudential regulation on the exchange rate become border line insignificant (except for the impact of the VIX on the real effective exchange rate) when adding controls for the interactions of global financial shocks with the level of official reserves. The interactions with official reserves are not statistically significant.

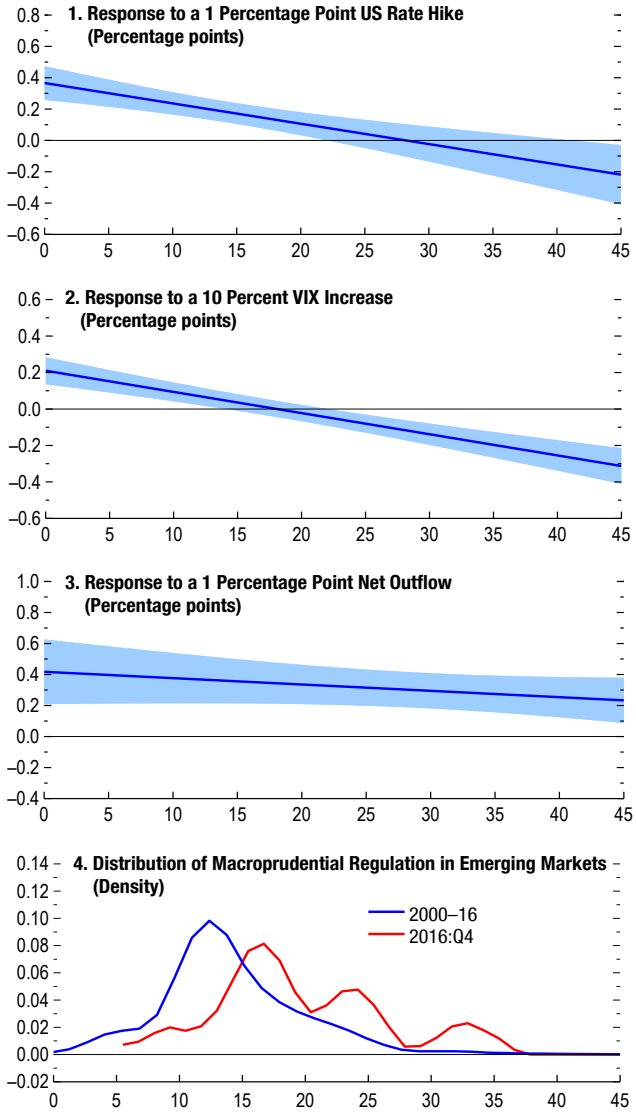
that may undermine financial stability. In these situations, monetary policy appears to operate procyclically, exacerbating the negative effects of tighter global financial conditions on domestic economic growth.

To enhance monetary independence, the trilemma calls for using capital controls to restrain free capital mobility.[23] Could macroprudential regulation also support a more countercyclical response of monetary policy? By mitigating financial stability concerns, macroprudential policy could allow monetary policy to focus more squarely on domestic economic conditions. Furthermore, as the previous analysis documents, macroprudential regulation can limit exchange rate fluctuations and thus central banks' need to respond procyclically to stabilize the currency.

To shed light on this issue, the analysis examines whether macroprudential regulation affects monetary policy's response to global financial shocks in emerging markets. It considers only periods when countries had flexible exchange rates and thus retained control of monetary policy. Policy rates are regressed on the set of global financial variables—US monetary policy, the VIX, and instrumented net capital outflows—and their interactions with the stringency of macroprudential regulation.[24] The regression includes country fixed effects and various control variables, such as the domestic output gap, expected inflation, real credit growth, and commodity terms of trade.

Figure 3.7. Policy Rate Responses in Emerging Markets to Global Financial Shocks

Macroprudential regulation allows monetary policy in emerging markets to respond more countercyclically to global financial shocks



Source: IMF staff calculations.
Note: The *x*-axis denotes the level of macroprudential regulation. See Online Annex 3.1 for data sources and country coverage. Panels 1 to 3 show the estimated policy rate response to global financial shocks for different levels of macroprudential regulation; panel 4 shows the probability density function of macroprudential regulation in the sample; see Online Annex 3.3 for details. The coefficients on the interaction terms between the shock and macroprudential regulation are statistically significant in panel 1 and panel 2, but not in panel 3. The shaded areas correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. VIX = Chicago Board Options Exchange Volatility Index.

[23] Foreign exchange intervention may also play a role in enhancing monetary independence by helping central banks to stabilize the exchange rate in case of disorderly market conditions.

[24] Unlike in the analysis of macroprudential regulation's dampening effects, the regression includes actual US policy rates rather than unexpected shocks, in line with the empirical literature on the trilemma and also because the empirical analysis shows that emerging markets in

Figure 3.7 illustrates the results. Panels 1 and 2 show that at low levels of macroprudential regulation, emerging markets tighten monetary policy in response to a hike in US monetary policy or increase in the VIX. A more stringent level of macroprudential regulation dampens this procyclical response. In fact, a sufficiently high level of macroprudential regulation allows central banks in emerging markets to react countercyclically by lowering policy rates in response to a tightening in US monetary policy or increase in the VIX.

The results show that macroprudential regulation can support a more countercyclical monetary policy response to US monetary policy and the VIX.[25] However, macroprudential regulation has no tangible effects on the response of monetary policy to capital outflow shocks (panel 3 in Figure 3.7). Capital outflows appear to trigger a monetary tightening in emerging markets independent of the macroprudential regulation level. This suggests that even in countries with tight macroprudential regulation, central banks continue to face important policy trade-offs in responding to sharp fluctuations in capital flows and that additional policy tools might be required, such as foreign exchange intervention in case of disorderly market conditions.

Are the effects of macroprudential policies on the monetary policy response robust to endogeneity tests? A first concern is that the macroprudential regulation level could be adjusted in reference to domestic policy rates, thus leading to reverse causality problems. In the regression sample, macroprudential regulation does indeed tend to be loosened when monetary policy is tightened.

To ensure that reverse causality does not drive the results, the regression analysis is replicated using lagged—by one quarter and one year—values of macroprudential regulation, as well as the average level of regulation in each country, in which case the identification is purely cross-sectional. Table 3.3 shows that across all these specifications, macroprudential regulation continues to support a more countercyclical response of monetary policy to global financial conditions. The only difference from the baseline specification is when average levels of macroprudential regulation are used, in which case regulation supports a more countercyclical response to capital flow shocks rather than to changes in US monetary policy. Online Annex 3.3 reports details of the analysis.

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the sample tend to adjust policy rates in reference to actual US policy rates rather than to the unexpected component only. The US policy rate is adjusted for the effect of unconventional monetary policy during the zero-lower-bound period using the implied rate calculated by Wu and Xia (2016).

[25] This evidence is consistent with Aizenman, Chinn, and Ito (2017), which shows that macroprudential regulation can reduce the comovement of policy rates between peripheral and center economies. Relatedly, Manu and Sgherri (2020) finds that macroprudential policies and capital flow measures strengthen the responsiveness of monetary policy to expected inflation.

Table 3.3. Robustness to Reverse Causality: Supporting Countercyclical Monetary Response

	Global Financial Shocks		
	US rate	Ln VIX	Net outflows
Baseline	√	√	n.s.
Macroprudential Regulation, One Quarter Lagged	√	√	n.s.
Macroprudential Regulation, One Year Lagged	√	√	n.s.
Average Macroprudential Regulation	n.s.	√	√

Source: IMF staff calculations.

Note: See Online Annex 3.1 for data sources and country coverage. Check marks denote significantly more countercyclical response at the 10 percent significance level, computed with Driscoll-Kraay standard errors. The columns denote the shocks, and the rows list the test performed; see Online Annex 3.3 for details. n.s. = nonsignificant effect on monetary policy response. VIX = Chicago Board Options Exchange Volatility Index.

In regard to concerns about omitted-variable bias, the regression specification is augmented to include, one at a time, the interactions of global financial shocks with various country characteristics and policy variables, such as institutional quality, financial development, gross public debt, gross public debt in foreign currency, the cyclically adjusted fiscal balance, the anchoring of inflation expectations, capital controls, and the level of official reserves. Table 3.4 shows that macroprudential regulation continues to support a more countercyclical response of monetary policy to changes in US policy rates and the VIX across all these specifications. The only exception is that macroprudential regulation no longer affects the monetary policy response to changes in US policy rates when the level of official reserves is controlled for.[26] The results on the effects of macroprudential regulation on the monetary policy response are also robust to the inclusion of time fixed effects.

Table 3.4. Robustness to Omitted Variables: Supporting Countercyclical Monetary Response

	Global Financial Shocks		
	US rate	Ln VIX	Net outflows
Baseline	√	√	n.s.
Institutional Quality	√	√	n.s.
Financial Development	√	√	n.s.
Gross Public Debt	√	√	n.s.
Gross Public Debt in Foreign Currency	√	√	n.s.
Cyclically Adjusted Balance	√	√	√
Inflation Expectation Anchoring	√	√	n.s.
Capital Controls	√	√	n.s.
Official Reserves	n.s.	√	n.s.
Time Fixed Effects	√	√	n.s.

Source: IMF staff calculations.

Note: See Online Annex 3.1 for data sources and country coverage. Check marks denote significantly more countercyclical response at the 10 percent significance level, computed with Driscoll-Kraay standard errors. The columns denote the shocks, and the rows list the additional controls that enter the specification, along with their interactions with the shocks; see Online Annex 3.3 for details. n.s. = nonsignificant effect on monetary policy response. VIX = Chicago Board Options Exchange Volatility Index.

[26] Annex Table 3.3.3 shows that a higher stock of official reserves supports a more countercyclical response of monetary policy in emerging markets to changes in US policy rates, possibly because it allows for more decisive foreign exchange intervention. The robustness tests cannot easily control for foreign exchange intervention because the decision to intervene is highly endogenous as it depends on global financial shocks and their expected impact on the economy.

Are There Side Effects of Macroprudential Regulation on Average Growth or via Cross-Country Spillovers?

The empirical evidence presented so far suggests that macroprudential regulation can dampen the macroeconomic effects of global financial shocks and can allow monetary policy to respond more countercyclically. Do these benefits come at the cost of negative side effects—for example, lower average economic growth or harmful cross-border spillovers?

Effects on Economic Growth

The analysis finds that macroprudential regulation has symmetric dampening effects, which implies that the gains from greater economic growth when global financial shocks are adverse come at the cost of foregone economic activity when financial conditions are supportive. Beyond these symmetric effects, there could be a concern that tight macroprudential regulation might lower the average rate of economic growth if regulation excessively constrains credit provision or leads to a suboptimal level of risk taking.

Nonetheless, macroprudential regulation might also have positive effects on average economic growth by ensuring a more efficient allocation of credit, mobilizing savings, and reducing the permanent GDP losses associated with financial crises (Agénor 2019; Ma, forthcoming). The empirical literature documents a variety of results. Some studies show that tightening macroprudential policies leads to a temporary decline in GDP (Kim and Mehrotra 2018; Eickmeier, Kolb, and Prieto 2018; Richter, Schularick, and Shim 2019). Others focus on longer-term effects, finding that macroprudential policies tend to boost economic growth (Boar and others 2017; Agénor and others 2018; Neanidis 2019).

The empirical approach used to analyze the dampening effects of macroprudential regulation can also shed some light on the effects of regulation on average GDP growth. Using the estimated regression coefficients, it is possible to predict the rate of GDP growth that a country would have experienced during 2000–16 if it had a high or low level of macroprudential regulation. These levels are based on the 75th and 25th percentiles, respectively, of the distribution of macroprudential regulation in the sample of analysis.

Panel 1 in Figure 3.8 plots the differential in the GDP growth rate between a high and a low level of macroprudential regulation. Higher levels of regulation would have delivered significantly stronger economic growth in the early 2000s and during the global financial crisis, when global financial conditions were adverse. For example, higher levels of macroprudential regulation would have increased quarterly GDP growth by about 0.6 percent between the fourth quarter of 2008 and the second quarter of 2009. However, higher levels of macroprudential regulation would also have lowered economic growth considerably in the years before the global financial crisis, when global financial conditions were buoyant. Thus macroprudential regulation reduces the amplitude of economic fluctuations by sustaining growth in the face of adverse shocks while lowering economic activity when global financial conditions are supportive.

In line with the dampening effects documented earlier in the analysis, these results imply that a more stringent level of macroprudential regulation reduces the volatility of GDP growth. As shown in panel 2 of Figure 3.8, a higher level of macroprudential regulation at the 75th

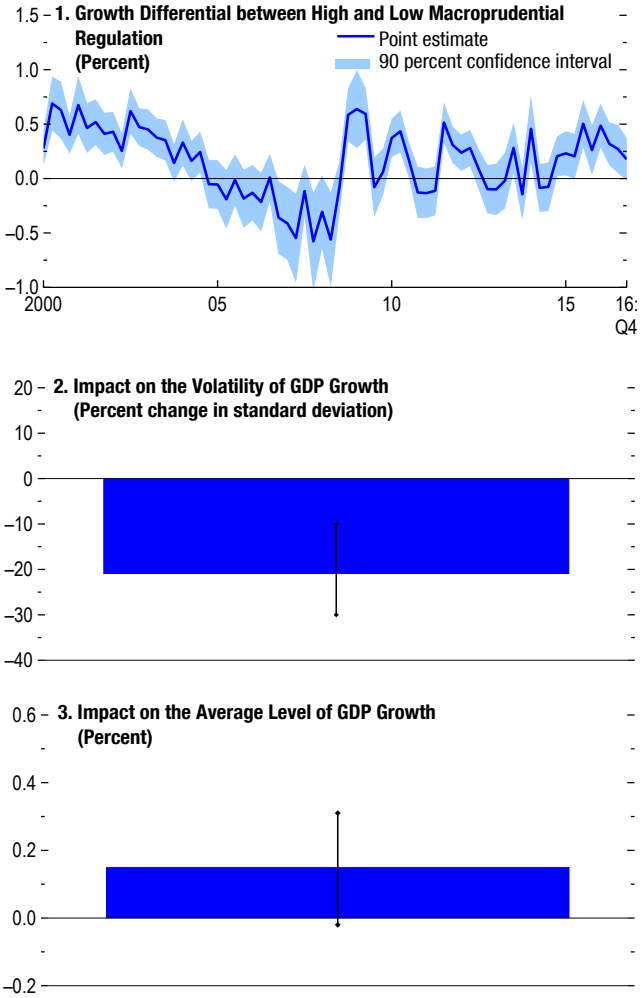
percentile of the sample distribution would have reduced the standard deviation of GDP growth during 2000–16 by about 20 percent relative to a lower level of regulation at the 25th percentile.

