Journal of Financial Stability 64 (2023) 101087

Contents lists available at ScienceDirect

Journal of Financial Stability

journal homepage: www.elsevier.com/locate/jfstabil

Addressing Spillovers from Prolonged U.S. Monetary Policy Easing☆

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A R T I C L E I N F O

JEL Classifications:
E52
E58
F38
G21
G23
G28

Keywords:
Spillovers
Prolonged monetary policy easing
Financial stability
Macroprudential policies
Foreign-exchange intervention
Capital flow management measures

A B S T R A C T

There is growing recognition that prolonged U.S. monetary policy easing has extraterritorial spillovers, driving up financial system leverage elsewhere in the world. Faced with financial stability threats that are not of their own making, what can these countries do? Specifically, is there a role for macroprudential tools, capital controls or foreign exchange intervention in safeguarding financial stability from risks arising externally? We examine the efficacy of these policy interventions by exploring whether preventative or reactive policy interventions can mitigate such risks. Using a sample of 950 bank and nonbank financial firms across 28 non-U.S. economies over the past two decades, we show that if policymakers are able to implement policies prior to an additional consecutive decline in U.S. interest rates, financial institutions do not increase their leverage by as much as they otherwise would. By contrast, it is more difficult to counter the spillovers with reactive policy interventions.

1. Introduction

"*When monetary policy in large countries is extremely and unconventionally accommodative, capital flows into recipient countries tend to increase local leverage; this is not just due to the direct effect of cross-border banking flows but also the indirect effect, as the appreciating exchange rate and rising asset prices, especially of real estate, make it seem that borrowers have more equity than they really have.*" Raghuram Rajan, Governor of the Reserve Bank of India, April 2014 (Rajan, 2014).

Central bankers in small open economies have always questioned the sufficiency of monetary policy as the sole tool for countering external financial shocks. Recently, researchers have joined the debate, concluding that a number of economies are strongly influenced by changing global financial conditions, with U.S. monetary policy playing a central role.[1] Recent theoretical contribtuions suggest that, in the presence of frictions and externalities, assuring monetary autonomy and safeguarding financial stability may require more than just traditional interest rate tool.[2] For authorities to achieve their stabilization

☆ We thank Apoorv Bhargava for outstanding research assistance, Luis Brandao-Marques, Gaston Gelos, Erlend Nier, and Wenyue Yang for sharing their codes on policy shocks, Tobias Adrian, Futoshi Narita and other colleagues at the IMF for helpful discussions, Sara Durrani and Joanna Zaffaroni for production assistance, and three referees for their very detailed and extremely constructive comments. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. Cecchetti's disclosure statement is available here. The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF.

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[1] See, for example, Obstfeld (2015), Passari and Rey (2015), Rey (2013), Choi et al. (2017), Arregui et al. (2018), and Avdjiev et al. (2019).

[2] See Farhi and Werning (2016), Ghosh et al. (2016), Korinek and Sandri (2016), Arce et al. (2019), Cavallino (2019), Adrian et al. (2020), Basu et al. (2020), and Fanelli and Straub (2021).

https://doi.org/10.1016/j.jfs.2022.101087
Received 6 August 2021; Received in revised form 29 October 2022; Accepted 7 November 2022
Available online 11 November 2022

objectives, they may need to avail themselves of some combination of macroprudential policies, capital flow management tools (CFMs), and foreign exchange intervention (FXI). As we survey the landscape, we see a broad cross-section of countries employing many of these measures.[3]

In this paper, we examine the efficacy of these less traditional policy interventions. To do so, we first document the size and importance of spillovers of prolonged U.S. policy easing on financial firms' leverage; and then proceed to study whether reactive or preventative policy interventions are effective in mitigating the spillovers. In the first step of our analysis, using a sample of 950 bank and nonbank financial firms across 28 non-U.S. economies, we confirm the results of Cecchetti et al. (2020). Namely, prolonged U.S. monetary policy easing spills over to other countries, driving up financial system leverage; and that these spillovers are larger than the impact of domestic policy easing. That is, a sustained reduction in U.S. interest rates increases bank and nonbank financial firms' leverage by more than an equivalent change in the path of domestic interest rates.

Finding evidence that U.S. monetary policy has a large extraterritorial impact surely comes as no surprise to country authorities, managers of private financial and nonfinancial firms, and market participants. The global dominance of the dollar means that monetary policy easing in the United States has an impact not only on exchange rates, but also on prices of dollar-denominated commodities, cross-border financial flows and the price of risk. Faced with changes in the prices of virtually all assets, financial firms everywhere reoptimize their portfolios.

But such spillovers from U.S. monetary policies have often raised financial stability concerns in other countries. U.S. monetary policymakers calibrate their actions to domestic macro-financial condition, which may naturally be different from those elsewhere. For example, monetary easing may be appropriate in the United States at times when it serves to amplify financial expansion further away from economic fundamentals in other countries. In such cases, leverage of financial firms outside the United States may increase in a manner that poses significant financial stability risks.[4]

What can authorities do if prolonged easing of U.S. monetary policy drives up leverage, increasing domestic financial stability risks? To address this question, we turn to quarterly data from 1998 to 2019, and examine whether countries can use macroprudential, capital flow management, or foreign exchange intervention policies to mitigate the impact of prolonged U.S. policy easing on their financial institutions' leverage. Here, there are two cases. In one, policymakers move contemporaneously, and in the second they act to prevent the impact of the spillover before it comes.

Our results suggest that preventative actions are more effective than reactive ones.[5] That is, when policymakers are able to implement mitigating policies in anticipation of the possibility that U.S. interest rates will decline further, financial institutions do not increase their leverage by as much as they otherwise would. By contrast, waiting has little mitigating impact on the increase in financial risk that spillovers bring. This is the pattern for all policy tools that we examine.

Our study contributes to the rich and growing empirical literature examining policies that aim to manage international spillovers. Rey (2013) and many others document significant international spillovers from U.S. monetary policy on financial stability via capital flows, exchange rates, and financial firms leverage.[6] At the same time, a number of studies investigate the efficacy of various policy tools in countering the spillovers.[7] One conclusion from this literature is that the impact of policy depends on economic and structural conditions. To these existing findings, we add that, when the objective is to contain the spillovers of U.S. policy on financial institution leverage, prevention is more effective than reaction. We see our results as analogous to those of Klein (2012), who concludes that having capital flow management measures in place for long periods tends to be more effective than episodic implementation that is aimed at addressing specific vulnerabilities that arise.

Following this brief introduction, in Section 2, we reproduce the results of Cecchetti et al. (2020) for our expanded data set that includes more countries and a longer time period. We confirm their conclusion that the impact of prolonged U.S. monetary policy easing on financial firms' leverage is typically larger than that of domestic monetary policy easing. In Section 3, we address the core question of this paper: Are domestic policy tools to either prevent or mitigate effective in addressing the risks arising when prolonged U.S. monetary policy easing drives up financial firms' leverage? The final section provides a brief conclusion.

2. Measuring spillovers

We begin by establishing that the results in Cecchetti et al. (2020) hold for our expanded data set. Using a measure of duration constructed from the number of consecutive quarters during which interest rates fall, Cecchetti et al. (2020) examine the impact of prolonged monetary policy easing in the United States on financial firm's leverage both in the United States and elsewhere. They find that this duration measure is useful in capturing persistence, which may not be captured by the interest rate levels alone.[8] The persistence of monetary easing plays a key role in formulating expectations of macro-financial conditions and thus influences financial firms' leverage. We confirm these findings in an expanded data set that covers additional countries and more recent periods.

Briefly, for our expanded data set, we collect quarterly information from 1998Q1 to 2019Q3 on 950 financial firms in 20 non-U.S. advanced and 8 emerging market economies (Brazil, Colombia, Malaysia, Mexico, Russia, South Africa, Thailand, and Türkiye).[9] These are divided into six industry groups based on the Global Industry Classification Standard provided by Morgan Stanley Capital International (MSCI) and Standard & Poor's categories: commercial banks; insurance companies; real estate

[3] For example, Ghosh et al. (2017), Mano and Sgherri (2020), and Pasricha (2020) show that various policies respond to capital flow shocks or financial stability concerns, by estimating policy reaction functions in emerging market economies. See also Finger and Lopez Murphy (2019) and IMF (2020).

[4] For example, see Gourinchas and Obstfeld (2012), Schularick and Taylor (2012), and Acharya et al. (2014) for the studies showing that a high level or a rapid increase of leverage is a useful predictor of a build-up of financial vulnerabilities. While an increase in leverage is expected when financial costs are low, the increase can be too much in the presence of externality (for classic references, see Bernanke and Gertler, 1995, Kiyotaki and Moore, 1997).

