U.S. or Domestic Monetary Policy: Which Matters More for Financial Stability?

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Abstract

Using firm-level data for nearly 1,000 bank and nonbank financial institutions in 21 countries over the past 15 years we study the impact of prolonged monetary policy easing on risk-taking behavior. We find that both bank and nonbank financial firms increase leverage following domestic monetary policy easing. More puzzling is that, following easing in the United States (but not in the euro area), leverage in non-U.S. firms increases as well. But, as we show, there is substantial cross-country variation in the strength of these spillovers from U.S. policy; effects that are stronger for countries that are more financially developed, less open to trade, and have smaller gross U.S. dollar liabilities. We go on to identify a supply-side channel whereby dollar-based lenders offer more credit across foreign firms, and a demand-side channel whereby foreign firms respond differently depending on how much their currency's appreciation strengthens their balance sheets.

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I. INTRODUCTION

The objective of stabilization policy is to keep real growth high and stable, and inflation low and stable. But when either growth or inflation falls below their long-term goal, policymakers are likely to act. Those responsible for monetary policy will be moved to ease their policy stance. In most cases, this means lowering interest rates. When they do this, the hope is that a variety of factors will cushion the fall and return the economy to the desired path. Specifically, authorities trust that monetary policy easing will move asset values and exchange rates in a way that improves household, firm and bank balance sheets. The intended consequence is that lending will rise.

But with higher debt comes the risk of instability. This leads us to ask the following questions: Does prolonged monetary policy easing increase financial vulnerability? And, does prolonged monetary policy easing in the United States have an influence on financial vulnerability elsewhere in the world? In other words, does U.S. policy have financial stability spillovers?

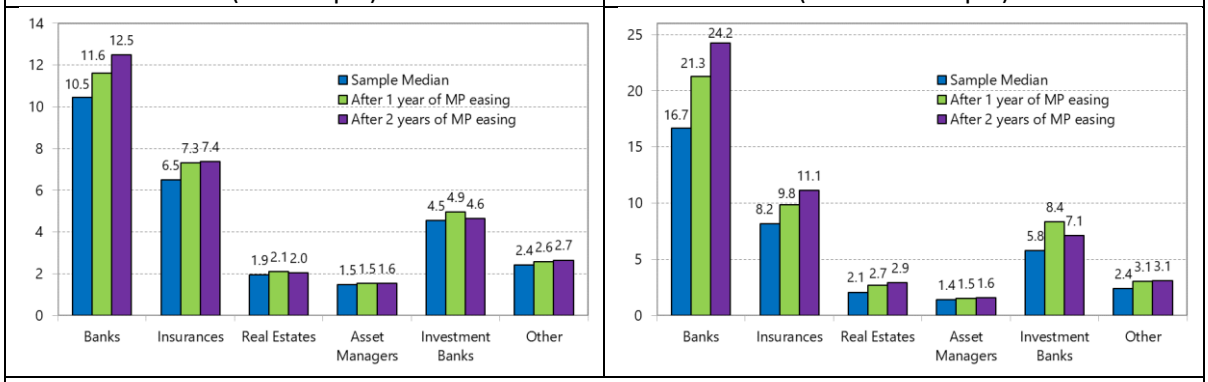
A simple plot of the raw data suggests a positive answer to these questions. We examine a comprehensive firm-level data set composed of 988 publicly listed financial institutions in 21 countries from 1998 Q1 to 2014 Q4. In the left panel of Figure 1 we plot the median financial institution leverage in our sample for six separate segments of the financial system (the blue bars). In addition, we compute how leverage changes following a one- and two-year prolonged domestic monetary policy easing (the green and purple bars respectively). The impact is generally sizeable. For banks, median leverage across countries is 10.5. But after two consecutive years of policy easing, the level rises to 12.5. Insurance companies also show a notable increase following an extended period of monetary easing—after two years, the median firm's leverage increases from 6.5 to 7.4. By contrast, the remaining sectors – real estate, asset management, investment banks, and the catch-all "other" category – show small changes.

Figure 1 also reports estimates of the impact of prolonged U.S. monetary policy easing on non-U.S. financial firms. These results are striking, as the impact appears to be even larger than the own-country policy impact. For example, the median banks' leverage rises from 16.7 to 24.2 after two years of U.S. policy easing, insurance companies' leverage increases from 8.2 to 11.1, and real estate firms' leverage rises form 2.1 to 2.9.

These results are consistent with those reported in a growing literature that finds large effects of U.S. monetary policy on foreign credit and of exchange rate movements on leverage. These include Rey's (2013) finding that U.S. policy easing is associated with a rise in bank flows; Bruno and Shin's (2015a,b) investigation of the determinants and evolution of global banks' leverage; McCauley et al.'s (2015) analysis of dollar lending outside of the

United States; Morais et al.'s (2017) study of foreign bank credit; Temesvary et al.'s (2018) work on cross-border lending; Avdjiev et al.'s (2018) work on cross-border dollar credit; and Kalemli-Özcan et al.'s (2012) conclusion that domestic currency appreciation drives up leverage, especially when foreign currency debt is high.

Figure 1. Change in the Asset-to-Equity Ratio following extended monetary easing



Leverage following a sustained monetary policy easing as measured by the deviations from the eight-quarter average in the 2-year sovereign rate. See Section II for details.
Sources: Bloomberg, Datastream, Haver, Worldscope, and authors' calculations.
Note: The asset-to-equity ratios are calculated using the median percent changes and median levels in each industry. We first take firm-level medians, and then industry-level medians of the firm-level medians. Panel A is based on data for 988 publicly listed financial firms in 17 advanced economies plus Brazil, Mexico, and South Africa from 1998Q1 to 2014Q4. Panel B is based on the sub-sample of the 613 non-U.S. financial firms.

