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In the face of spillovers: prudential policies in emerging economies

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Abstract

We examine whether emerging market prudential policies help to reduce the macro-financial spillover effects of US monetary policy. We find that emerging markets with tighter prudential policies face significantly smaller, and less negative, spillovers to total credit from US monetary policy tightening shocks. Loan-to-value ratio limits and reserve requirements appear to be particularly effective prudential measures at mitigating the spillover effects of US monetary policy. Our findings indicate that domestic prudential policies can dampen emerging markets' exposure to US monetary policy and the associated global financial cycle, even when accounting for capital controls, suggesting they may be a useful tool in the face of international macroeconomic policy trade-offs.

JEL Codes: E52, E58, E61, F44.

Key Words: International spillovers; Local projections; Policy Interactions; Monetary policy; Prudential policy.

Non-Technical Summary

Emerging markets (EMs) are often disproportionately hit by spillovers from US monetary policy, in part due to their exposure to the 'global financial cycle'. This poses challenges for policymakers, who can only pursue independent monetary policy with recourse to capital controls or prudential policies. We show that, in the face of global spillovers, prudential policies in EMs can help to offset US monetary policy spillovers, helping to resolve policymakers' 'dilemma'.

We use data measuring a range of prudential policy actions in 29 EMs from 2000 to 2017, spanning capital and reserve requirements, LTV ratio limits, interbank exposure limits and concentration limits. Combined with a measure of unexpected US monetary policy shocks, we estimate the interaction between US monetary policy and EM prudential policies within a panel local projections setup. We examine how domestic lending (total and bank credit) and house prices in EMs respond to US monetary policy shocks, and how this differs depending on the prudential policy actions taken by each EM.

We find that EMs with tighter prudential policy face significantly smaller, and less negative, spillovers to total domestic credit from US monetary policy tightening shocks. Importantly, this result is robust to accounting for interactions from other factors, such as capital controls. A $+1$pp exogenous tightening of US monetary policy leads to around 7% fall in total credit and 5% fall in bank credit in EMs on average. However, an EM with an additional (a one standard deviation) prudential policy tightening action faces a substantially smaller spillover, facing reductions in total and bank credit of around 5.6% (3.5%) and 4% (2.5%), respectively. These results indicate that an additional (a one standard deviation) prudential policy tightening can offset the monetary policy spillover by around 20% (50%)—an economically significant amount. Loan-to-value ratio limits and reserve requirements appear to be particularly effective prudential measures at mitigating the spillover effects of US monetary policy.

Our analysis provides novel empirical evidence on the interactions between monetary and prudential policy in a global context that complements existing analyses of the direct and indirect effects of prudential policies on macro-financial stability. Our main finding—that prudential policies can help to offset the spillover effects of US monetary policy, even when accounting for capital controls—indicates that prudential policies may be an important and useful tool for EM policymakers looking to gain monetary policy autonomy in the face of spillovers and the global financial cycle.

1 Introduction

Prudential policies—both micro and macro in nature—have been widely used to address financial stability concerns since the 2007-09 global financial crisis. Yet their effects are still debated. On the one hand, they are seen to contain risks and contribute to macroeconomic stability (Galati and Moessner, 2018); on the other, some have suggested they could harm macroeconomic activity (Sánchez and Röhn, 2016). We contribute to this debate from a novel angle, assessing the extent to which domestic prudential policies interact with the spillovers from foreign shocks.

This paper focuses specifically on prudential policies in emerging markets (EMs). EMs are often disproportionately hit by spillovers from shocks emanating from advanced economies (Bernanke, 2017) and their 'spillbacks' are a growing concern for developed countries (Carney, 2019). The sensitivity of EMs to foreign shocks is, in part, related to the well-documented 'global financial cycle' (Passari and Rey, 2015), characterised by a high degree of cross-border co-movement in capital flows, asset prices and credit growth in the world economy. The influence of US monetary policy on the global cycle (Miranda-Agrippino and Rey, 2019), alongside the dominant role of the US dollar in global trade and financial markets (Boz, Casas, Díez, Gopinath, Gourinchas, and Plagborg-Møller, 2019; Maggiori, Neiman, and Schreger, 2018), ensures that US monetary policy is a timeless concern amongst policymakers in EMs.

In the face of the global financial cycle, Rey (2015) argues that policymakers face a dilemma: domestic policymakers can pursue independent monetary policy if they have recourse to capital controls or prudential policies. In this paper, we assess whether domestic prudential policies are an effective tool for helping to offset the spillover effects of US monetary policy and, in turn, dampen the cyclical macro-financial fluctuations associated with it. In doing so, our analysis provides novel empirical evidence on the interactions between monetary and prudential policy in a global context, that complements existing analyses of the direct and indirect effects of direct prudential policies on macro-financial stability.

Specifically, we ask three questions. First, to what extent do EM prudential policies offset the spillover effects of US monetary policy? Second, which specific prudential policies are most effective at doing so? Third, to what extent do other factors in an EM influence the size of the interaction between domestic prudential policy and US monetary policy? Our questions are at the heart of contemporary policy debates, contributing to a broader assessment of the optimal policy mix for EMs facing external pressures. For instance, while Blanchard (2017) suggests that EMs are equipped with policy instruments to deal with foreign shocks, Rajan (2015) states that "macroprudential policies have little traction" against cross-border capital flows. Our paper contributes to this debate from a novel, but specific, angle, focusing exclusively on the extent to which prudential policies help to shield EMs against foreign monetary policy shocks, and accounts for other factors—such as capital controls—that could also reduce spillovers. While beyond the scope of this paper, a complete assessment of the appropriate EM policy mix should account for all the costs and benefits these policies could have—for instance, their direct and indirect effects on domestic real activity and financial stability.

Using a panel dataset summarising prudential policy actions in EMs, we show that the macro-financial spillovers from US monetary policy shocks differ depending on the prudential policies enacted by EMs. In particular, we find that an EM with tighter prudential policies faces significantly smaller reductions in total credit and bank credit—common indicators of financial (in)stability—following a US monetary policy tightening shock. A $+1$pp exogenous tightening of US monetary policy leads to around 7% fall in total credit and 5% fall in bank credit in EMs on average, after around 15 months. But an EM with an additional (a one standard deviation) prudential policy tightening action faces a substantially smaller spillover, facing reductions in total and bank credit of around 5.6% (3.5%) and 4% (2.5%), respectively. These results indicate that an additional (a one standard deviation) prudential policy tightening can offset the monetary policy spillover by around 20% (50%)—an economically significant amount—implying that national prudential policies help to offset some of the spillovers of US monetary policy by partially insulating an EM's financial sector against global financial market moves and limiting the cyclicality of credit growth and leverage.

Our empirical study builds on a long-standing literature quantifying the spillover effects of US monetary policy to EM economies. We extend a local projection-based empirical setup for monetary policy spillovers to study the interactions of US monetary policy with prudential policy in EMs. To attain unbiased estimates of coefficients of interest, we identify exogenous US monetary policy shocks via external instruments (Gürkaynak, Sack, and Swanson, 2005; Gertler and Karadi, 2015). To measure prudential policies, we use data spanning 64 countries, including 29 EMs, from 2000:Q1 to 2017:Q4 summarising prudential policy actions from Cerutti, Correa, Fiorentino, and Segalla (2017b). The dataset covers changes in several widely used prudential tools, with both micro- and macro-prudential objectives, specifically: capital buffers, loan-to-value (LTV) ratio limits, reserve requirements, interbank exposure limits, and concentration limits. Although the dataset captures prudential policy actions within a given quarter, we cumulate actions—over a two-year period in our baseline specification, and a one-year period in robustness analysis—to proxy the prudential policy actions relevant for monetary policy spillovers, accounting for implementation lags, activation lags, transmission lags and the persistence of policies. Importantly, our estimates for the interaction between US monetary policy spillovers and EM prudential policies are robust to the inclusion of potential competing explanations for the heterogeneous transmission of US monetary policy to EMs—including their degree of capital controls, exchange rate regime, housing market structure and measures of underlying country vulnerabilities.

Using the granularity of the prudential policy dataset, we find that LTV ratio limits and reserve requirements are particularly effective at partially mitigating the spillover effects of US monetary policy shocks, thereby dampening a country's exposure to cyclical fluctuations driven by US monetary policy. LTV ratio limits most strongly help to offset the response of EM house prices to US monetary policy shocks, reflecting their application to real estate transactions. Reserve requirements have a broad-based effect on credit.

Our analyses of the economic factors influencing the size of the policy interaction indicates regional differences. Latin American economies—which are both close to the US geographically and are highly dollarised—have prudential policies that most strongly offset the spillovers from US monetary policy, although regional differences are not statistically significant. We also find that prudential policies—especially LTV ratio limits—are particularly effective at dampening cyclical fluctuations in EMs with higher home ownership shares, while differences in the interaction appear more limited across fixed and floating exchange rate regimes.

The remainder of the paper is structured as follows. Following a short literature review, Section 2 describes the empirical specification and data. Section 3 briefly presents evidence on US monetary policy spillovers to EMs, placing our main results on policy interactions into context. Section 4 presents estimates of the interaction between EM prudential policies and US monetary policy. Section 5 discusses the economic determinants of the interaction, assessing the drivers of heterogeneity in policy interactions across countries. Section 6 concludes.

Related Literature There is a large literature studying the spillover effects of advanced economy shocks to EMs, much of which has focused on the effects of US monetary policy from both empirical (e.g. Banerjee et al., 2016; Rey, 2016; Bräuning and Ivashina, 2018; Iacoviello and Navarro, 2018) and theoretical (e.g. Akinci and Queralto, 2018) standpoints. Alongside this, a sizable literature has amassed studying the international spillover effects of prudential policies (e.g. Aiyar, Calomiris, Hooley, Korniyenko, and Wieladek, 2014; Berrospide, Correa, Goldberg, and Niepmann, 2017; Buch and Goldberg, 2017; Hills, Reinhardt, Sowerbutts, and Wieladek, 2017) and their potential unintended consequences (e.g. Ahnert, Forbes, Friedrich, and Reinhardt, 2018).

Our work contributes to a growing literature on interactions between monetary and prudential policies. Unlike our paper, much of this literature has focused on within-country policy interactions, with theoretical (e.g Angelini, Neri, and Panetta, 2014; Chen and Columba, 2016) and empirical (e.g. Bruno, Shim, and Shin, 2017) contributions.

In the context of contemporary debates around the optimal mix policy tools in EMs, these literatures complement our work in uncovering the numerous benefits and costs of prudential policies. Our work focuses on a specific benefit of prudential policy, namely helping to shield EMs against foreign shocks, primarily contributing to a comparatively limited literature studying cross-border interactions of monetary and prudential policies. Using BIS data on bilateral cross-border lending flows, Takats and Temesvary (2019a) find that macroprudential measures applied in emerging market economies prior to the 2013 'Taper Tantrum'—linked to US monetary policy—directly stabilised domestic financial systems and make cross-border bank lending flows less volatile. Concurrent work by Hills, Lloyd, Reinhardt, and Sowerbutts (2019) and Takats and Temesvary (2019b) studies the interaction of monetary and macroprudential policies via cross-border bank lending. Garcia-Lazaro, Ozkan, Puspitarasia, and Unsal (2019) provide complementary theoretical analyses. In comparison to this existing literature, the contribution of our paper is twofold. First, we focus on spillovers to macro-financial variables. Second, we consider a broad range of US monetary policy shocks and not just the US Taper Tantrum.

2 Empirical Specification

We use the local projection methodology (Jordà, 2005) to estimate the interaction of US monetary policy shocks with EM prudential policies. For our purposes, there are two major advantages to adopting a local projection setup relative to vector autoregressive methods. First, as we demonstrate, a standard local projections spillover framework can be parsimoniously extended to account for prudential policy interactions. Second, compared to alternative empirical specifications, the local projection setup is more robust to misspecification, a pertinent concern when studying the effect of various heterogeneous prudential policy instruments.

Monetary Policy Spillovers To provide context to our analysis of policy interactions, we first document some general features of US monetary policy spillovers to EMs. We model the impact of a US monetary policy shock in quarter t, $MP_t^{\$}$, on the variable of interest $y_{i,t+h}$ in country i at quarter $t+h$ using the following local projection specification:

$$y_{i,t+h} - y_{i,t-1} = \alpha^h + \beta_{mp}^h MP_t^{\$} + \boldsymbol{\gamma}^{h\prime}\mathbf{X}_{i,t-1} + \boldsymbol{\theta}^{h\prime}\mathbf{G}_{t-1} + f_i^h + \varepsilon_{i,t+h} \quad (1)$$

for $h = 0, 1, ..., H$. $\mathbf{X}_{i,t-1}$ is a $K \times 1$ vector of control variables known prior to the US monetary policy shock, with associated coefficients $\boldsymbol{\gamma}^h$. Country fixed effects f_i^h capture potentially confounding factors that are specific to countries, but fixed over time. Because the US monetary policy shock $MP_t^{\$}$ is the same for all countries, we cannot include time fixed effects in (1) as these would absorb all variation in the explanatory variable of interest. As a consequence, we account for variables summarising the global cycle in $\mathbf{G}_{t-1}$, a $J \times 1$ vector with associated coefficients $\boldsymbol{\theta}^h$. Assuming the conditional mean can be linearly approximated, β_{mp}^h measures the average effect of a period-t US monetary policy shock on $y_{i,t+h}$ at $t+h$.

We explore a range of dependent variables, primary amongst which are aggregate measures of financial stability in a country: total credit and bank credit. A large body of work has highlighted a role for credit growth as a leading indicator of financial crises (e.g. Schularick and Taylor, 2012), motivating our focus on these variables. In addition, we use data on house prices, as a number of prudential policies—such as LTV ratio limits—have been applied with a focus on housing sector risks. We include two lags of output growth, inflation and the dependent variable (quarterly changes) in the set of country-varying controls $\mathbf{X}_{i,t-1}$ to capture the prevailing macroeconomic state ahead of a US monetary policy innovation. The global controls $\mathbf{G}_{t-1}$ include two lags of US output growth, VIX and past US monetary policy shocks, reflecting global economic and financial conditions. Our macro-financial dataset spans 29 EMs, reflecting country coverage in the prudential policy actions dataset.[1]

[1]For reference, we also compare our monetary policy spillover findings to results from a panel of 35 advanced economies, also covered in the prudential policy actions dataset.