Do the gains from lower GDP volatility come at the cost of lower average GDP growth? The analysis finds no evidence that macroprudential regulation has detrimental effects on average economic growth. Panel 3 of Figure 3.8 shows that during 2000–16, a higher level of regulation would have had no statistically significant effect on average GDP growth.[27]

The lack of evidence regarding negative effects of macroprudential regulation on average GDP growth comes with important caveats. First, negative effects on average economic growth could materialize at a higher level of regulation than that observed during the analysis period. Second, reverse causality could affect the results, whereby country authorities may systematically tighten macroprudential regulation when economic growth is greater and vice versa. The stickiness in the level of regulation and policymakers' tendency not to use macroprudential policies to respond to GDP developments attenuate concerns regarding reverse causality (Richter, Schularick, and Shim 2019).[28] However, further analysis is needed to reach more definitive conclusions on the causal effects of macroprudential regulation on average GDP growth.

Figure 3.8. Effects of Macroprudential Regulation on GDP Growth

Macroprudential regulation can reduce the volatility of GDP growth. The analysis does not detect effects of regulation on the average level of GDP growth.



Source: IMF staff calculations.
Note: See Online Annex 3.1 for data sources and country coverage. Panel 1 shows the growth differential between a country with macroprudential regulation set at the 75th percentile of the sample distribution and one with macroprudential regulation set at the 25th percentile; panel 2 shows the point estimate of the impact of macroprudential regulation on the volatility of GDP growth; and panel 3 shows the impact of macroprudential regulation on average GDP growth; see Online Annex 3.4 for details. The vertical lines correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors.

[27] Analyzing the derivative of GDP growth with respect to the level of macroprudential regulation yields similar results. The regression estimates show that macroprudential regulation does not generally have significant effects on GDP growth, except when financial conditions are tight, in which case regulation appears to marginally increase economic growth.

[28] Concerns about reverse causality are less severe in the previous analysis of the dampening effects of macroprudential regulation because the results are robust to using the average level of macroprudential regulation for each country. In that case, the dampening effects are estimated based on whether global financial shocks affect countries with higher macroprudential regulation less. A similar exercise is not possible for the analysis of the effects of macroprudential regulation on GDP growth, because country fixed effects absorb cross-country differences in the average level of macroprudential regulation.

Cross-Country Spillovers

Another possible concern with macroprudential regulation is that if a country protects itself from swings in global financial conditions through tight macroprudential regulation, it could expose other countries to greater volatility.[29] For example, measures that curb risk taking in a given country could lead to the relocation of risky financial activities to other countries (Houston, Lin, and Ma 2012; Ongena, Popov, and Udell 2013; McCann and O'Toole 2019), thus making those countries more susceptible to global financial shocks.

However, macroprudential regulation may also entail positive cross-country spillovers. If a country uses macroprudential regulation to strengthen its resilience to global financial shocks, other countries may enjoy greater stability through less volatile trade and financial flows with the country using macroprudential regulation.

The regression framework used to analyze the dampening effects of macroprudential regulation in a given country can be extended to capture the presence and nature of cross-country spillovers. Besides interacting the global financial shocks with the level of macroprudential regulation in a given country, the regression is expanded to include interaction terms of the shocks with the average level of regulation in other emerging markets. These new interaction terms capture whether the level of macroprudential regulation in other countries affects the sensitivity of GDP growth in a given country to global financial shocks.

Spillovers are likely to occur across emerging markets that share similar characteristics. The analysis groups countries into three alternative categories based on geographic region, income level, and risk class. Regarding income level, countries are grouped depending on whether their GDP per capita is above or below the median of the emerging market sample in any given year. The same procedure is followed to differentiate countries according to their risk class, based on a composite risk index that Giordani and others (2017) use to analyze spillovers from capital flows management measures.

Figure 3.9 shows the regression coefficients on the interaction terms of the global financial shocks with the average level of macroprudential regulation in other emerging markets within the same geographic, income, and risk category. The average level of regulation is computed by weighting countries according to the size of gross capital inflows that they receive. Positive coefficients on the interaction terms indicate positive spillovers, so GDP growth in a given country is higher in the face of adverse global financial shocks if other countries have tight macroprudential regulation. Regardless of the country group categories, the analysis finds no evidence of spillovers associated with shocks to US monetary policy and the VIX, because the regression coefficients on these interactions are statistically nonsignificant. However, the results

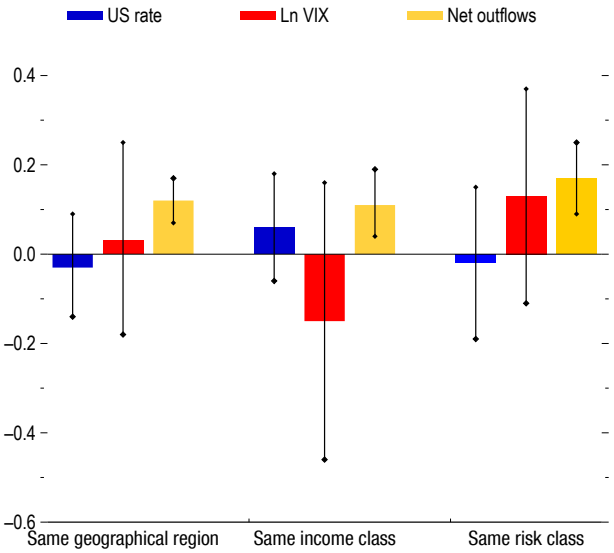
[29] Similar arguments have been raised regarding capital flow management measures (Lambert, Ramos-Tallada, and Rebillard 2012; Forbes and others 2016; Giordani and others 2017). As in the previous sections of the chapter, the analysis looks at possible spillovers associated with how global financial shocks interact with the *level* of macroprudential regulation. This is different from analyzing the cross-border effects of *changes* in macroprudential regulation, for example, whether tightening capital requirements reduces foreign lending.

point to the presence of positive spillovers associated with shocks to net capital flows. This finding is consistent across all three types of country groupings.[30]

Therefore, the analysis finds no evidence of negative cross-country spillovers, thus alleviating concerns that tighter macroprudential regulation in a given country could exacerbate macroeconomic instability in other countries. On the contrary, there is some evidence of positive cross-country spillovers, consistent with the idea that macroprudential regulation in a given country may also benefit other countries by supporting more stable trade and financial links. More research is needed, however, to better understand these transmission channels.

Figure 3.9. Cross-Country Spillovers from Macroprudential Regulation
(Percent)

Macroprudential regulation appears to generate positive cross-country spillovers by strengthening resilience to capital flow shocks.



Source: IMF staff estimates.
Note: See Online Annex 3.1 for data sources and country coverage. The bars show the point estimate of the coefficient, and the vertical lines correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors; see Online Annex 3.4 for details. VIX = Chicago Board Options Exchange Volatility Index.

Conclusion

The key result of the analysis in this chapter is that macroprudential regulation can dampen the macroeconomic impacts of global financial shocks on emerging markets. More specifically, a tighter level of macroprudential regulation reduces the sensitivity of GDP growth in emerging markets to fluctuations in risk premia and changes in foreign capital flows.

The dampening effects of macroprudential regulation do not seem to be driven by a specific set of tools: instead, a broad range of macroprudential measures targeting liquidity, capital, foreign exchange exposures, and risky forms of credit all appear to play a role in enhancing macroeconomic resilience. However, the dampening effects of different tools are heterogenous and depend on the particular type of global financial shock hitting an economy. Macroprudential regulation can also help stabilize real credit growth and the nominal and real exchange rates.

However, maintaining a permanently high level of macroprudential regulation is not costless, because macroprudential regulation has symmetric dampening effects: it attenuates the negative impact on GDP from a tightening in global financial conditions but also limits GDP growth when financial conditions are loose. This finding calls for more research on how to adjust macroprudential regulation optimally depending on domestic and external financial conditions.

One possible channel through which macroprudential regulation may strengthen macroeconomic resilience is by allowing monetary policy to respond more countercyclically to

[30] There is no evidence of negative spillovers even if the regression controls for time fixed effects. In this case, spillovers remain positive on capital flow shocks when countries are grouped by geographic location and risk class.

global financial shocks. The empirical evidence suggests that at low levels of macroprudential regulation, central banks in emerging markets tend to increase policy rates when global financial conditions tighten, possibly because of financial stability concerns arising from movements in exchange rates and capital outflows. However, at higher levels of macroprudential regulation, central banks tend to lower policy rates when US monetary policy tightens and the VIX increases, thus cushioning the impact of adverse financial shocks on domestic economic growth. Macroprudential regulation does not seem to have tangible effects on the response of monetary policy to capital flow shocks, which remains procyclical. Additional policy tools may thus be needed to support monetary policy in dealing with large capital outflows.

Regarding possible side effects associated with macroprudential regulation, the analysis does not find detrimental effects of regulation on average GDP growth. However, this result should be interpreted with caution given endogeneity challenges. The analysis also finds no evidence of negative cross-country spillovers. On the contrary, a higher level of macroprudential regulation in a given country appears to strengthen resilience to capital flow shocks even in other countries, possibly as a result of more stable trade and financial links.

The empirical results presented in this chapter are subject to important caveats. First, the indexes of macroprudential regulation used in the analysis suffer from several measurement limitations. Therefore, this chapter's empirical findings will need to be reexamined as the quality of macroprudential data continues to improve. Second, it is important to test for the robustness of the results using empirical frameworks that allow for dynamic effects and for a richer interplay of macroprudential regulation with other policy tools and country characteristics. These issues will be covered in upcoming work by the IMF that will develop a framework to analyze the complex interactions between various policy tools, namely monetary policy, macroprudential regulation, capital flow management measures, and foreign exchange intervention.

The analysis suggests various avenues for future research. First, given the symmetric dampening effects of macroprudential regulation against both positive and negative global financial shocks, more research is needed to better understand how to optimally adjust regulation in line with domestic and external developments. Second, the chapter's analysis has considered whether a higher level of macroprudential regulation—which is expected to enhance financial resilience—can dampen the effects of global financial shocks on domestic macroeconomic conditions. Future research could explore whether policymakers could also offset the impact of global shocks by promptly adjusting macroprudential regulation, for example, by easing regulation when an adverse shock hits. Finally, the analysis has identified possible channels through which macroprudential regulation may dampen global financial shocks, for example, by stabilizing credit growth or the exchange rate and by allowing monetary policy to respond more countercyclically. However, more research is warranted to improve the characterization of these transmission channels and link them to specific macroprudential measures.

Box 3.1. Macroprudential Policies and Credit: A Meta-analysis of the Empirical Findings

1. A growing body of empirical literature attempts to shed light on the effectiveness of macroprudential policy, focusing mostly on whether macroprudential policies are effective in controlling credit growth—a key issue because credit is the single best predictor of banking crises (Schularick and Taylor 2012). Drawing on 58 empirical studies encompassing cross-country and microlevel studies, Araujo and others (forthcoming) builds a repository of the empirical findings and synthesizes them using a meta-analysis framework. Meta-analysis techniques combine the results of several studies quantitatively to provide an overview of the results in the literature (Stanley 2001).

The meta-analysis uses the following regression framework:

$$\hat{\beta}_j = \theta_B MPM_j^B + \theta_H MPM_j^H + \theta_L MPM_j^L + \gamma \mathbf{X}_j + \varepsilon_j. \qquad (3.1.1)$$

In this framework, the dependent variable $\hat{\beta}_j$ is the standardized effect of tightening macroprudential policy on domestic credit growth corresponding to result j in a particular research study.[1] MPM_j^B, MPM_j^H, and MPM_j^L are dummy variables that denote whether the macroprudential tightening analyzed involves broad-based, housing, or liquidity and other structural measures.[2] The coefficients on these dummy variables (θ) represent the average effect of each measure on credit. $\mathbf{X}_j$ is a set of control variables, which, in line with the standard practice in the meta-analysis literature, includes a publication bias correction based on the standard error of the estimate (Stanley and Doucouliagos 2012) and a dummy that identifies robust results within a study.

Figure 3.1.1 shows the average effects of macroprudential tightening on credit, differentiating between estimates based exclusively on emerging markets and those from mixed samples including low-income countries, emerging markets, and advanced economies. Overall, macroprudential policy tightening has statistically significant effects on credit, reducing it by 0.04 standard deviation on average.[3] The magnitude of these effects varies depending on the specific macroprudential measure and country sample. Housing and

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The author of this box is Manasa Patnam.

[1] To ensure the comparability of results across studies, the selected coefficients on macroprudential policy impacts and their standard errors are standardized. In the sample of estimates, credit is typically measured as the nominal or real growth rate of bank credit to households and the private sector or total credit in the economy. Araujo and others (forthcoming) examines a broad range of effects in addition to those on credit, including effects on other outcome variables, effects of each individual tool, and effects at different time horizons.

[2] The regression specification equation (3.1.1) follows the predominant strand of the literature, which measures macroprudential policy in discrete changes taking the values of −1, 0, and 1 to indicate loosening, neutral, and tightening policy actions, respectively. The samples are restricted to estimated effects within a one-year horizon. The classification of tools into the categories (broad-based, housing, liquidity and other) is from IMF (2014). Equation (3.1.1) is estimated using a weighted-least-squares procedure with weights proportional to each estimate's precision, because the specification is heteroscedastic to a degree determined by the estimate's standard error.