There are a variety of mechanisms through which U.S. policy could influence financial stability elsewhere in the world. In a simple Mundell-Fleming model, for example, domestic easing boosts aggregate output and leads to a currency depreciation. The overall impact on the foreign economy and its exports is ambiguous, depending on the degree of foreign for domestic product substitution, and the foreign monetary policy response. As a result, in this standard model, it is the evolution of the constellation of interest rates around the world that is the sole determinant of credit growth, and potentially leverage.

Any effect over and above this baseline requires the presence of some form of financial friction such constraints on borrowers or lenders based on their net worth.[1] On the supply side, U.S.-based lenders might be induced to search for yield abroad when faced with lower domestic rates. They would thus tend to increase lending across foreign firms and countries. On the demand side, firms with U.S. dollar borrowing would see their balance sheets strengthen when U.S. policy easing leads to dollar depreciation.[2] In this case, as Bruno and

[1] See, for example, Blanchard et al. (2015).
[2] See Eichenbaum and Evans, 1995.

Shin (2015 a,b) describe, lenders' value-at-risk constraint slackens, allowing them to extend more credit and take on higher leverage. But borrowers can respond in three ways: they can act passively and allow leverage to decline; they can increase borrowing proportionally to keep leverage unchanged; or they can procyclically increase borrowing to drive up their leverage. This last response is similar to the one identified by Adrian and Shin (2009, 2014) for the case of U.S. investment banks, though in a cross-border context.

We take on the challenge of disentangling these various effects. Controlling for domestic growth, future growth prospects, and interest rates helps account for the real effects of U.S. monetary policy easing, as might arise in a Mundell-Flemind model. If the effects on non-U.S. firms' leverage remain after controlling for these variables, then other channels, rooted in financial frictions such as value-at-risk or collateral constraints, must be at play. In particular, controlling for dollar liabilities helps differentiate supply and demand effects. We expect the latter to differ across firms, depending on the degree to which a dollar depreciation strengthens firms' balance sheets. Supply side effects would instead be equal across firms, irrespective of their balance sheet composition.

The fact that U.S. Federal Reserve policy decisions might have financial stability implications beyond America's borders reflects the global role of the U.S. dollar in international trade and finance. In trade, Casas et al. (2015) describe how 40 percent of all trade is invoiced in dollars. Since the United States accounts for roughly 10 percent of world trade, this means that roughly 30 percent of world trade involving non-American entities as either an importer or an exporter is pricing its products in dollars. As a result, financial and nonfinancial firms' balance sheets will contain a significant quantity of U.S. dollar assets and liabilities.

The extraterritorial dominance of the U.S. dollar is the driving force behind the existence of a second dollar system outside the United States. The BIS reports that U.S. dollar liabilities of non-U.S. banks are on the order of US$15 trillion.[3] Borio et al (2017) describe how foreign exchange swaps lead to additional U.S. dollar exposures that suggest doubling this already large number. And, the U.S. Treasury reports that foreigners hold 45 percent of outstanding U.S. Treasury securities—an amount in excess of US$6 trillion.[4] To put these numbers into perspective, total assets of U.S. depository institutions are currently US$17 trillion. In other words, the U.S. dollar financial system outside of the United States is bigger than the American banking system.[5] Given this, it is no surprise that changes in U.S. dollar interest rates have major repercussions elsewhere in the world.

[3] See Table A5 of BIS locational banking statistics https://www.bis.org/statistics/bankstats.htm?m=6%7C31%7C69.
[4] See https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/index.aspx.
[5] See Cecchetti and Schoenholtz (2017).

In the remainder of this paper, we examine the influence of monetary policy easing on leverage of financial institutions in detail. We begin in Section II by looking at the effect of the duration of domestic monetary policy easing on financial stability risks, where easing is defined as the number of quarters with consecutive declines in an eight-quarter moving average of the two-year sovereign bond rate and financial stability risks are measured as leverage of financial institutions. Our conclusion is that, while the impact across different parts of the financial sector varies, domestic policy easing results in an economically (and statistically) significant increase in leverage. For example, after two years, in a typical case, banking system leverage rises from roughly 10 to 12, an effect similar in sign and magnitude to the one we see the raw data plotted in Figure 1.

Section III expands the analysis to include the impact of U.S. policy on non-U.S. financial insitutions. Here we find that the effect of U.S. policy is even larger than the impact of domestic policy easing. For a representative non-U.S. country banking system, we conclude that after two years, U.S. policy easing drives leverage from roughly 16 to nearly 19.

In Section IV, we examine the impact of euro area monetary policy easing on non-euro-area financial system leverage and find no effect. That is, while euro-area policy easing has a clear and measureable impact on banks, insurance companies, and the like inside the euro area, it has no measureable influence elsewhere. Given the much smaller role of the euro in non-euro area countries, we find this unsurprising.

This leads us back to the importance of U.S. policy easing outside of the United States. In Section V, we first establish that the estimated impact differs not only across sectors within countries, but across countries as well. We then show that this variation is related to financial development, trade openness and the size of a country's U.S. dollar liablities. Interestingly, the impact is bigger, the more financially developed a country, the less open, and the smaller the dollar liablities. The latter two result from the interplay among the channels noted earlier. The greater the dollar liabilities—which are highly correlated to the degree of openness—the greater the valuation effects on firms' balance sheets from currency appreciation. To the extent lower U.S. rates lead to a weaker dollar, it reduces leverage mechanically. On the demand side, firms with larger valuation effects tend to keep leverage equal or smaller. The exception are investment banks and wealth managers whose leverage appears pro-cyclical. Firms still end up increasing leverage in the end, with effects common to all firms being positive and significant, indicating sizable supply-side effects.