[5] We use the term "preventative" to refer to measures taken to proactively prevent a build-up of vulnerabilities (e.g., an increase in leverage due to spillovers). By contrast, the literature on capital flows typically labels "preemptive" measures as those taken in response to a build-up of vulnerabilities during the capital inflow phase to proactively prevent sudden stops.

[6] For example, see Chen et al. (2014), Albagli et al. (2019), and Kalemli-Özcan (2019) for the spillovers via risk perceptions and exchange rates; and Bruno and Shin (2015a, 2015b), Barroso et al. (2016), Morais et al. (2019), Cecchetti et al. (2020), for those via cross-border credits and financial firms' leverage.

[7] For the literature survey on policy effects, see Galati and Moessner (2018) and Araujo et al. (2020) for macroprudential policy; Erten et al. (2021) and Rebucci and Ma (2019) for capital flow management measures; and Sarno and Taylor (2001) and Chamon et al. (2019) for foreign exchange intervention.

[8] Cecchetti et al. (2020, Section 2.5 and Appendix 2) show that the results are similar even after controlling for the interest rate levels and when using an alternative duration measure that also reflects the interest rate levels.

[9] Cecchetti et al. (2020) study 613 non-U.S. firms from 20 countries over the period 1998Q1 to 2014Q4. So, we have 327 additional firms, covering 8 added countries, over 5 more years.

firms; asset managers; investment banks; and a residual category, "other."[10] See the appendix for a full description of the data.

We measure financial stability risks using financial firm leverage. We compute the market-value version of leverage, which is defined as the market value of equity plus the book value of liabilities divided by the market value of equity. We use this measure because of its relationship with systemic risks.[11] Here, we point to two related results in the literature. First, likely because market prices reflect firm's prospects and intangible assests more quickly and accurately, Campbell et al. (2008) show that market-value leverage has stronger explanatory power than book-value leverage in explaining financial distress. Second, Acharya et al. (2014, 2017) conclude that a market-value measure of leverage is a useful input to systemic risk indicators that track the results of macro-prudential stress tests.[12]

Fig. 1 reports summary information for our sample. The bars represent the interquartile range and the red diamonds (♦) are the median for leverage in each industry group. We also report the number of firms in each category above each bar. Note that banks tend to have both the highest leverage, and the broadest range—in the sample, the median is 14.4 and the interquartile range varies from 9.5 to 25.8. By contrast, asset managers have very low leverage in a very narrow range—the median is 1.2 and the interquartile range is less than 1.

To examine the spillover impact of prolonged or sustained U.S. monetary easing on non-U.S. financial firms' leverage, we follow Cecchetti et al. (2020) and measure the duration of U.S. monetary policy easing (D_t^{US}) at time t as below:

$$D_t^{US} = \begin{Bmatrix} D_{t-1}^{US} + 1 & \text{if} \quad \bar{i}_t^{US} < \bar{i}_{t-1}^{US} \\ 0 & Otherwise \end{Bmatrix}. \tag{1}$$

This duration variable counts the number of consecutive quarters with a decline in the trend component of the interest rate i_t^{US}, measured as the moving average: $\bar{i}_t^{US} = \frac{1}{8}\sum_{\tau=1}^{8} i_{t-\tau+1}^{US}$. In this way we focus on the trend component, removing temporary movements in the interest rate. For the interest rate i_t^{US}, we use the two-year sovereign bond yield, as it reflects both conventional and unconventional monetary policies.[13]

Analogously, we compute the duration of domestic monetary policy easing (D_{kt}) for each country k in our sample.[14] We plot D_t^{US} in Fig. 2 below.

It is important to note that the duration variables are based on consecutive easings (i.e., successive rate declines). As such, we are not measuring whether the stance of monetary policy is more or less accomodative.[15] For example, even when monetary policy easing leads to a reduction in the market rates, the monetary policy stance remains tight if the market rates are still above the natural rate of interest. Instead, our focus is on declines in observable market interest rates. This means both that our duration measure is not a measure of policy stance and that movements could reflect various factors other than changes in monetary policy.

Turning to policy spillovers, we estimate the impact of prolonged monetary policy easing, both domestic and U.S., on financial institution leverage using the following equation:

$$\ln(Y_{ikt}) = \alpha_0 + \alpha_1 D_{kt} + \alpha^{US} D_t^{US} + \beta X_{k,t-1} + c_i + \varepsilon_{ikt}, \tag{2}$$

where Y_{ikt} is leverage for firm i in country k at time t; D_{kt} and D_t^{US} are the duration of domestic and U.S. monetary policy easing, respectively; c_i is a firm fixed effect; and $X_{k,t-1}$ is a vector of lagged macroeconomic control variables that includes year-on-year GDP growth, equity price growth, equity volatility and the sovereign's bond rating. This specification allows us to interpret the coefficient of the duration as a semi-elasticity. For example, α^{US} measures the percentage change in financial firms' leverage for each additional one-quarter of U.S. monetary policy easing.

Table 1 reports the results of estimating Eq. (2). Looking at the details, first note that we report the marginal effect of a one-quarter increase in the duration of policy easing evaluated at the median of the data.[16] As a result, these numbers are in the same units as the raw leverage numbers. For example, we estimate that a one-quarter easing increases bank leverage in a representative country by 0.07, from 14.4 to 14.5, an increase that is significantly different from zero at the 10 % level.[17]

Overall, we confirm the results first reported in Cecchetti et al. (2020) that prolonged U.S. monetary policy increases financial firms' leverage, and its effects are typically larger than those of domestic monetary policy easing. For example, one quarter of additional U.S. monetary policy easing increases bank leverage by 0.13—nearly double that of domestic easing, which is 0.07.[18]

Evidence of sizable spillover effects from U.S. monetary policy

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[10] "Banks" are firms that derive their revenue primarily from conventional banking operations. "Insurance companies" include life- and non-life insurers, as well as reinsurance companies. "Investment banks" are firms that primarily engage in investment banking and brokerage services. "Asset management" are entities that invest third-party funds. "Real estate firms" consist of real estate investment trusts (REITs), as well as real estate management and development firms. And "other" includes holding companies, consumer finance firms, and firms that provide specialized or diversified financial services.

[11] The market-value leverage of a financial firm reflects not only the firm's risk-taking behavior but also market valuation effects. In the context of U.S. monetary policy easing, as the U.S. dollar depreciates, the valuation effects include a mechanical reduction in the market-value leverage to the extent that liabilities are denominated in U.S. dollars. However, Cecchetti et al. (2020, Table 6) find that the overall spillover effects on the market-value leverage remain roughly unchanged even after excluding the mechanical reduction, which is found to be empirically small.

[12] Adrian and Shin (2014), Adrian et al. (2016) argue that book-value leverage is useful in assessing the lending capacity of financial intermediaries.

[13] The two-year sovereign yield is used as an indicator of monetary policy in many studies that cover periods during which unconventional monetary policies are in place (e.g., Swanson and Williams, 2014, Gertler and Karadi, 2015, Gilchrist et al., 2015, Hanson and Stein, 2015, Ambler and Rumler, 2019), while it is fair to say that the extent of monetary policy transmission to two-year yield may vary across time periods and countries (e.g., Rogers et al., 2014). As a robustness check, we also construct the duration measure of U.S. monetary policy easing using the "shadow" short-term interest rate by Wu and Xia (2016) and find that its correlation with our baseline duration measure is high at 0.8 (at a one-percent level of statistical significance). The regression results in Section III are also nearly identical when using this alternative duration variable.

[14] Cecchetti et al. (2020) discuss alternative measures of the duration of monetary policy easing, including a measure based on the cumulative declines in the interest rate during the sustained easing, and report that results are similar.

[15] The policy stance is often measured by deviations from the natural interest rate or a Taylor rule, both of which involve unobservable variables (e.g., natural interest rate, output gap). Hence, results can vary across specifications (e.g., Carare and Tchaidze, 2005, Nikolsko-Rzhevskyy et al., 2014). Also, Laubach and Williams (2003) and Holston et al. (2017) emphasize the uncertainty in the estimated natural rate.

[16] To compute the marginal impact of a change in duration on the level of leverage, first rewrite equation (2) as $Y_{ikt} = \exp(\alpha_1 D_{kt} + \ldots)$. Then take the derivative with respect to D_{kt} to obtain $[\partial Y_{ikt}/\partial D_{kt}] = \alpha_1 \exp(\alpha_1 D_{kt} + \ldots) = \alpha_1 Y_{ikt}$, which is the marginal effect. Alternatively, differentiate (2) to obtain $(1/Y_{ikt})\, dY_{ikt} = a_1 dD_{kt}$, so $(dY_{ikt}/dD_{kt}) = a_1 Y_{ikt}$. We evaluate $\alpha_1 Y_{ikt}$ at the sample median leverage and report the result in Table 1. Standard errors are computed using the delta-method, evaluated at this same sample median.