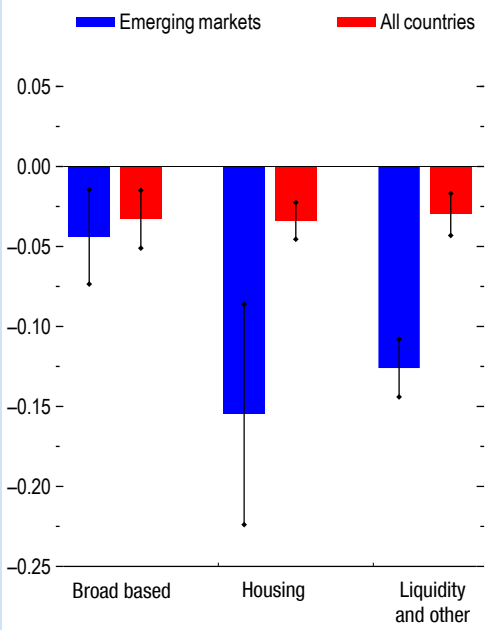
[3] A standardized effect of –0.04 corresponds to about a 0.6 percentage point reduction in year-over-year growth of real credit (measured at quarterly frequency), based on the average standard deviation of this variable (13 percent) in the sample.

liquidity-based measures appear to have larger average effects in emerging markets, although with wider confidence bands, reflecting the substantial heterogeneity of individual estimates found in this setting.

Araujo and others (forthcoming) also documents that studies using microlevel data find stronger effects of macroprudential policies on credit than studies using aggregate data, which also holds true in the emerging markets context. This could be explained by the stronger identification power provided by micro-level data or the existence of leakages that reduce the transmission of the microlevel effects of macroprudential policy on bank lending to aggregate credit.

Indeed, using the same meta-analysis framework, Araujo and others (forthcoming) finds that macroprudential tightening tends to be associated with leakages, mainly through increases in cross-border or nonbank lending. This association is consistent with the hypothesis that international banks or other unconstrained institutions may fulfill domestic lending needs when local banks become constrained (Ahnert, Forbes, and Reinhardt 2018; Reinhardt and Sowerbutts 2015). However, a few studies suggest that even after possible leakages are factored in, macroprudential tightening still tends to constrain credit growth (for example, Aiyar, Calomiris, and Wieladek 2014; Ahnert, Forbes, and Reinhardt 2018).

Figure 3.1.1. Average Effects of Macroprudential Tightening on Credit Growth
(Percent)



Source: IMF staff estimates.
Note: The figure reports results from a metaregression in which the dependent variable is the standardized effect on credit. The reported point estimates (bar height) with 90 percent confidence intervals correspond to coefficients on dummy variables identifying the macroprudential measures analyzed. Standard errors are clustered by research study to account for possible dependence across results from the same study. The analysis also adjusts for study overweighting, since some studies report many more results than others. For more details on the specification and methodology, see Araujo and others (forthcoming).

Box 3.2. Do Emerging Markets Adjust Macroprudential Regulation in Response to Global Financial Shocks?

1. This box explores whether policymakers in emerging markets adjust macroprudential regulation in response to global financial shocks. The analysis is based on the following panel regression:

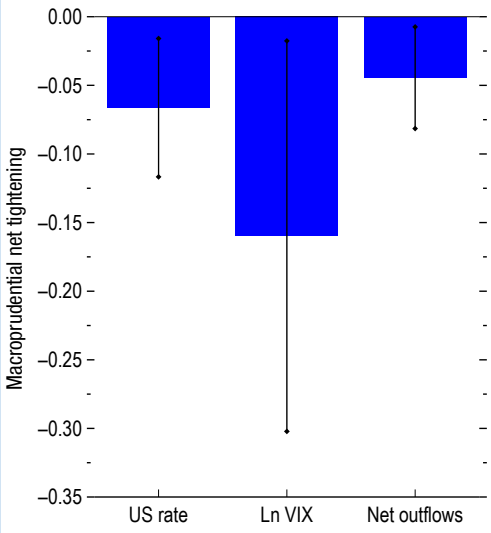
$$\Delta MPru_{i,t} = \alpha_i + \beta \cdot \mathbf{S}_{i,t} + \gamma \cdot C_{i,t} + \varepsilon_{i,t,}$$

in which $\Delta MPru_{i,t}$ is the number of macroprudential net tightening actions in a given quarter. The vector $\mathbf{S}_{i,t}$ includes the three global financial shocks examined in the chapter: US monetary policy shocks, the Chicago Board Options Exchange Volatility Index (VIX), and net capital outflows, instrumented in line with the analysis in the chapter. The regression also includes country fixed effects, α_i, and several control variables, $C_{i,t}$, namely, expected inflation, the output gap, real credit growth, and commodity terms of trade, $TOT_{i,t}$, from Gruss and Kebhaj (2019).

2. The regression results reveal that emerging markets do tend to adjust macroprudential regulation in response to external financial developments. Figure 3.2.1 shows that the regression coefficients on shocks to US monetary policy, the VIX, and net capital outflows are all negative and statistically significant. These results are robust to excluding macroprudential measures targeted at foreign currency exposures. Online Annex 3.5 reports the regression details.

3. Therefore, the analysis suggests that policymakers in emerging markets tend to loosen macroprudential policies when global financial conditions tighten, or conversely, they tend to tighten regulation when global financial conditions ease. More research is needed to determine whether these responses are optimal and what other domestic and external factors should drive decisions to adjust macroprudential regulation.

Figure 3.2.1. Global Financial Shocks and Changes in Macroprudential Regulation



Source: IMF staff calculations.
Note: See Online Annex 3.1 for data sources and country coverage. The bars show the point estimates of the coefficients, and the vertical lines correspond to 90 percent confidence intervals computed with Driscoll-Kraay standard errors. VIX = Chicago Board Options Exchange Volatility Index.

The authors of this box are Katharina Bergant, Francesco Grigoli, Niels-Jakob Hansen, and Damiano Sandri.

References

Agénor, Pierre-Richard. 2019. "Growth and Welfare Effects of Macroprudential Regulation." *Macroeconomic Dynamics* 23 (8): 3140–62.

Agénor, Pierre-Richard, Leonardo Gambacorta, Enisse Kharroubi, and Luiz A. Pereira da Silva. 2018. "The Effects of Prudential Regulation, Financial Development, and Financial Openness on Economic Growth." BIS Working Paper 752, Bank for International Settlements, Basel, Switzerland.

Ahnert, Toni, Kristin J. Forbes, and Dennis Reinhardt. 2018. "Macroprudential FX Regulations: Shifting the Snowbanks of FX Vulnerability?" NBER Working Paper 25083, National Bureau of Economic Research, Cambridge, MA.

Aiyar, Shekhar, Charles W. Calomiris, and Tomasz Wieladek. 2014. "Does Macro-pru Leak? Evidence from a UK Policy Experiment." *Journal of Money, Credit and Banking* 46 (1): 368–82.

Aizenman, Joshua, Menzie D. Chinn, and Hiro Ito. 2016. "Monetary Policy Spillovers and the Trilemma in the New Normal: Periphery Country Sensitivity to Core Country Conditions." *Journal of International Money and Finance* 68: 298–330.

———. 2017. "Financial Spillovers and Macroprudential Policies*"* NBER Working Paper 24105, National Bureau of Economic Research, Cambridge, MA.

Akinci, Ozge, and Jane Olmstead-Rumsey. 2018. "How Effective Are Macroprudential Policies? An Empirical Investigation." *Journal of Financial Intermediation* 33 (C): 33–57.

Akinci, Ozge, and Albert Queralto. 2018. "Exchange Rate Dynamics and Monetary Spillovers with Imperfect Financial Markets." Federal Reserve Bank of New York Staff Report 849, Federal Reserve Bank of New York, New York.

Alam, Zohair, Adrian Alter, Jesse Eiseman, Gaston Gelos, Heedon Kang, Machiko Narita, Erlend Nier, and Naixi Wang. 2019. "Digging Deeper—Evidence on the Effects of Macroprudential Policies from a New Database." IMF Working Paper 19/66, International Monetary Fund, Washington, DC.

Aoki, Kosuke, Gianluca Benigno, and Nobuhiro Kiyotaki. 2018. "Monetary and Financial Policies in Emerging Markets." Unpublished, Tokyo University.

Araujo, Juliana, Manasa Patnam, Adina Popescu, Fabian Valencia, and Weijia Yao. Forthcoming. "Effects of Macroprudential Policy: Evidence from Over 6,000 Estimates." IMF Working Paper, International Monetary Fund, Washington, DC.

Bems, Rudolfs, Francesca G. Caselli, Francesco Grigoli, Bertrand Gruss, and Weicheng Lian. 2018. "Expectations' Anchoring and Inflation Persistence." IMF Working Paper 18/280, International Monetary Fund, Washington, DC.

Bengui, Julien, and Javier Bianchi. 2018. "Macroprudential Policy with Leakages." NBER Working Paper 25048, National Bureau of Economic Research, Cambridge, MA.

Bhattarai, Saroj, Arpita Chatterjee, and Woong Yong Park. Forthcoming. "Global Spillover Effect of US Uncertainty." *Journal of Monetary Economics*.

Blanchard, Olivier, Jonathan D. Ostry, Atish R. Ghosh, and Marcos Chamon. 2017. "Are Capital Inflows Expansionary or Contractionary? Theory, Policy Implications, and Some Evidence." *IMF Economic Review* 65 (3): 563–85.

Boar, Codruta, Leonardo Gambacorta, Giovanni Lombardo, and Luiz Pereira da Silva. 2017. "What Are the Effects of Macroprudential Policies on Macroeconomic Performance?" *BIS Quarterly Review* (September): 71–99.

Braggion, Fabio, Alberto Manconi, and Haikun Zhu. 2018. "Can Technology Undermine Macroprudential Regulation? Evidence from Peer-to-Peer Credit in China." Unpublished.

Brandao-Marques, Luis, Gaston Gelos, Machiko Narita, and Erlend Nier. Forthcoming. "Leaning against the Wind: An Empirical Cost-Benefit Analysis." IMF Working Paper, International Monetary Fund, Washington, DC.

Bräuning, Falk, and Victoria Ivashina. Forthcoming. "U.S. Monetary Policy and Emerging Market Credit Cycles." *Journal of Monetary Economics*.

Broner, Fernando, Tatiana Didier, Aitor Erce, and Sergio L. Schmukler. 2013. "Gross Capital Flows: Dynamics and Crises." *Journal of Monetary Economics* 60 (1): 113–33.

Canova, Fabio. 2005. "The Transmission of US Shocks to Latin America." *Journal of Applied Econometrics* 20 (2): 229–51.

Cavallino, Paolo, and Damiano Sandri. 2018. "The Open-Economy ELB: Contractionary Monetary Easing and the Trilemma." IMF Working Paper No. 18/236, International Monetary Fund, Washington, DC.

Cerutti, Eugenio, Stijn Claessens, and Luc Laeven. 2017. "The Use and Effectiveness of Macroprudential Policies: New Evidence." *Journal of Financial Stability* 28: 203–24.

Choi, Woon G., Taesu Kand, Geun-Young Kim, and Byongju Lee. 2017. "Divergent Emerging Market Economy Responses to Global and Domestic Monetary Policy Shocks." ADB Economics Working Paper 532, Asian Development Bank, Manila.

Cizel, Janko, Jon Frost, Aerdt Houben, and Peter Wierts. 2020. "Effective Macroprudential Policy: Cross-Sector Substitution from Price and Quantity Measures." *Journal of Money, Credit and Banking* 51: 1209–35.

Dedola, Luca, Giulia Rivolta, and Livio Stracca. 2017. "If the Fed Sneezes, Who Catches a Cold?" *Journal of International Economics* 108 (S1): 23–41.

Driscoll, John C., and Aart C. Kraay. 1998. "Consistent Covariance Matrix Estimation with Spatially Dependent Data." *Review of Economics and Statistics* 80: 549–60.

Egorov, Konstantin, and Dmitry Mukhin. 2019. "Optimal Monetary Policy under Dollar Pricing." 2019 Meeting Papers 1510, Society for Economic Dynamics.

Eickmeier, Sandra, Benedikt Kolb, and Esteban Prieto. 2018. "Macroeconomic Effects of Bank Capital Regulation." Bundesbank Discussion Paper 44/2018, Bundesbank, Frankfurt.

Farhi, Emmanuel, and Ivan Werning. 2016. "A Theory of Macroprudential Policies in the Presence of Nominal Rigidities." *Econometrica* 84 (5): 1645–1704.

Fernandez, Andres, Michael Klein, Alessandro Rebucci, Martin Schindler, and Martin Uribe. 2016. "Capital Control Measures: A New Dataset." *IMF Economic Review* 64: 548–74.

Fleming, J. Marcus. 1962. "Domestic Financial Policies under Fixed and under Floating Exchange Rates." *IMF Staff Papers* 9 (3): 369–80.

Forbes, Kristin. 2018. "Macroprudential Policy after the Crisis: Forging a Thor's Hammer for Financial Stability in Iceland." Report prepared for the Task Force to review monetary policy in Iceland. Reykjavik, Iceland.

Forbes, Kristin J., Marcel Fratzscher, Thomas Kostka, and Roland Straub. 2016. "Bubble Thy Neighbour: Portfolio Effects and Externalities from Capital Controls." *Journal of International Economics* 99: 85–104.

Forbes, Kristin J., Marcel Fratzscher, and Roland Straub. 2013. "Capital Controls and Macroprudential Measures: What Are They Good For?" MIT Sloan Research Paper No. 506113, Sloan School of Management, Massachusetts Institute for Technology, Cambridge, MA.

Galati, Gabriele and Richhild Moessner. 2017. "What Do We Know About the Effects of Macroprudential Policy?" *Economica* 85 (340): 735-770.

Georgiadis, Georgios. 2016. "Determinants of Global Spillovers from US Monetary Policy." *Journal of International Money and Finance* 67 (C): 41–61.

Ghosh, Atish, Jonathan D. Ostry, and Mahvash S. Qureshi. 2017. "Managing the Tide: How Do Emerging Markets Respond to Capital Flows?" IMF Working Paper 17/69, International Monetary Fund, Washington, DC.

Giordani, Paolo E., Michele Ruta, Hans Weisfeld, and Ling Zhu. 2017. "Capital Flow Deflection." *Journal of International Economics* 105: 102–18.

Gopinath, Gita, Emine Boz, Camila Casas, Federico Diez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Moller. 2019. "Dominant Currency Paradigm." NBER Working Paper 22943, National Bureau of Economic Research, Cambridge, MA.

Gruss, Bertrand, and Suhaib Kebhaj. 2019. "Commodity Terms of Trade: A New Database." IMF Working Paper 19/21, International Monetary Fund, Washington, DC.