II. Domestic Monetary Policy and Financial Stability Risks

We begin with an examination of the impact of domestic policy on the leverage of domestic financial institutions. To do this, we first define our measures of monetary policy and financial stability risks, and then examine the impact of the first on the second.

A. Measuring the Stance of Monetary Policy and Financial Stability Risks

In contrast to prior studies that identify surprises or shocks, our interest is in the impact of sustained or persistent monetary policy easing on financial stability.[6] To that end, we begin by defining the "duration" of monetary policy easing as the number of consecutive quarters of interest rate cuts based on the nominal two-year sovereign yield. In order to remove high-frequency movements in interest rates, we compute an eight-quarter moving average. A cut in interest rates from one quarter to the next is then defined as a drop in the moving average calculated up to the current quarter, relative to the moving average of the previous quarter.[7] Specifically, we compute the duration D_t as:

$$D_t = \begin{cases} D_{t-1} + 1 & \text{if } MA_t < MA_{t-1} \\ 0 & otherwise, \end{cases} \quad (1)$$

where $MA_t = \frac{1}{8}\sum_{\tau=1}^{8} i_{t-\tau+1}$. We explicitly focus on market rates that can be readily observed, as opposed to deviations from Taylor rules, the natural interest rate, or other benchmarks, which are based on unobservable variables that require strong model-based assumptions to compute.[8]

For several reasons, we prefer the measure of duration based on the two-year sovereign bond yields. While the short-term interest rate is one of the most widely used indicators of monetary policy, during recent episodes of unconventional monetary policy (UMP), withthe policy rate at the effective lower bound, we see the longer-term sovereign rate is a better measure of the stance of policy.[9] Use of the two-year rate has the added advantage of

[6] Exemplified by the work of Gürkaynak, Swanson, and Sack (2005) and Chen, Mancini-Griffoli and Sahay (2014), this alternative line of research identifies what is arguably an exogenous shock, thus can investigate a causal relationship with other fast-moving variables such as asset prices. However, firm leverage is likely to be a slow moving variable reacting more with monetary policy expectations than with very small monetary policy surprises which may offset each other over subsequent monetary policy announcements.

[7] Another measure is also possible, found by adding the extent—as opposed to counting the instances—of consecutive drops in interest rates. We return to this continuous measure as a robustness check, where we find that results do not vary.

[8] For a survey of the debate over various specifications of the Taylor type interest rate rules, see Taylor (1993, 1999), Orphanides (2001), Carare and Tchaidze (2005), Rudebusch (2005), Christiano et al. (2010), and Nikolsko-Rzhevskyy and Papell (2013). On the natural interest rate, see Laubach and Williams (2003) and Wu (2005).

[9] For a discussion of how UMP acts through long-term rates, see, for example, Gagnon et al. (2011), Wright (2012), Swanson and Williams (2014), and Chen, Mancini-Griffoli and Sahay (2014). In an earlier paper, Cecchetti, Mancini-Griffoli and Narita (2017), we show that the results are robust to various interest rate measures. There, we examine the nominal and real three-month sovereign rate, and the nominal 10-year rate.

capturing expected monetary policy easing, which is likely to be better correlated to leverage decisions than just immediate policy rates.[10]

To measure financial stability risks, we focus on leverage in the financial system.[11] Importantly, to avoid well-known problems associated with accounting measures of the book value of equity, we compute leverage as the market value of equity plus the book value of liabilities divided by the market value of equity.

Table 1 reports summary statistics from our complete data set of 988 publicly listed financial firms in 21 countries from 1998 Q1 to 2014 Q4. We divide the data into six industry groups using the Global Industry Classification Standard provided by MSCI and Standard & Poor's. These are banks, insurance companies, invesment banks, asset managers, real estate firms, and others.[12] The median leverage ratio ranges from 1.2 for asset managers to 10.5 for banks.[13]

Table 1. Leverage Ratio by Financial Industry

	25th percentile	50th percentile	75th percentile	Number of Firms
Banks	6.4	10.5	19.8	241
Insurance	3.2	6.5	12.6	122
Real Estate	1.6	1.9	2.6	369
Asset management	1.2	1.5	2.1	124
Investment banks	3.2	4.5	12.2	47
Other	1.5	2.4	5.1	85

Sources: Datastream, Worldscope, and authors' calculations.
Note: Computations are based on an unbalanced panel data for a total of 988 publicly listed financial firms in 21 countries (17 advanced economies plus Brazil, Mexico, and South Africa) from 1998Q1-2014Q4. To avoid over-representation from firms with more observations, industry percentiles (reported in the first three columns) are calculated from firm-level medians.

[10] Other studies using two-year yields as the indicator of monetary policy include Gilchrist et al. (2014) and Gertler and Karadi (2015).
[11] As we note below, we confirm the robustness of these results to alternative measures of financial stability, including risk-adjusted return on equity and z-score.
[12] "Banks" are firms whose revenue is derived primarily from conventional banking operations; "insurance companies" include life and non-life insurers, and reinsurance companies; "investment banks" are firms primarily engaged in investment banking and brokerage services; "asset managers" invest for third party funds; "real estate firms" consists of real estate investment trusts (REITs), and real estate management and development firms; and "other" includes holding companies, consumer finance firms, and firms that provide specialized or diversified financial services.
[13] These calculations are not weighted by asset size.