Interactions of Spillovers with Receiving-Country Prudential Policy The monetary policy spillover regression marks the point of departure for our empirical specification. To analyse how prudential policies in EMs interact with spillovers from US monetary policy shocks we adapt (1) to account for country-i prudential policy $Pru_{i,t}$ using the following setup:

$$\begin{aligned} y_{i,t+h} - y_{i,t-1} =& \alpha^h + \delta^h \left(MP_t^{\$} \times Pru_{i,t-1} \right) + \beta^h_{pru} Pru_{i,t-1} + \boldsymbol{\gamma}^{h\prime} \mathbf{X}_{i,t-1} \\ &+ \boldsymbol{\theta}^{h\prime} \boldsymbol{\Gamma}_{i,t-1} + \boldsymbol{\vartheta}^{h\prime} \left(MP_t^{\$} \times \boldsymbol{\Gamma}_{i,t-1} \right) + f_i^h + f_t^h + \varepsilon_{i,t+h} \end{aligned} \quad (2)$$

where $Pru_{i,t-1}$ represents an indicator of prudential actions, taking positive values for a (net) tightening and negative for a (net) loosening. In comparison to (1), we include time fixed effects f_t^h to account for potentially confounding factors that are the same for all countries in a given time period—for example, the state of the global financial cycle. Because the time fixed effects f_t^h account for all observed *and* unobserved global factors that vary over time, we exclude $\mathbf{G}_{t-1}$ from (2).[2]

Our controls $\mathbf{X}_{i,t-1}$, which vary by time *and* country, are the same as in (1). In robustness analyses, we extend the controls to include other factors that could plausibly interact with US monetary policy spillovers, aside from prudential policies, in order to rule out competing hypotheses. To account for them, we define a $\boldsymbol{\Gamma}_{i,t-1}$ as a (set of), possibly time-varying, country characteristic(s) that could potentially influence the size of US monetary policy spillovers to EMs—such as a country's capital controls. We then include the interaction of this variable with the contemporaneous US monetary policy shock, $MP_t^{\$} \times \boldsymbol{\Gamma}_{i,t-1}$, in addition to its lagged level $\boldsymbol{\Gamma}_{i,t-1}$ in our set of time- and country-varying controls $\mathbf{X}_{i,t-1}$.[3]

The time fixed effects f_t^h also absorb all variation in $MP_t^{\$}$, explaining why this is not in (2). Nevertheless, the *sign* of coefficient estimates from (1) can help to interpret results from (2).[4] The coefficient of interest in the latter, capturing policy interactions, is δ^h. If, for a given

[2]Because the time fixed effects f_t^h capture all observed and unobserved time-varying factors, (2) is our preferred specification for statistical inference. However, to illustrate the *economic significance* of our findings and compare monetary policy spillovers with prudential policy interactions—i.e. $\hat{\beta}^h_{mp}$ and $\hat{\delta}^h$—we also estimate a hybrid specification of (1) and (2) that includes the monetary policy term $MP_t^{\$}$, its interaction with lagged prudential policy $MP_t^{\$} \times Pru_{i,t-1}$ and lagged observed global factors $\mathbf{G}_{t-1}$, but excludes time fixed effects f_t^h to avoid absorbing variation in $MP_t^{\$}$.

[3]In some cases, we classify the variable using an indicator variable. To do this, we define a (potentially) time-varying indicator variable $\mathbb{1}_{g,i,t-1} \equiv \mathbb{1}\left[\boldsymbol{\Gamma}_{i,t-1} \in g\right]$ where $\mathbb{1}$ is an indicator function equal to 1 if the country characteristic falls into a particular 'bin' of the distribution, a country's group $g = 1, ..., G$.

[4]A direct quantitative comparison of coefficients from (1) and (2) is not possible, because the former specification excludes time fixed effects f_t^h while the latter includes them.

dependent variable $y_{i,t+h}$, monetary policy spillovers are negative $\hat{\beta}^h_{mp} < 0$, then a positive interaction coefficient $\hat{\delta}^h > 0$ implies that tighter prudential policy helps to *offset* some of the negative spillover effects of a US monetary policy tightening. In contrast, if the interaction coefficient is negative $\hat{\delta}^h < 0$, tighter prudential policy *does not mitigate* the negative spillover effects of tighter US monetary policy.[5] The sequence $\{\hat{\delta}^h\}_{h=0}^H$ can thus be interpreted as the average interactions associated with a US monetary policy impulse at time t.

Importantly, we include prudential policy with a lag in (2) to avoid accounting for policy actions that could possibly occur *in response* to a US monetary policy shock, or simultaneity of economic conditions and domestic prudential policy. By using lagged prudential policy, we explicitly assess whether prudential policy actions, in advance of a US monetary policy innovation, can help to offset some of the spillovers effects of the centre country monetary policy driving the global financial cycle.

Assessing the Determinants of Interactions Regression (2) captures the average interaction between US monetary policy and EM prudential policy, but suppresses potential cross-country heterogeneity in the interaction by imposing $\delta^h_i = \delta^h$ for all i. To account for this in an economically meaningful way, we estimate an extended local projection regression. To do so, we define $\mathbf{Z}_{i,t-1}$ as a (set of) country characteristic(s) that could potentially influence the size of the interaction, such as the exchange rate regime or home ownership share in a country. We define a (potentially) time-varying indicator variable $\mathbb{1}_{g,i,t-1} \equiv \mathbb{1}\left[\mathbf{Z}_{i,t-1} \in g\right]$ where $\mathbb{1}$ is an indicator function taking a value of 1 if the country characteristic falls into a particular 'bin' of the distribution, which we denote as a country's group $g = 1, ..., G$. The general form for this extended specification is:

$$
\begin{aligned}
y_{i,t+h} - y_{i,t-1} = & \sum_{g=1}^{G} \alpha^h_g \cdot \mathbb{1}_{g,i,t-1} + \sum_{g=1}^{G} \delta^h_g \left(MP^{\$}_t \times Pru_{i,t-1} \times \mathbb{1}_{g,i,t-1} \right) \\
& + \sum_{g=1}^{G} \tilde{\beta}^h_{mp,g} \left(MP^{\$}_t \times \mathbb{1}_{g,t-1} \right) + \sum_{g=1}^{G} \beta^h_{pru,g} \left(Pru_{i,t-1} \times \mathbb{1}_{g,i,t-1} \right) \\
& + \boldsymbol{\gamma}^{h\prime} \mathbf{X}_{i,t-1} + f^h_i + f^h_t + \varepsilon_{i,t+h} \qquad (3)
\end{aligned}
$$

[5]The reverse is true if the US monetary policy spillover is positive $\hat{\beta}^h_{mp} > 0$. Then, a negative interaction coefficient $\hat{\delta}^h < 0$ reflects an offsetting policy interaction, and a positive coefficient $\hat{\delta}^h > 0$ a non-offsetting one.

By accounting for country characteristics in this way, we estimate separate interaction coefficients δ_g^h for each group $g = 1, ..., G$, non-parametrically capturing potential cross-country heterogeneity in policy interactions.[6]

Importantly, (3) includes a term for the interaction of the monetary policy shock with the indicator variable $\left(MP_t^{\$} \times \mathbb{1}_{g,i,t-1}\right)$, with associated coefficient $\tilde{\beta}_{mp,g}^h$, reflecting the fact that the product of the monetary policy innovation and the indicator variable can vary along both country and time-dimensions, so is not fully absorbed by time fixed effects.

In all regressions, we use Driscoll and Kraay (1998) standard errors to account for potential cross-sectional and temporal dependence in inference, and impulse responses are reported out to a two-year horizon—i.e. $H = 8$.

2.1 Prudential Policy Data

We use the prudential policy actions dataset of Cerutti et al. (2017b), constructed for the cross-country International Banking Research Network (IBRN) project on cross-border spillovers of prudential policy (Buch and Goldberg, 2017). The dataset spans 64 countries, including the same 29 EMs in our panel of macro-financial data.[7] The prudential policy data is quarterly, from 2000:Q1 to 2017:Q4,[8] and covers five types of prudential policy instruments with both micro- and macro-prudential objectives: capital requirements; interbank exposure limits; concentration limits; LTV ratio limits; and reserve requirements. The dataset further breaks down some of these categories, differentiating general capital requirements—which predominantly reflect convergence to Basel Accords—from sectoral capital buffers—such as risk weights on specific bank exposures—as well as the currency breakdown of reserve requirements. The availability of prudential policy data defines the beginning of our sample period. With forward lags in our local projection setup, we use macro-financial data up to 2018:Q2 on the left-hand side of our regressions.

The Cerutti et al. (2017b) dataset has been constructed from a range of sources, and observations in the database were reviewed by staff from national central banks.[9] The raw dataset

[6]Because $\mathbb{1}_{g,i,t-1}$ is time and country-varying, the product of the indicator with monetary and prudential policy measures also varies across time and countries, ensuring the time fixed effect f_t^h remains well-defined in this specification.

[7]The 29 EMs in our dataset span 11 Asian economies, 8 in Europe, 7 in Latin America and 3 in Africa.

[8]The Cerutti et al. (2017b) dataset has recently been extended by its authors, from a 2014:Q4 end date to 2017:Q4.

[9]The database builds on existing information in Cerutti, Claessens, and Laeven (2017a) which covers a smaller set of macroprudential policy instruments in 125 countries, as well as secondary sources compiled by Lim et al. (2011), Akinci and Olmstead-Rumsey (2015), and Reinhardt and Sowerbutts (2015).

measures *changes* in prudential policy instruments within a quarter, assigning a value of $+1$ to a given prudential policy if it was tightened in a specific quarter, a value of -1 if it was loosened, and 0 if no change occurred. For some policy instruments, information about the *intensity* of the policy change is retained. For example, for sectoral capital requirements and reserve requirements, indices ranging from -3 to 5 reflect the intensity of policy changes.

To suit our study, we manipulate the raw dataset in the following ways. First, we sum prudential policy actions over a number of quarters, reflecting the fact that changes in prudential polices in a single quarter are unlikely to solely influence the spillovers from US monetary policy shocks accounting for potential implementation lags, activation lags, transmission lags, and the persistence and level of prudential policies. In our baseline formulation we sum actions over two years such that the prudential policy measure at time $t-1$, $Pru_{i,t-1}$, includes information on all prudential policy changes from $t-8$ to $t-1$, inclusive. The choice of a two-year summation period in our baseline specification balances a compromise. On the one hand, we need a long enough summation period to capture sufficient variation in prudential policy measures over time, as well as proxy aspects of cross-country differences in their level. On the other hand, we need to ensure that the summation period is not too long such that it suppresses variation in the prudential measure because of policy reversals over time. Importantly, we assess the robustness of our results to different cumulation periods. We report the results of this analysis in Appendix B.4, where we show that our main results are quantitatively robust to a shorter one-year summation period for prudential policy. This indicates that even prudential policies announced just before a foreign shock can help to lessen the spillovers it generates for EMs, implying that activating prudential measures is never too late to help offset potential spillovers from center countries.

Second, we construct measures of *aggregate* prudential policy, by summing cumulated measures of different instruments. Our baseline measure of aggregate prudential policy actions includes all prudential policy instruments in the Cerutti et al. (2017b) dataset, with the exception of general capital requirements in line with Takats and Temesvary (2019a). Like Takats and Temesvary (2019a), we primarily exclude general capital requirements because they reflect microprudential policy adjustment, such that the remaining instruments in the proxy more closely match macroprudential measures.[10] In addition, Takats and Temesvary (2019a) men-

[10]We show that our headline results are robust to the inclusion of general capital requirements in the aggregate prudential policy measure in Appendix B.3.

Table 1: Summary statistics for prudential policy proxies constructed by cumulating actions over a two-year period

Prudential Policy Measure	# Obs.	$\overline{Pru}_{i,t}$	$\sigma\left(Pru_{i,t}\right)$	$\min\left(Pru_{i,t}\right)$	$\max\left(Pru_{i,t}\right)$
Aggregate Proxy	1885	0.255	2.517	-9	11
Specific Prudential Instruments					
Reserve Requirements	1885	0.048	2.179	-9	11
LTV Ratio Limits	639	0.078	0.834	-3	5
Sectoral Capital Buffers	1885	0.100	0.675	-3	4
Concentration Ratio Limits	1272	0.078	0.371	-1	2
Interbank Exposure Limits	611	0.083	0.283	-1	1

Note: Statistics constructed by pooling observations across the 29 EMs and over full sample period.

tion that these general capital requirements largely reflect the adoption of the Basel III regime, an internationally harmonised and broadly anticipated move resulting in limited cross-country variation in the specific series[11], mostly capturing differences in prudential regulation.

Our aggregate prudential policy measure includes reserve requirements, including those levied on both domestic and foreign currency-denominated deposits. Although reserve requirements have been used as instruments to conduct monetary policy in some jurisdictions, Cordella, Federico, Vegh, and Vuletin (2014) note that these policies have predominantly recently been used as countercyclical macroprudential tools in EMs. Cerutti et al. (2017b) account for this in the construction of their dataset, ensuring that the reserve requirements they capture are used to satisfy prudential objectives within a country, warranting their inclusion in our aggregate prudential policy proxy.

We also present analyses using cumulated measures of specific prudential policies, to isolate their differential impacts across dependent variables.

Table 1 presents summary statistics for our two-year cumulated prudential policy proxies, constructed by pooling observations across the 29 EMs in our dataset and over the full sample.[12] Over the sample, all policy proxies—aggregate and specific—were, on average and on net, tightened. Nevertheless, all measures take a range of positive and negative values, with the aggregate prudential policy measure varying from -9 to 11 with a standard deviation of around 2.5. In our sample of 29 EMs, reserve requirements and, to a lesser extent, LTV ratio limits are the most actively used measures, with the widest range and standard deviation.

[11]Our aggregated measure still includes sectoral capital requirements, for instance those levied on real estate or consumer credit.

[12]See Appendix A.2 for additional details and summary statistics on the prudential policy dataset.

2.2 Monetary Policy Shocks

A key concern for our analysis is that our measure of US monetary policy $MP_t^{\$}$ is exogenous in order to attain unbiased estimates of the parameters of interest. This prevents us from using raw measures of US interest (or shadow) rates to capture changes in US monetary policy. Of particular concern in our setting are potentially omitted factors, such as a global financial moves, that could simultaneously affect the US monetary policy stance as well as macro-financial outcomes in EMs, especially if they have heterogeneous effects across EMs.

Drawing on an extensive literature, we identify monetary policy shocks with the widely used external instruments VAR approach of Mertens and Ravn (2013) and Stock and Watson (2018), applied to US monetary policy by Gertler and Karadi (2015). Relative to Gertler and Karadi (2015), we make one change to our VAR specification: estimating it with data up to the end of 2018 (instead of 2012).[13] Like Gertler and Karadi (2015), our VAR consists of four monthly frequency US variables: industrial production, the consumer price index, the 1-year zero-coupon government bond yield, and the excess bond premium (Gilchrist and Zakrajsek, 2012). We estimate the model with 12 lags of monthly variables, using monthly data from 1979 to 2018. We construct quarterly monetary policy shocks from the monthly VAR, by cumulating monthly shocks within the quarter. To identify a monetary policy shock, we use high-frequency monetary policy surprise measures from Gürkaynak et al. (2005)—changes in monetary policy expectations in a short time window (30 minutes) around Federal Open Market Committee (FOMC) announcements—as instruments for the reduced-form monetary policy innovation. The key identifying assumption is that no other potentially confounding events, which could simultaneously drive private sector behavior and the monetary policy decision, can occur within the short time window around the FOMC announcements. Despite the sample extension, our instrument—changes in the three-month-ahead federal funds futures rate in 30-minute windows around FOMC announcements—continues to pass tests for instrument validity, with a first-stage F-statistic in excess of 10.