Han, Xuehui, and Shang-Jin Wei. 2018. "International Transmission of Monetary Shocks: Between a Trilemma and a Dilemma." *Journal of International Economics* 110: 205–19.

Houston, Jue F., Chen Lin, and Yue Ma. 2012. "Regulatory Arbitrage and International Bank Flows." *Journal of Finance* 67 (5): 1845–95.

Iacoviello, Matteo, and Gaston Navarro. 2019. "Foreign Effects of Higher U.S. Interest Rates." *Journal of International Money and Finance* 95: 232–50.

Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth S. Rogoff. 2019. "Exchange Arrangements Entering the Twenty-First Century: Which Anchor Will Hold?" *Quarterly Journal of Economics* 234 (2): 599–646.

Im, Kyung So, M. Hashem Pesaran, and Yongcheol Shin. 2003. "Testing for Unit Roots in Heterogeneous Panels." *Journal of Econometrics* 115 (1): 53–74.

International Monetary Fund. 2014. "Staff Guidance Note on Macroprudential Policy." Washington, DC. Available at https://www.imf.org/external/np/pp/eng/2014/110614.pdf.

Jeanne, Olivier, and Damiano Sandri. 2020. "Global Financial Cycle and Liquidity Management." Unpublished.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina. 2012. "Macroprudential Policy, Countercyclical Bank Capital Buffers and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments." *Journal of Political Economy* 125 (6): 2126–77.

Kalemli-Özcan, Sebnem. 2020. "US Monetary Policy and International Risk Spillovers." NBER Working Paper 26297, National Bureau of Economic Research, Cambridge, MA.

Kao, Chihwa. 1999. "Spurious Regression and Residual-Based Tests for Cointegration in Panel Data." *Journal of Econometrics* 90 (1): 1–44.

Kim, Soyoung, and Aaron Mehrotra. 2018. "Effects of Monetary and Macroprudential Policies—Evidence from Four Inflation Targeting Economies." *Journal of Money, Credit and Banking* 50(5): 967–92.

Kirti, Divya. 2018. "Lending Standards and Output Growth." IMF Working Paper 18/23, International Monetary Fund, Washington, DC.

Klein, Michael W. 2012. "Capital Controls: Gates versus Walls." NBER Working Paper 18526, National Bureau of Economic Research, Cambridge, MA.

Krippner, Leo. 2013. "Measuring the Stance of Monetary Policy in Zero Lower Bound Environments." *Economics Letters* 118 (1): 135–38.

Lambert, Frederic J., Julio Ramos-Tallada, and Cyril Rebillard. 2012. "Capital Controls and Spillover Effects: Evidence from Latin-American Countries." Banque de France Working Paper 357, Banque de France, Paris.

Lane, Philip R., and Gian Maria Milesi-Ferretti. 2018. "The External Wealth of Nations Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis." *IMF Economic Review* 66 (1): 189–222.

Levin, Andrew, Chien-Fu Lin, and Chia-Shang James Chu. 2003. "Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties." *Journal of Econometrics* 108 (1): 1–24.

Ma, Chang. Forthcoming. "Financial Stability, Growth and Macroprudential Policy." *Journal of International Economics*.

Maćkowiak, Bartosz. 2007. "External Shocks, U.S. Monetary Policy and Macroeconomic Fluctuations in Emerging Markets." *Journal of Monetary Economics* 54 (8): 2512–20.

Magud, Nicolas E., Carmen M. Reinhart, and Kenneth S. Rogoff. 2011. "Capital Controls: Myth and Reality—A Portfolio Balance Approach." NBER Working Paper 16805, National Bureau of Economic Research, Cambridge, MA.

Manu, Rui C., and Silvia Sgherri. 2020. "One Shock, Many Policy Responses." IMF Working Paper No. 20/10, International Monetary Fund, Washington, DC.

McCann, Fergal, and Conor O'Toole. 2019. "Cross-Border Macroprudential Policy Spillovers and Bank Risk-Taking." *International Journal of Central Banking* 15 (4): 267–311.

Monnet, Eric, and Damien Puy. 2019. "One Ring to Rule Them All? New Evidence on World Cycles." IMF Working Paper 19/202, International Monetary Fund, Washington, DC.

Mundell, Robert. 1963. "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates." *Canadian Journal of Economics and Political Science* 29: 475–85.

Neanidis, Kyriakos C. 2019. "Volatile Capital Flows and Economic Growth: The Role of Banking Supervision." *Journal of Financial Stability* 40: 77–93.

Obstfeld, Maurice. 2015. "Trilemmas and Tradeoffs: Living with Financial Globalization." In *Global Liquidity Spillovers to Emerging Markets and Policy Responses*, edited by Claudio Raddatz, Diego Saravia, and Jaume Ventura. Santiago: Central Bank of Chile.

Obstfeld, Maurice, Jonathan D. Ostry, and Mahvash S. Qureshi. 2019. "A Tie That Binds: Revisiting the Trilemma in Emerging Market Economies." *Review of Economics and Statistics* 101 (2): 279–93.

Obstfeld, Maurice, Jay C. Shambaugh, and Alan M. Taylor. 2005. "The Trilemma in History: Tradeoffs and Exchange Rates, Monetary Policy, and Capital Mobility." *Review of Economics and Statistics* 87 (3): 423–38.

Ongena, Steven, Alexander Popov, and Gregory F. Udell. 2013. "When the Cat's Away the Mice Will Play: Does Regulation at Home Affect Bank Risk-Taking Abroad?" *Journal of Financial Economics* 108 (3): 727–50.

Ostry, Jonathan D., Atish R. Ghosh, Marcos Chamon, and Mahvash S. Qureshi. 2012. "Tools for Managing Financial-Stability Risks from Capital Inflows." *Journal of International Economics* 88: 407–21.

Ottonello, Pablo. 2015. "Optimal Exchange Rate Policy under Collateral Constraints and Wage Rigidity." Unpublished.

Reinhardt, Dennis, and Rhiannon Sowerbutts. 2015. "Regulatory Arbitrage in Action: Evidence from Banking Flows and Macroprudential Policy." Bank of England Working Paper 546, Bank of England, London.

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

———. 2016. "International Channels of Transmission of Monetary Policy and the Mundellian Trilemma." *IMF Economic Review* 64 (1): 6–35.

Richter, Björn, Moritz Schularick, and Ilhyock Shim. 2019. "The Costs of Macroprudential Policy." *Journal of International Economics* 118 (2): 263–82.

Sahay, Ratna, Martin Čihák, Papa N'Diaye, Adolfo Barajas, Ran Bi, Diana Ayala, Yuan Gao, Annette Kyobe, Lam Nguyen, Christian Saborowski, Katsiaryna Svirydzenka, and Seyed Reza Yousefi. 2015. "Rethinking Financial Deepening: Stability and Growth in Emerging Markets." IMF Staff Discussion Note 15/08, International Monetary Fund, Washington, DC.

Schularick, Moritz, and Alan M. Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008." *American Economic Review* 102 (2): 1029–61.

Stanley, Tom D. 2001. "Wheat from Chaff: Meta-analysis as Quantitative Literature Review." *Journal of Economic Perspectives* 15 (3): 131–50.

Stanley, Tom D., and Hristos Doucouliagos. 2012. *Meta-regression Analysis in Economics and Business*. London: Routledge.

Vicondoa, Alejandro. 2019. "Monetary News in the United States and Business Cycles in Emerging Economies." *Journal of International Economics* 117 (C): 79–90.

Westerlund, Joakim. 2007. "Testing for Error Correction in Panel Data." *Oxford Bulletin of Economics and Statistics* 69 (6): 709–48.

Wu, Jing C., and Fan D. Xia. 2016. "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound." *Journal of Money, Credit, and Banking* 48 (2–3): 253–91.

CHAPTER 3

Dampening Global Financial Shocks in Emerging Markets: Can Macroprudential Regulation Help?

Online Annex

Annex 3.1. Data Sources and Country Coverage

Annex Table 3.1.1 lists the data sources used in the analysis. The country coverage is reported in Annex Table 3.1.2. The sample consists of 38 emerging markets, based on the April 2020 *World Economic Outlook* classification, from the first quarter of 2000 to the last quarter of 2016. The criteria used for the country and period selection are: (i) a population larger than one million, (ii) at least 10 years of GDP data, (iii) at least 5 years of data for net capital inflows, (iv) with data on macroprudential regulation from the dataset of Alam and others (2019).

In some instances, the analysis differentiates countries depending on whether the exchange rate is fixed or flexible using the coarse classification in Ilzetzki and others (2019). Flexible exchange rate regimes include bands, crawls, and managed floats (categories 2, 3, and 4). Fixed exchange rate regimes include hard pegs, currency board arrangements, horizontal bands, and de facto pegs (category 1). Freely falling exchange rate regimes are excluded from the analysis (category 5).

Annex Table 3.1.1. Data Sources

Indicator	Source
Capital controls	Fernandez and others (2016)
Chicago Board Options Exchange Volatility Index (VIX)	Haver Analytics
Commodity terms of trade	Gruss and Kebhaj (2019)
Composite risk rating	International Country Risk Guide, The PRS Group, Inc, www.prsgroup.com
Cyclically adjusted balance	IMF, *World Economic Outlook*
Financial development	Sahay and others (2015)
Exchange rate regime	Ilzetzki and others (2019)
Expected inflation	Consensus Economics, Haver Analytics, IMF staff calculations
Gross capital inflows	IMF, *Balance of Payments and International Investment Position Statistics*
Gross capital outflows without FX reserves	IMF, *Balance of Payments and International Investment Position Statistics*
Gross public debt	IMF, *World Economic Outlook*
Gross public debt in foreign currency	IMF, *World Economic Outlook*
Inflation expectation anchoring index	Bems and others (2018)
Institutional quality	Worldwide Governance Indicators
Macroprudential regulation	Integrated Macroprudential Policy (iMaPP) dataset, Alam and others (2019)
Net capital inflows	IMF, *Balance of Payments and International Investment Position Statistics*
Nominal effective exchange rate	IMF staff calculations
Nominal gross domestic product	Haver Analytics
Official Reserves	IMF, *Balance of Payments and International Investment Position Statistics*
Policy rates	Bank for International Settlements; Haver Analytics; and IMF, *International Financial Statistics*
Population	IMF, *World Economic Outlook*
Real credit from banks	Bank for International Settlements; Haver Analytics; and IMF, *International Financial Statistics*
Real effective exchange rate	IMF staff calculations
Real GDP	Haver Analytics
US monetary policy shock	Iacoviello and Navarro (2019)

Source: IMF staff compilation.

Annex Table 3.1.2. Country Coverage

Country		
Albania	El Salvador	Paraguay
Argentina	Georgia	Peru
Belarus	Hungary	Philippines
Bosnia and Herzegovina	India	Poland
Brazil	Indonesia	Romania
Bulgaria	Jamaica	Russia
Chile	Jordan	Serbia
China	Kazakhstan	South Africa
Colombia	Malaysia	Thailand
Costa Rica	Mexico	Turkey
Croatia	Morocco	Ukraine
Dominican Republic	Northern Macedonia	Uruguay
Ecuador	Pakistan	

Source: IMF staff compilation.

Data on macroprudential measures are from the IMF's integrated Macroprudential Policy (iMaPP) that provides information about 12 macroprudential tools. These measures are grouped into an overall index and in five subcategories targeting bank capital, credit demand, credit supply, foreign exchange positions, and liquidity.[1] The mapping between the iMaPP variables and the five categories is shown in Annex Table 3.1.3.

Annex Table 3.1.3. Categories of Macroprudential Measures

Category	Measure (iMaPP database variable)	Notes
Capital	Capital requirements (Capital)	Including risk weights
	Leverage limits (LVR)	
	Loan loss provision requirements (LLP)	Including dynamic and sector-specific provisioning (e.g. housing)
	Countercyclical capital buffer (CCB)	
	Capital conservation buffer requirements (Conservation)	
	Measures targeted at SIFIs (SIFI)	Including capital and liquidity surcharges
Credit Demand	Limits to loan-to-value ratio (LTV)	Mostly targeted at housing loans
	Limites to debt-service-to-income ratio (DSTI)	
	Tax on transactions (Tax)	Including stamp duties and capital gain taxes
Credit Supply	Limits on credit growth or volume (LCG)	Including penalties for exceeding limits
	Loan restrictions (LoanR)	Tailored LCG conditional on loan and bank characteristics, or other factors
FX Exposure	Limits on foreign currency lending (LFC)	
	Limits on gross open FX positions (LFX)	Including currency mismatch regulations
	Reserve requirements on FC assets (RR_FCD)	
Liquidity	Reserve requirements (RR_dom)	On domestic currency assets
	Liquidity measures (Liquidity)	Including liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios, and external debt restrictions
	Limits to loan-to-deposit ratio (LTD)	Including penalties for exceeding limits

Source: IMF staff compilation.

Note: iMaPP = integrated macroprudential policy; SIFI = systemically important financial institutions; FX = foreign exchange; FC = foreign currency.

[1] Capital and liquidity measures account for about two thirds of the overall tightening in macroprudential regulation between 1990 and 2016.

Annex 3.2. Dampening Effects of Macroprudential Regulation

This annex describes the methodology to assess whether macroprudential regulation can dampen the effects of global financial shocks on GDP growth in emerging markets.

Empirical Framework

The analysis is based on the following panel regression:[2]

$$Y_{i,t} = \alpha_i + \beta \cdot S_{i,t} + \gamma \cdot \left(S_{i,t} * MPru_{i,t}\right) + \delta \cdot \left(S_{i,t} * Mpru_{i,t}^2\right) + \zeta MPru_{i,t} + \theta MPru_{i,t}^2 + \kappa \cdot C_{i,t} + \varepsilon_{i,t} \quad (3.1)$$

where $Y_{i,t}$ denotes quarterly real GDP growth for country i at time t. The variable $S_{i,t}$ denotes a vector of global financial shocks including US policy rate shocks from Iacoviello and Navarro (2019) to capture shocks to the risk-free interest rate, the VIX as a proxy for shocks to the risk premium, and net capital inflows to capture shocks to the quantity supply of foreign capital. Since net capital flows are also affected by domestic pull factors, the variation due to global push factors is isolated by instrumenting net capital inflows to country *i* with gross inflows to the other emerging markets following Blanchard and others (2017).