B. The Impact of Domestic Monetary Policy Easing on Domestic Leverage

Our empirical analysis focuses on the impact of monetary policy easing on financial institution leverage. To start, we examine the impact of own-country monetary policy. Specifically, we estimate the following regression, for each of the six industry categories:

$$\ln(Y_{ikt}) = \alpha_0 + \alpha_1 D_{kt} + \beta X_{kt-1} + c_{ki} + \varepsilon_{ikt} \ , \qquad (2)$$

The model relates financial firms' leverage for firm *i* in country *k* at time *t* (Y_{ikt}) to the duration of own-country monetary policy easing (D_{kt}) measured as the number of consecutive quarters of declines in country *i*'s interest rates. The regression allows us to control for other (lagged) macroeconomic variables (X_{kt-1}). We include real GDP growth to capture changes in income and confidence, growth of the stock price index to control for the cost of equity financing as well as growth prospects, and the automatic valuation effect on leverage from stock prices,[14] a volatility index to control for the degree of uncertainty in financial markets, and a sovereign bond rating to control for actual or perceived sovereign risk. To control for structural differences among the six industries and 21 countries, such as differences in business models, domestic regulations, and accounting practices we include a set of fixed effects (c_{ki}).

Table 2: Impact of Domestic Monetary Policy Easing

	Banks	Insurance	Real Estate	Asset Mgmt	Investment Banks	Other
Impact of Dom. Pol. Easing (α_1)	0.192** (0.052)	0.081** (0.017)	0.002 (0.004)	0.005† (0.003)	0.080** (0.014)	0.018 (0.012)
Median Leverage	10.5	6.5	1.9	1.5	4.5	2.4
R^2	0.15	0.12	0.10	0.06	0.13	0.07

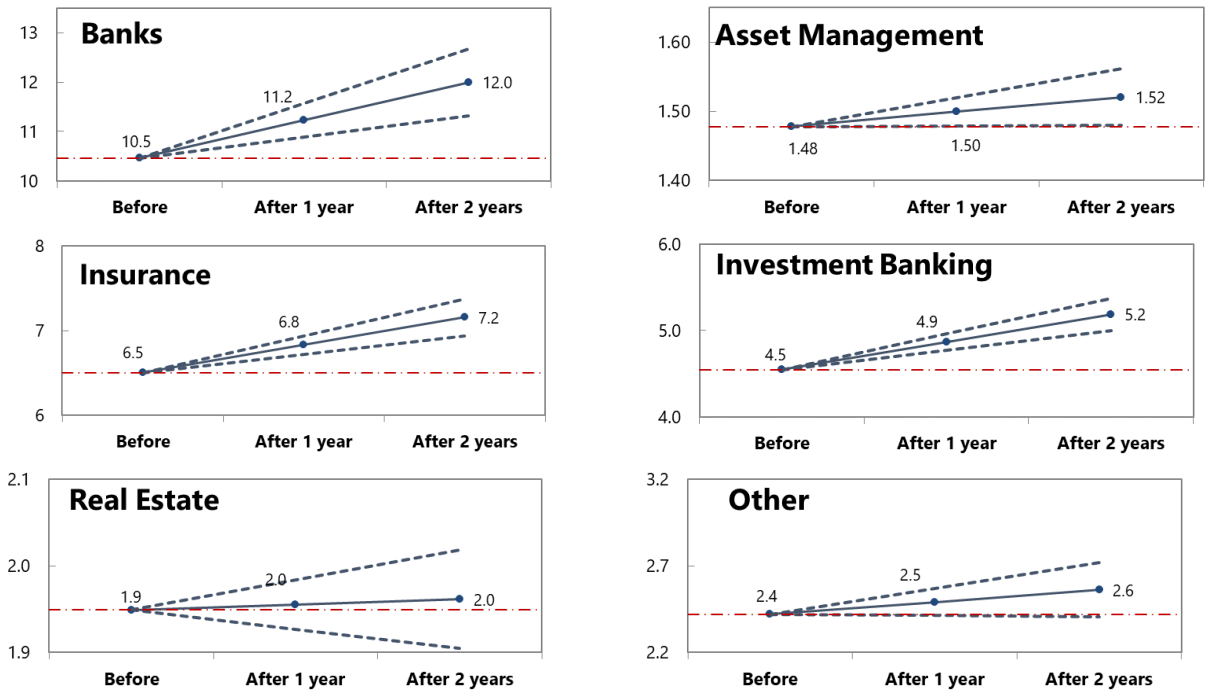
Estimate, from equation (2), of marginal effect of increase in duration of own-country monetary policy easing, evaluated at the median of the data. Standard errors, computed using the delta method, are in parentheses.
** Significantly different from zero at the 1 percent level.
* Significantly different from zero at the 5 percent level.
† Significantly different from zero at the 10 percent level

We estimate equation (2) for each of the six financial sectors, and report the results in Table 2. Rather than report the estimated coefficients, which are semi-elasticities, we compute the marginal effects of a one quarter increase in the duration of policy easing, evaluated at the median of the data.[15] That means that these numbers are in the same units

[14] As Adrian and Shin (2010) point out, if other things are unchanged, leverage would decline when stock prices go up.
[15] To compute the marginal impact of a change in duration on the level of leverage, first rewrite equation (2) as $Y_{ikt}=\exp(\alpha_1 D_{kt}+\cdots\cdots)$. Then take the derivative with respect to D_{kt} to obtain $[dY_{ikt}/d\ D_{kt}\ ]=\alpha_1\exp(\alpha_1 D_{kt}+\cdots\cdots)=\alpha_1 Y_{ikt}$, which is the

as the raw leverage numbers. For example, we estimate that a one-quarter easing drives up banking system leverage in a representative country by 0.192, from 10.5 to 10.7, an increase that is significantly different from zero at the 1% level. For insurance, a typical rise is from 6.5 to 6.6. [16]

Figure 2. Impact of Domestic Monetary Policy Easing on Domestic Financial Firm Leverage



Sources: Bloomberg, Datastream, WEO, Worldscope, and authors' estimates.
Note: The asset-to-equity leverage ratios before and after monetary policy easing are calculated with the estimated semi-elasticities and median levels in each industry. The duration is the number of the consecutive quarters with a decline in the moving average of two-year bond yields. Estimates are based equation (2) and use the full sample of firms and countries.