3 Monetary Policy Spillovers

To contextualise our estimates of prudential policy interactions, we first estimate the spillover effects of US monetary policy to EMs using (1). Figure 1 presents estimates of the spillover

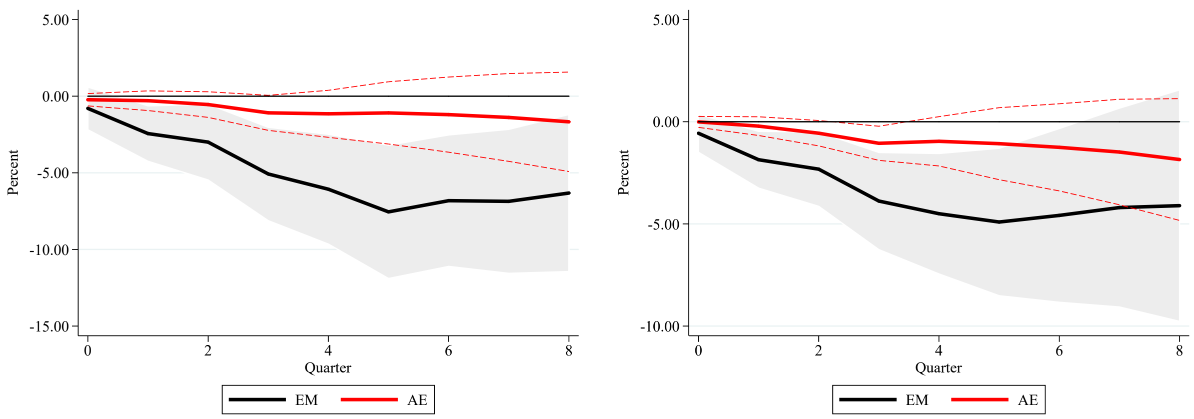
[13] Additional detail on our monetary policy shocks is provided in Appendix A.3.

coefficient for (log) total credit and (log) bank credit in EMs. For comparison, we also plot the impulse response of the two variables to the US monetary policy shock in a group of 34 advanced economies, which exclude the US. The coefficient estimates can be interpreted as average impulse responses to a +1pp US monetary policy tightening shock in the two groups.

Two observations are noteworthy. First, in line with a large body of literature, a US monetary policy tightening is associated with a financial tightening abroad. Total credit falls significantly in EMs, and bank credit falls significantly in both advanced and emerging economies, within two years of a US monetary policy shock. Second, EMs are disproportionately negatively affected by a US monetary policy tightening, in comparison to advanced economies. Total credit in EMs falls by significantly more than in advanced economies. As well as being statistically significant, the difference is economically significant: the average fall in EM bank credit after a +1pp US monetary policy tightening shock is substantially larger than the corresponding average impact for advanced economies.

Figure 2 plots spillover coefficient estimates for (log) house prices. The point estimate for spillovers to EMs is negative at all horizons. A US monetary policy tightening is associated, on average, with a reduction in house prices, albeit smaller than the responses of total credit and bank credit. Although the point estimates are statistically insignificant, the wide confidence bands, in part, reflect heterogeneity across emerging markets. The heterogeneity in spillovers

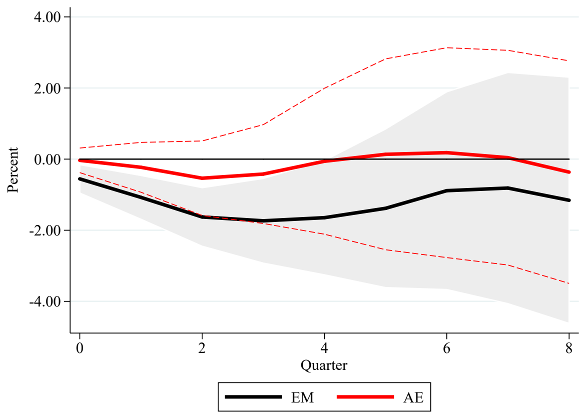
Figure 1: US monetary policy spillovers to total credit and bank credit in emerging markets and advanced economies



Notes: $\{\beta^h_{mp}\}^8_{h=0}$ estimates with (log) total credit (left-hand side) and (log) bank credit (right-hand side) for 29 emerging markets ('EM'; black) and 34 advanced economies ('AE'; excluding US, red) as dependent variable (regression (1)). The classification of advanced and emerging economies is from the IMF's World Economic Outlook. The gray shaded area and the red-dashed lines denotes 90% confidence intervals around point estimates for emerging and advanced economies, respectively, constructed from Driscoll and Kraay (1998) standard errors.

to emerging markets is well known. Iacoviello and Navarro (2018), for example, assess how the effects of higher US interest rates on EMs differ depending on an economy's exchange rate, trade openness and vulnerability. In this paper, we assess a policy-relevant dimension of US monetary policy spillover variation in EMs: prudential policy.

Figure 2: US monetary policy spillovers to house prices in emerging markets and advanced economies



Notes: $\{\beta^h_{mp}\}^8_{h=0}$ estimates with (log) house prices for 29 emerging markets ('EM'; black) and 34 advanced economies ('AE'; excluding US, red) as dependent variable (regression (1)). The classification of advanced and emerging economies is from the IMF's World Economic Outlook. The gray shaded area and the red-dashed lines denotes 90% confidence intervals around point estimates for emerging and advanced economies, respectively, constructed from Driscoll and Kraay (1998) standard errors.

4 Prudential Policy Interactions

To assess how the prudential policies in EMs interact with the spillovers from US monetary policy, we estimate (2) using different prudential policy measures $Pru_{i,t-1}$.

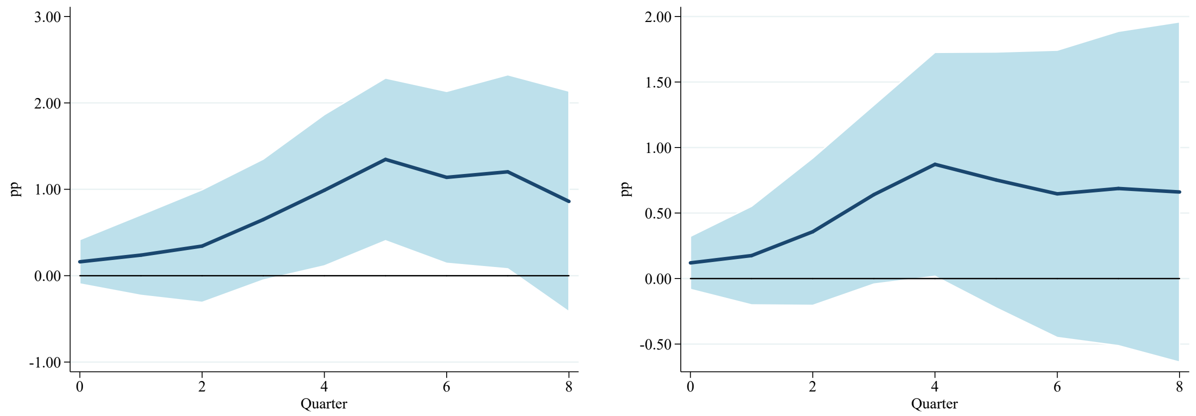
4.1 Aggregate Prudential Policy

We first study the interaction of US monetary policy with our measure *aggregate* EM prudential policy, including all prudential policy indicators in the Cerutti et al. (2017b) dataset with the exception of general capital requirements.

Figure 3 presents estimates of the sequence of interaction coefficients $\{\hat{\delta}^h\}^8_{h=0}$ from (2) with EM (log) total credit and (log) bank credit as dependent variables.[14] The plots show that the

[14]For house prices, the interaction coefficient with respect to the aggregate prudential policy proxy is insignifi-

Figure 3: Interaction of US monetary policy spillovers with aggregate prudential policy measures in recipient emerging markets for total credit and bank credit



Notes: $\{\delta^h\}_{h=0}^{8}$ estimates with (log) total credit (left-hand side) and (log) bank credit (right-hand side) for 29 emerging markets as dependent variable (regression (2)). The light blue shaded area denotes the 90% confidence interval around point estimates, constructed from Driscoll and Kraay (1998) standard errors. The aggregate prudential policy measure is defined as the two-year cumulated sum of all prudential policy actions, excluding aggregate capital requirements, in the Cerutti et al. (2017b) dataset.

interaction coefficient is significantly positive around the 12 to 21-month ($h = 4$ to 7) horizon when total credit is the dependent variable. The point estimates of the coefficient for bank credit are positive at all horizons too, significantly so at $h = 4$. The coefficients have the following interpretation: controlling for time fixed effects, an additional prudential policy tightening in an EM in advance of a +1pp US monetary policy tightening can, on average, reduce the total credit hit from the US monetary policy tightening by around 1.4pp over a 15-month horizon ($h = 5$).

Using our proxies for *aggregate* prudential policy, we do not uncover significantly positive interaction coefficients for house prices, CPI and real GDP in EMs. However, as we discuss in the next sub-section, we do find that the interaction effects of *specific* prudential policy instruments can significantly feed through to macro-financial outcomes—house prices in particular.

Nevertheless, our findings for aggregate prudential policy alone have important policy implications for EMs. In the face of spillovers from US monetary policy and the associated global financial cycle, our results indicate that EMs can rely on prudential policies to significantly reduce the extent to which US monetary policy drives cyclical fluctuations in credit conditions. Following an unexpected US monetary policy tightening, EMs with tighter prudential policy face smaller falls in total lending, consistent with their financial sector being better placed to

cantly different from zero at all horizons.

absorb the adverse spillovers tighter US monetary policy due to domestic prudential policies.

Competing Hypotheses To assess the robustness of our headline findings, we extend (2) to account for other factors $\mathbf{\Gamma}_{i,t-1}$ that could possibly interact with the US monetary policy spillovers to EMs that are distinct from prudential policy. Table 2 documents the results of robustness analyses, presenting estimates of the interaction coefficient δ^h for spillovers to total credit when additional interactions $MP_t^{\$} \times \mathbf{\Gamma}_{i,t-1}$ (and $\mathbf{\Gamma}_{i,t-1}$ alone) are included in the set of controls $\mathbf{X}_{i,t-1}$. For reference, column (1) reports the $\hat{\delta}^h$ estimates from the baseline specification, plotted in figure 3 (left-hand side).

In columns (2) and (3), we extend the regression specification to include interactions between the US monetary policy shock and countries' lagged capital flow restrictiveness—i.e. $MP_t^{\$} \times KC_{i,t-1}$ and $KC_{i,t-1}$ are included in the set of time and country-varying controls $\mathbf{X}_{i,t-1}$, where $KC_{i,t-1}$ is a measure of capital controls in country i at time $t-1$. This is an important robustness test because, like prudential policies, capital controls may help to mitigate the spillovers from foreign shocks by limiting cross-border flows. By accounting for this interaction independently, we assuage worries that our results could simply reflect the effects of, potentially correlated, capital flow restrictions. To measure capital flows in our set of EMs, we use the index of Fernández, Klein, Rebucci, Schindler, and Uribe (2016).[15] In column (2), we use a measure of overall capital controls, spanning restrictions on inflows and outflows of a range of asset categories. In column (3), our measure of capital controls is focused on inflow restrictions, again spanning a range of asset categories.

Importantly, although the inclusion of an additional capital control interaction reduces the absolute size of our $\hat{\delta}^h$ estimates at all horizons relative to the baseline in column (1), the interaction coefficient estimates remain statistically significant at (at least) the 5-quarter horizon. The coefficient estimates in columns (2) and (3) indicate that, once controlling for capital flow restrictiveness, an additional tightening of prudential policy in an EM in advance of a $+1$pp US monetary policy tightening can, on average, reduce the hit to total credit from the shock by around 1pp after one year.[16]

In columns (4)-(6), we add alternative interaction time and country-varying variables. In column (4), we additionally allow US monetary policy shocks to interact with the level of

[15] This index is measured at an annual frequency. We translate to quarterly frequency by assuming the index value for the calendar year is maintained in each quarter.

[16] We present the capital flow interaction coefficients—i.e. the coefficients on $MP_t^{\$} \times KC_{i,t-1}$—in Appendix B.2.

Table 2: Interaction coefficient estimates $\hat{\delta}^h$ from regression (2) for total credit using aggregate prudential policy measures, which exclude aggregate capital requirements, in recipient emerging markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Additional Interaction Variables					
	Baseline	Capital Control	Capital Inflow Control	Credit-to-GDP Growth	FX Regime	Home Own. Share	Country FE
$MP_t^{\$} \times Pru_{i,t-1}$							
$h = 0$	0.16	0.09	0.10	0.11	0.10	0.17	0.12
	(0.16)	(0.17)	(0.16)	(0.16)	(0.14)	(0.15)	(0.10)
$h = 1$	0.24	0.07	0.11	0.12	0.25	0.26	0.31
	(0.28)	(0.27)	(0.27)	(0.29)	(0.25)	(0.28)	(0.23)
$h = 2$	0.34	0.10	0.15	0.18	0.38	0.37	0.40
	(0.40)	(0.37)	(0.37)	(0.40)	(0.35)	(0.39)	(0.31)
$h = 3$	0.65	0.42	0.45	0.45	0.79**	0.67	0.60
	(0.43)	(0.39)	(0.39)	(0.38)	(0.39)	(0.41)	(0.36)
$h = 4$	0.99*	0.74	0.76	0.79*	1.09**	0.98*	0.81*
	(0.53)	(0.51)	(0.50)	(0.47)	(0.50)	(0.52)	(0.44)
$h = 5$	1.35**	1.02**	1.06**	1.12**	1.52***	1.36**	1.47***
	(0.57)	(0.49)	(0.52)	(0.54)	(0.52)	(0.56)	(0.52)
$h = 6$	1.14*	0.86*	0.90	0.90	1.27**	1.14*	1.32**
	(0.60)	(0.51)	(0.55)	(0.58)	(0.54)	(0.59)	(0.61)
$h = 7$	1.20*	0.90	0.95	0.92	1.37**	1.22*	1.68**
	(0.68)	(0.57)	(0.62)	(0.65)	(0.63)	(0.67)	(0.73)
$h = 8$	0.86	0.57	0.59	0.56	0.91	0.84	0.89
	(0.78)	(0.73)	(0.75)	(0.73)	(0.73)	(0.77)	(0.85)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE $\times MP_t^{\$}$	NO	NO	NO	NO	NO	NO	YES

Notes: $\hat{\delta}^h$, for $h = 1, ..., 8$, coefficient estimates from various specifications of (2) designed to account for other potential interactors with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

lagged credit-to-GDP growth in country i. Column (5) includes an interaction between US monetary policy and the *de facto* exchange rate regime of the emerging market (Ilzetzki, Reinhart, and Rogoff, 2019). By accounting for this, the peak prudential policy interaction coefficient increases in size and significance, indicating that the exchange rate regime, indicating that the exchange rate regime is an important dimension of heterogeneity in monetary policy spillovers. Column (6) accounts for the role of home ownership in the interaction, defined as an indicator variable equal to 1 if a country's home ownership share exceeds the cross-country median of 70%, and 0 otherwise.[17] In all cases, the alternative interaction term reflects a dimension of

[17] Home ownership share data is from HOFINET and measures average home ownership rates in each country

a country's vulnerability to foreign shocks, distinct from prudential policy and the continued positive and statistically significant coefficient, on $MP_t^{\$} \times Pru_{i,t-1}$, at the four and five-quarter horizons at least, validates our main result.