[17] To address the possible endogeniety bias in estimating the effect of the duration of sustained easing, Cecchetti et al. (2020) conduct a robustness check with the panel generalized method of moments (GMM) estimator and find that results are similar.

[18] See Table 3 of the earlier paper. We also confirm the earlier results using two alternative measures of risk, the Sharpe ratio and the z-score.

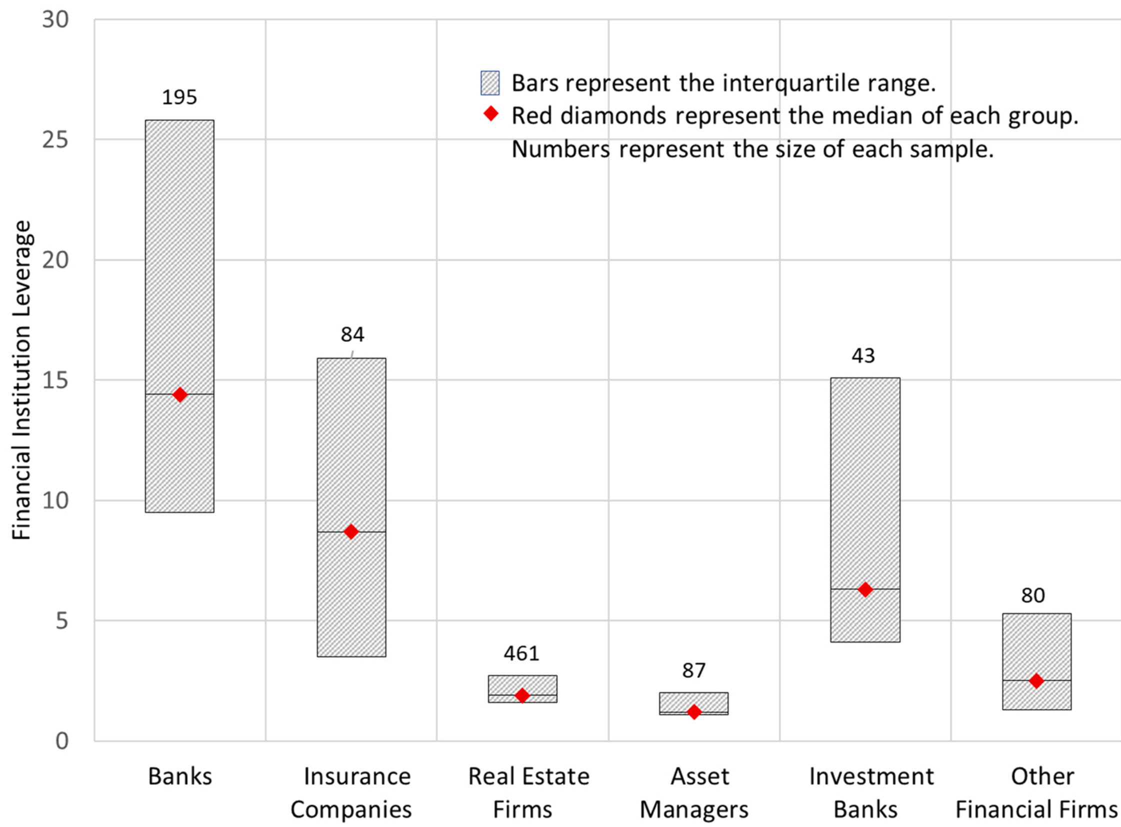

Fig. 1. Leverage Ratio of Financial Firms by Industry Group. Sources: Datastream, Worldscope, and authors' calculations. Notes: Computations are based on an unbalanced panel data for 950 publicly listed financial firms in 28 non-U.S. countries from 1998Q1–2019Q3. To avoid over-representation from firms with more observations, we report industry percentiles from firm-level medians. The statistics are not weighted by asset size. Leverage is measured as the market value of equity plus the book value of liabilities divided by the market value of equity.

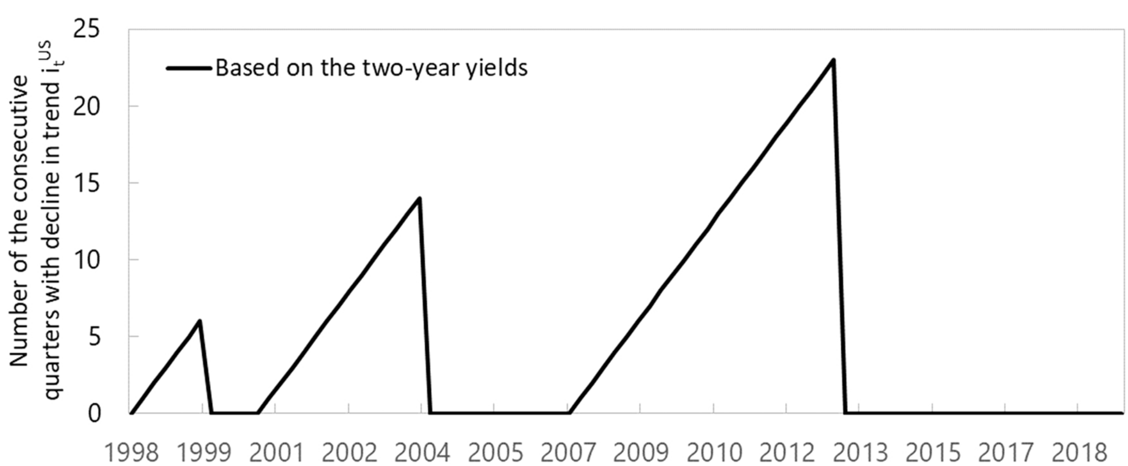

Fig. 2. Duration of U.S. Monetary Policy Easing. Sources: Bloomberg and authors' calculations. Notes: The figure displays the time-series of the duration variables of U.S. monetary policy easing. As defined in Eq. (1), the duration variable is the number of consecutive quarters with a decline in the trend component of the two-year U.S. sovereign yields (i_t^{US}), measured as the moving average: $\bar{i}_t^{US} = \frac{1}{8}\sum_{\tau=1}^{8} i_{t-\tau+1}^{US}$.

highlights the complex challenge facing many authorities, especially those in small open economies. When a country's business cycle is correlated with that of the United States, domestic monetary policy and spillovers will work together without amplifying the swings in financial sector vulnerability. But, when a given country and the United States business cycles are at different stages, domestic authorities may feel the need to counter the impact of U.S. policy.

Other empirical studies provide complementary evidence to support the view that U.S. monetary policy spillovers have financial stability implications across a wide range of countries. For example, Barroso, Pereira da Silva and Soares Sales (2016) conclude that U.S. quantitative easing led to an increase in accumulated gross capital inflows by 2–4 % in Brazil. And, Morais et al. (2019) find that monetary policy easing in major advanced economies softens lending conditions more for high-credit-risk firms in Mexico, suggesting international search-for-yield behavior. The general concern is that U.S. monetary policy actions induce cross-border financial flows that can create financial stability risks in recipient countries.

Table 1
Impact of Domestic and U.S. Monetary Policy Easing on Financial Firm Leverage.

	Banks	Insurance Companies	Real Estate Firms	Asset anagers	Investment Banks	Other
Impact of Dom. Pol. Easing (α_1)	0.074†	0.039†	–0.006†	0.000	0.064 **	–0.010†
	(0.042)	(0.021)	(0.003)	(0.001)	(0.022)	(0.006)
Impact of U.S. Pol. Easing (α^{US})	0.131 **	0.070 **	0.014 **	0.004 **	0.045†	0.024 **
	(0.045)	(0.015)	(0.004)	(0.002)	(0.025)	(0.008)
Median Leverage	14.441	8.750	1.940	1.249	6.272	2.512
Number of Observations	10,130	4015	17,787	3105	1823	3520
R^2	0.17	0.09	0.09	0.04	0.11	0.06

Sources: Bloomberg, Datastream, Haver, WEO, Worldscope, and authors' estimates.
Notes: Estimates, from Eq. (2), of the marginal effect of one additional quarter of own-country and U.S. monetary policy easing, evaluated at the sample median (e.g., for domestic duration, it shows $\partial Y/\partial D = \widehat{\alpha}_1 \overline{Y}$, where $\overline{Y}$ is the sample median of leverage). Standard errors are in parentheses, based on Driscoll and Kraay (1998), which are robust to heteroscedasticity and cross-sectional and temporal dependences with stationary variables.
** Significantly different from zero at the 1 % level.
* Significantly different from zero at the 5 % level.
† Significantly different from zero at the 10 % level.

3. Domestic policies to address risks from spillovers

We now turn to our primary question: Can countries use domestic policies to mitigate or prevent the spillover effects from prolonged U.S. monetary policy easing?