The regression specification includes the interactions of the shocks with the level of macroprudential regulation, $MPru_{i,t}$. Hence, the coefficients γ on the interaction terms reveal if macroprudential regulation can dampen the effects of global shocks on GDP growth. To allow for non-linear effects, the specification includes interaction terms of the shocks with the squared level of macroprudential regulation. Furthermore, the specification includes macroprudential regulation and its squared term; country fixed effects, α_i; and a set of control variables $C_{i,t}$ following Obstfeld and others (2019), among which lagged GDP growth, lagged log of real GDP per capita, institutional quality, and a linear trend. The vector $C_{i,t}$ also includes the lagged output gap to capture growth dynamics over the business cycle and commodity terms of trade since some emerging markets are large importers or exporters of commodities.[3]

The estimation approach uses a two-stage least squares procedure, where net capital inflows to country i (as well as their interaction with macroprudential regulation and with macroprudential regulation squared) are instrumented with gross capital inflows to all other emerging markets (and their interactions). The regression results are reported by inverting the sign of net capital inflows, thus by considering the effects of net capital outflows. In this way, all three shocks (to US rates, VIX, and net outflows) are expected to have a negative impact on emerging markets.

Given the complex correlation structure of the error term involving dependence across economies, autocorrelation, and heteroscedasticity, the Driscoll and Kraay (1998) correction to

[2] This specification is inspired by Obstfeld and others (2019) who analyze if the impact of the VIX on emerging markets' macroeconomic conditions is influenced by the exchange rate regime.

[3] Compared to Obstfeld and others (2019), the regression does not control for the contemporaneous credit to GDP ratio since a possible channel through which global financial shocks affect GDP growth (the left-hand side variable) is through the impact on domestic credit.

the standard errors is used to make statistical inferences.[4] The derivative of GDP growth with respect to the global shocks is used to assess how the impact of global financial shocks varies with the level of macroprudential regulation provides. This is calculated as:

$$\partial Y_{i,t}/\partial S_{j,t} = \beta + \gamma_j MPru_{i,t} + \delta_j\, MPru_{i,t}^2 \qquad (3.2)$$

which is a nonlinear function of the level of macroprudential regulation. Figure 3.3 in the chapter shows the value of these derivatives for different levels of macroprudential regulation.

Baseline Results

Annex Table 3.2.1 reports the baseline results. The results in column (1) show that increases in the VIX and in capital outflows negatively affect GDP growth in emerging markets, while shocks to the risk-free rate—proxied by US monetary policy shocks—turn out insignificant. The instrumentation approach for net capital flows appears reliable since the F-statistic is well above the conventional threshold.[5] Regarding the control variables, the coefficient on the lag of the output gap is negative and significant, suggesting that deviations from potential growth tend to be reduced over the following quarter.

The level of macroprudential regulation and the interactions of macroprudential regulation with global shocks enter the specification in column (2). The coefficients on the VIX and net outflows remain significant. Importantly, the coefficients on the interaction terms between the shocks and the level of macroprudential regulation are highly statistically significant and show that macroprudential regulation dampens the effects of the shocks on GDP growth. The results are robust to excluding periods during which countries had a fixed exchange rate, as shown in column (3).

Finally, column (4) reports the estimates of the regression specification that also includes the squared level of macroprudential regulation and its interactions with the shocks. The results corroborate the negative effects of VIX increases and capital outflows, and the buffering properties of macroprudential regulation. Moreover, the results show that the buffering effects of macroprudential regulation are subject to decreasing marginal returns.

The dampening effects of macroprudential regulation are quantitatively important. For example, when the VIX doubles—an increase similar to the one occurred during the global financial crisis—an emerging market at the lowest level of macroprudential regulation in the sample would experience a decline in quarterly GDP growth by 1.8pp, suffering a recession.[6] Net outflows worth one percent of GDP would lead to a fall in GDP growth by 0.6pp. However, an economy with the median level of macroprudential regulation would experience a GDP decline by only 0.5pp in the case of a doubling of the VIX and by 0.3pp in the case of a

[4] Lagrange Multiplier tests point to the existence of serial correlation and the modified Wald test for group-wise heteroskedasticity indicates the presence of heteroscedasticity. Also, the Pesaran test, the Frees test, and the Friedman test all reject the null hypothesis of cross-sectional independence.

[5] The Kleinbergen-Papp rk Wald F statistic is reported in every table showing instrumental variable estimations. This is appropriate in presence of more than one endogenous variable and non-i.i.d. errors.

[6] The average quarterly real GDP growth in the sample is about one percent.

1pp capital outflow. All in all, the results show that macroprudential policy can play an important role in dampening the effects of global financial shocks in emerging markets.

Robustness

The results on the dampening effects of macroprudential regulation are subject to various tests to alleviate concerns about reverse causality and omitted variables. These tests exclude the interactions of the shocks with the quadratic level of regulation to keep the specifications tractable and because the focus is on the robustness of the dampening effects of macroprudential regulation rather than on the non-linear effects.

Annex Table 3.2.2 presents the results of the robustness tests for reverse causality. As policymakers might be more prone to change macroprudential regulation in bad times, the first test excludes all observations in which GDP growth is negative (column 1). Other tests consist of replacing the level of macroprudential regulation with its first lag (column 2) or its fourth lag (column 3). Finally, the most conservative test replaces the time-varying levels of macroprudential regulation with time-invariant country averages, so that the identification is purely cross-sectional (column 4). The coefficients on the interaction terms between macroprudential regulation and the VIX or net outflows are statistically significant in all specifications. Therefore, the dampening effects of macroprudential regulation appear robust to reverse causality concerns.

Annex Table 3.2.3 shows the results of the robustness tests for omitted variables. These consist of controlling for other slow-moving covariates that may correlate with the level of macroprudential regulation and for their interactions with the global shocks. These covariates include country characteristics, such as institutional quality (column 1) and financial development (column 2); and variables related to policy instruments, such as gross public debt in percent of GDP (column 3), gross public debt in foreign currency in percent of gross public debt (column 4), the cyclically adjusted balance in percent of trend GDP (column 5), the monetary policy rate (column 6), monetary policy credibility proxied by an index of anchoring of inflation expectations of Bems and others (2018) (column 7), the exchange rate regime (column 8), capital controls (column 9), or official reserves in percent of trend GDP (column 10). The results show that the dampening effects of macroprudential regulation against the VIX and net outflows remain statistically significant in all specifications.[7] The results are also robust to the inclusion of time fixed effects, which capture all factors common to the countries in our sample but come at the cost of excluding global shocks (column 11).[8]

[7] In these tests, the instrumentation becomes cumbersome, since three variables need to be instrumented: net inflows, the interaction term between net inflows and the level of macroprudential regulation, and the interaction term between net inflows and the relevant variable for the test (which is instrumented with the interaction term between gross inflows to other emerging markets and the same variable). As shown in Annex Table 3.2.3, the F- statistic falls below ten when institutional quality, gross debt, gross debt in foreign currency, and the inflation expectation anchoring index are used.

[8] The results are also robust to excluding any country from the sample; only in the specification that includes the squared macroprudential regulation and its interactions, the significance on the interaction with the VIX occasionally drops below 10 percent. Also, excluding the global financial crisis period (2008:Q3-2009:Q4) confirms the baseline results.

Symmetric Dampening Effects

The analysis also investigates if the dampening effects of macroprudential regulation are symmetric to positive and negative shocks. To address this question, the regression specification is amended following Han and Wei (2018):

$$Y_{i,t} = \alpha_i + \beta^+ \cdot \left(D_{i,t}^+ * S_{i,t}\right) + \beta^- \cdot \left(D_{i,t}^- * S_{i,t}\right) + \gamma^+ \cdot \left(D_{i,t}^+ * S_{i,t} * MPru_{i,t}\right) + \gamma^- \cdot \left(D_{i,t}^- * S_{i,t} * MPru_{i,t}\right) + \zeta^+ (D_{i,t}^+ * MPru_{i,t}) + \zeta^- (D_{i,t}^- * MPru_{i,t}) + \kappa \cdot C_{i,t} + \varepsilon_{i,t} \quad (3.3)$$

where $D_{i,t}^+$ ($D_{i,t}^-$) is a dummy variable that takes value one when the global shock under analysis is positive (negative), and zero otherwise. In equation (3.3), the dummies are multiplied by the shocks; and by the interaction terms between the shocks and the level of macroprudential regulation. The coefficients $\gamma^+$and γ^- measure the dampening effects of regulation under positive and negative shocks, respectively. The dummies and their interactions are introduced separately, first for the VIX and then for net capital flows.

The results in Annex Table 3.2.4 show that the $\gamma^+$and γ^-coefficients on the triple interaction terms are statistically significant and similar in magnitude. A Wald test for the equality between the two coefficients (reported in Table 3.3.4) rules out the possibility that the coefficients are statistically different from each other. In other words, the dampening effects against VIX shocks and net outflow shocks operate symmetrically.

Categories of Macroprudential Measures

The index of macroprudential regulation can be disaggregated into five categories targeting bank capital, credit demand, credit supply, foreign exchange positions, and liquidity. Annex Table 3.2.5 analyzes the dampening effects of each of them. For VIX shocks, measures on credit demand, foreign exchange exposure, and liquidity exhibit a significant coefficient on the interaction terms. In the case of capital outflows, the interaction terms with measures targeting capital, credit demand, and credit supply turn out significant, albeit the results using capital-based macroprudential measures should be taken with caution owing to the low F-statistic. Overall, these findings suggest that the dampening effects of macroprudential regulation arise from a broad range of measures.

Dampening Effects on Credit and Exchange Rates

The empirical framework in equation (3.1) can also be used to analyze the dampening effects of macroprudential regulation on other macroeconomic variables. Specifically, the dependent variable is replaced with real bank credit growth, the nominal effective exchange rate (NEER), and the real effective exchange rate (REER).[9] NEER and REER are defined in such a way that positive values denote an appreciation.

Annex Table 3.2.6 shows that VIX and net capital shocks lead to a depreciation of the NEER (column 2) and the REER (column 3). Net outflows tend to also slow down real credit growth

[9] The vector of independent variable remains the same for all these specifications except for the one for real credit growth where the regression includes also the share of credit to trend GDP.

(column 1). Macroprudential regulation reduces the sensitivity of the nominal and real exchange rate to movements in the VIX. Furthermore, macroprudential regulation dampens the effects of net capital outflows on both credit growth and the exchange rate.

Annex Table 3.2.1. Dampening Effects of Macroprudential Regulation on GDP Growth

	Full sample	Full sample	Excluding fixed ER	Full sample
	(1)	(2)	(3)	(4)
Lag dependent variable	0.071	0.072	0.012	0.072
	(0.057)	(0.050)	(0.054)	(0.048)
Lag output gap	-0.378***	-0.369***	-0.342***	-0.368***
	(0.035)	(0.035)	(0.033)	(0.035)
Lag ln real GDP per capita	-0.880*	-1.689**	-1.111*	-1.713**
	(0.505)	(0.707)	(0.630)	(0.749)
Institutional quality	-0.281	-0.132	-0.536	0.078
	(0.644)	(0.813)	(0.938)	(0.930)
Linear trend	0.003	0.005	0.002	0.002
	(0.005)	(0.007)	(0.006)	(0.007)
Commodity terms of trade	0.050	0.037	0.083	0.035
	(0.035)	(0.050)	(0.052)	(0.058)
US monetary policy shock	-0.158	-0.008	-0.077	0.017
	(0.168)	(0.311)	(0.318)	(0.357)
Ln VIX	-0.712***	-1.556***	-1.571***	-1.762***
	(0.182)	(0.312)	(0.287)	(0.487)
Net outflows	-0.186***	-0.393***	-0.378***	-0.624***
	(0.046)	(0.113)	(0.122)	(0.183)
Macroprudential regulation (MPru)		-1.380***	-1.480***	-1.514
		(0.401)	(0.404)	(1.234)
US monetary policy shock * MPru		-0.100	-0.074	-0.164
		(0.109)	(0.118)	(0.221)
Ln VIX * MPru		0.631***	0.609***	0.997**
		(0.143)	(0.148)	(0.419)
Net outflows * MPru		0.108***	0.095**	0.319***
		(0.036)	(0.043)	(0.111)
$MPru^2$				0.237
				(0.209)
US monetary policy shock * $MPru^2$				0.037
				(0.037)
Ln VIX * $MPru^2$				-0.129*
				(0.073)
Net outflows * $MPru^2$				-0.040**
				(0.016)
Observations	2,260	2,260	1,658	2,260
Countries	38	38	32	38
F-statistic	73.1	33.1	24.4	18.6

Source: IMF staff calculations.

Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. MPru is divided by 10 to ease the visualization of the coefficients. The estimations are based on a sample of EM from 2000:Q1 to 2016:Q4. All specifications include country fixed effects. Driscoll-Kraay standard errors are reported in parentheses.* $p < .10$; ** $p < .05$; *** $p < .01$.

Annex Table 3.2.2. Dampening Effects on GDP Growth, Robustness to Reverse Causality

	Excluding negative GDP growth	MPru on the left equals to		
		One-quarter lag of MPru	One-year lag of MPru	Country average of MPru
	(1)	(2)	(3)	(4)
Lag dependent variable	-0.054	0.076	0.076	0.079
	(0.039)	(0.051)	(0.054)	(0.052)
Lag output gap	-0.180***	-0.367***	-0.353***	-0.368***
	(0.024)	(0.035)	(0.034)	(0.035)
Lag ln real GDP per capita	-0.791*	-1.608**	-1.833**	-1.675**
	(0.474)	(0.736)	(0.822)	(0.754)
Institutional quality	-0.650	-0.197	-0.541	-0.343
	(0.501)	(0.813)	(0.811)	(0.766)
Linear trend	-0.002	0.005	0.010	0.007
	(0.005)	(0.007)	(0.008)	(0.007)
Commodity terms of trade	0.079*	0.039	0.041	0.052
	(0.048)	(0.050)	(0.055)	(0.039)
US monetary policy shock	0.207	-0.013	-0.008	-0.046
	(0.166)	(0.298)	(0.265)	(0.314)
Ln VIX	-0.597***	-1.504***	-1.498***	-1.356***
	(0.221)	(0.305)	(0.298)	(0.402)
Net outflows	-0.258***	-0.396***	-0.424***	-0.444***
	(0.071)	(0.111)	(0.108)	(0.151)
Macroprudential regulation (MPru)	-0.639**	-1.286***	-1.534***	
	(0.323)	(0.375)	(0.388)	
US monetary policy shock * MPru	-0.120*	-0.101	-0.133	-0.070
	(0.068)	(0.100)	(0.090)	(0.116)
Ln VIX * MPru	0.259**	0.598***	0.683***	0.444**
	(0.120)	(0.133)	(0.137)	(0.208)
Net outflows * MPru	0.067***	0.111***	0.125***	0.149**
	(0.024)	(0.035)	(0.035)	(0.062)
Observations	1,846	2,235	2,153	2,260
Countries	38	38	38	38
F-statistic	35.1	32.9	32.6	29.7

Source: IMF staff calculations.

Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. MPru is divided by 10 to ease the visualization of the coefficients. The estimations are based on a sample of EM from 2000Q1 to 2016Q4. All specifications include country fixed effects. Driscoll-Kraay standard errors are reported in parentheses. * $p < .10$; ** $p < .05$; *** $p < .01$.

Annex Table 3.2.3. Dampening Effects on GDP Growth, Robustness to Omitted Variables

	Variable X on the left equals to										Including time fixed effects
	Institutional quality	Financial development	Gross public debt	Gross public debt in foreign currency	Cyclically adjusted balance	Monetary policy rate	Inflation expectation anchoring	Fixed exchange rate regime	Capital controls	Official reserves	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Lag dependent variable	0.071	0.064	0.059	0.090*	0.103**	0.085	0.221***	0.071	0.120**	0.072	0.058
	(0.050)	(0.050)	(0.051)	(0.050)	(0.049)	(0.060)	(0.071)	(0.049)	(0.047)	(0.052)	(0.059)
Lag output gap	-0.370***	-0.371***	-0.373***	-0.350***	-0.316***	-0.326***	-0.252***	-0.372***	-0.325***	-0.373***	-0.401***
	(0.035)	(0.035)	(0.037)	(0.034)	(0.024)	(0.037)	(0.053)	(0.036)	(0.029)	(0.038)	(0.034)
Lag ln real GDP per capita	-1.758**	-1.405*	-1.584**	-0.794	-0.764	-2.705**	-5.289	-1.509**	-1.164*	-1.437*	-0.660
	(0.774)	(0.805)	(0.720)	(0.723)	(0.587)	(1.086)	(3.605)	(0.673)	(0.639)	(0.749)	(0.467)
Institutional quality	0.433	-0.077	-0.284	-0.112	0.097	-0.449	0.432	-0.182	-0.564	-0.395	-0.844*
	(1.232)	(0.887)	(0.718)	(0.840)	(0.582)	(0.659)	(1.001)	(0.797)	(0.810)	(0.772)	(0.446)
Linear trend	0.006	0.008	0.007	0.003	0.003	0.006	0.029	0.004	0.002	-0.000	
	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)	(0.010)	(0.025)	(0.007)	(0.006)	(0.007)	
Commodity terms of trade	0.035	0.034	0.007	0.056	0.041	0.016	-0.172	0.034	0.028	0.071	0.047*
	(0.048)	(0.058)	(0.051)	(0.051)	(0.029)	(0.036)	(0.190)	(0.053)	(0.047)	(0.045)	(0.026)
US monetary policy shock	0.038	0.359	-0.295	-0.030	-0.338	0.328	-0.021	-0.017	-0.042	0.009	
	(0.323)	(0.376)	(0.407)	(0.148)	(0.247)	(0.377)	(0.389)	(0.293)	(0.361)	(0.254)	
Ln VIX	-1.623***	-2.169***	-1.265*	-1.372***	-1.294***	-1.999***	-1.555***	-1.540***	-1.996***	-1.592***	
	(0.326)	(0.488)	(0.649)	(0.418)	(0.299)	(0.656)	(0.484)	(0.282)	(0.324)	(0.343)	
Net outflows	-0.412***	-0.410***	-0.552***	-0.491***	-0.251***	-0.302**	-0.358**	-0.419***	-0.321***	-0.525***	-0.108***
	(0.120)	(0.109)	(0.160)	(0.141)	(0.091)	(0.126)	(0.157)	(0.112)	(0.094)	(0.132)	(0.032)
Macroprudential regulation (MPru)	-1.412***	-1.285***	-1.439***	-1.428***	-1.402***	-1.399***	-1.679**	-1.348***	-1.357***	-1.128***	-1.090***
	(0.418)	(0.435)	(0.464)	(0.355)	(0.405)	(0.467)	(0.808)	(0.412)	(0.343)	(0.435)	(0.402)
US monetary policy shock * MPru	-0.108	-0.105	-0.111	-0.069	0.012	-0.125	-0.109	-0.087	-0.058	-0.011	-0.003
	(0.115)	(0.107)	(0.129)	(0.075)	(0.081)	(0.123)	(0.145)	(0.104)	(0.098)	(0.098)	(0.073)
Ln VIX * MPru	0.644***	0.627***	0.620***	0.641***	0.559***	0.652***	0.816**	0.615***	0.575***	0.522***	0.449***
	(0.152)	(0.149)	(0.171)	(0.131)	(0.148)	(0.172)	(0.341)	(0.148)	(0.121)	(0.150)	(0.156)
Net outflows * MPru	0.117***	0.124***	0.131***	0.101***	0.065**	0.094**	0.097*	0.102***	0.091***	0.064**	0.025*
	(0.042)	(0.043)	(0.042)	(0.032)	(0.029)	(0.040)	(0.051)	(0.035)	(0.031)	(0.028)	(0.014)
US monetary policy shock * X	0.207	-0.999**	0.007**	-0.164	-0.008	-0.053*	-0.118	-0.002	-0.117	-0.008	
	(0.128)	(0.455)	(0.003)	(0.444)	(0.017)	(0.031)	(0.482)	(0.104)	(0.212)	(0.005)	
Ln VIX * X	-0.242	1.937	-0.005	-0.476	0.005	0.074	-2.203	-0.026	1.223**	0.007	
	(0.272)	(1.193)	(0.010)	(0.589)	(0.032)	(0.081)	(1.631)	(0.280)	(0.492)	(0.011)	
Net outflows * X	0.043	0.080	-0.003	-0.203	0.001	0.008	-0.475	-0.093*	0.081	-0.009***	
	(0.081)	(0.270)	(0.002)	(0.146)	(0.009)	(0.006)	(0.373)	(0.054)	(0.076)	(0.003)	
X		-8.999*	0.025	2.978	0.131	-0.309	7.720	0.519	-4.315**	0.020	
		(4.719)	(0.033)	(1.870)	(0.102)	(0.251)	(5.596)	(0.877)	(1.874)	(0.034)	
Observations	2,260	2,260	2,194	1,949	1,965	1,796	1,200	2,260	1,925	2,207	2,260
Countries	38	38	38	35	35	34	20	38	31	38	38
F-statistic	5.8	10.5	2.7	9.8	29.9	19.8	0.7	24.3	18.2	10.8	23.4

Source: IMF staff calculations.

Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. MPru is divided by 10 to ease the visualization of the coefficients. The estimations are based on a sample of EM from 2000:Q1 to 2016:Q4. All specifications include country fixed effects. Driscoll-Kraay standard errors are reported in parentheses. * p < .10; ** p < .05; *** p < .01.

Annex Table 3.2.4. Symmetric Dampening Effects of Macroprudential Regulation on GDP Growth

	Symmetric dampening effects against	
	Ln VIX	Net outflows
	(1)	(2)
Lag dependent variable	0.070	0.100*
	(0.047)	(0.051)
Lag output gap	-0.396***	-0.388***
	(0.036)	(0.037)
Lag ln real GDP per capita	-1.676**	-1.968**
	(0.738)	(0.776)
Institutional quality	-0.075	-0.048
	(0.854)	(0.931)
Linear trend	0.005	0.008
	(0.007)	(0.007)
Commodity terms of trade	0.035	0.033
	(0.054)	(0.077)
US monetary policy shock	0.069	0.082
	(0.251)	(0.314)
Ln VIX		-1.555***
		(0.329)
Net outflows	-0.420***	
	(0.106)	
US monetary policy shock * MPru	-0.117	-0.132
	(0.101)	(0.122)
Ln VIX * MPru		0.634***
		(0.158)
Net outflows * MPru	0.114***	
	(0.035)	
Mpru * D+	-1.101**	-1.324***
	(0.491)	(0.466)
Mpru * D-	-1.721***	-1.346***
	(0.606)	(0.436)
Ln VIX * D+	-1.080**	
	(0.475)	
Ln VIX * D-	-2.139***	
	(0.461)	
Ln VIX * D+ * MPru	0.535***	
	(0.164)	
Ln VIX * D- * MPru	0.751***	
	(0.225)	
Net outflows * D+		-0.456***
		(0.142)
Net outflows * D-		-0.478***
		(0.163)
Net outflows * D+ * MPru		0.126**
		(0.051)
Net outflows * D- * MPru		0.132**
		(0.055)
Observations	2,260	2,260
Countries	38	38
F-statistic	27.3	6.9
Wald test (p-value)	0.421	0.943

Source: IMF staff calculations.
Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. MPru is divided by 10 to ease the visualization of the coefficients. The estimations are based on a sample of EM from 2000:Q1 to 2016:Q4. All specifications include country fixed effects. Driscoll-Kraay standard errors are reported in parentheses. The Wald test is for the equality between the coefficient on (S * D+ * MPru) and the one on (S * D- * MPru). MPru = macroprudential regulation. * p < .10; ** p < .05; *** p < .01.

Annex Table 3.2.5. Dampening Effects of Macroprudential Categories on GDP Growth

	MPru on the left equals to				
	Capital	Credit demand	Credit supply	FX exposure	Liquidity
	(1)	(2)	(3)	(4)	(5)
Lag dependent variable	0.061	0.067	0.067	0.066	0.071
	(0.054)	(0.053)	(0.055)	(0.055)	(0.054)
Lag output gap	-0.374***	-0.381***	-0.374***	-0.383***	-0.372***
	(0.039)	(0.036)	(0.035)	(0.036)	(0.035)
Lag ln real GDP per capita	-2.012**	-0.773	-0.936	-0.682	-1.193*
	(0.972)	(0.594)	(0.584)	(0.531)	(0.627)
Institutional quality	1.456	0.039	-0.207	-0.417	-0.300
	(1.439)	(0.733)	(0.688)	(0.661)	(0.677)
Linear trend	0.009	-0.001	0.002	-0.000	0.003
	(0.010)	(0.006)	(0.006)	(0.005)	(0.006)
Commodity terms of trade	0.058	0.049	0.046	0.049	0.052
	(0.079)	(0.047)	(0.046)	(0.038)	(0.037)
US monetary policy shock	-0.059	-0.155	-0.146	-0.162	-0.160
	(0.194)	(0.168)	(0.172)	(0.174)	(0.173)
Ln VIX	-0.524	-0.741***	-0.672***	-0.777***	-0.766***
	(0.435)	(0.193)	(0.197)	(0.179)	(0.196)
Net outflows	-0.495***	-0.247***	-0.223***	-0.199***	-0.205***
	(0.177)	(0.064)	(0.059)	(0.049)	(0.053)
Macroprudential regulation (Mpru)	8.040	-3.021	0.886	-10.270***	-2.044**
	(12.012)	(2.376)	(5.846)	(2.420)	(0.887)
US monetary policy shock * Mpru	-1.106	-0.245	-0.349	0.169	0.067
	(1.190)	(0.422)	(0.855)	(0.646)	(0.136)
Ln VIX * Mpru	-1.119	1.663*	0.806	3.324***	0.846***
	(4.752)	(0.866)	(1.918)	(0.756)	(0.248)
Net outflows * Mpru	2.390**	0.638***	0.709**	-0.115	0.062
	(1.129)	(0.223)	(0.300)	(0.128)	(0.072)
$MPru^2$	-19.297	2.019	-2.833	10.829***	0.315
	(19.623)	(2.647)	(6.464)	(2.698)	(0.434)
US monetary policy shock * $MPru^2$	0.501	0.390	0.245	0.017	-0.054
	(2.061)	(0.356)	(0.858)	(0.743)	(0.078)
Ln VIX * $MPru^2$	5.784	-1.179	0.073	-3.068***	-0.127
	(7.565)	(1.005)	(2.201)	(0.844)	(0.146)
Net outflows * $MPru^2$	-3.214**	-0.426***	-0.886	0.318**	0.015
	(1.624)	(0.163)	(5.846)	(0.145)	(0.042)
Observations	2,260	2,260	2,260	2,260	2,260
Countries	38	38	38	38	38
F-statistic	4.0	14.2	12.7	22.9	12.4

Source: IMF staff calculations.

Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. MPru is divided by 10 to ease the visualization of the coefficients. The estimations are based on a sample of EM from 2000:Q1 to 2016:Q4. All specifications include country fixed effects. Driscoll-Kraay standard errors are reported in parentheses. * $p < .10$; ** $p < .05$; *** $p < .01$.

Annex Table 3.2.6. Dampening Effects of Macroprudential Regulation on Credit Growth and Exchange Rates

	Dependent variable equals to		
	Real credit growth	NEER appreciation	REER appreciation
	(1)	(2)	(3)
Lag dependent variable	0.226***	0.206***	0.174***
	(0.051)	(0.041)	(0.043)
Lag output gap	0.196**	-0.071	-0.050
	(0.083)	(0.058)	(0.059)
Lag ln real GDP per capita	-3.606	-2.225*	-2.337*
	(2.830)	(1.201)	(1.233)
Institutional quality	-1.525	0.448	0.642
	(1.382)	(1.328)	(1.264)
Linear trend	0.014	0.012	0.005
	(0.022)	(0.010)	(0.010)
Commodity terms of trade	-0.126	0.115	0.055
	(0.089)	(0.177)	(0.164)
US monetary policy shock	0.520	0.082	0.075
	(0.730)	(0.491)	(0.446)
Ln VIX	-1.232	-2.469**	-2.248**
	(0.981)	(1.031)	(1.000)
Net outflows	-0.563*	-0.396**	-0.410***
	(0.288)	(0.173)	(0.158)
Macroprudential regulation (MPru)	-1.065	-2.552*	-2.412*
	(1.125)	(1.332)	(1.353)
US monetary policy shock * MPru	-0.150	-0.174	-0.165
	(0.308)	(0.231)	(0.216)
Ln VIX * MPru	0.480	1.066**	1.037**
	(0.413)	(0.521)	(0.520)
Net outflows * MPru	0.173*	0.134**	0.129**
	(0.093)	(0.065)	(0.060)
Credit to GDP	-0.002**		
	(0.001)		
Observations	2,049	2,164	2,164
Countries	38	35	35
F-statistic	25.5	33.4	33.2

Source: IMF staff calculations.

Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. The share of credit to GDP uses trend GDP as the denominator. MPru is divided by 10 to ease the visualization of the coefficients. The estimations are based on a sample of EM from 2000:Q1 to 2016:Q4. All specifications include country fixed effects. Driscoll-Kraay standard errors are reported in parentheses. * p < .10; ** p < .05; *** p < .01.

Annex 3.3 Macroprudential Regulation and Monetary Policy Responses

This annex describes the methodology used to analyze the effects of macroprudential regulation on the response of monetary policy in emerging markets to global financial shocks.

Empirical Framework

The analysis is based on the following panel specification:

$$I_{i,t} = \alpha_i + \beta \cdot S_{i,t} + \gamma \cdot \left(S_{i,t} * MPru_{i,t}\right) + \zeta MPru_{i,t} + \kappa \cdot C_{i,t} + \varepsilon_{i,t} \qquad (3.4)$$

where the dependent variable $I_{i,t}$ denotes the policy rates for country *i* at time *t*. The vector of global shocks $S_{i,t}$ includes (i) the US policy rate, (ii) the VIX, and (iii) net capital outflows.[1] This analysis uses the US policy rate rather than the monetary policy shocks used in Annex 3.2 since monetary policy in emerging markets is found to react to changes in actual US policy rates rather than in their unexpected components. The regression also includes control variables from an augmented Taylor rule, such as expected inflation over the next 12 months, the output gap, real credit growth, and commodity terms of trade. Country fixed effects are also included. To evaluate if macroprudential regulation affects the monetary policy response to global financial shocks, the regression includes interaction terms between the level of macroprudential regulation, $MPru_{i,t}$, and the shock vector, $S_{i,t}$. The coefficients ζ thus capture the degree to which macroprudential regulation affects the monetary response. If macroprudential regulation allows for a more countercyclical monetary policy response to global financial shocks, the ζ coefficients should be negative and significant.

Equation (3.4) is estimated using quarterly data for up to 30 emerging market economies depending on data availability covering the period 2000 to 2016. In contrast to Annex 3.2, hard pegs are excluded to focus on countries that have monetary autonomy according to the policy trilemma.[2] As in section 3.2, estimation is done using two-stage least squares by instrumenting net capital inflows. The standard errors are computed using the Driscoll and Kraay (1998) correction.[3]

Baseline Results

Table 3.3.1 reports the baseline results. Column 1 shows the results of a specification with only the global financial shocks as independent variables. These results show that policy rates in emerging markets respond pro-cyclicality to a tightening in global financial conditions. Specifically, policy rates increase in response to rises in the US policy rate and the VIX. Moreover, policy rates increase in response to higher net capital outflows. These results are

[1] The US policy rate is the federal funds rate except during the zero lower bound period where the implied policy rate from Wu and Xia (2015) is used. This is done to account for the use of unconventional monetary policy. The results below are robust to using the alternative measure of the implied policy rate by Krippner (2013).

[2] Countries exchange rate arrangements are categorized using Ilzetzki and others (2019).

[3] A potential concern about the specification in (1) is non-stationarity. To address this, tests for non-stationarity of the policy rates are conducted using the panel unit root tests by Levin, Lin and Chu (2002) and Im, Pesaran and Smith (2003). These point to stationarity. Furthermore, tests for stationarity the linear combination of the policy rates, output gap, expected inflation and the global financial shocks are done using the tests by Kao (1999) and Westerlund (2007). These also point to stationarity.

broadly consistent with those in the literature (Obstfeld et al., 2005; Aizenman et al., 2016, 2017; Han and Wei, 2018; Cavallino and Sandri, 2018; and Bhattarai et al., forthcoming).[4] Column 2 shows that the monetary policy response remains procyclical when controlling for expected inflation and the output gap. The output gap and expected inflation have the expected signs, with central banks reacting to higher output gap or expected inflation by tightening monetary policy. Column 3 shows that the procyclical response of monetary policy is also robust to controlling for real credit growth and commodity terms of trade. For all the specifications, the instrumentation F-tests point to instrument validity.

Column 4 reports the full specification with the global financial shocks, all controls, and macroprudential regulation. Macroprudential regulation is included in level and interacted with the shocks. The estimates show significant and negative interaction terms between the level of regulation and (i) the US policy rate and (ii) the VIX. This implies that the procyclical response of domestic monetary policy to global financial shocks is muted as the level of macroprudential regulation increases. In fact, if the level of regulation is sufficiently tight, the monetary response to an increase in US policy rates and the VIX becomes countercyclical, with emerging markets lowering policy rates. Nonetheless, macroprudential policy does not appear to affect the monetary policy response to net capital outflows since the interaction between net capital outflows and macroprudential regulation in column 4 is insignificant.

[4] Bhattarai et al. (forthcoming) find that the responses to positive U.S. policy innovations vary across countries with the response in Latin America being negative.

Annex Table 3.3.1. Regressions of Domestic Policy Rates, Baseline Results

	(1)	(2)	(3)	(4)
US policy rate	0.597***	0.359***	0.295***	0.366***
	(0.068)	(0.034)	(0.037)	(0.066)
Ln VIX	1.396***	0.587**	0.599**	2.098***
	(0.482)	(0.283)	(0.302)	(0.451)
Net outflows	0.404***	0.347***	0.337***	0.418***
	(0.118)	(0.079)	(0.084)	(0.127)
Expected inflation, next 12 months		1.235***	1.224***	1.227***
		(0.075)	(0.077)	(0.075)
Output gap		0.250***	0.148**	0.208***
		(0.082)	(0.066)	(0.071)
Real credit growth			0.050***	0.050***
			(0.014)	(0.014)
Commodity terms of trade			-0.085**	-0.102**
			(0.042)	(0.044)
Macroprudential regulation (MPru)				0.220***
				(0.053)
US policy rate * MPru				-0.013***
				(0.004)
Ln VIX * MPru				-0.116***
				(0.020)
Net outflows * MPru				-0.004
				(0.004)
Observations	1360	1262	1250	1250
Countries	30	25	25	25
F-statistic	73.98	56.42	49.70	21.98

Source: IMF staff calculations.

Notes: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. The US policy rate is the effective federal funds rate except during the zero lower bound period where the implied policy rate from Wu and Xia (2015) is used. The estimations are done using fixed effects on a panel of EMs, excluding countries with pegged and freely falling exchange rates (Ilzetzki et al., 2019), during 2000:Q1 to 2016:Q4. Driscoll-Kraay standard errors are reported in parenthesis. * $p < .10$; ** $p < .05$; *** $p < .01$.

Robustness

This section considers two potential endogeneity concerns about the results above. First, reverse causality is a concern if countries move macroprudential regulation in response to policy rate changes. Specifically, countries may raise macroprudential regulation in response to a decrease in the policy rates to mitigate financial stability concerns form monetary easing. Second, omitted variable bias is a concern if macroprudential regulation correlates with other country characteristics relevant for the monetary policy response to global shocks.

Table 3.3.2 reports the robustness tests designed to address the reverse causality concern. Column 1 and 2 lag the level of macroprudential regulation by one and four quarters, respectively. The interactions of macroprudential regulation with US policy rates and the VIX

remain negative and statistically significant. Column 3 uses the average level of macroprudential regulation, thus letting the estimation rely solely on the cross-country variation in regulation. The interaction coefficient of regulation with the VIX is again negative and statistically significance. The interaction with the US policy rate loses significance, but macroprudential regulation is now found to support a more countercyclical monetary policy response to net capital outflows. In sum, these tests alleviate concerns about reverse causality.

Annex Table 3.3.2. Regressions of Domestic Policy Rates, Robustness to Reverse Causality

	MPru on the left equals to		
	One-quarter lag of Mpru	One-year lag of MPru	Country average of MPru
	(1)	(2)	(3)
US policy rate	0.366***	0.409***	0.351***
	(0.065)	(0.067)	(0.063)
Ln VIX	2.120***	2.175***	2.407***
	(0.452)	(0.480)	(0.402)
Net outflows	0.406***	0.391***	0.566***
	(0.126)	(0.130)	(0.182)
Expected inflation, next 12 months	1.207***	1.186***	1.238***
	(0.075)	(0.080)	(0.079)
Output gap	0.204***	0.160**	0.157**
	(0.071)	(0.071)	(0.069)
Real credit growth	0.052***	0.052***	0.052***
	(0.014)	(0.015)	(0.015)
Commodity terms of trade	-0.102**	-0.091**	-0.084**
	(0.045)	(0.046)	(0.042)
Macroprudential regulation (MPru)	0.217***	0.242***	
	(0.055)	(0.061)	
US policy rate * MPru	-0.014***	-0.018***	-0.005
	(0.004)	(0.004)	(0.003)
Ln VIX * MPru	-0.116***	-0.129***	-0.124***
	(0.021)	(0.025)	(0.021)
Net outflows * MPru	-0.003	-0.001	-0.014**
	(0.004)	(0.004)	(0.007)
Observations	1241	1211	1250
Countries	25	25	25
F-statistic	22.97	22.15	20.53

Source: IMF staff calculations.

Notes: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. The US policy rate is the effective federal funds rate except during the zero lower bound period where the implied policy rate from Wu and Xia (2015) is used. The estimations are done using fixed effects on a panel of EMs, excluding countries with pegged and freely falling exchange rates (Ilzetzki et al., 2019), during 2000:Q1 to 2016:Q4. Driscoll-Kraay standard errors are reported in parenthesis. * $p < .10$; ** $p < .05$; *** $p < .01$.

Table 3.3.3 reports robustness tests addressing the potential omitted variable issue. Column 1 to 6 augment the baseline specification with additional structural and policy variables included both in levels and interacted with macroprudential regulation. These include institutional quality (column 1), financial development (2), gross public debt in percent of GDP (column 3), gross public debt in foreign currency in percent of gross public debt (column 4), the cyclically adjusted balance in percent of trend GDP (column 5), the anchoring of inflation expectations (column 6), capital controls (column 7), or official reserves in percent of trend GDP (column 8). Finally, column 9 reports the estimates using the baseline specification augmented with time fixed effects. The results support the baseline results, as the interaction of macroprudential regulation and the VIX remains negative and significant in all tests. The interaction with the US policy rate also remains negative and significant, except for the specification augmented with official reserves. In that case, the interactions remain negative but loses significance at the 10 percent level.[5]

[5] The results are also robust to excluding the period of the global financial crisis (2008:Q3-2009:Q4).

Annex Table 3.3.3. Regressions of Domestic Policy Rates, Robustness to Omitted Variables

	Variable X on the left equals to								Including time fixed effects
	Institutional quality	Financial development	Gross public debt	Government FX debt	Cyclical adjusted balance	Inflation expectation anchoring	Capital flow measures	Official reserves	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
US policy rate	0.347***	0.053	-0.061	0.583***	0.566***	0.235***	0.315***	0.324***	2.899***
	(0.073)	(0.136)	(0.128)	(0.090)	(0.079)	(0.070)	(0.089)	(0.097)	(0.428)
Ln VIX	1.941***	2.757***	0.187	1.260**	1.960***	1.884***	1.490***	1.637***	0.643**
	(0.486)	(0.699)	(0.963)	(0.540)	(0.376)	(0.401)	(0.434)	(0.435)	(0.312)
Net outflows	0.415***	0.178	0.347*	0.591***	0.331***	0.146	0.221***	0.591***	0.076
	(0.123)	(0.168)	(0.187)	(0.142)	(0.100)	(0.185)	(0.081)	(0.174)	(0.047)
Expected inflation, next 12 months	1.218***	1.197***	1.230***	1.209***	1.182***	1.150***	1.205***	1.143***	1.161***
	(0.077)	(0.084)	(0.072)	(0.085)	(0.070)	(0.097)	(0.078)	(0.077)	(0.075)
Output gap	0.202***	0.189***	0.194***	0.212***	0.227***	0.170*	0.175***	0.162***	0.120*
	(0.070)	(0.070)	(0.066)	(0.072)	(0.068)	(0.087)	(0.067)	(0.058)	(0.069)
Real credit growth	0.048***	0.047***	0.047***	0.035***	0.049***	0.031	0.042***	0.050***	0.034***
	(0.013)	(0.012)	(0.013)	(0.011)	(0.013)	(0.020)	(0.011)	(0.013)	(0.009)
Commodity terms of trade	-0.104**	-0.075	-0.148***	-0.114**	-0.119***	-0.043	-0.082*	-0.081**	-0.038
	(0.047)	(0.046)	(0.048)	(0.058)	(0.045)	(0.035)	(0.042)	(0.040)	(0.038)
Macroprudential regulation (MPru)	0.201***	0.228***	0.172***	0.166***	0.148***	0.160	0.190***	0.164***	0.084**
	(0.055)	(0.042)	(0.062)	(0.050)	(0.055)	(0.101)	(0.046)	(0.053)	(0.040)
US policy rate * MPru	-0.012***	-0.012***	-0.008*	-0.017***	-0.021***	-0.008**	-0.013***	-0.005	-0.016***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.002)
Ln VIX * MPru	-0.111***	-0.107***	-0.097***	-0.099***	-0.088***	-0.074**	-0.104***	-0.091***	-0.064***
	(0.021)	(0.016)	(0.024)	(0.019)	(0.020)	(0.037)	(0.017)	(0.020)	(0.015)
Net outflows * MPru	-0.004	-0.002	-0.002	-0.005	-0.008*	0.001	-0.004	-0.000	0.001
	(0.004)	(0.004)	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)
US policy rate * X	0.039	0.670**	0.009***	-0.407**	-0.010	-0.101	0.067	-0.008*	
	(0.058)	(0.310)	(0.002)	(0.189)	(0.009)	(0.196)	(0.102)	(0.005)	
Ln VIX * X	0.568	-1.851	0.037**	2.290**	0.068	-1.066	0.478	0.009	
	(0.441)	(1.609)	(0.016)	(1.126)	(0.087)	(1.428)	(0.966)	(0.021)	
Net outflows * X	-0.053	0.362	0.001	-0.525**	-0.045**	0.167	0.329**	-0.016***	
	(0.178)	(0.392)	(0.003)	(0.235)	(0.020)	(0.190)	(0.137)	(0.005)	
X	0.942	-0.803	-0.144***	-6.287*	-0.716**	2.055	-0.121	-0.127*	
	(2.117)	(6.952)	(0.040)	(3.402)	(0.289)	(4.867)	(3.336)	(0.069)	
Observations	1250	1250	1239	1157	1212	976	1250	1236	1250
Countries	25	25	25	24	24	18	25	25	25
F-statistic	3.952	6.900	11.87	12.45	5.799	2.749	20.18	22.77	15.46

Source: IMF staff calculations.