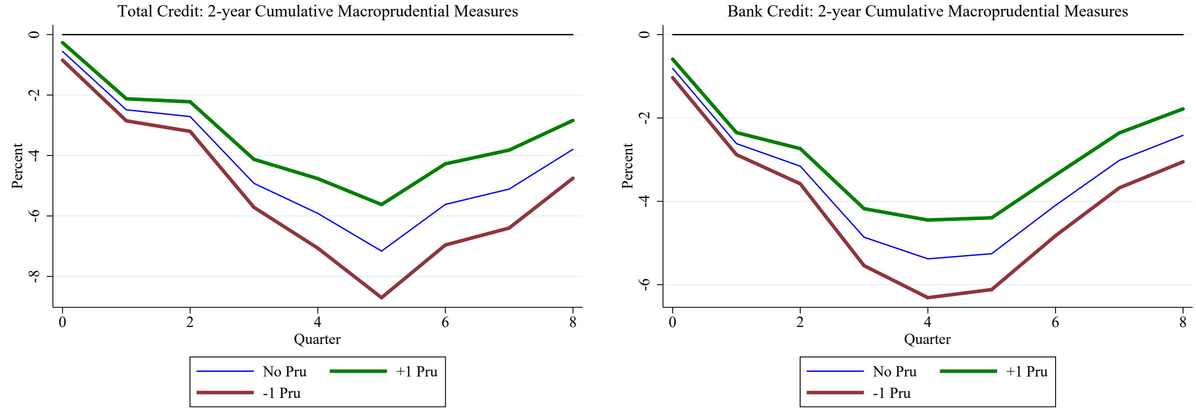
In column (7), we further extend the regression specification to include interactions between the US monetary policy shock and the country fixed effects—i.e. $MP_t^{\$} \times f_i^h$ is included in the set of time and country-varying controls $\mathbf{X}_{i,t-1}$. This extension accounts for the possibility that country-specific, non-time-varying, factors could also interact with spillovers from US monetary policy aside from prudential policies. These factors are likely to capture persistent country-specific vulnerabilities, including structural imbalances, debt levels and institutional features. The fact the interaction coefficient estimate remains positive and statistically significant across these various robustness interactions, supports our main conclusion.

Economic Significance Direct comparison of coefficient estimates from (1) and (2) is not possible as the latter includes time fixed effects f_t^h, while the former does not. To illustrate the economic significance of our headline results, we estimate a hybrid version of (2) that includes the monetary policy variable $MP_t^{\$}$ as an additional explanatory variable and, in order to do so, omits time fixed effects f_t^h. To replace the fixed effects, we add observed time-varying global control variables $\mathbf{G}_{t-1}$ to the regression specification. This enables concurrent estimation of the direct average spillover effect of US monetary policy to EMs β_{mp}^h and the interaction coefficient with domestic prudential policy δ^h. Because we omit time fixed effects, we do not rely on this hybrid specification for inference, instead we use it to compare the two coefficients to gauge the economic significance of our findings.

Figure 4 illustrates how the estimated spillover from a $+1$pp US monetary policy tightening varies depending on the lagged aggregate prudential policy actions carried out in an EM. Here the prudential policy measure sums all two-year cumulated actions in the Cerutti et al. (2017b) dataset. The blue line plots the estimated spillover to an EM with zero net prudential policy actions, $Pru_{i,t-1} = 0$, indicating that a $+1$pp exogenous tightening of US monetary policy leads to around a 7% fall in total credit and 5% fall in bank credit in such EMs after around 12 to 18 months. An EM with an additional prudential policy tightening action, $Pru_{i,t-1} = 1$, is estimated to face a substantially smaller spillover. The peak spillover of a US monetary policy tightening shock in this EM to total credit is around 5.6% and to bank credit around

over the 2005-2014 period.

Figure 4: US monetary policy spillovers to total credit and bank credit for different levels of aggregate prudential policy in recipient emerging markets



Notes: $\{\beta^h_{mp} + \delta^h\}^8_{h=0}$ estimates with (log) total credit (left-hand side) and (log) bank credit (right-hand side) for 29 emerging markets as dependent variable in hybrid version of regression (2) that excludes time fixed effects f^h_t, but includes US monetary policy measure $MP^\$_t$ and lagged global controls $\mathbf{G}_{t-1}$. The aggregate prudential policy measure is defined as the two-year cumulated sum of all prudential policy actions, excluding aggregate capital requirements, in the Cerutti et al. (2017b) dataset. The blue line denotes estimated spillover from a 1pp US monetary policy tightening shock to an EM with a 0 value for prudential policy. The green line denotes the comparable spillover estimate for an EM with a $+1$ prudential policy action—i.e. on net, one additional policy tightening. The red line denotes the opposite spillover, for an EM with a -1 prudential policy action.

4%, indicating that an additional prudential policy tightening can offset the monetary policy spillover by around 20%.

In the context of a the summary statistics presented in table 1, this figure can be scaled by the standard deviation of the aggregate prudential policy proxy (2.5). In this case, the peak spillover of a US monetary policy tightening shock to an illustrative EM with a prudential policy setting one standard deviation above the mean would be around 3.5% and 2.5% to total and bank credit, respectively. A one standard deviation tightening is then associated with a spillover reduction of around 50%.

4.2 Specific Prudential Policy Instruments

In this sub-section, we explore the interaction of US monetary policy with *specific* prudential policies in EMs. Within the Cerutti et al. (2017b) dataset, we are able to investigate interactions with five categories of prudential policies: (i) LTV ratio limits, (ii) reserve requirements, (iii) (sectoral) capital buffers, (iv) interbank exposure limits, and (v) concentration ratio limits. This classification is particularly interesting in light of the distinction between prudential policy instruments that 'dampen the cycle'—(i) and (ii), in particular—and those that 'increase resilience'—(iii)-(v)—laid out in Borio (2010) and Claessens et al. (2013).

Within our framework we find that, consistent with the view that US monetary policy is a driver of global cyclical fluctuations, LTV ratio limits and reserve requirements significantly interact with US monetary policy spillovers, while we do not find evidence of a significant interaction for sectoral capital requirements, interbank exposure limits and concentration ratio caps—the latter two of which were used to a limited extent by EMs in our sample. Our results provide a novel test of this classification, externally validating the separation of instruments that predominantly dampen the cycle, versus those that increase resilience.

4.2.1 Loan-to-Value Ratio Limits

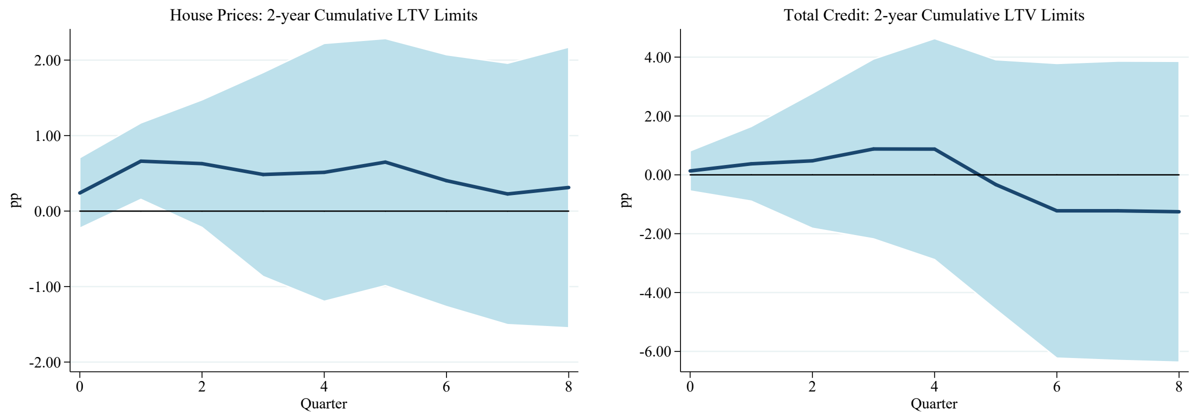
LTV ratio limits restrict the maximum amount an individual or firm can borrow against their collateral. These restrictions are most commonly applied to real estate transactions and the Cerutti et al. (2017b) dataset focuses on this aspect. As a consequence, we assess the interaction of LTV ratio limits with US monetary policy spillovers with the hypothesis that the policy should significantly reduce cyclical fluctuations in house prices.

Using the two-year cumulated LTV ratio limit indices as the prudential policy measure in regression 2, figure 5 presents the interaction coefficients for house prices and total credit.[18] The results for house prices, in the left-hand side of the figure, accord with our hypothesis. LTV ratio limits are associated with smaller cyclical fluctuations in house prices in EMs following innovations to US monetary policy.

However, the interaction effect for total credit (right-hand side), and also bank credit, is insignificantly different from zero at all horizons. This result is perhaps not surprising: in a market, like the housing market, with an inelastic short-run supply curve, the majority of adjustment in response to cyclical fluctuations must occur in prices and not quantities. Studying the direct effects of LTV ratio limits, Akinci and Olmstead-Rumsey (2015) and Richter, Schularick, and Shim (2018) find that changes in LTV limits do not have significant effects on total credit quantities.

[18] See Appendix B.5 for additional robustness analyses.

Figure 5: Interaction of US monetary policy spillovers with loan-to-value ratio limits in recipient emerging markets for house prices and total credit



Notes: $\{\delta^h_{mp}\}^8_{h=0}$ estimates with (log) house prices (left-hand side) and (log) total credit (right-hand side) for 29 emerging markets as dependent variable (regression (2)). The light blue shaded area denotes the 90% confidence interval around point estimates, constructed from Driscoll and Kraay (1998) standard errors. The prudential policy measure is defined as the two-year cumulated sum of loan-to-value ratio limits in the Cerutti et al. (2017b) dataset.

4.2.2 Reserve Requirements

Within the Cerutti et al. (2017b) dataset, reserve requirements encompass all changes imposed on deposit accounts denominated in both domestic and foreign currency with prudential policy objectives. Given their broad application, we estimate (2) with the two-year cumulated reserve requirement indices, hypothesising that these policies should significantly interact with US monetary policy spillovers for both total credit and bank credit.

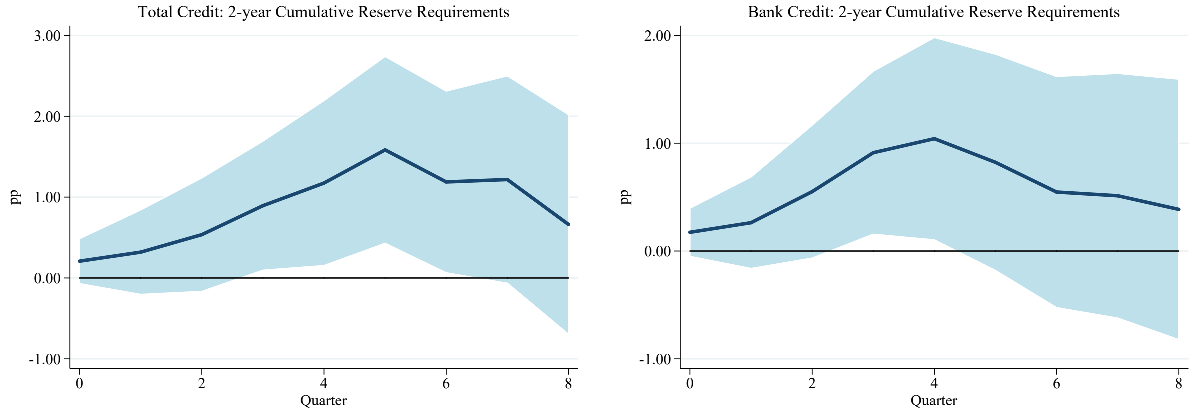
Figure 6 presents the interaction coefficient estimates at different horizons for total credit and bank credit.[19] In line with our hypothesis, the estimates are significantly positive at a range of horizons, indicating that reserve requirements can help to offset the spillover effects of US monetary policy shocks in EMs.[20]

Taken together, the results in this section suggest that two subsets of prudential policies instruments—specifically LTV ratio limits and reserve requirements—are particularly effective at offsetting the spillover effects of US monetary policies and dampening a country's exposure to the associated global credit cycle. This is an important mechanism through which Borio (2010) and Claessens et al. (2013) identify these prudential policies to be effectively used by

[19]For house prices, the interaction coefficient with respect to the reserve requirement proxy is insignificantly different from zero at all horizons. See Appendix B.6 for additional robustness analyses.

[20]Within our dataset, we do not find significant differences between domestic and foreign currency denominated reserve requirements, although more granular analyses of currency denomination may prove useful here.

Figure 6: Interaction of US monetary policy spillovers with reserve requirements in recipient emerging markets for total credit and bank credit



Notes: $\{\delta^h_{mp}\}^8_{h=0}$ estimates with (log) total credit (left-hand side) and (log) bank credit (right-hand side) for 29 emerging markets as dependent variable (regression (2)). The light blue shaded area denotes the 90% confidence interval around point estimates, constructed from Driscoll and Kraay (1998) standard errors. The prudential policy measure is defined as the two-year cumulated sum of all reserve requirements, levied on domestic and foreign currency-denominated deposits, in the Cerutti et al. (2017b) dataset.

national authorities to counter-cyclically dampen an expected credit boom or credit crunch.