Recently developed theoretical models demonstrate how, in the presence of financial frictions and externalities, achieving macroeconomic and financial stability objectives may require using multiple policy tools. For example, Farhi and Werning (2016) and Korinek and Sandri (2016) show that macroprudential policies and capital flow management measures (CFMs) can enhance macro-financial stability by preventing excessive borrowing when private agents do not internalize their collective impact on aggregate demand or asset prices (i.e., when externalities exist). Cavallino (2019) and Fanelli and Straub (2021) conclude that when international financial markets are imperfect, to meet the objective of macro-financial stability, foreign exchange intervention (FXI) should lean against cross-border portfolio flows by accumulating reserves. Basu et al. (2020) show that, depending on country-specific characteristics, optimal stabilization policy requires that authorities use a combination of policies. With this in mind, we examine the efficacy of macroprudential, CFM, and FXI policies in addressing the risks posed by prolonged U.S. monetary policy easing on financial firms' leverage.

Before turning to the estimates, we document the use of these tools in our sample economies. In Fig. 3 we plot the average across countries of the fraction of macroprudential and capital flow management policy instruments in place at any one time.[19] For the former, we use the annual indices from Cerutti et al. (2017), covering 12 categories of instruments.[20] For CFMs, we use information on 29 categories of the measures intended to restrict capital inflows that Baba et al. (forthcoming) construct (named "FARI") from information in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.

The black line in Fig. 3 indicates the growing use of macroprudential measures in recent years. Unsurprisingly, use of these tools increases following the global financial crisis—a fact others document as well.[21] Note that at the beginning of our sample, roughly 10 % of the macroprudential instruments were in place. Over the intervening 20 years, the number has gradually risen to 35 % as more instruments have been introduced. Considered individually, the borrower- and institution-based components of the combined index follow the same pattern.

For CFMs, the usage of inflow measures is relatively low in our sample of 28 countries, while there is heterogeneity across countries. The average fraction of the inflow restrictions in use fluctuates around 20 % (see the red dotted line in Fig. 3). Furthermore, it is worth noting that CFMs are more actively used among emerging market economies.[22]

Turning to official FX intervention, while it is common in emerging market economies, the overall frequency in our sample of countries is relatively low.[23] Focusing on the 12 countries whose FX intervention data are publicly available, Fig. 4 reports the number of countries conducting official intervention in each quarter. On average, just one or two countries announce either FX purchases (black bars) or sales (red bars) in a quarter.

Our interest is in the ability of policies to both mitigate and prevent the potentially damaging impact from U.S. monetary policy spillovers on leverage that we documented in Section 2. However, in practice, it is often difficult to identify policymakers' intentions (i.e., whether a policy action is intended to address current or future spillovers). Thus, in estimating the impact of mitigative and preventative actions, we focus on the timing of policy actions. To study mitigation, we look at the impact of policy shocks that are coincident with U.S. policy easing. To examine prevention, we examine the influence of domestic pre-existing policy to capture the impact of actions taken anytime in the past. We note that, at an operational level, preventative policies can be taken without the need to predict spillovers. Instead, it is possible to put them in place simply in anticipation of the possibility that they might occur.

3.1. Mitigating the impact of spillovers on leverage

Starting with mitigation, we ask whether macroprudential, CFM and FXI policies can neutralize the influence of prolonged U.S. monetary policy easing on financial firm leverage. Policy is, however, endogenous. When they act, policymakers are reacting to changing macroeconomic and financial conditions. To address the possibility of reverse causality, we look at the impact of policy shocks—that is, we use the portion of the policy action that is orthogonal to changes in the macro-financial environment.

Specifically, we estimate the following equation:

[19] Please note that information in Fig. 3 is based solely on whether indicators are on or off, so it captures introductions and repeals but not the intensity of the measures. For the regression analysis, we additionally consider other indicators that also capture adjustments in the calibration of the measures (e.g., tightening, loosening), going beyond the broad on/off usage. Unfortunately, we do not have information on the intensity of the adjustments.

[20] Of these,10 measures are institution-based, including capital buffers, exposure limits, and reserve requirements; and 2 measures are borrower-based, including the limits on debt-to-income and loan-to-value ratios.

[21] For example, see IMF-FSB-BIS (2016), Akinci and Olmstead-Rumsy (2018), and Alam et al. (2019).

[22] See Chinn and Ito (2006), Klein (2012), Fernandez, et al. (2016), and Erten et al. (2020).

[23] Mano and Sgherri (2020) show that the use of FXI is heterogeneous even within emerging market economies. Please also see Chamon et al. (2019) and Fratzscher et al. (2019).

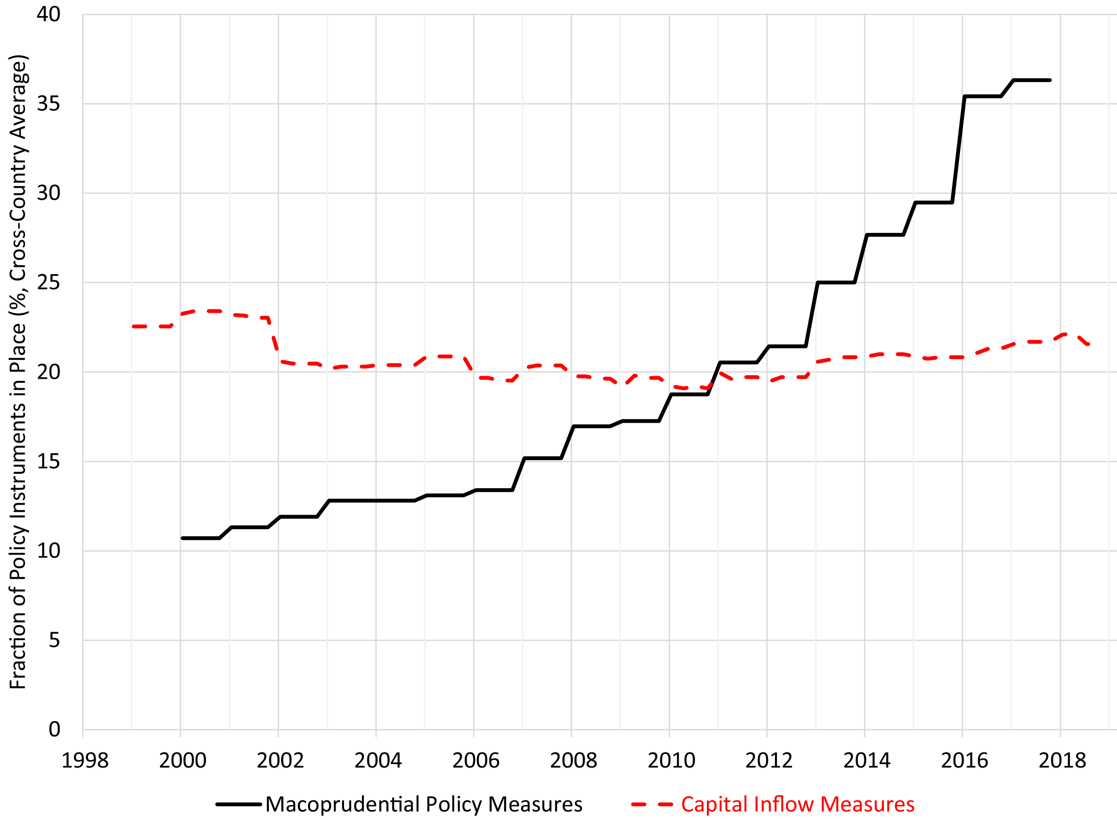

Fig. 3. Macroprudential and Capital Flow Management Measures in Place. Notes: The figure shows the average across countries of the fraction of instruments in place (i.e., the number of instruments in place relative to the number of all instruments covered in the relevant databases) at any point in time for macroprudential policy (black line) and capital inflow restrictions (red line). See the appendix for details. Sources: Macroprudential indicators are from Cerutti et al. (2017), and capital inflow restrictions indicators are from Baba et al. (forthcoming).

$$\ln(Y_{ikt}) = \alpha_0 + \gamma_1 P_{k,t}^{Shock} + \gamma_2 P_{k,t}^{Shock} x D_t^{US} + \beta X_{k,t-1} + c_i + d_t + \varepsilon_{ikt}, \quad (3)$$

where Y_{ikt} is leverage of firm i in country k, D_t^{US} is the U.S. easing duration defined above, $P_{k,t}^{Shock}$ is the policy shock, $X_{k,t-1}$ is a vector of domestic controls listed in the previous section, c_i is the firm fixed effects, d_t is the time fixed effects to control for global factors (including D_t^{US} on its own), and ε_{ikt} is the residual.[24] Our interest is in the direct impact of a shock (γ_1), the marginal effect of reacting to U.S. policy easing $(\gamma_2 D_t^{US})$, and the combined influence ($\gamma_1 + \gamma_2 D_t^{US}$).