Figure 2 plots the results of a sustained, two-year easing, on leverage in all six of the sectors. The results suggest that, on average, an easing that is sustained for two years will increase banking system leverage from an average of 10.5 to 12.0. For other sectors, there is a rise, albeit less pronounced. For example, we find that over the same two-year period, a representative asset management firms' leverage will rise from a very modest 1.48 to a still quite low 1.52.

marginal effect. We evaluate $\alpha_1 Y_{ikt}$ at the sample median leverage, and report the result in the Table. Standard errors are computing using the delta-method, evaluated at this same sample median.

[16] We note that if we substitute four-quarter-lagged duration for contemporaneous duration in equation (2), the results are somewhat weaker.

These results lead us to conclude that domestic policy easing increases domestic leverage for banks, insurance, asset management and investment banks. Furthermore, the effects can be quite large. In terms of financial stability policy, the important conclusion is that policy easing does have its intended short-term impact, but over time risks in the system can build up.

III. The Impact of U.S. Monetary Policy Easing on non-U.S. Leverage

We now turn to our second question: Does prolonged monetary policy easing in the United States have an influence on financial vulnerability elsewhere in the world? To study the possibility of such spillovers, we remove U.S. financial firms from our sample and add the duration of U.S. policy easing to equation (2). That is, we estimate:

$$\ln(Y_{ikt}) = \alpha_0 + \alpha_1 D_{kt} + \alpha^{US} D_t^{US} + \beta X_{kt-1} + c_{ki} + \varepsilon_{ikt}, \qquad (3)$$

where *k* includes all countries in our sample except for the U.S., D^{US} is the duration of US monetary policy easing (and is the same for all countries), and all other variables are the same as in equation (2).

Table 3: Impact of Domestic and US Monetary Policy Easing

	Banks	Insurance	Real Estate	Asset Mgmt	Invt Banks	Other
Impact of Dom. Pol. Easing (α_1)	0.223** (0.076)	0.054** (0.023)	0.005 (0.006)	0.006* (0.003)	0.108** (0.031)	-0.001 (0.011)
Impact of U.S. Pol. Easing (α^{US})	0.362** (0.101)	0.103** (0.025)	0.023** (0.007)	0.008** (0.003)	0.099* (0.039)	0.036** (0.011)
Median Leverage	16.7	8.2	2.1	1.4	5.8	2.4
Number of Obs	5,521	2,539	7,049	2,070	1,014	1,871
R^2	0.31	0.15	0.13	0.07	0.22	0.10

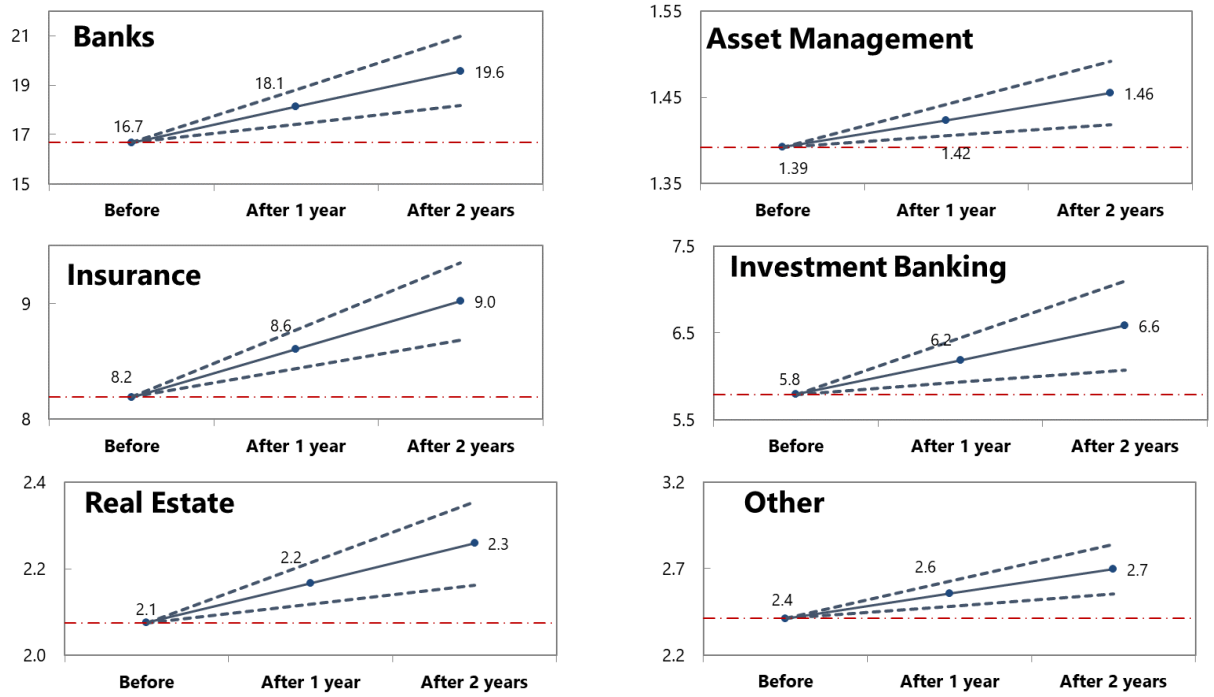
Estimates, from equation (3), of marginal effect of increase in duration of own-country and U.S. monetary policy easing, evaluated at the median of the data. Robust standard errors, computed using the delta method, are in parentheses.
** Significantly different from zero at the 1 percent level.
* Significantly different from zero at the 5 percent level.
† Significantly different from zero at the 10 percent level

Table 3 presents the results of this analysis. Again, we report marginal effects evaluated at the median leverage for each sector (now computed excluding American firms). The results are striking. First, the impact of domestic easing is similar in economic magnitude and statistical precision to the results without the U.S. duration reported in Table 2. The

marginal impact of a one-quarter domestic easing on banking system leverage is still about 0.2, and on investment banks' leverage remains around 0.1.