5 Cross-Country Heterogeneity in Policy Interactions

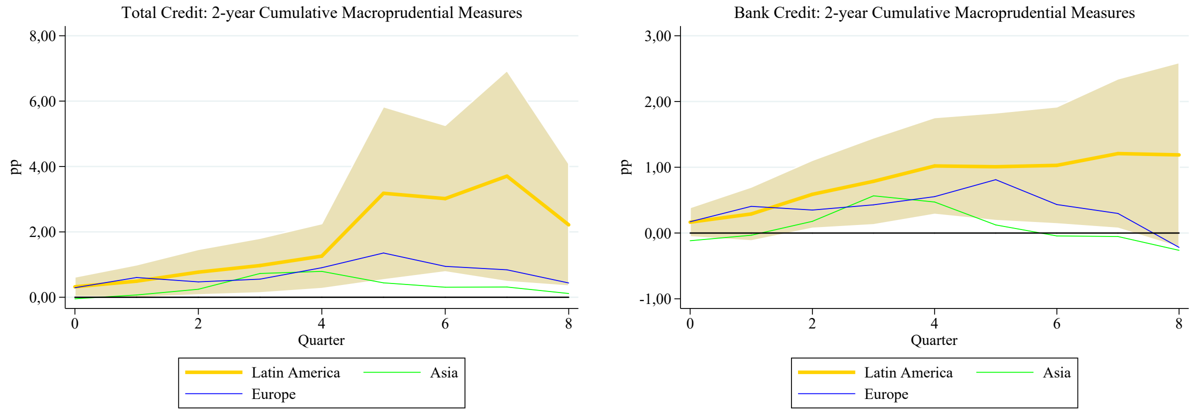
In this section, we ask what conditions make this interaction effect stronger? To do so, we estimate (3) using different country characteristics $\mathbf{Z}_{i,t-1}$ as additional interactors.

5.1 Geography

We first investigate geographical differences in the strength of the policy interaction. To do this, we estimate separate interaction coefficients for the 7 Latin American economies, 8 European economies and 11 Asian economies that comprise our set of EMs.[21] There are reasons to expect differences across the groups. First, the geographical proximity of Latin American economies to the US is likely to strengthen economic ties between the two regions, both through trade and financial links. Second, data from Gopinath (2015) shows that the degree of dollar currency invoicing of international trade differs significantly across the three regions. Based on a smaller subset of EMs than in our macro-financial panel, the data from Gopinath (2015) illustrates that the average degree of dollarisation in Latin American EMs is around 97%, while in Asia and

[21]We omit the remaining 3 African economies from this comparison.

Figure 7: Interaction of US monetary policy spillovers with aggregate prudential policies, excluding aggregate capital requirements, in recipient emerging markets in Latin America, Asia and Europe



Notes: $\{\delta^h_{mp}\}^8_{h=0}$ estimates with (log) total credit (left-hand side) and (log) bank credit (right-hand side) for 29 emerging markets as dependent variable (regression (3)), grouped by region. The light yellow shaded area denotes the 90% confidence interval around point estimates for countries in Latin America, constructed from Driscoll and Kraay (1998) standard errors. The aggregate prudential policy measure is defined as the two-year cumulated sum of all prudential measures, excluding aggregate capital requirements, in the Cerutti et al. (2017b) dataset.

Europe the shares are around 80% and 41%, respectively.

We thus assess regional differences in the interaction with the hypothesis that geographically close and more dollarised EMs are likely to gain the most from offsetting prudential policy actions in the face of US monetary policy spillovers. Our results appear to confirm this, quantitatively at least. Estimates of the interaction coefficient are most strongly positive for Latin America (Figure 7), although differences are not statistically significant.

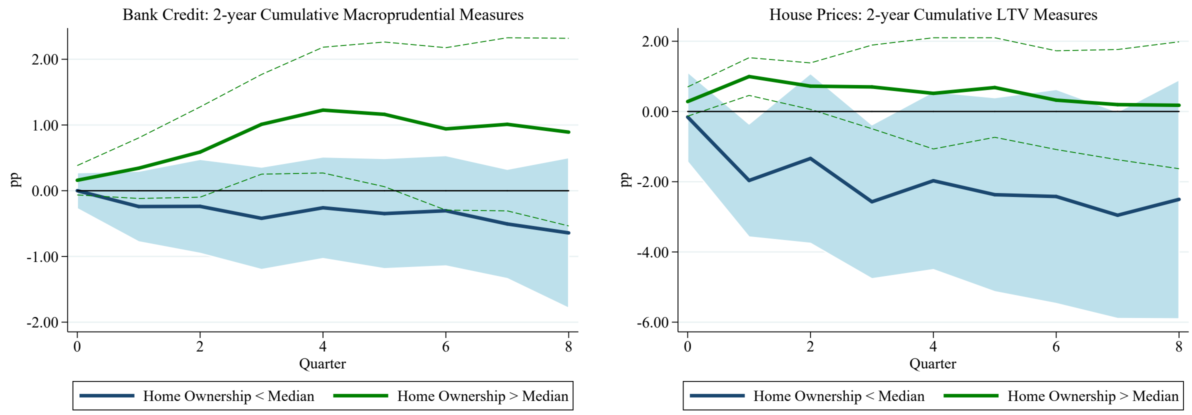
5.2 Home Ownership

The degree of home ownership within an economy is another important determinant of financial risks. Higher home ownership rates tend to be associated greater housing market risks, as more households borrow and lever-up to buy housing.

Our results indicate that prudential polices are indeed more effective at dampening cyclical fluctuations in EMs with higher home ownership shares (Figure 8). The left-hand plot shows that, in countries with above median home ownership shares, the interaction between our baseline measure of aggregate prudential policy and US monetary policy for spillovers to bank credit is significantly positive.[22] In contrast, the interaction is insignificantly different for

[22]Home ownership share data is described with reference to Table 2.

Figure 8: Interaction of US monetary policy spillovers with aggregate prudential policies, excluding general capital requirements, in recipient emerging markets with home ownership shares above and below the median



Notes: $\{\delta_{mp}^h\}_{h=0}^8$ estimates with (log) bank credit (left-hand side) and (log) house prices (right-hand side) for 29 emerging markets as dependent variable (regression (3)), grouped by share of home ownership. The light blue shaded area and green-dashed lines denote the 90% confidence interval around point estimates for countries with below and above median home ownership shares, respectively, constructed from Driscoll and Kraay (1998) standard errors. The aggregate prudential policy measure is defined as the two-year cumulated sum of all prudential measures, excluding general capital requirements, in the Cerutti et al. (2017b) dataset (left-hand side); the right-hand side uses two-year cumulated LTV ratio limits only.

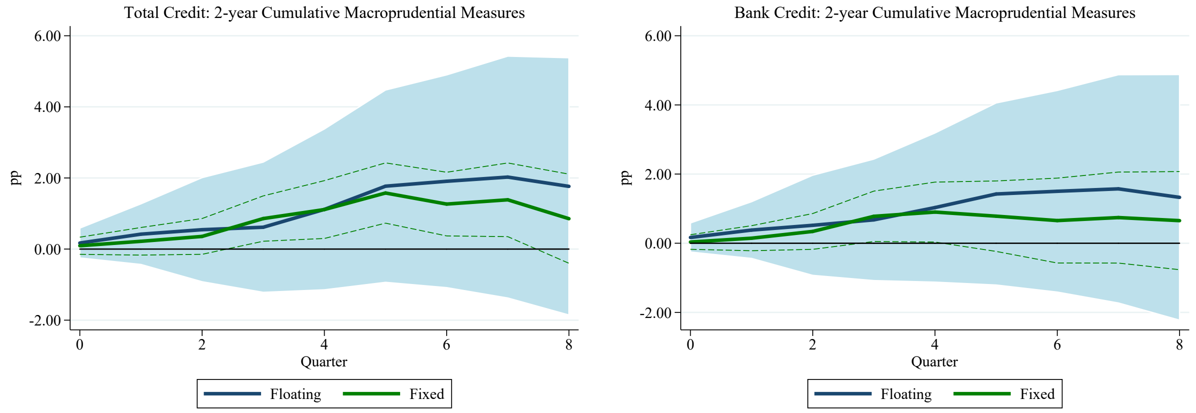
countries with home ownership shares that lie below the cross-country median.

The right-hand panel hones in specifically on the role of LTV ratio limits, which we found to be significantly important for spillovers to house prices in the previous section. Consistent with the view that housing sectors with high home ownership shares pose greater risks to a country's financial stability, our results indicate that LTV ratio limits are indeed more effective at dampening housing market fluctuations in these economies. We find a significantly positive interaction coefficient for above median home ownership countries when considering spillovers to house prices and the role of LTV ratio limits. In contrast, the interaction for below median home ownership countries is broadly insignificant. The difference between the two is significantly positive at the $h = 1$ horizon.

5.3 Exchange Rate Regimes

Exchange rate regimes are at the centre of the traditional international macroeconomic policy trilemma. A country with free capital mobility can only pursue an independent monetary policy if their exchange rate is allowed to float. Ever since the work of Mundell (1963) and Fleming (1962), it has been understood that the spillover effects of foreign shocks will depend

Figure 9: Interaction of US monetary policy spillovers with aggregate prudential policy in recipient emerging markets under fixed and floating exchange rates for total credit and bank credit



Notes: $\{\delta^h_{mp}\}^8_{h=0}$ estimates with (log) total credit (left-hand side) and (log) bank credit (right-hand side) for 29 emerging markets as dependent variable (regression (2)). The light blue shaded area and green-dashed lines denote the 90% confidence interval around point estimates for countries with floating and fixed exchange rate regimes, respectively, constructed from Driscoll and Kraay (1998) standard errors. Aggregate prudential policy measure is defined as the two-year cumulated sum of all prudential measures, excluding general capital requirements, in the Cerutti et al. (2017b) dataset. Exchange rate regimes are classified using the *de facto* measure of Ilzetzki et al. (2019).

on the prevailing exchange rate regime. Within the Mundell-Fleming paradigm, monetary policy spillovers are likely to be larger than for countries with floating exchange rates, as relative prices are unable to adjust to insulate against the effects of foreign shocks. But, in the context of our EM-focused study, a competing channel is at play: foreign currency-denominated debt. In a country with a high share of foreign currency-denominated debt, a fixed exchange rate is likely to insulate against foreign shocks to some extent, by preventing valuation effects.

To assess how the interaction changes with respect to exchange rate regimes, we estimate (3) using the *de facto* exchange rate regime classification of Ilzetzki et al. (2019) as our indicator of country characteristics $\mathbf{Z}_{i,t-1}$, differentiating between countries anchored to the US dollar and those not. We favour a *de facto* classification precisely because we wish to account for the role of exchange rate adjustment in determining the interaction, rather than possible institutional characteristics associated with *de jure* measures.

Our results indicate that prudential policies appear to equally dampen cyclical fluctuations from US monetary policy shocks under floating and fixed exchange rate regimes (Figure 9). Point estimates for the interaction effect are approximately the same for fixed and floating regimes, suggesting that the competing effects of exchange rate regimes for spillovers tend to roughly balance in the context of cross-border prudential policy interactions.

6 Conclusion

This paper has presented novel evidence into the role of prudential policy in reducing the macro-financial spillover effects of US monetary policy shocks to EMs. We find that prudential policies can partially offset the negative spillover effects of US monetary policy, and dampen a country's exposure to the associated global credit cycle, in a statistically and economically significant manner. Importantly, our findings are robust to accounting for other factors—such as capital controls—that could also reduce spillovers to EMs. In particular, we identify LTV ratio limits and reserve requirements to be effective tools for achieving this. Reserve requirements significantly reduce the spillover effects of US monetary policy to credit supply, through bank credit especially, while LTV ratio limits significantly mitigate spillovers to house prices.

While our empirical specification allows us to estimate cross-border monetary and prudential policy interactions, some limitations in our analysis remain—common to the majority of extant literature on prudential policy. First, our aggregate measure of prudential policy includes a relatively restricted number of prudential instruments, limiting the range of measures that we consider. Second, our prudential policy dataset measures policy actions and captures the intensity of policy changes only to a limited extent. Third, our empirical framework cannot be easily reversed to study how the level of interest rates influences the spillovers of prudential policy 'shocks', due to challenges identifying exogenous innovations to prudential policies. Future research will, no doubt, benefit from improvements in prudential policy data coverage and granularity.

Nevertheless, our findings have important implications, suggesting that prudential policies can be effective at reducing the spillover effects of US monetary policy, helping policymakers to maintain monetary policy autonomy in the face of spillovers and the global financial cycle.

Appendix

A Data Sources

A.1 Macro-Financial Panel Dataset

Our macro-financial dataset spans 29 EMs (and 35 advanced economies). We use data for the following macro-financial variables from a range of sources, listed below:

- Total credit and Bank credit (Sources: Bank for International Settlements and International Financial Statistics)
- House prices (Sources: Bank for International Settlements and Oxford Economics)
- Real GDP (Sources: International Monetary Fund, OECD and National Statistics Institutes)
- Consumer Price Index (CPI) (Source: International Monetary Fund)

A.2 Prudential Policy Data

The Cerutti et al. (2017b) dataset includes information on the following types of prudential policies:

1. Capital requirements
   (a) Aggregate capital requirements, reflecting the implementation of Basel capital agreements
   (b) Sector-specific capital buffers, levied on
      i. Real estate credit
      ii. Consumer credit
      iii. Credit to other sectors
2. Concentration ratio limits
3. Interbank exposure limits
4. Loan-to-value ratio limits
5. Reserve requirements
   (a) Reserve requirements on local currency-denominated accounts
   (b) Reserve requirements on foreign currency-denominated accounts

A.2.1 Exploratory Prudential Policy Data

Figure 10 illustrates the the cross-sectional variation in the prudential policy dataset, plotting a global heat map of cumulated aggregate prudential policy actions from 2011:Q1 to 2012:Q4 for the 29 EMs in our dataset. The plot shows a wide degree of cross-country variation in the activeness with which prudential policy is used across countries, in particular in EMs. For this two-year period, the tightest aggregate prudential policies occurred in Peru and Nigeria, with the loosest in India.

Figures 11-14 illustrate the time series variation in our baseline measure of aggregate prudential policy for Emerging Asian, Emerging European, Latin American and African economies, respectively, constructed by cumulating all actions over a two-year period and summing all prudential policies, except general capital requirements, in the Cerutti et al. (2017b) prudential policy dataset.

A.2.2 Summary Statistics

Table 3 presents summary statistics for our aggregate prudential policy proxy cumulated over 2 years by country. Table 4 presents summary statistics for the same variable by year. Column (1) illustrates that, on average, most EMs tightened their prudential policies in aggregate (excluding general capital requirements) before the 2007-2008 financial crisis, loosening them immediately after. Columns (2)-(6) present summary statistics for 2-year cumulated measures of specific prudential policy instruments. This aggregate loosening post-crisis was concentrated in capital requirements, LTV ratio limits and reserve requirements.

