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. * $p < .10$; ** $p < .05$; *** $p < .01$.