Furthermore, the impact of U.S. policy is significantly different from zero at the 1% level for all sectors except for investment banks, where it is still significant at the 5% level.[17] In Figure 3, we plot the two-year impact. Comparing this to Figure 2, we see that the results are in fact stronger. Banks' leverage rises from roughly 16.7 to 19.6; insurance companies from 8.2 to 9.0, and investment banks from 5.8 to 6.6.

Figure 3. Impact of U.S. Monetary Policy Easing on non-U.S. Financial Firm Leverage



Sources: Bloomberg, Datastream, WEO, Worldscope, and authors' estimates.
Note: The asset-to-equity leverage ratios before and after monetary policy easing are calculated with the estimated semi-elasticities and median levels in each industry. The duration is the number of the consecutive quarters with a decline in the moving average of two-year U.S. bond yields. Estimates are based on equation (3) using the non-US sample. Blue dashed lines indicate 90 percent confidence intervals.

Perhaps surprisingly, we find that the effects of U.S. monetary policy easing are either equal to those of domestic monetary policy easing (for investment banks and asset managers), greater (for banks), or substantially greater (for insurance, real estate and other financial firms). Moreover, once we account for U.S. policy, the effects of domestic policy easing remain similar in magnitude to what they are when estimated on their own. When business

[17] All standard errors throughout the paper are calculated by Driscoll and Kraay (1998) standard errors, which is robust to heteroscedasticity and cross-sectional as well as temporal dependence.

cycles are correlated, domestic and U.S. monetary policies will work together to amplify the swings in financial sector vulnerability. And, when countries are at different stages of the business cycle, domestic authorities may feel the need to counter the impact of U.S. policy.[18] However, there is the possibility that a domestic tightening will have a preserve effect, attracting funds from abroad that are benefiting from the combination of relatively cheap foreign borrowing costs, higher deposit rates, and improved domestic borrower creditworthiness.

Before continuing, we note three extension that reinforce our conclusion that U.S. policy has important spillovers on the riskiness of non-U.S. financial intermediaries.[19] First, the results does not depend on the discrete nature of our measure of policy easing. Using a continuous measure yields similar results.[20] Second, we confirm that the results are qualitatively unchanged when we substitute two alternative measures of financial institution vulnerability for the leverage measure: z-score (a measure of a probability a firm will become insolvent) and risk-adjusted return on equity (a measure of risk-return profile of a firm).

Third, we find that more restrictive monetary policy drives leverage down in the same way as accommodative policy pushes it up. Looking at the results in Table 3 above, the point estimate for the marginal effect of domestic easing on banking system leverage is 0.223. By comparison, the impact of a quarter tightening is 0.399. Similarly, when U.S. eases for one quarter, bank leverage rises by an estimated 0.362, while when policy tightens it falls by 0.568. This same pattern holds for other parts of the financial system.[21]

[18] Effects are slightly stronger across the board with 4 lags (and more significant for investment banks), suggesting persistence, and more so than for domestic effects.
[19] In the robustness section of the paper, Cecchetti, Mancini-Griffoli and Narita (2017) report a subset of these results in detail.
[20] Specially, we estimate equation (3) using a measure that accumulates the size of the changes in the eight-quarter moving average of the two-year rate during the easing period (i.e., during the consecutive quarters with a decline in the moving average of two-year bond yield). In that case, the results suggest that a one percentage point easing is equivalent to an easing that is between four and five quarters long.
[21] Using a continuous measure of policy easing and tightening, we obtain similar results.

IV. Impact of Euro Area Monetary Policy Easing on non-Euro-Area Leverage

Is the U.S. policy special, or are there spillovers from elsewhere, as well? To examine this possibility, we examine the case of the euro area.[22] We reproduce the same results for the U.S., but substituting euro-area duration using equation (1), as measured by the two-year German Bund yield. We remove all euro area financial institutions, replace D_t^{US} in equation (3) with D_t^{EA}, and estimate

$$\ln(Y_{ikt}) = \alpha_0 + \alpha_1 D_{kt} + \alpha^{EA} D_t^{EA} + \beta X_{kt-1} + c_{ki} + \varepsilon_{ikt} \ . \qquad (4)$$

Table 4 and Figure 4 report the results of this exercise. With the possible exception of insurance, the spillover effects are both economically and statistically very close to zero. And, even in the case of insurance, the estimates suggest an impact that is one quarter that of a comparable U.S. policy easing (see Table 3 and Figure 3).

Table 4: Impact of Domestic and Euro Area Monetary Policy Easing

	Banks	Insurance	Real Estate	Asset Mgmt	Invt Banks	Other
Impact of Dom. Pol. Easing (α_1)	0.156** (0.044)	0.071** (0.015)	-0.003 (0.002)	0.003 (0.003)	0.064** (0.015)	0.015 (0.016)
Impact of EA Pol. Easing (α^{EA})	-0.008 (0.048)	0.034* (0.017)	0.006 (0.005)	0.000 (0.003)	-0.018 (0.018)	-0.006 (0.017)
Median Leverage	8.8	6.3	1.8	1.5	4.3	2.8
Number of Obs	8,818	4,316	11,063	3,437	1,495	2,499
R^2	0.16	0.14	0.15	0.11	0.19	0.09