A.3 Monetary Policy Shocks

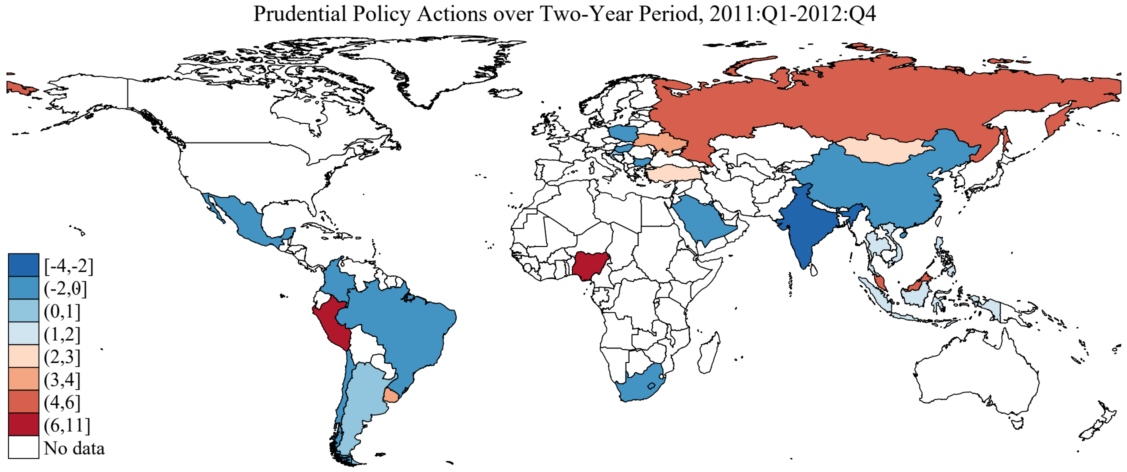
A.3.1 Methodology

To describe the econometric framework for identifying US monetary policy shocks, we draw heavily on Gertler and Karadi (2015) (Section II). Let $\mathbf{Y}_t$ be a $K \times 1$ vector of economic and financial variables and ε_t be a vector of structural white noise shocks. A general structural form VAR is given by

$$\mathbf{A}\mathbf{Y}_t = \sum_{j=1}^{p} \mathbf{C}_j \mathbf{Y}_{t-j} + \varepsilon_t \tag{4}$$

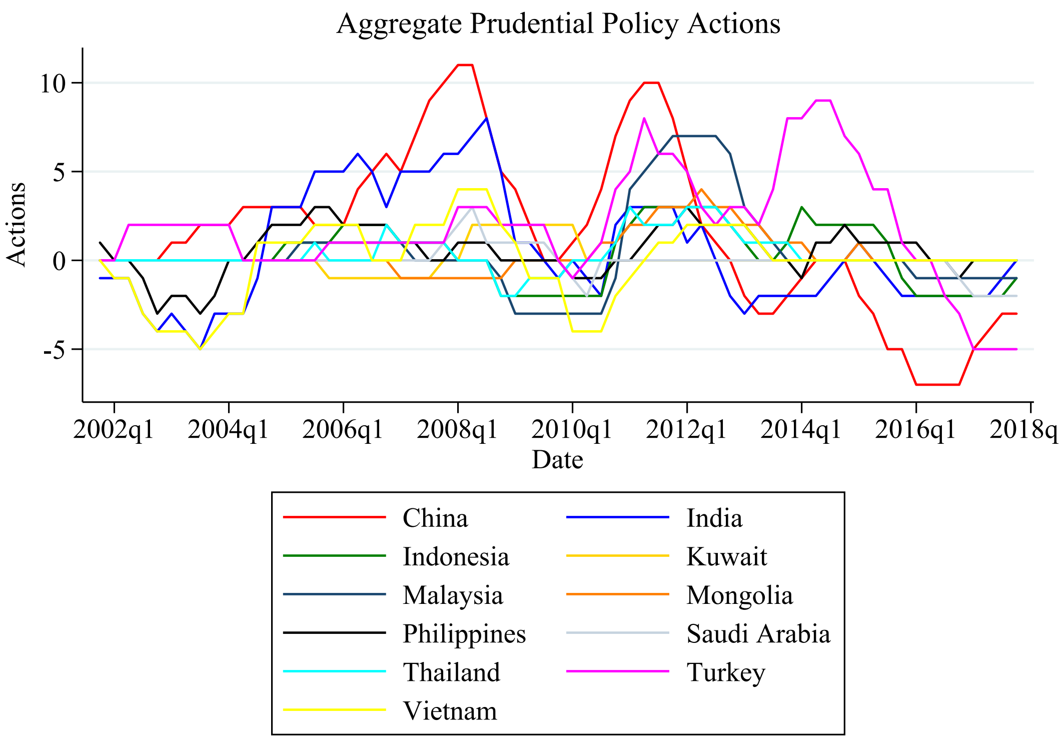
where $\mathbf{A}$ and $\mathbf{C}_j$ $\forall j \geq 1$ are conformable coefficient matrices.

Figure 10: Cumulated aggregate prudential policy actions by EM country, 2011:Q1-2012:Q4



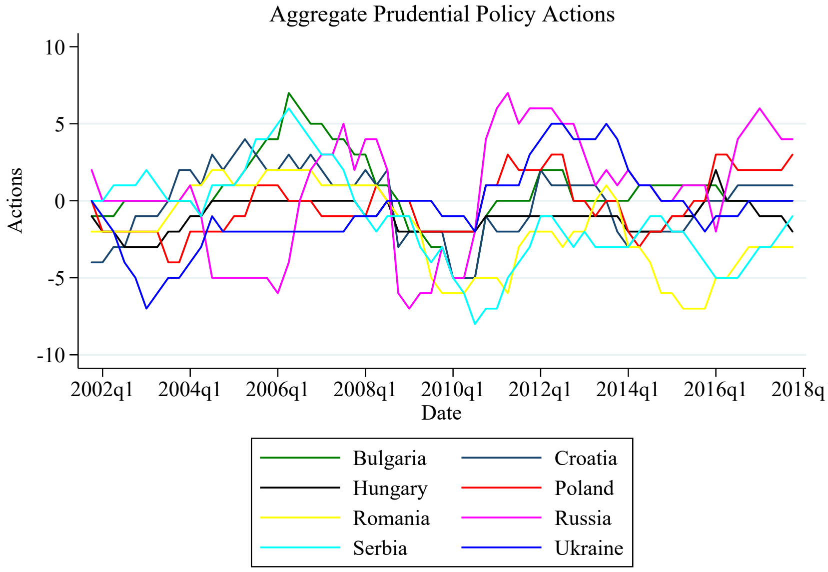
Notes: Sum of the all prudential policy actions, excluding general capital requirements, in the Cerutti et al. (2017b) prudential policy actions dataset between 2011:Q1 and 2012:Q4 in each of the 29 EMs in our dataset.

Figure 11: Time series variation in two-year cumulated aggregate prudential policy actions in Emerging Asian economies, 2001:Q4-2017:Q4



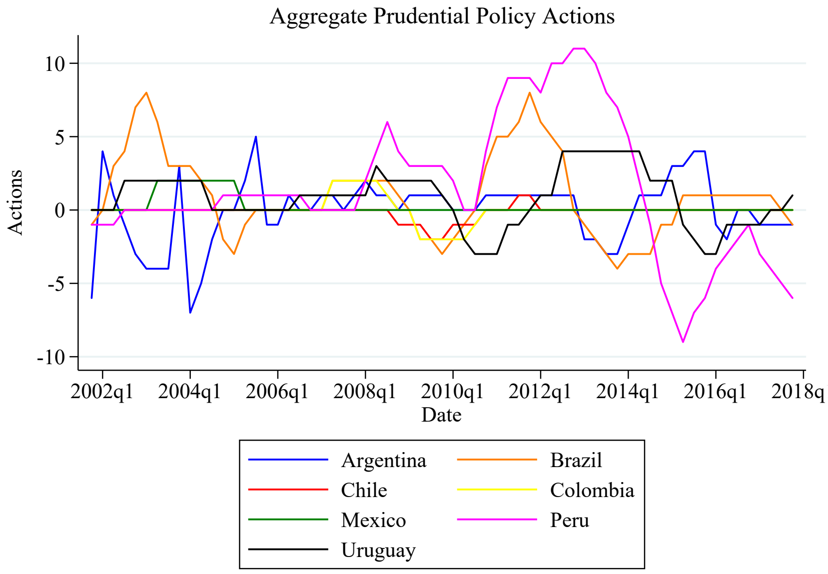
Notes: Time series of two-year cumulated aggregate prudential policy actions, constructed using all prudential policies, except general capital requirements, in the Cerutti et al. (2017b) prudential policy actions dataset between 2001:Q4 and 2017:Q4 in Emerging Asian economies.

Figure 12: Time series variation in two-year cumulated aggregate prudential policy actions in Emerging European economies, 2001:Q4-2017:Q4



Notes: Time series of two-year cumulated aggregate prudential policy actions, constructed using all prudential policies, except general capital requirements, in the Cerutti et al. (2017b) prudential policy actions dataset between 2001:Q4 and 2017:Q4 in Emerging European economies.

Figure 13: Time series variation in two-year cumulated aggregate prudential policy actions in Latin American economies, 2001:Q4-2017:Q4



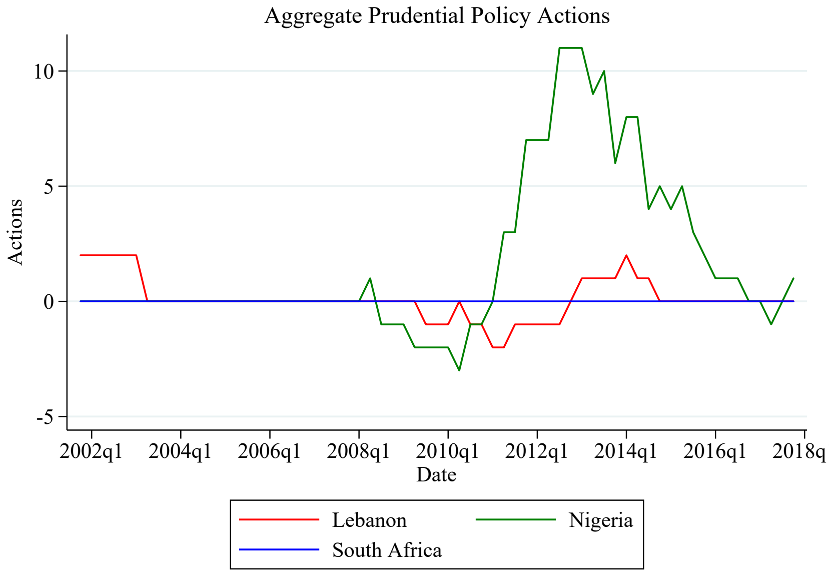
Notes: Time series of two-year cumulated aggregate prudential policy actions, constructed using all prudential policies, except general capital requirements, in the Cerutti et al. (2017b) prudential policy actions dataset between 2001:Q4 and 2017:Q4 in Latin American economies.

Table 3: Summary statistics for prudential policy proxies constructed by cumulating actions over a two-year period by country

Prudential Policy Measure	# Obs.	$\overline{Pru}_{i,t}$	$\sigma\left(Pru_{i,t}\right)$	$\min\left(Pru_{i,t}\right)$	$\max\left(Pru_{i,t}\right)$
Argentina	65	-0.046	2.308	-7	5
Brazil	65	1.000	2.817	-4	8
Bulgaria	65	0.585	2.297	-5	7
Chile	65	-0.123	0.484	-2	1
China	65	1.631	4.629	-7	11
Colombia	65	0.000	0.810	-2	2
Croatia	65	-0.185	2.221	-5	4
Hungary	65	-1.046	0.975	-3	2
India	65	0.569	3.211	-5	8
Indonesia	65	0.354	1.643	-2	3
Kuwait	65	0.123	0.781	-1	2
Lebanon	65	0.092	0.897	-2	2
Malaysia	65	0.492	2.463	-3	7
Mexico	65	0.246	0.662	0	2
Mongolia	65	0.385	1.128	-1	4
Nigeria	65	1.723	3.560	-3	11
Peru	65	1.415	4.687	-9	11
Philippines	65	0.538	1.347	-3	3
Poland	65	-0.292	1.826	-4	3
Romania	65	-1.923	2.740	-7	2
Russia	65	0.585	3.832	-7	7
Saudi Arabia	65	-0.015	0.800	-2	3
Serbia	65	-1.215	3.059	-8	6
South Africa	65	0.000	0.000	0	0
Thailand	65	0.385	1.026	-2	3
Turkey	65	1.908	3.121	-5	9
Ukraine	65	-0.538	2.586	-7	5
Uruguay	65	0.800	1.897	-3	4
Vietnam	65	-0.062	2.098	-5	4

Notes: Summary statistics are constructed for each country by pooling observations over the full sample period.

Figure 14: Time series variation in two-year cumulated aggregate prudential policy actions in African economies, 2001:Q4-2017:Q4



Notes: Time series of two-year cumulated aggregate prudential policy actions, constructed using all prudential policies, except general capital requirements, in the Cerutti et al. (2017b) prudential policy actions dataset between 2001:Q4 and 2017:Q4 in African economies.

The reduced-form representation is attained by pre-multiplying each side of (4) by $\mathbf{A}^{-1}$:

$$\mathbf{Y}_t = \sum_{j=1}^{p} \mathbf{B}_j Y_{t-j} + \mathbf{u}_t \tag{5}$$

where $\mathbf{u}_t$ is a vector of reduced-form shocks, with the following relationship to structural disturbances

$$\mathbf{u}_t = \mathbf{S}\varepsilon_t \tag{6}$$

with $\mathbf{B}_j = \mathbf{A}^{-1}\mathbf{C}_j$ and $\mathbf{S} = \mathbf{A}^{-1}$. $\mathbf{\Sigma} = \mathbb{E}\left[\mathbf{u}_t\mathbf{u}_t'\right] = \mathbb{E}\left[\mathbf{S}\mathbf{S}'\right]$ is the variance-covariance matrix of the reduced-form errors.

Define $Y_t^p \in \mathbf{Y}_t$ as the *policy indicator*, with corresponding exogenous structural shock $\varepsilon_t^p \in \varepsilon_t$. Like Gertler and Karadi (2015), let the policy indicator in the VAR differ from the policy instrument to permit interest rate variation due to forward guidance. The policy indicator is defined as a government bond interest rate of somewhat longer maturity than the policy instrument—e.g. federal funds rate in US. The government bond rate captures innovations to both the current policy rate and expectations about the path of future policy rates.