Briefly, we construct the policy shocks as the deviations from estimated policy rules, following Brandao-Marques et al. (2020). For macroprudential policy and CFMs, we begin with a set of monthly indicators that take on a value of +1 for a tightening, –1 for a loosening, and 0 for neutral or no action, and aggregate them to create a quarterly series.[25] Using an ordered probit, we estimate a policy reaction function, from which we derive a series of shocks. The units of the policy shock are thus the number of tightening actions, net of the number of loosening actions, within the specified policy category during a given quarter. For FXI, we construct the shock as the residual of an OLS regression of a policy reaction function, using the amount of FXI in percent of GDP. The appendix provides additional details.

In light of our nonlinear specification, the use of policy shocks in the estimation has a benefit of tractability. If models are linear, this two-stage approach (i.e., first estimate policy shocks and then estimate the main regressions) yields the same point estimates as the one-stage approach (i.e., estimate the main regressions by adding all regressors used to estimate policy shocks).[26] However, this equivalence does not hold for our nonlinear specifications, where the main regressions include cross-terms with the policy shock and the policy shock estimations are mostly probit models (except for FXI). A caveat of this two-stage approach, though, is that the standard errors of the main regressions do not reflect estimation uncertainty from the first stage of estimating policy shocks and thus tend to indicate stronger statistical significance of estimated coefficients.

Turning to the results, in Table 2 we report estimates of the marginal impact of a one standard deviation policy shock evaluated at the sample median. Both the standard deviation of the shocks and the median leverage for each group are noted in the table. So, for example, the standard deviation of the shocks to macroprudential policy is 0.53 for all instruments, 0.14 for borrower-based instruments, and 0.47 for institution-based instruments. For CFMs, the standard deviation is 0.27. (Recall that these are all based on the number of policy-tightening actions, net of the number of loosening actions.) For FXI the standard deviation is 0.0018.

We group the results into five blocks, one for each group of policies that we study. These include the borrower- and institution-based macroprudential policy measures, as well as the sum; the capital inflow

[24] Time fixed effects are not included in equation (2) because they would absorb the effect of prolonged U.S. monetary policy easing, which is our primary variable of interest there. However, in equation (3), our primary interest is to see the impact of the use of policy on financial firms' leverage. We include time fixed effects here to control for global factors, which could be correlated with the use of policy measures.

[25] These dummy-type indices of macroprudential policy and CFMs only indicate the direction of a policy change, and thus still lack information on the intensity of the change. For example, see Alam et al. (2019) for more discussion.

[26] This is a direct implication of the Frisch-Waugh-Lovell Theorem. See Frisch and Waugh (1933) and Lovell (1963).

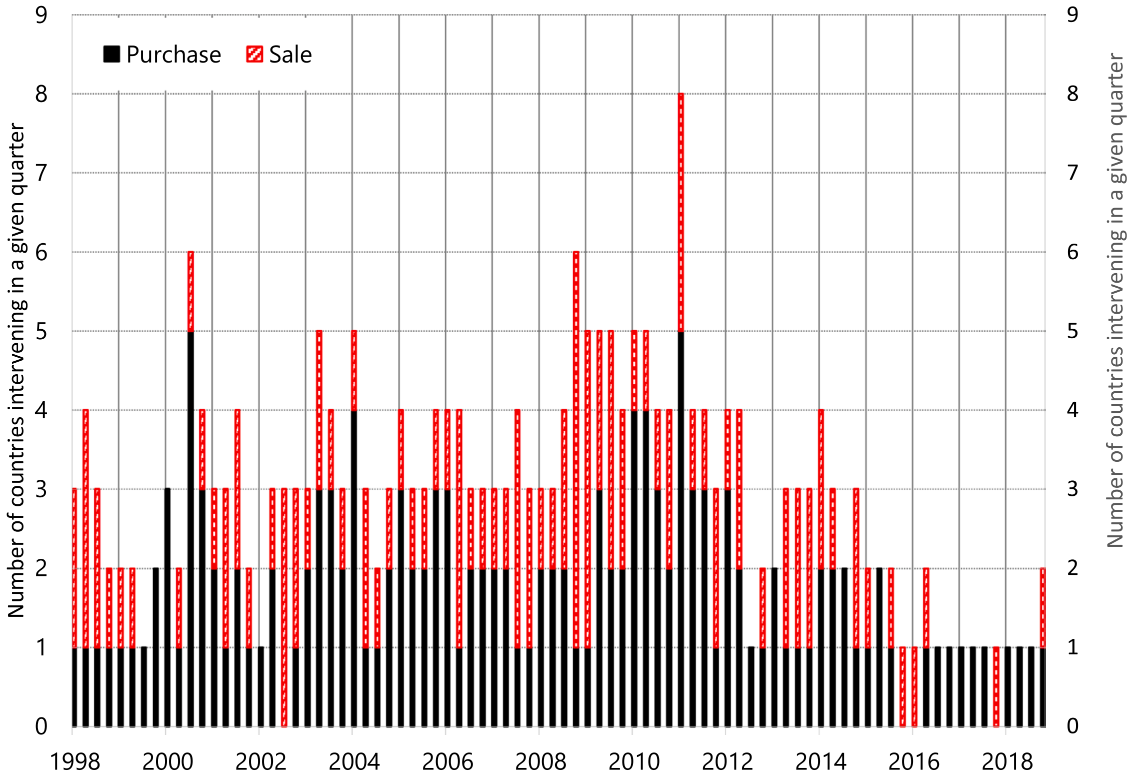

Fig. 4. Foreign exchange interventions. (Number of Countries Intervening Per Quarter). Notes: The figure shows the number of countries where official foreign exchange (FX) interventions (i.e., FX sales or purchases) took place in each quarter for the subsample of 12 countries with actual FX intervention data published—Australia, Brazil, Canada, Switzerland, Colombia, Germany (before 1999), Italy (before 1999), Japan, Mexico, Russia, Türkiye and United Kingdom. From 1999Q1, there are only 11 countries, as Italy and Germany joined the euro area. Please note that, if one country conducts both purchases and sales of FX in the same quarter, the country is counted twice in the quarter. See the appendix for details. Sources: Central banks' websites and the Federal Research Economic Database (FRED).

measures; and foreign exchange interventions. We highlight in yellow those estimates that are significantly different from zero at the 1 % or 5 % level. Estimates that are significantly different from zero at the 10 % level are in gray. Since we hope for negative estimates—policy interventions intended to increase systemic financial resilience should be associated with reduced leverage—we indicate positive estimates in red if they are statistically significant.

As in Table 1, the numbers in Table 2 are in the same units as the leverage variable. This means that a one standard deviation shock to all macroprudential measures—an unexpected increase of 0.53 in the number of tightening actions—results in decline in bank leverage from the median of 14.441 to 14.187, a decrease of 0.254 (the number in the top-left-most cell in the table).

Overall, the results are discouraging. While the macroprudential policy does have an impact on banks—note the yellow highlighted cells in the first row of the top three panels—the interaction term tends to be both statistically and economically small. Even in the cases where estimates are statistically significantly negative—that is the case for real estate firms, asset managers, and other financial firms—the impact is never greater than 0.004. While macroprudential policy may succeed in reducing bank leverage in normal times, it is generally ineffective at containing the leverage spillovers arising from prolonged U.S. monetary policy easing.[27]

Other studies also find weak effects when macroprudential tightening is in reaction to easy financial conditions. Brandao-Marques et al. (2020) conclude that tightening macroprudential policy in response to a loosening shock in financial conditions does not offset its stimulating effects on output in the short term. And Gelos et al. (2019) find that macroprudential actions in response to an adverse shock in global financial conditions do not affect the short-term outlook for portfolio inflows. However, both studies report some benefits in the medium term, providing mild support for the preventative use of macroprudential policies that we examine below.

For CFMs, the effects tend to be even smaller and less statistically significant than those for macroprudential policy (Section B of Table 2). That is, the reactive tightening of CFMs appears to be ineffective. We note that our "all inflow" restriction index may include some less relevant restrictions, thereby obscuring the impact of the effective measures.[28] With this qualification, we conclude that there is little evidence for the effectiveness of reactive tightening of CFMs.

Reactive FXI that aims to counteract the spillover of U.S. policy on financial institution leverage is not promising, either. Our estimates of the interaction term (γ_2) in Section C of Table 2 are close to zero for all sub-groups of the industry. Although the results for the total effect of FXI is negative in all industries, it tends to be small and statistically insignificant. That is, official FX purchases aimed at countering capital inflows during a prolonged U.S. monetary policy easing may discourage

[27] Our result of significant effects on bank leverage in normal times ("Total effect" in Section A of Table 2 for "Banks") is consistent with the findings in Claessens et al. (2013), Zhang and Zoli (2016), and Forbes et al. (2015). The insignificant effects on non-bank financial institutions' leverage could reflect the fact that macroprudential policies have been mostly applied to loans by banks (Cizel et al., 2019).