Notes: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. The US policy rate is the effective federal funds rate except during the zero lower bound period where the implied policy rate from Wu and Xia (2015) is used. The estimations are done using fixed effects on a panel of EMs, excluding countries with pegged and freely falling exchange rates (Ilzetzki et al., 2019), during 2000:Q1 to 2016:Q4. Driscoll-Kraay standard errors are reported in parenthesis. * p < .10; ** p < .05; *** p < .01.

Annex 3.4 Side Effects of Macroprudential Regulation

After establishing that macroprudential regulation can help emerging markets to dampen the effects of global financial shocks on GDP growth, the analysis looks at the existence of potential side effects from a tighter level of regulation.

Effects on Average GDP Growth

A first concern is that a more stringent level of macroprudential regulation may lead to lower average GDP growth. In other words, do macroprudential regulation involve a trade-off between lower growth volatility and lower average growth?

To assess the impact of macroprudential regulation on growth during the sample period, the analysis constructs two counter-factual GDP growth series. Using the coefficient estimates in the baseline specification (column 4 in Annex Table 3.2.1), the rate of GDP growth during 2000-2016 is predicted for a country with a tight macroprudential regulation and a country with a loose one.[1] Such levels correspond to the 25th and 75th percentiles of the distribution of macroprudential regulation in the sample, respectively.

As shown in Figure 3.8 in the chapter, higher regulation would have delivered significantly faster economic growth in the early 2000s and during the global financial crisis when emerging markets faced adverse global financial conditions. However, macroeconomic regulation would have lowered economic growth considerably in the run-up to the global financial crisis when global financial conditions were supportive. Overall, tighter macroprudential regulation would have reduced the standard deviation of GDP growth by about 20 percent.

The gains from lower volatility do not appear to come at the cost of lower average growth. Indeed, the analysis does not find statistically significant effects on average GDP growth during 2000-2016. This can also be seen by considering the derivative of GDP growth with respect to macroprudential regulation using the regression coefficients in column 4 of Annex Table 3.2.1. While the coefficient on macroprudential regulation alone is negative, the total effect of macroprudential regulation on GDP growth considering the interaction terms is generally not statistically significant.

Cross-Country Spillovers

A second concern is that macroprudential regulation in a given country could generate adverse spillovers to other countries. This is possible if macroprudential regulation leads to a relocation of risky financial activities to other countries. However, positive spillovers are also conceivable. If tighter macroprudential regulation provides more stability, other economies can benefit from such strengthened resilience through more stable trade and financial flows.

To assess cross-country spillovers, the specification in equation (3.1) is amended as follows:

[1] The exercise computes the one-quarter ahead GDP growth forecast based on the realizations of GDP rather than the predicted values. While the exercise can be conducted using the predicted values of GDP growth, the coefficients on the lagged dependent variable and on real GDP per capita are not significant; and, with respect to the output gap, it would be difficult to separate the cyclical component of the change in GDP.

$$Y_{i,t} = \alpha_i + \beta \cdot S_{i,t} + \gamma \cdot \left(S_{i,t} * MPru_{i,t}\right) + \bar{\gamma} \cdot \left(S_{i,t} * \overline{MPru}_{i,t}\right) + \zeta MPru_{i,t} + \bar{\zeta}\, \overline{MPru}_{i,t} + \kappa \cdot C_{i,t} + \varepsilon_{i,t} \quad (3.5)$$

where $\overline{MPru}_{i,t}$ is the average level of macroprudential regulation in other emerging markets excluding country i. The average of other emerging markets is weighted by gross capital inflows to track the relevance of each country in capital movements. One may argue that when investors allocate assets, they are likely to look at economies within the same regional group, income class, or risk class, rather than the entire spectrum of emerging markets. Thus, the average macroprudential regulation of other economies is alternatively computed only across economies in those groups.[2]

Annex Table 3.4.1 presents the evidence on spillovers. In column (1), the average is calculated across all countries in the sample. Column (2) uses the average of the countries in the same region. Columns (3) and (4) use the average of countries within the same income class. Finally, columns (5) and (6) use the average of countries within the same risk class. In columns (3) and (5), the group composition is allowed to change over time, while in columns (4) and (6), it is fixed based on average values during the 2000/2016 sample period.

The analysis does not find evidence of negative spillovers. Spillovers tend instead to be positive vis-à-vis net outflows. The coefficient on the interaction between net outflows and the average level of macroprudential regulation in other emerging markets is significant regardless of how the average is computed. This implies that a country becomes more resilient to capital flow shocks if other emerging markets have a higher level of macroprudential regulation.

In terms of magnitude, the dampening effects from domestic or foreign macroprudential regulation are similar. This is evident from the similar coefficient estimates on the interaction terms between global financial shocks with domestic or foreign macroprudential regulation. However, the coefficient on the interaction term between net outflows and the average macroprudential regulation in other emerging markets captures the effect of a one-unit increase in the average level of macroprudential regulation in all other emerging markets in the same group. This is a larger macroprudential tightening than a one-unit increase of an economy's own level of macroprudential regulation.

[2] The economies in the same group are identified with a dummy variable. For each country the dummy variable takes value one if they are in the same IMF WEO regional group. In the case of the income and the risk classifications, the sample is split in two using the median value of the nominal GDP per capita in USD and the ICRG composite risk rating index, respectively. The dummy variable takes value one if the other emerging markets belong to the same half of the sample. For the income and risk classifications, the dummy variable can be either time varying or time invariant. In the latter case, the median to split the sample is computed using country averages of nominal GDP per capita in USD and the composite risk rating index. This approach is similar to the one in Giordani and others (2017).

Annex Table 3.4.1. Regressions of Real GDP Growth, Spillovers

	Others' MPru on the left equals MPru averaged over					
	Others in full sample	Others in the same region	Others in the same income class (time varying)	Others in the same income class (time invariant)	Others in the same risk class (time varying)	Others in the same risk class (time invariant)
	(1)	(2)	(3)	(4)	(5)	(6)
Lag dependent variable	0.024	0.070	0.071	0.055	0.067	0.052
	(0.055)	(0.050)	(0.048)	(0.048)	(0.055)	(0.047)
Lag output gap	-0.382***	-0.381***	-0.381***	-0.360***	-0.339***	-0.359***
	(0.046)	(0.037)	(0.039)	(0.034)	(0.031)	(0.032)
Lag ln real GDP per capita	-1.448	-1.579**	-0.992	-1.763**	-3.431***	-1.568**
	(1.235)	(0.723)	(0.779)	(0.728)	(1.038)	(0.771)
Institutional quality	2.967	0.416	0.950	0.394	2.327*	0.865
	(1.911)	(0.865)	(1.083)	(0.884)	(1.203)	(0.883)
Linear trend	-0.089*	0.008	-0.003	0.011	-0.011	-0.009
	(0.047)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)
Commodity terms of trade	0.089	0.063	0.024	0.022	0.063	0.067
	(0.097)	(0.051)	(0.063)	(0.050)	(0.063)	(0.050)
US monetary policy shock	0.137	0.028	-0.173	-0.253	0.008	-0.058
	(0.699)	(0.349)	(0.475)	(0.448)	(0.387)	(0.331)
Ln VIX	-1.469*	-1.748***	-1.236**	-1.498***	-1.817***	-1.669***
	(0.794)	(0.472)	(0.579)	(0.471)	(0.484)	(0.458)
Net outflows	-1.367***	-0.600***	-0.683***	-0.535***	-0.828***	-0.626***
	(0.479)	(0.153)	(0.226)	(0.168)	(0.225)	(0.152)
Macroprudential regulation (MPru)	-2.864***	-1.582***	-1.855***	-1.429***	-1.479***	-1.630***
	(0.932)	(0.459)	(0.556)	(0.456)	(0.463)	(0.453)
US monetary policy shock * MPru	-0.166	-0.105	-0.097	-0.088	-0.109	-0.084
	(0.145)	(0.120)	(0.136)	(0.125)	(0.116)	(0.100)
Ln VIX * MPru	1.207***	0.709***	0.731***	0.635***	0.747***	0.692***
	(0.374)	(0.168)	(0.197)	(0.165)	(0.178)	(0.165)
Net outflows * MPru	0.148***	0.120***	0.138***	0.121***	0.145***	0.105***
	(0.054)	(0.040)	(0.053)	(0.044)	(0.049)	(0.034)
US monetary policy shock * others' MPru	0.005	-0.025	0.059	0.077	-0.021	0.004
	(0.195)	(0.070)	(0.075)	(0.061)	(0.102)	(0.069)
Ln VIX * others' MPru	-0.515	0.031	-0.149	-0.004	0.130	0.034
	(0.435)	(0.131)	(0.189)	(0.139)	(0.144)	(0.104)
Net outflows * others' MPru	0.418**	0.120***	0.113**	0.068**	0.170***	0.116***
	(0.175)	(0.031)	(0.044)	(0.031)	(0.050)	(0.032)
Others' MPru	4.296*	-0.027	0.863	0.148	0.486	0.469
	(2.388)	(0.367)	(0.682)	(0.433)	(0.480)	(0.336)
Observations	2,260	2,192	2,260	2,260	2,108	2,260
Countries	38	37	38	38	35	38
F-statistic	4.1	19.6	9.4	6.4	10.8	20.7
Wald test (p-value)	0.063	0.993	0.384	0.078	0.511	0.739

Source: IMF staff calculations.

Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. MPru is divided by 10 to ease the visualization of the coefficients. The estimations are based on a sample of EM from 2000:Q1 to 2016:Q4. All specifications include country fixed effects. Driscoll-Kraay standard errors are reported in parentheses. The Wald test is for the equality between the coefficient on (net outflows * MPru) and the one on (net outflows * others' MPru). * $p < .10$; ** $p < .05$; *** $p < .01$.

Annex 3.5 Do Emerging Markets Adjust Macroprudential Regulation in Response to Global Financial Shocks?

This section describes the econometric approach and empirical results presented in Box 3.2. Policy response functions for macroprudential policies are estimated using data for a sample of 38 emerging markets over 2000-2016 at quarterly frequency. Building on the approach by Ghosh and others (2017), the following regression is estimated:

$$\Delta MPru_{i,t} = \alpha_i + \beta \cdot S_{i,t} + \gamma \cdot C_{i,t} + \varepsilon_{i,t} \quad (3.6)$$

$\Delta MPru_{i,t}$ is the number of macroprudential net tightening actions in a given quarter. The vector $S_{i,t}$ includes global financial shocks: US policy rate shocks from Iacoviello and Navarro (2019), the VIX, and net capital inflows. As in the main body of the chapter, the latter is instrumented with net flows to the other emerging markets (all in percent of GDP).[1] α_i are country fixed effects to control for unobserved, time invariant country characteristics. Finally, the vector $C_{i,t}$ includes standard control variables, such as expected inflation, the output gap, commodity terms of trade, and real credit growth. Standard errors are clustered following Driscoll-Kraay (1998) in order to correct for cross-country correlations, autocorrelation, and heteroscedasticity of the error term.

The regression results are shown in table 3.5.1. In column 1, the coefficients on the global financial shocks are negative and statistically significant. These results are robust to adding the control variables $C_{i,t}$ in column 2. Therefore, the evidence suggests that policy makers in emerging markets tend to loosen macroprudential policies when global financial conditions tighten or, conversely, they tend to tighten regulation when global financial conditions ease. This is in line with Ghosh and others (2017) who show that the probability of tightening of macroprudential measures is significantly higher when capital flows surge.

Are the results driven by changes in macroprudential tools targeted at foreign currency exposures? Column 3 shows that this is not the case. The regression coefficients on global financial shocks are negative and statistically significant even if measures targeted at foreign currency exposures are excluded in the construction of the left-side variable $\Delta MPru_{i,t}$.

[1] In the regression output, the coefficient on net outflows rather than inflows is shown so that all shocks – the VIX, the US rate, and the outflows – are negative shocks for emerging markets.

Annex Table 3.5.1. Policy Response Functions of Macroprudential Measures

	All Macroprudential Measures	All Macroprudential Measures	Excluding FX Exposure Measures
	(1)	(2)	(3)
Net ouflows	-0.035**	-0.044**	-0.038**
	(0.015)	(0.023)	(0.018)
US monetary policy shocks	-0.056*	-0.066**	-0.056**
	(0.030)	(0.031)	(0.026)
Ln VIX	-0.170**	-0.160*	-0.128**
	(0.077)	(0.086)	(0.055)
Expected inflation		-0.011	-0.011*
		(0.007)	(0.006)
Output gap		-0.017	-0.007
		(0.016)	(0.013)
Real Credit Growth		-0.003	-0.003
		(0.003)	(0.002)
Commodity terms of trade		0.016**	0.010*
		(0.006)	(0.005)
Observations	2,286	1,798	1,798
Countries	38	32	32
F-statistic	69.64	42.61	42.61

Source: IMF staff calculations

Note: Net inflows (in percent of trend GDP) for each country are instrumented using gross inflows to other EMs (in percent of trend GDP). Results are presented in terms of net outflows. The estimations are based on a sample of EM from 2000:Q1 to 2016:Q4. All specifications include country fixed effects. Driskoll-Kraay standard errors are reported in parenthesis. * $p < .10$; ** $p < .05$; *** $p < .01$.