Table 4: Summary statistics for prudential policy proxies constructed by cumulating actions over a two-year period by year

Prudential Policy Measure	# Obs.	$\overline{Pru_{i,t}}$	$\sigma\left(Pru_{i,t}\right)$	$\min\left(Pru_{i,t}\right)$	$\max\left(Pru_{i,t}\right)$
2002	116	-0.336	1.704	-5	7
2003	116	-0.405	2.261	-7	8
2004	116	-0.034	1.724	-7	3
2005	116	0.586	1.818	-5	5
2006	116	0.966	2.030	-6	7
2007	116	1.043	2.019	-2	10
2008	116	1.138	2.509	-6	11
2009	116	-0.759	1.998	-7	4
2010	116	-1.164	2.442	-8	7
2011	116	1.638	3.425	-7	10
2012	116	2.078	3.005	-3	11
2013	116	0.871	2.983	-4	11
2014	116	0.310	2.576	-6	9
2015	116	-0.345	2.506	-9	6
2016	116	-0.707	2.068	-7	5
2017	116	-0.638	1.944	-6	6

Notes: Summary statistics are constructed for each year by pooling observations over quarters within the year and across the 29 EMs.

To identify the monetary policy shock ε_t^P, let $\mathbf{Z}_t$ be a vector of instrumental variables and $\boldsymbol{\varepsilon}_t^q$ a vector of structural shocks excluding the policy shock. The identification assumptions are:

$$\mathbb{E}\left[\mathbf{Z}_t \varepsilon_t^{p\prime}\right] = \boldsymbol{\phi} \tag{7}$$

$$\mathbb{E}\left[\mathbf{Z}_t \boldsymbol{\varepsilon}_t^{q\prime}\right] = \mathbf{0} \tag{8}$$

To be valid, the instruments must be correlated with the policy shock, but orthogonal to all other structural shocks.

Let s represent the column in matrix $\mathbf{S}$ corresponding to the impact of the structural monetary policy shock ε_t^p on each element of the reduced-form residuals $\mathbf{u}_t$ (see (6)). Estimates of the elements in the vector s can be obtained in the following two steps:

1. Estimate the reduced-form VAR (5) by OLS to obtain a vector of reduced-form residuals $\hat{\mathbf{u}}_t$. Define $\hat{u}_t^p$ as the reduced-form residual from the equation for the policy indicator, and let $\hat{\mathbf{u}}_t^q$ be the vector of reduced-form residuals from the other variable equations, for $q \neq p$.

2. Define $\mathrm{s}^q \in \mathrm{s}$ as the response of $\mathbf{u}_t^q$ to a unit increase in the structural policy shock ε_t^p. Obtain an estimate of the ratio s^q/s^p from a two-stage least squares regression of $\hat{\mathbf{u}}_t^q$ on $\hat{u}_t^p$, using the instrument set $\mathbf{Z}_t$. Estimates of s^p and s^q can be derived up to a sign convention

using the estimates reduced-form variance-covariance matrix of residuals $\hat{\Sigma}$.[23]

A.3.2 Data and Results

We estimate the structural shocks using a common methodology and 1979:07-2018:10 sample for the US. Because the regression framework includes 12 lags, monthly frequency estimates of policy shocks begin in 1980:07.

The VARs include four variables that match the baseline specification in Gertler and Karadi (2015): the 1-year government bond interest rate, industrial production, the consumer price index (CPI), and a measure of corporate credit spreads.[24] Industrial production and CPI are included in log levels, while interest rates and credit spreads are included in levels. The VARs for all regions include 12 lags of monthly variables—i.e. $p = 12$. The instrument for monetary policy $\mathbf{Z}_t$ is selected based on its relevance, measured by first-stage F-statistics, which is 22.9 for this sample.

B Additional Empirical Results

In this appendix, we touch upon additional coefficient estimates from regressions unreported in the main body of the paper.

B.1 Additional Aggregate Interactions

Figure 15 reports interaction coefficient estimates for EM real GDP and CPI using the aggregate measure of prudential policy, excluding general capital requirements. The point estimates are insignificant at all horizons, further motivating our focus on the interactions for total and bank credit.

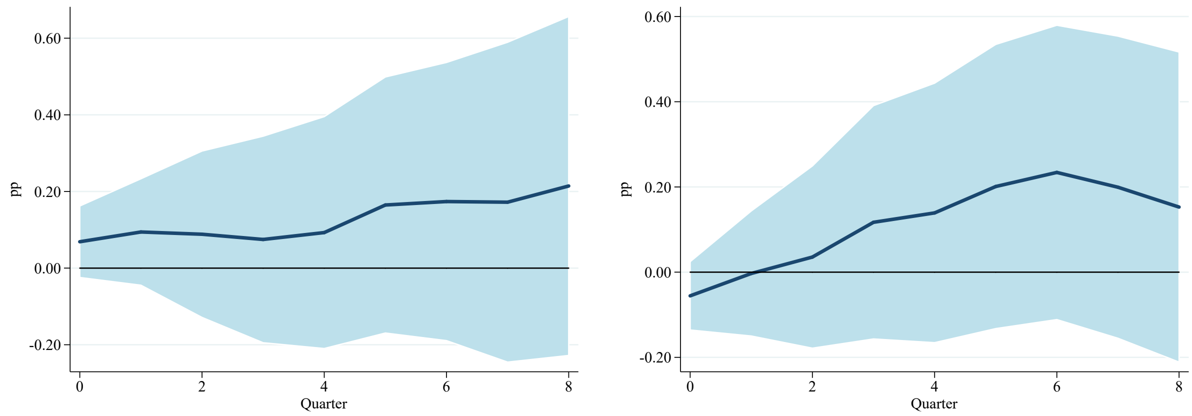
B.2 Accounting for Capital Controls

In table 2, we report to regression specifications which include additional interactions between the US monetary policy shock and countries' lagged capital flow restrictiveness—i.e. $MP_t^{\$} \times$

[23]See Gertler and Karadi (2015, pp. 51-52).

[24]US industrial production and CPI data are from FRED. The 1-year government bond interest rate is from Gürkaynak et al. (2007). Credit spreads are measured using the excess bond premium from Gilchrist and Zakrajsek (2012). Monetary policy surprises are from Gürkaynak et al. (2005), constructed using intraday variation in the three month-ahead federal funds futures rate in 30-minute windows around FOMC announcements.

Figure 15: Interaction of US monetary policy spillovers with aggregate prudential policy in recipient emerging markets for real GDP and the consumer price index



Notes: $\{\delta^h_{mp}\}_{h=0}^{8}$ estimates with (log) real GDP (left-hand side) and the CPI (right-hand side) for 29 emerging markets as dependent variable (regression (2)). The light blue shaded area denotes the 90% confidence interval around point estimates, constructed from Driscoll and Kraay (1998) standard errors. Aggregate prudential policy is defined as the two-year cumulated sum of all prudential policies, excluding general capital requirements, in the Cerutti et al. (2017b) dataset.

$KC_{i,t-1}$ and $KC_{i,t-1}$ are included in the set of controls $\mathbf{X}_{i,t-1}$, where $KC_{i,t-1}$ is a measure of capital controls in country i at time $t-1$. Consistent with the focus of our paper, we only report the δ^h coefficient estimates in the main body of the paper—i.e. the coefficients on $MP^{\$}_t \times Pru_{i,t-1}$.

Although not the main focus of our paper, the coefficient estimates on the $MP^{\$}_t \times KC_{i,t-1}$ provide some indication about the extent to which capital controls can help to insulate against the spillover effects of US monetary policy. A positive interaction coefficient for capital controls can be interpreted in a similar vein to the coefficient estimates on the prudential policy interaction in the main body of the paper. Table 5 reports the capital control interaction coefficients for total credit (columns (1) and (2)) and bank credit (columns (3) and (4)). Odd-numbered columns use the overall capital flow restrictiveness measure of Fernández et al. (2016), even-number columns use the inflow-focused measures. In both cases, a higher number indicates greater capital flow restrictions. A significantly positive interaction coefficient suggests that capital controls can help to offset some of the spillovers of US monetary policy for EMs.

The point estimates in table 5 are positive at all horizons, and significantly different from zero at some of them. These coefficients indicate that—like prudential policy—tighter capital controls in advance of a US monetary policy tightening shock can help to mitigate the negative spillovers from US monetary policy. Importantly for our study, as columns (2) and (3) of table

Table 5: Interaction coefficient estimates for capital controls from regression (2) for total and bank credit, when assessing the interaction of emerging market aggregate prudential policy with US monetary policy

	Total Credit		Bank Credit	
	(1) Capital Controls	(2) Capital Inflow Controls	(3) Capital Controls	(4) Capital Inflow Controls
$MP_t^{\$} \times KC_{i,t-1}$				
$h = 0$	0.74	0.65	1.02	1.48
	(1.21)	(1.14)	(1.21)	(1.15)
$h = 1$	3.60*	3.03	3.06	3.36*
	(1.96)	(1.87)	(2.01)	(1.98)
$h = 2$	5.19*	4.37	4.27	4.43
	(3.02)	(2.82)	(3.17)	(2.98)
$h = 3$	5.65	5.79	3.41	4.17
	(3.77)	(3.69)	(3.94)	(3.78)
$h = 4$	5.96	6.87	2.95	4.42
	(4.75)	(4.54)	(4.79)	(4.49)
$h = 5$	9.89	10.07	2.43	3.28
	(6.97)	(6.51)	(5.77)	(5.27)
$h = 6$	8.13	8.74	1.03	2.50
	(6.88)	(6.67)	(6.31)	(5.86)
$h = 7$	10.17	10.69	0.85	2.59
	(8.60)	(8.38)	(7.26)	(6.80)
$h = 8$	9.27	11.42	0.82	3.87
	(8.47)	(8.50)	(7.62)	(7.17)
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

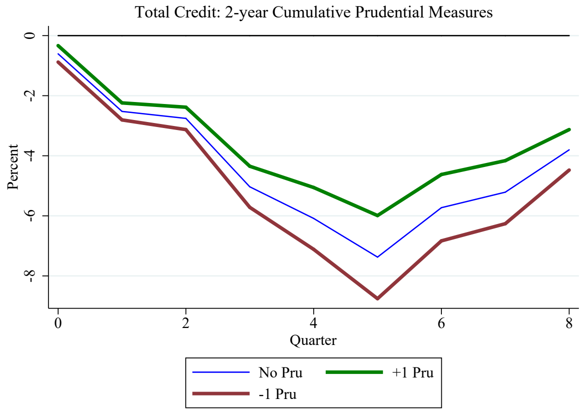
Notes: $MP_t^{\$} \times KC_{i,t-1}$ coefficient estimates from an extended variant of regression (2), which includes $MP_t^{\$} \times KC_{i,t-1}$ and $KC_{i,t-1}$ in the set of control variables $\mathbf{X}_{i,t-1}$ to account for other potential interactors, in addition to prudential policy, with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

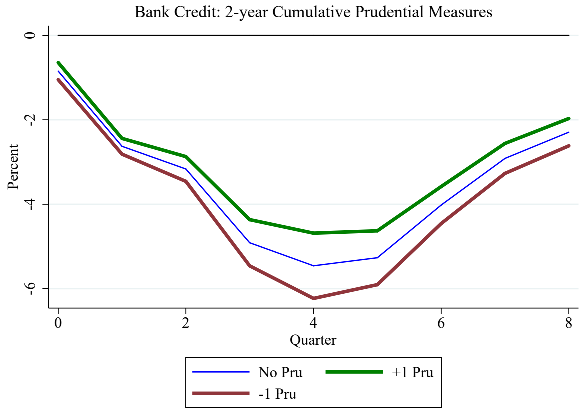
2 show, prudential policies continue to significantly offset the spillovers of US monetary policy to EM total credit, even when accounting for the potentially competing role of capital flow restrictions.

B.3 Including General Capital Requirements in $Pru_{i,t-1}$

In the main body of the paper, our measure of aggregate prudential policy excludes general capital requirements, which predominantly reflect Basel III requirements—as explained in section 2.1. Column (1) of table 6 documents point estimates for the interaction coefficient for total, at different horizons, when general capital requirements are included in the aggregate

Figure 16: US monetary policy spillovers to total credit and bank credit for different levels of aggregate prudential policy in recipient emerging markets





Notes: $\{\beta^h_{mp} + \delta^h\}^8_{h=0}$ estimates with (log) total credit (left-hand side) and (log) bank credit (right-hand side) for 29 emerging markets as dependent variable in hybrid version of regression (2) that excludes time fixed effects f^h_t, but includes US monetary policy measure $MP^\$_t$ and lagged global controls $\mathbf{G}_{t-1}$. The aggregate prudential policy measure is defined as the two-year cumulated sum of all prudential policy actions, including general capital requirements, in the Cerutti et al. (2017b) dataset. The blue line denotes estimated spillover from a 1pp US monetary policy tightening shock to an EM with a 0 value for prudential policy. The green line denotes the comparable spillover estimate for an EM with a $+1$ prudential policy action—i.e. on net, one additional policy tightening. The red line denotes the opposite spillover, for an EM with a -1 prudential policy action.

prudential policy measure. As in table 2, the point estimates are positive at all horizons. In this case, the significantly positive 5-quarter-ahead coefficient indicates that an additional tightening of prudential policy in an EM in advance of a $+1$pp US monetary policy tightening can, on average, reduce the hit to total credit hit from the shock by around 1.2 pp.

Columns (2)-(8) repeat the robustness analyses of table 2 for the extended measure of aggregate prudential policy. As in the main body of the paper, significantly positive interaction coefficients remain at the 5-quarter-ahead horizon, at least, when potentially competing interaction hypotheses are included in the regression, in addition to the $MP^\$_t \times Pru_{i,t-1}$ term.

Economic Significance Our headline economic significance is robust to the inclusion of general capital controls in the aggregate prudential policy measure, as figure 16 shows. The quantitative effect of domestic prudential policy is similar, with an additional prudential policy tightening action associated with a reduction in the peak total credit spillover from around 7% to 6%, and a from a little under 5.5% to 4.5% for bank credit.