[28] To address this, we ideally want to consider a CMF shock based on the restrictions that target inflows of debt, money markets and financial credits, which are arguably more relevant for financial firms' leverage. However, since these sub-categories are only available from 2016 in the IMF's AREAER database, we cannot conduct robustness checks in a reliable way.

Table 2
Mitigation Policies.

		Banks	Insurance Companies	Real Estate Firms	Asset Managers	Investment Banks	Other
A. Macroprudential Policy Shocks							
All measures (s.d.= 0.53)	Macroprudential tightening	-0.254† (0.148)	-0.037 (0.077)	0.007 (0.015)	0.011 (0.01)	-0.243 (0.167)	0.029 (0.02)
	Interaction	-0.017 (0.013)	0.011 (0.01)	-0.003** (0.001)	-0.002** (0.001)	0.016 (0.011)	-0.004* (0.002)
	Total effect	-0.332** (0.111)	0.014 (0.068)	-0.008 (0.013)	0.002 (0.008)	-0.171 (0.134)	0.009 (0.020)
Borrower-based measures (s.d.= 0.14)	Macroprudential tightening	-0.124* (0.054)	-0.012 (0.03)	0.002 (0.007)	0.005 (0.007)	-0.073 (0.069)	0.017 (0.014)
	Interaction	-0.001 (0.005)	0.010** (0.002)	-0.001** (0)	-0.001† (0)	0.009* (0.004)	-0.002† (0.001)
	Total effect	-0.129** (0.050)	0.034 (0.030)	-0.004 (0.006)	0.001 (0.005)	-0.033 (0.055)	0.008 (0.013)
Institution-based measures (s.d.= 0.47)	Macroprudential tightening	-0.327** (0.121)	0.031 (0.084)	0.004 (0.014)	0.020† (0.011)	-0.245† (0.151)	0.029 (0.02)
	Interaction	-0.011 (0.016)	-0.010 (0.01)	-0.002** (0.001)	-0.002* (0.001)	0.007 (0.011)	0.000 (0.002)
	Total effect	-0.378** (0.100)	-0.014 (0.073)	-0.006 (0.014)	0.011 (0.009)	-0.214† (0.119)	0.030 (0.020)
B. Capital Inflow Policy Shocks							
Inflow CFMs (s.d.= 0.27)	CFM tightening	-0.097 (0.095)	-0.041 (0.039)	-0.003 (0.009)	0.002 (0.004)	-0.142* (0.061)	-0.008 (0.016)
	Interaction	0.006 (0.006)	0.003 (0.007)	0.000 (0.001)	-0.001† (0.001)	0.018** (0.006)	0.002 (0.001)
	Total effect	-0.067 (0.071)	-0.029 (0.039)	-0.003 (0.006)	-0.003 (0.004)	-0.058 (0.049)	0.002 (0.012)
C. Foreign Exchange Intervention							
FXI (s.d. = 0.0018)	FX purchase	-0.031 (0.023)	-0.005 (0.017)	-0.003 (0.002)	-0.001 (0.002)	-0.012 (0.018)	-0.007* (0.004)
	Interaction	0.001 (0.002)	0.001 (0.001)	0.0000 (0.0002)	-0.0001 (0.0001)	0.001 (0.001)	0.0003 (0.0003)
	Total effect	-0.027 (0.019)	-0.003 (0.013)	-0.002 (0.002)	-0.001 (0.001)	-0.009 (0.013)	-0.006* (0.003)
Median Leverage		14.4	8.7	1.9	1.2	6.3	2.5

Sources: Bloomberg, Datastream, Haver, WEO, Worldscope, others (see the appendix), and authors' estimates.
Notes: Based on Eq. (3), reported estimates are for the marginal impact of one standard deviation policy shock on leverage, evaluated at the sample mean for U.S monetary policy duration (4.6 quarters) and the median for leverage. One standard deviation policy shock is shown in parenthesis in the first column, and it is calculated by taking country-specific standard deviations and then taking their median. Standard errors of the estimated coefficients, in parentheses, use the method of Driscoll and Kraay (1998) and are robust to heteroscedasticity and cross-sectional and temporal dependences with stationary variables. The sample is from 1998 Q1 to 2018 Q4 for macroprudential policy, from 1998 Q3 to 2017 Q4 for capital inflow policy, from 1998 Q3 to 2018 Q4 and for FXI.
** Significantly different from zero at the 1 % level.
* Significantly different from zero at the 5 % level.
† Significantly different from zero at the 10 % level.
Red indicates estimates that are significantly greater than zero.

some risk-taking of financial firms, but their overall impact seems to be minor. Since a firm's response to FXI could depend on its FX exposure, we also consider alternative specification, adding the firm-level stock of U.S. dollar liabilities in the regression.[29] But we find that the results are broadly the same as those reported in Table 2: even accounting for variation in U.S. dollar exposure, the effects of the reactive FXI on financial institution leverage are almost zero.

These results are again consistent with the few studies that are available. Examining the reactive use of CFMs and FXI in response to global shocks, others also report limited evidence for their effectiveness. For example, Brandao-Marques et al. (2020) find that tightening CFMs or purchasing FX to counter loose global financial conditions entail very small benefits on macroeconomic stability. Gelos et al. (2019) conclude that, in response to an adverse shock, tightening CFMs exacerbates the downside risks to portfolio outflows, so it is counterproductive. They find that FX sales in the face of adverse shocks reduce the tail risk of large outflows but only in the short term.

3.2. Preventing the impact of spillovers on leverage

Turning to prevention, we examine whether pre-existing policy measures can inoculate a country's financial system from the potentially damaging spillovers arising from U.S. monetary easing. Our goal is to see if pre-existing policy can build resilience to adverse events, including U.S. monetary policy easing. To address this question, we replace policy shocks in Eq. (3) with a lagged indicator of policies and estimate:

$$\ln(Y_{ikt}) = \alpha_0 + \gamma_1 P_{k,t-4} + \gamma_2 P_{k,t-4} x D_t^{US} + \beta X_{k,t-1} + c_i + d_t + \varepsilon_{ikt}, \quad (4)$$

where $P_{k,t-4}$ is the four-quarter lag of the measure of existing policy in country k. All other variables are as in Eq. (3).

As the measure of existing policy ($P_{k,t-4}$), we use the four-quarter lag of the number of policy instruments in place as a share of total number of policy instruments under consideration. This is a number from 0 to 100, with the higher values indicating that more instruments are in use. For macroprudential measures (all, borrower-based, financial-institution-based), we use the annual indicators by Cerutti et al. (2017), covering from 2000 to 2017.[30] For CFMs, we use the quarterly indices from Baba et al. (forthcoming). For FX buffers, on the other hand, we use the four-quarter lag of FX reserves as a percentage of GDP. Arguably, pre-existing policies are less correlated with current macro-financial developments, and thus less subject to reverse causality. For this reason, we estimate (4) using the actual policies themselves rather than policy shocks.[31]

We note that because they reflect introductions and repeals of a regulation only (ignoring any changes in intensity), these existence-based indicators have limited variation. For example, for borrower-based macroprudential measures, there is no variation in 16 of 28 countries, while all but two countries have variation for institution-based measures.[32] For the capital inflow measures, there are three countries for which the data show no variation over the sample: Belgium, Ireland and the Netherlands.[33]

Our results strongly suggest that preventative policy works. In Table 3, we report our estimates of Eq. (4) for six sectors and five types of policy interventions. First, 35 of the 90 estimated coefficients are significantly less than zero at the 5 % level or lower (these are the negative numbers highlighted in yellow). Furthermore, some of the effects are quite large.[34]

In numerous cases, those in red, policy do seem to be counterproductive. In our view, however, these are likely a consequence of the limited variation in the policy indices we employ. For example, in the case of impact of borrower-based macroprudential measures on insurance companies, the estimates are quite large and statistically significantly *greater* than zero at the 5 % level. They are based on a very limited number of firm-quarter observations with policy variation (due to the lack of variation in 16 of 28 countries for borrower-based measures, as discussed earlier).

Looking at the details, the first column of the table shows that macroprudential policies are particularly effective at containing leverage buildup in banks. This is true for borrower-based measures, where the estimated coefficient is significant at the 1 % level. For institution-based measures, the impact is of the right sign, albeit imprecisely estimated. As we note earlier, this is unsurprising given that the bulk of these policies are currently aimed at banks.