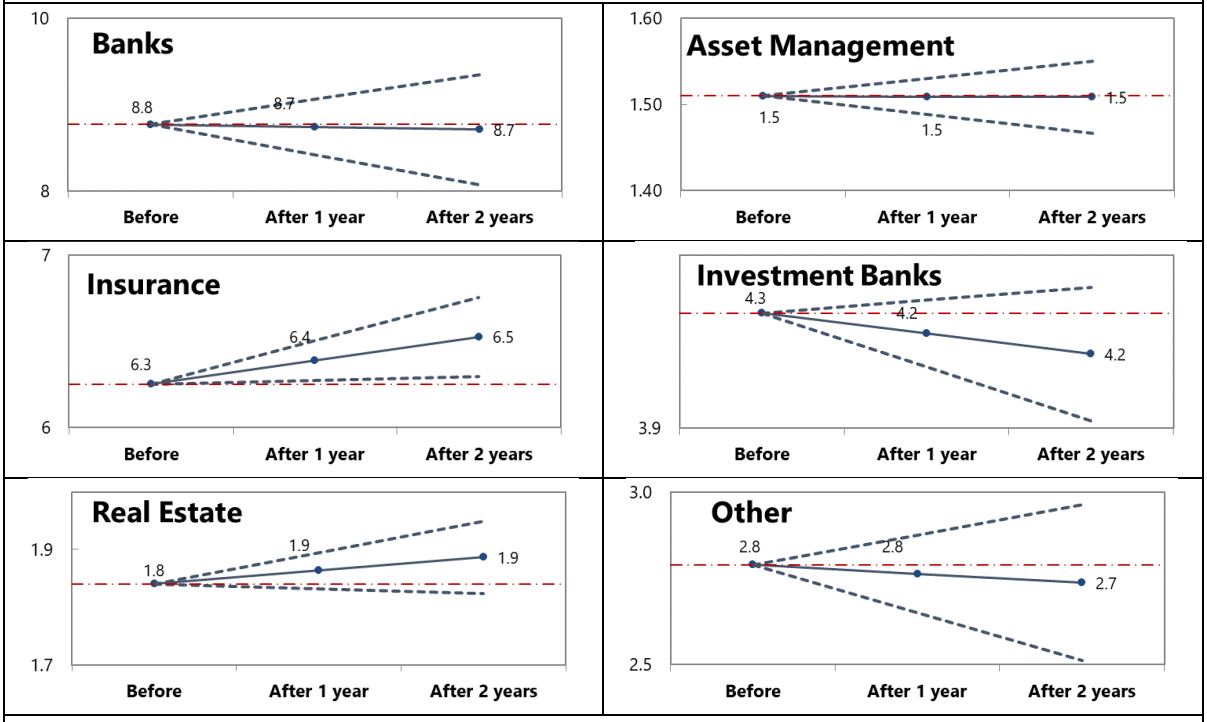
Estimate, from equation (4), of marginal effect of increase in duration of own-country and euro area monetary policy easing, evaluated at the median value for leverage of the data. Robust standard errors, computed using the delta method, are in parentheses.
Numbers in parentheses are robust standard errors.
** Significantly different from zero at the 1 percent level.
* Significantly different from zero at the 5 percent level.
† Significantly different from zero at the 10 percent level.

The most likely explanation for the difference between the estimate of U.S. policy spillovers and that of euro-area policy spillovers is that the euro plays a far smaller role in global trade and finance. On trade, the fraction of invoicing in euro roughly matches the import and export share of the euro. And, in finance, while non-U.S. banks issue $15 trillion in liabilities,

[22] In principle, we could also examine spillovers from Japan, but the lack of interest rate variation over our sample period makes this difficult.

non-euro-area banks only issue €4 trillion in liabilities.[23] This suggests that there may be cross-countries variation in the size of the spillovers, and that these differences might be related to exposure to the dollar.

Figure 4. Impact of Euro-Area Monetary Policy Easing on non-Euro-Area Financial Firm Leverage



Sources: Bloomberg, Datastream, WEO, Worldscope, and authors' estimates.
Note: The asset-to-equity leverage ratios before and after monetary policy easing are calculated with the estimated semi-elasticities and median levels in each industry. The duration is the number of the consecutive quarters with a decline in the moving average of two-year German bond yields. Estimates are based on equation (4) and use the non-euro-area sample. Blue dashed lines indicate 90 percent confidence intervals.

[23] The Financial Stability Board (2018) reports that in 2016, the euro area banks had assets of US$31 trillion, something like 50 percent higher than U.S. banks' assets.

V. UNDERSTANDING U.S. MONETARY POLICY SPILLOVERS

We now turn to an exploration of the potential causes of the spillovers from U.S. monetary policy easing. To set the stage, we start by examining the differences in the effects across countries, and then turn to a more rigorous study of what might be causing them.

A. Country-by-Country Estimates of Spillovers

To begin, we re-estimate equation (3) on a country-by-country basis. For each of the six sectors and each of the 20 countries, we estimate:

$$\ln(Y_{ikt}) = \alpha_{0k} + \alpha_{1k} D_{kt} + \alpha_k^{US} D_t^{US} + \beta X_{kt-1} + \varepsilon_{ikt}. \qquad (3')$$