Table 6: Interaction coefficient estimates $\hat{\delta}^h$ from regression (2) for total credit using aggregate prudential policy measures, which include general capital requirements, in recipient emerging markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Additional Interaction Variables					
	Baseline	Capital Control	Capital Inflow Control	Credit-to-GDP Growth	FX Regime	Home Own. Share	Country FE
$MP_t^\$ \times Pru_{i,t-1}$							
$h = 0$	0.15	0.08	0.10	0.09	0.09	0.15	0.12
	(0.17)	(0.18)	(0.18)	(0.18)	(0.15)	(0.16)	(0.11)
$h = 1$	0.18	0.01	0.05	0.05	0.18	0.20	0.26
	(0.29)	(0.28)	(0.28)	(0.30)	(0.25)	(0.28)	(0.24)
$h = 2$	0.26	0.01	0.07	0.08	0.28	0.29	0.35
	(0.39)	(0.37)	(0.38)	(0.39)	(0.34)	(0.38)	(0.33)
$h = 3$	0.57	0.34	0.38	0.36	0.68*	0.59	0.55
	(0.43)	(0.41)	(0.41)	(0.37)	(0.39)	(0.42)	(0.39)
$h = 4$	0.87	0.63	0.66	0.66	0.94*	0.86	0.72
	(0.55)	(0.53)	(0.53)	(0.47)	(0.50)	(0.53)	(0.47)
$h = 5$	1.22**	0.92*	0.96*	0.97*	1.35**	1.23**	1.41**
	(0.59)	(0.53)	(0.56)	(0.55)	(0.52)	(0.57)	(0.56)
$h = 6$	0.96	0.72	0.77	0.70	1.05*	0.96	1.22*
	(0.61)	(0.54)	(0.59)	(0.57)	(0.54)	(0.60)	(0.66)
$h = 7$	1.05	0.80	0.86	0.73	1.17*	1.06	1.68**
	(0.70)	(0.61)	(0.67)	(0.65)	(0.65)	(0.69)	(0.80)
$h = 8$	0.69	0.46	0.49	0.35	0.70	0.66	0.82
	(0.79)	(0.75)	(0.80)	(0.72)	(0.76)	(0.79)	(0.98)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE $\times MP_t^\$$	NO	NO	NO	NO	NO	NO	YES

Notes: $\hat{\delta}^h$, for $h = 1, \ldots, 8$, coefficient estimates from various specifications of regression (2) designed to account for other potential interactors with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

B.4 Robustness: Cumulating Prudential Policy over 1 Year

In the main body of the paper, we construct a measure of prudential policy that cumulates actions in the two years prior to a monetary policy shock. As we explain in section 2.1, this choice represents the balancing of a trade-off. On the one hand, the cumulation period needs to be sufficiently long to capture policy transmission and implementation lags and proxy persistence in the level of prudential policy. But, on the other, we want to avoid a cumulation period that is too long such that reversals in prudential policy suppress variation in our proxy. To assess the robustness of our results to the choice of a two-year cumulation period, we repeat our headline interaction analysis for a one-year cumulated measure of aggregate prudential policy, which again excludes general capital requirements.

The results of this, for total credit and bank credit, are documented in tables 7 and 8, respectively. Column (1) of both tables broadly corroborate with the results in the main body of the paper, in terms of sign, significance and magnitude. Column (1) of table 7 indicates that, using our one-year cumulated aggregate prudential policy measure, an additional EM prudential policy tightening in advance of a +1pp US monetary policy shock can, on average, reduce the hit to total credit hit from the shock by around 1.5pp. The corresponding figure for the two-year cumulated headline result is 1.4pp.

Table 7: Interaction coefficient estimates $\hat{\delta}^h$ from regression (2) for total credit using aggregate prudential policy measures, which exclude general capital requirements and are cumulated over 1 year, in recipient emerging markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Additional Interaction Variables					
	Baseline	Capital Control	Capital Inflow Control	Credit-to-GDP Growth	FX Regime	Home Own. Share	Country FE
$MP_t^\$ \times Pru_{i,t-1}$							
$h = 0$	0.61**	0.64**	0.64**	0.57**	0.51**	0.61**	0.54**
	(0.25)	(0.26)	(0.28)	(0.24)	(0.20)	(0.23)	(0.20)
$h = 1$	0.49	0.40	0.42	0.34	0.42	0.51	0.46
	(0.44)	(0.40)	(0.44)	(0.43)	(0.37)	(0.41)	(0.33)
$h = 2$	0.66	0.60	0.62	0.45	0.56	0.68	0.48
	(0.59)	(0.53)	(0.56)	(0.58)	(0.48)	(0.55)	(0.44)
$h = 3$	0.90	0.87	0.84	0.73	0.80	0.86	0.50
	(0.61)	(0.54)	(0.55)	(0.61)	(0.49)	(0.56)	(0.48)
$h = 4$	1.51**	1.44**	1.40**	1.37**	1.32**	1.41**	0.99*
	(0.70)	(0.64)	(0.62)	(0.68)	(0.59)	(0.66)	(0.51)
$h = 5$	1.49**	1.20*	1.15*	1.28*	1.37**	1.45**	1.06
	(0.70)	(0.66)	(0.65)	(0.72)	(0.57)	(0.65)	(0.66)
$h = 6$	1.14	0.94	0.87	0.90	0.99	1.07	0.68
	(0.85)	(0.81)	(0.80)	(0.89)	(0.73)	(0.82)	(0.87)
$h = 7$	1.16	0.99	0.90	0.87	1.09	1.12	0.87
	(0.98)	(0.92)	(0.92)	(1.02)	(0.86)	(0.95)	(1.04)
$h = 8$	0.73	0.65	0.51	0.42	0.54	0.62	0.10
	(1.05)	(1.06)	(1.03)	(1.09)	(0.95)	(1.04)	(1.12)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE $\times MP_t^\$$	NO	NO	NO	NO	NO	NO	YES

Notes: $\hat{\delta}^h$, for $h = 1, ..., 8$, coefficient estimates from various specifications of regression (2) designed to account for other potential interactors with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

Table 8: Interaction coefficient estimates $\hat{\delta}^h$ from regression (2) for bank credit using aggregate prudential policy measures, which exclude general capital requirements and are cumulated over 1 year, in recipient emerging markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Additional Interaction Variables					
	Baseline	Capital Control	Capital Inflow Control	Credit-to-GDP Growth	FX Regime	Home Own. Share	Country FE
$MP_t^{\$} \times Pru_{i,t-1}$							
$h = 0$	0.22*	0.19	0.18	0.18	0.14	0.21*	0.13
	(0.13)	(0.15)	(0.15)	(0.14)	(0.12)	(0.12)	(0.11)
$h = 1$	0.01	-0.08	-0.08	-0.09	-0.04	0.02	-0.07
	(0.28)	(0.29)	(0.29)	(0.28)	(0.23)	(0.24)	(0.21)
$h = 2$	0.19	0.16	0.15	0.06	0.09	0.18	-0.02
	(0.36)	(0.35)	(0.35)	(0.36)	(0.28)	(0.32)	(0.29)
$h = 3$	0.43	0.43	0.41	0.36	0.39	0.41	0.08
	(0.40)	(0.37)	(0.34)	(0.40)	(0.32)	(0.37)	(0.31)
$h = 4$	0.96*	0.94*	0.89**	0.92*	0.83*	0.87*	0.47
	(0.52)	(0.48)	(0.42)	(0.53)	(0.42)	(0.50)	(0.35)
$h = 5$	0.74	0.68	0.62	0.74	0.66	0.68	0.22
	(0.60)	(0.62)	(0.55)	(0.61)	(0.50)	(0.58)	(0.50)
$h = 6$	0.50	0.49	0.41	0.49	0.41	0.42	-0.06
	(0.73)	(0.79)	(0.71)	(0.72)	(0.64)	(0.71)	(0.66)
$h = 7$	0.49	0.53	0.42	0.53	0.46	0.44	-0.11
	(0.79)	(0.87)	(0.78)	(0.79)	(0.66)	(0.76)	(0.72)
$h = 8$	0.31	0.40	0.26	0.36	0.18	0.21	-0.47
	(0.85)	(0.95)	(0.85)	(0.85)	(0.70)	(0.82)	(0.79)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE $\times MP_t^{\$}$	NO	NO	NO	NO	NO	NO	YES

Notes: $\hat{\delta}^h$, for $h = 1, \ldots, 8$, coefficient estimates from various specifications of regression (2) designed to account for other potential interactors with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

B.5 Robustness: Loan-to-Value Ratio Limits and House Prices

Table 9 complements the analysis in section 4.2.1 in the main body of the paper, focusing specifically on the effects of loan-to-value ratio limits. Column (1) documents the $\hat{\delta}^h$ estimates presented in left-hand side of figure 5 for house prices. Columns (2)-(7) present the robustness of these estimates to the inclusion of additional interaction terms, designed to capture potentially competing hypotheses.

Table 9: Interaction coefficient estimates $\hat{\delta}^h$ from regression (2) for house prices using loan-to-value ratio limit prudential policy measures in recipient emerging markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Additional Interaction Variables					
	Baseline	Capital Control	Capital Inflow Control	Credit-to-GDP Growth	FX Regime	Home Own. Share	Country FE
$MP_t^{\$} \times Pru_{i,t-1}$							
$h = 0$	0.24	0.41	0.35	0.16	0.24	0.23	0.46
	(0.28)	(0.35)	(0.32)	(0.35)	(0.28)	(0.25)	(0.34)
$h = 1$	0.66**	1.00**	0.84**	0.45	0.62**	0.62**	0.75
	(0.31)	(0.44)	(0.36)	(0.38)	(0.31)	(0.28)	(0.54)
$h = 2$	0.63	0.82	0.74	0.39	0.60	0.47	0.29
	(0.51)	(0.81)	(0.68)	(0.61)	(0.49)	(0.45)	(0.70)
$h = 3$	0.48	0.69	0.55	0.21	0.44	0.30	-0.22
	(0.82)	(1.29)	(1.09)	(0.90)	(0.75)	(0.75)	(0.96)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE $\times MP_t^{\$}$	NO	NO	NO	NO	NO	NO	YES

Notes: $\hat{\delta}^h$, for $h = 1, ..., 8$, coefficient estimates from various specifications of regression (2) designed to account for other potential interactors with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

B.6 Robustness: Reserve Requirements and Credit

Tables 10 and 11 complement the analysis in section 4.2.2 in the main body of the paper, focusing specifically on the effects of reserve requirements. Column (1) of each table documents the $\hat{\delta}^h$ estimates presented in figure 6 for total credit and bank credit, respectively. Columns (2)-(7) present the robustness of these estimates to the inclusion of additional interaction terms, designed to capture potentially competing hypotheses.

Table 10: Interaction coefficient estimates $\hat{\delta}^h$ from regression (2) for total credit using reserve requirement prudential policy measures in recipient emerging markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Additional Interaction Variables					
	Baseline	Capital Control	Capital Inflow Control	Credit-to-GDP Growth	FX Regime	Home Own. Share	Country FE
$MP_t^{\$} \times Pru_{i,t-1}$							
$h = 0$	0.21	0.18	0.19	0.16	0.15	0.21	0.20
	(0.17)	(0.18)	(0.17)	(0.17)	(0.15)	(0.16)	(0.13)
$h = 1$	0.32	0.23	0.27	0.21	0.33	0.34	0.37
	(0.32)	(0.32)	(0.31)	(0.31)	(0.28)	(0.31)	(0.26)
$h = 2$	0.54	0.43	0.48	0.38	0.58	0.57	0.61*
	(0.43)	(0.42)	(0.41)	(0.41)	(0.38)	(0.42)	(0.36)
$h = 3$	0.89*	0.85*	0.88*	0.70*	1.04**	0.91*	0.89**
	(0.49)	(0.48)	(0.47)	(0.41)	(0.45)	(0.47)	(0.44)
$h = 4$	1.17*	1.14*	1.15*	0.97*	1.27**	1.16*	1.04*
	(0.62)	(0.62)	(0.60)	(0.53)	(0.57)	(0.61)	(0.53)
$h = 5$	1.58**	1.54**	1.58**	1.35**	1.75***	1.59**	1.85***
	(0.70)	(0.60)	(0.62)	(0.66)	(0.65)	(0.69)	(0.62)
$h = 6$	1.19*	1.22**	1.27**	0.96	1.31**	1.18*	1.58**
	(0.68)	(0.57)	(0.61)	(0.64)	(0.60)	(0.66)	(0.71)
$h = 7$	1.22	1.27**	1.32*	0.96	1.37*	1.22	1.99**
	(0.78)	(0.63)	(0.68)	(0.75)	(0.73)	(0.77)	(0.87)
$h = 8$	0.66	0.73	0.76	0.40	0.69	0.63	0.96
	(0.83)	(0.78)	(0.80)	(0.76)	(0.78)	(0.82)	(1.02)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE $\times MP_t^{\$}$	NO	NO	NO	NO	NO	NO	YES

Notes: $\hat{\delta}^h$, for $h = 1, ..., 8$, coefficient estimates from various specifications of regression (2) designed to account for other potential interactors with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

Table 11: Interaction coefficient estimates $\hat{\delta}^h$ from regression (2) for bank credit using reserve requirement prudential policy measures in recipient emerging markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Additional Interaction Variables					
	Baseline	Capital Control	Capital Inflow Control	Credit-to-GDP Growth	FX Regime	Home Own. Share	Country FE
$MP_t^{\$} \times Pru_{i,t-1}$							
$h = 0$	0.17	0.15	0.15	0.14	0.11	0.17	0.12
	(0.14)	(0.15)	(0.14)	(0.13)	(0.12)	(0.13)	(0.11)
$h = 1$	0.26	0.22	0.23	0.19	0.28	0.28	0.26
	(0.26)	(0.27)	(0.25)	(0.24)	(0.23)	(0.25)	(0.23)
$h = 2$	0.55	0.51	0.53	0.44	0.58*	0.56	0.56
	(0.37)	(0.39)	(0.37)	(0.34)	(0.33)	(0.36)	(0.34)
$h = 3$	0.91*	0.97**	0.97**	0.80*	1.04**	0.92**	0.86**
	(0.46)	(0.48)	(0.46)	(0.41)	(0.41)	(0.44)	(0.39)
$h = 4$	1.04*	1.11*	1.09*	0.93*	1.08**	1.01*	0.84*
	(0.57)	(0.60)	(0.57)	(0.53)	(0.50)	(0.56)	(0.48)
$h = 5$	0.82	0.92	0.93	0.72	0.90*	0.80	0.71
	(0.61)	(0.64)	(0.63)	(0.57)	(0.53)	(0.60)	(0.58)
$h = 6$	0.55	0.68	0.69	0.48	0.61	0.52	0.44
	(0.65)	(0.69)	(0.68)	(0.61)	(0.57)	(0.64)	(0.71)
$h = 7$	0.51	0.66	0.67	0.47	0.60	0.49	0.43
	(0.69)	(0.74)	(0.71)	(0.66)	(0.61)	(0.68)	(0.83)
$h = 8$	0.39	0.55	0.54	0.36	0.40	0.34	0.18
	(0.73)	(0.77)	(0.74)	(0.70)	(0.65)	(0.73)	(0.97)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Country FE $\times MP_t^{\$}$	NO	NO	NO	NO	NO	NO	YES

Notes: $\hat{\delta}^h$, for $h = 1, ..., 8$, coefficient estimates from various specifications of regression (2) designed to account for other potential interactors with monetary policy spillovers. *, ** and *** denote statistically significant coefficient estimates at 10%, 5% and 1% significance levels, respectively, using Driscoll and Kraay (1998) standard errors (reported in parentheses).

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