Next, focusing on the top panel labelled "all measures", we see that the interaction (γ_2) is significantly negative at the 5 % level for banks, real estate firms, asset managers and investment banks. That is, a higher existing measure of macroprudential policy helps prevent the leverage spillovers from U.S. policy. The results using the two types of measures separately (in the corresponding estimates in the second and third panel) confirm this conclusion. There is a stark difference from the results in Table 2—the mitigative effects (γ_2) from the reactive tightening of macroprudential policy in response to prolonged U.S. monetary easing were generally not statistically significant.

Turning to the overall impact of the pre-existing macroprudential policies, the term ($\gamma_1 + \gamma_2 D_t^{US}$) measures the percentage change in financial firms' leverage due to an increase in *the share of already-in-use* measures shown in the left-hand side panel. For example, for all measures, the experiment is an increase of 8.3 %, which represents activation of one instrument. In all cases, we set the number of quarters of U.S. monetary easing to the sample average of 4.6. Our estimates suggest that the borrower-based measures have the intended impact on banks; and that institution-based measures succeed in depressing leverage in

[29] Using EIKON's issuance-level data of new bonds and syndicated loans by currency, we constructed the time-series of the USD liability stock as a share of the total stock of each firm. Our underlying assumptions are (1) the USD liability share in the category of bonds and syndicated loans is the same for other liability categories; and (2) the debt is paid entirely at the maturity (due to the lack of repayment data). See also Table A3 in the appendix.

[30] Please note that the indicator by Cerutti et al. (2017) is only available at the annual frequency and covering less instruments than those from the IMF's iMaPP database that we used for the mitigation analysis.

[31] While we could examine preventative actions using lagged policy shocks, in practice this requires choosing appropriate prefixed lags to capture the impact of policy changes that could have been taken anytime in the past. As Klein (2012) highlights, in cases like "long-standing" CFMs, measures implemented in the far past cannot be ignored. This implies that we would need to include so many lagged shocks in the regressions that the result would no longer be reliable. Therefore, our solution is to use the stock of pre-existing measures in examining the effect of preventative actions.

[32] For borrower-based macroprudential measures, over the 2000–2017 sample, there is no variation in the measure of existing policy ($P_{k,t}$) for Australia, Austria, Belgium, Colombia, France, Germany, Hong Kong, Japan, Mexico, Malaysia, Portugal, Russia, Spain, Switzerland, South Africa, and the United Kingdom. In the case of the institution-based measures, Brazil and Malaysia have no variation.

[33] Such limited or missing variation in these policies-in-place indices could cause the attenuation bias in the estimated policy effects. See Erten et al. (2021).

[34] Recall that the size of the estimated effects between mitigation and prevention regressions are not directly comparable, because policy variables are in different units—e.g., the number of net tightening actions vs. the fraction of instruments in place, for macroprudential policies and CFMs. Therefore, when comparing the effects of mitigative and preventative policies, we focus on the sign and statistical significance of the estimates.

Table 3
Preventative policies.

		Banks	Insurance Companies	Real Estate Firms	Asset Managers	Investment Banks	Other
A. Macroprudential Policy							
All measures (Δ=8.3%)	Macroprudential tightening	-0.798** (0.187)	-0.454* (0.209)	-0.015 (0.017)	0.043** (0.016)	0.151 (0.236)	0.027 (0.046)
	Interaction	-0.042** (0.013)	0.003 (0.009)	-0.006** (0.002)	-0.003* (0.001)	-0.025* (0.012)	-0.010† (0.006)
	Total effect	-0.993** (0.191)	-0.441* (0.178)	-0.043** (0.016)	0.030* (0.014)	0.034 (0.202)	-0.021 (0.042)
Borrower-based measures (Δ=50%)	Macroprudential tightening	-1.958** (0.31)	0.979** (0.339)	0.052 (0.056)	0.005 (0.024)	1.159** (0.391)	0.238† (0.122)
	Interaction	-0.104** (0.031)	-0.043* (0.021)	-0.009** (0.003)	-0.002† (0.001)	-0.061** (0.017)	-0.022* (0.009)
	Total effect	-2.441** (0.242)	0.779** (0.288)	0.012 (0.050)	-0.006 (0.022)	0.876* (0.347)	0.134 (0.106)
Institution-based measures (Δ=10%)	Macroprudential tightening	-0.124 (0.197)	-0.983** (0.157)	-0.047† (0.025)	0.056* (0.023)	-0.297† (0.173)	-0.067 (0.069)
	Interaction	-0.034** (0.012)	0.017* (0.007)	-0.005** (0.002)	-0.004* (0.002)	0.004 (0.01)	-0.006 (0.006)
	Total effect	-0.282 (0.204)	-0.905** (0.146)	-0.071** (0.025)	0.038† (0.022)	-0.276† (0.164)	-0.093 (0.069)
B. Capital Inflow Policy							
Inflow CFMs (Δ=3.45)	CFM tightening	0.238 (0.145)	0.290* (0.139)	0.059** (0.014)	-0.010 (0.011)	-0.337** (0.113)	0.242** (0.047)
	Interaction	-0.026** (0.007)	-0.016** (0.004)	-0.002** (0.0005)	-0.0004 (0.0005)	0.005 (0.008)	-0.003* (0.001)
	Total effect	0.119 (0.136)	0.215† (0.130)	0.051** (0.014)	-0.012 (0.010)	-0.313** (0.099)	0.230** (0.048)
C. Foreign Exchange Buffers							
FX buffers (Δ=9.78)	FX buffer increase	-0.020 (0.04)	-0.098** (0.017)	0.003 (0.005)	0.007** (0.002)	-0.145** (0.014)	-0.017 (0.012)
	Interaction	-0.006** (0.002)	-0.002 (0.001)	-0.0003* (0.0001)	0.0001* (0.0001)	-0.0003 (0.001)	-0.001** (0.0002)
	Total effect	-0.049 (0.041)	-0.107** (0.018)	0.002 (0.005)	0.008** (0.002)	-0.146** (0.015)	-0.020 (0.012)
Median Leverage		14.4	8.7	1.9	1.2	6.3	2.5

Sources: Bloomberg, Datastream, Haver, WEO, Worldscope, others (see the appendix), and authors' estimates.
Notes: Based on Eq. (4), reported estimates are for the marginal impact of the change in the preventative policy indicator on leverage, evaluated at the sample mean for U.S monetary policy duration (4.6 quarters) and the median for leverage. The change of each preventative policy indicator is shown in parentheses in the first column, and it corresponds to the activation of one additional instrument for macroprudential policies and CFMs. For FX buffers, it is calculated by taking country-specific standard deviations and then taking their median. Standard errors of the estimated coefficients, in parentheses, use the method of Driscoll and Kraay (1998) and are robust to heteroscedasticity and cross-sectional and temporal dependences with stationary variables. The sample is from 1998 Q1 to 2017 Q4 for macroprudential policy, from 1998 Q3 to 2017 Q4 for capital inflow policy, and from 1998 Q3 to 2018 Q4 for FXI.
* * Significantly different from zero at the 1 % level.
* Significantly different from zero at the 5 % level.
† Significantly different from zero at the 10 % level.
Red indicates estimates that are significantly greater than zero.

Table 4
Amplified spillover effects for already highly leveraged financial firms.

	Banks	Insurance Companies	Real Estate Firms	Asset Managers	Investment Banks	Other
Impact of U.S. Pol. Easing (θ_1^{US})	-0.005	0.022	-0.003	-0.004†	0.009	-0.007
	(0.027)	(0.017)	(0.003)	(0.002)	(0.025)	(0.005)
Interaction with high initial leverage dummy (θ_2^{US})	0.251 **	0.116 **	0.029 **	0.012 **	0.109 **	0.065 **
	(0.047)	(0.024)	(0.006)	(0.004)	(0.023)	(0.018)
Median Leverage	14.441	8.750	1.940	1.249	6.272	2.512
Number of Observations	7062	2792	11,774	2275	1330	2488
R^2	0.33	0.23	0.18	0.13	0.31	0.15

Sources: Bloomberg, Datastream, Haver, WEO, Worldscope, and authors' estimates.
Notes: Estimates, from Eq. (5), of the marginal effect of one additional quarter of U.S. monetary policy easing, evaluated at the sample median (e.g., for U.S. duration, it shows $\partial Y/\partial D^{US} = \widehat{\theta}_1^{US}\overline{Y}$, where $\overline{Y}$ is the sample median of leverage). The "high initial leverage" dummy takes 1 if the four-quarter lag of the leverage is above the sample median. Standard errors are in parentheses, based on Driscoll and Kraay (1998), which are robust to heteroscedasticity and cross-sectional and temporal dependences with stationary variables.
** Significantly different from zero at the 1 % level.
* Significantly different from zero at the 5 % level.
† Significantly different from zero at the 10 % level.

insurance companies and real estate firms.[35]

The results for preventative inflow CFMs are in section B of Table 3. They, too, imply that policy is effective in protecting the system against the buildup of leverage when there is prolonged U.S. monetary policy easing. Focusing on the interaction terms, we note that (γ_2) is negative and significantly different from zero at the 5 % level in four of the six cases.[36][37] We note that the base effect (γ_1) is positive in three cases (insurance companies, real estate firms and "other"). This perverse effect of CFMs in normal times could be a consequence of the protection that they offer for domestic financial firms—they may be able to take advantage of less volatile capital flows thanks to inflow restrictions.

Section C of Table 3 reports estimates for the resilience afforded by additional FX buffers. While quantitatively small, we find evidence of FX buffers reducing the impact of U.S policy easing on leverage. This supports findings in the literature that official foreign reserve assets reduce vulnerabilities from external indebtedness.[38]

Results are robust to using a longer lag (8 quarters instead of 4 quarters used in the baseline) of policy instruments in place, as well as using an alternative version of the duration measure D_t^{US} constructed using the shadow interest rate from Wu and Xia (2016) in place of two-year U.S. Treasury rate. Our conclusions on the efficacy of macroprudential and capital flow management policies in preventing the buildup of financial institution leverage in the face of monetary policy spillovers are consistent with those in other studies. For example, Klein (2012) and several other studies provide empirical evidence suggesting that macroprudential policies or CFMs reduce financial vulnerabilities.[39]

3.3. Possible channels

Our results suggest that the form of intervention matters. Policies appear to be more effective when they are implemented preventatively than when they respond to shocks contemporaneously. Why might this be?

It is fair to say that some of our estimates appear weaker than others, but this may be because of technical reasons. Although actions taken to mitigate spillovers tend to have less statistically significant effects than those intended to prevent them, this difference could be a consequence of the way in which we address the possibility of reverse causality in the mitigation regression.

That said, our findings suggest the importance of proactively deploying sufficient measures in advance of possible spillovers. In practice, it may be challenging to optimally calibrate policies that respond to shocks, making it less effective immediately of adding more measure or adjusting the intensity of existing ones. Furthermore, in the presence of externality, having sufficient policies in place could be of first-order importance in weakening the mechanisms that amplify spillovers. Finally, the longer policies are in place, the more financial firms can adjust their balance sheets, lowering the sensitivity of leverage to any further spillovers.

To examine the possible channels through which these leverage adjustments occur, we examine the results controlling for initial levels of leverage. We do this by amending Eq. (2) to include an interaction between duration and initial leverage for both U.S. and domestic monetary policy durations:

$$\ln(Y_{ikt}) = \theta_0 + \theta_1 D_{kt} + \theta_2 I_{i,k,t-4} x D_{kt} + \theta_1^{US} D_t^{US} + \theta_2^{US} I_{i,k,t-4} x D_t^{US} + \beta X_{k,t-1} + c_i + \varepsilon_{ikt}, \tag{5}$$

where $I_{i,k,t-4}$ is the "high initial leverage" dummy that takes 1 if the four-quarter lag of firm's leverage is above the median for the industry group. The coefficients on these interactions tell us whether firms' balance sheet adjustments differ depending on whether their leverage was initially high or low.

Results from estimating Eq. (5) are in Table 4. The estimated coefficients on the interaction term of the high initial leverage dummy and

[35] The results for macroprudential policy are robust to using following alternative measures of pre-existing policy: the cumulative sum of the net number of tightening actions (i) in the past 4 quarters; (ii) in the past 8 quarters; and (iii) since the start of the sample period. We constructed these alternative measures using the policy action indicators by Alam et al. (2019).

[36] The results are largely robust to the use of following alternative measures of pre-existing CFM restrictions: (i) a customized inflow restriction on three asset classes (debt, money market, financial credits) using Fernández et al. (2016) index; (ii) a customized restriction on all flows (both inflows and outflows) on the three asset categories using FARI and Fernandez index, and (iii) inflow restrictions on all asset classes using FARI and Fernandez index.

[37] An important result of the work of Adrian et al. (2020) and Basu et al. (2020) is that restrictions on liabilities creating inflows (and not all inflows) may be desired to reduce vulnerabilities in small open economies. Our results on the effectiveness of pre-existing CFMs are robust to considering controls only on debt, money market and financial sector inflows.

[38] See Frankel and Saravelos (2012), Arce et al. (2019), Davis et al. (2020), Cubeddu et al. (2021), and Kalemli-Özcan (2021). Tong and Wei (2019), however, find that higher official reserves can also reduce book leverage of non-financial firms by reducing uncertainties.

[39] See Ostry et al. (2012), Bergant et al. (2020), Nier et al. (2020), Bhargava et al. (forthcoming), and Bouis et al. (forthcoming).

the U.S. duration (θ_2^{US}) are positive and statistically significant for all industries. This means that high leverage ex ante amplifies the sensitivity of leverage to prolonged U.S. monetary easing, and that the sensitivity to spillovers is lower for the firms with relatively low leverage levels. These results imply that preventative policies could be helping to reduce spillover effects by reducing financial firms' initial leverage levels. They further imply that mitigation policies may be less immediately effective because of the time it takes for financial firms to adjust their balance sheets.

4. Conclusion

In this paper, we start with confirming that the prolonged easing of U.S. monetary policy has played an important role in building up leverage of financial firms in a number of emerging markets and advanced economies. Faced with large capital inflows and easy financial conditions, financial firms tend to increase their borrowing during good times. When the tide turns and capital inflows dry up, highly leveraged financial intermediaries face currency depreciation and weakening balance sheets. With the potential to cascade, this adversely affects the liquidity and solvency of many firms, increasing fragility of the entire system. Depending on domestic characteristics and the nature of shocks, several non-U.S. authorities have deployed macroprudential tools, imposed capital controls, or engaged in foreign exchange interventions to enhance monetary autonomy and safeguard financial stability.

Our work is part of a growing body of research examining the implications of systematically deploying the three forms of policies to address financial fragility arising from external policy actions. Evidence to date indicates that these tools help in addressing risks arising from increases in financial firms' leverage. In particular, in this study, we conclude that preventative policies—preventatively accumulating large external reserves or preserving pre-existing capital control and macroprudential measures—are more effective in limiting the build-up of leverage in financial firms than reactive ones (those that are imposed in response to the spillovers).

Our estimates allow us to compare the effectiveness of the policy tools. Looking at macroprudential policies, we find that reactive policy actions are ineffective for banks, insurance companies, and investment banks, where we find statistically significant effects for others (real estate firms, asset managers, and "other"). In contrast, when applied preventatively, we find that macroprudential policies have a statistically significant impact with the right sign across all financial firms, except for insurance companies. Furthermore, they are particularly effective at containing leverage buildup in banks. Looking at CFMs, reactive tightening has virtually no impact across all types of financial firms. On the other hand, pre-existing CFMs do seem to work in most cases (exceptions are asset managers and investment banks). Lastly, in the case of FXI, we find that reactive measures are broadly ineffective in countering U.S. monetary policy spillovers. But, if substantial FX reserves are built up prior to the capital inflow surge, they do help in reducing leverage, ceteris paribus, in three types of firms (banks, real estate firms, and "other').

Proactive use of any of these tools—macroprudential, CFM or FXI—does raise questions from a broader international and macroeconomic perspective. First, employing CFMs or tight macroprudential measures for a sustained period could undermine domestic financial market development, reduce the efficiency of capital allocation, lowering investment and putting a drag on economic growth. In other words, there may be a need to consider inter-temporal trade-offs between short-term financial resilience and long-term welfare. Second, if some countries actively preserve or use such tools, but others do not, this could shift U.S. monetary policy spillovers, further elevating system-wide financial risks in some places. That is, there may be multilateral aspects or negative spillovers amongst non-U.S. countries that would be worth exploring. And finally, we know very little about the longer-term distributional impact of using any of these tools. A better understanding of these can shed light on how policymakers can meet their myriad of objectives in the face of large and rising inequality and populism in their countries. These, and numerous additional important questions, are beyond the scope of this paper but seem vital to investigate if we are to fully understand how to ensure financial stability and meet longer term welfare goals, especially in emerging market countries.

Data availability

The authors do not have permission to share data.

Acknowledgements

We thank Apoorv Bhargava for outstanding research assistance, Luis Brandao-Marques, Gaston Gelos, Erlend Nier, and Wenyue Yang for sharing their codes on policy shocks, Tobias Adrian, Futoshi Narita and other colleagues at the IMF for helpful discussions, Sara Durrani and Joanna Zaffaroni for production assistance, and three referees for their very detailed and extremely constructive comments. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. Cecchetti's disclosure statement is available here. The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF.

Appendix A. Supporting information

The description of data sources and definitions as well as the replication program files are available online at: doi:10.1016/j.jfs.2022.101087.

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