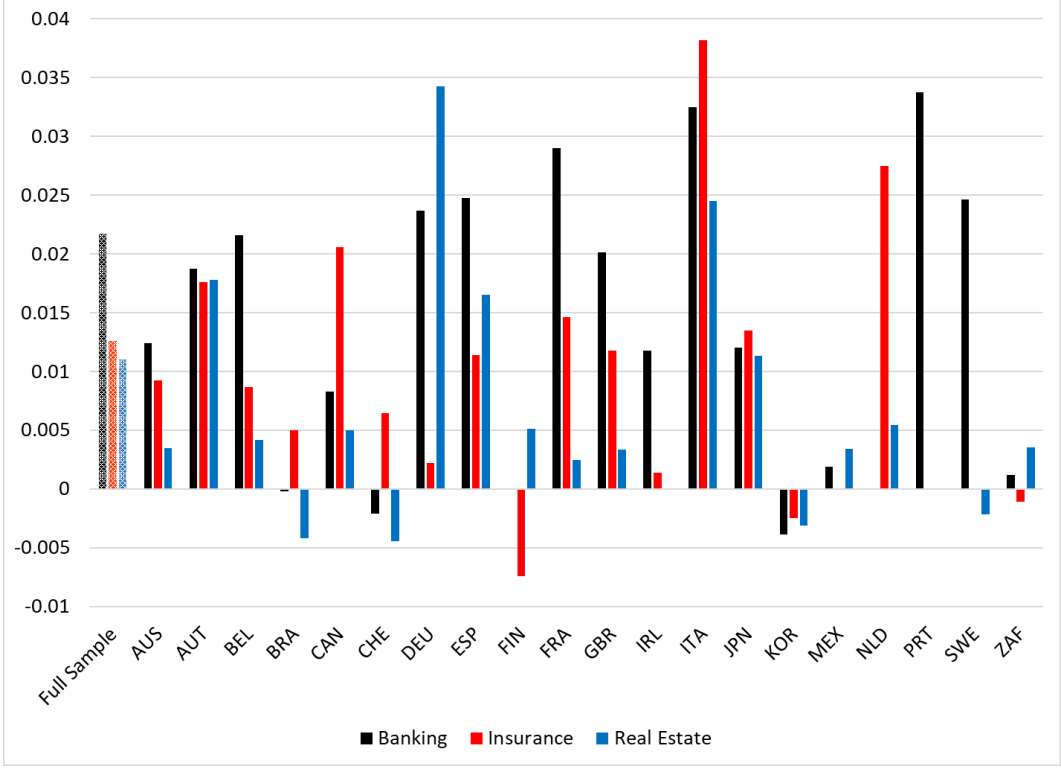
Figure 5 reports the estimates. The top panel includes banks, insurance and real estate; while the bottom panel reports estimates for asset management, investment banks and the residual category, other. In each case, the full sample estimates (from equation 3), are on the far left. Unlike the prior results, here we are reporting the estimates of the semi-elasticity of leverage with respect to the U.S. policy easing (the α_k^{US}'s) rather than the marginal effects described earlier. (Reporting the marginal effects, described in footnote 15, would create substantial dispersion, making the figures difficult to read.)

There is wide variation in the impact. Estimates range from zero, or slightly negative, to more than three times the full sample average (reported on the far left of each panel). For example, for banks, the estimates for Italy and Portugal are 50 percent larger than the full sample estimates. For Dutch insurance companies, the semi-elasticity estimate is more than twice that in the full sample. And Korean asset managers' leverage is three times as sensitive to U.S. monetary policy easing than the sample average.

What might explain this pattern? A number of possibilities come to mind. First, there is financial system development. We would expect that the more developed and deeper a country's financial institutions and markets, the more sensitive they might be to the evolution of financial conditions abroad. Second, there is the extent to which the country is connected to the rest of the world. These connections can be both real and nominal, in the form of trade openness and financial openness. As we noted earlier, there are substantial U.S. dollar assets and liabilities outside the U.S. As a result, when dollar exchange rates change on the back of U.S. monetary policy, it affects balance sheets of financial firms worldwide.[24]

[24] For example, Bruno and Shin (2015) document foreign currency assets and liabilities of banks outside the U.S. and point out the prominent role played by the U.S. dollar.

Figure 5. Impact of U.S. Monetary Policy Easing on Financial Firm Leverage by Country



Source: Full sample estimates are based on equation (3). Country estimates are based on equation (3').

This leads us to examine the relationship of cross-country differences in responses to U.S. monetary policy with some simple indicators: financial market development (a relative ranking based on depth, access, and efficiency computed by the IMF)[25], a standard measure of trade openness (the ratio of exports plus imports to GDP), and the sum of bank and nonbank US dollar liabilities to banks located outside of country (relative to total credit in the country).[26]

Before we get to our pooled regression results, it is worth noting that the country-specific estimates of the semi-elasticities for the banking, insurance and real estimate sectors reported in the top panel of Figure 5 tend to have a positive correlation with the financial development index, and a negative correlation with trade openness and U.S. dollar claims. While asset management and investment banking, reported in the bottom panel of Figure 5, have a negative correlation with financial development.

B. Understanding the Cross-Country Variation in Spillovers

Turning to a more rigorous statistical analysis, we estimate the following regression:

$$ln(Y_{ikt}) = \alpha_0 + \alpha_1 D_{kt} + \alpha^{US} D_t^{US} + \gamma^{US} Z_{kt-4} D_t^{US} + \beta X_{k,t-1} + c_{ki} + \varepsilon_{ikt}, \quad (5)$$

where Z_{kt-4} is the four-quarter lag of the variables identified above. Our interest is then in examining the semi-elasticities α^{US} and γ^{US} for the various parts of the financial system.

We examine the results for the three potential determinants and the six sectors in Table 5. The first row in each block reports the effect on domestic firm leverage of a one-quarter domestic monetary policy easing (α_1). These results are similar in magnitude, both economically and statistically, to those in Table 4. The second row of Table 5 focuses on the interaction γ^{US} in isolation, evaluated at the median, $\bar{Z}$, and median leverage for each sector. We produce this solely to show that the relative importance of the interaction with each of the candidate *Z*'s, as the full effect of an increase in duration on leverage also depends on the estimate of α^{US}. That said, we note that in a number of cases this interaction effect is large and statistically different from zero at standard levels of significance.

[25] The data and descriptions are available here.

[26] We also examine a variety of other possible determinants, including sub-indices of the financial depth index, cross-border assets and liabilities, claims of U.S. banks on a country, and the fraction of a country's exports that are to the United States, and the change in U.S. dollar claims. Overall, the results reported here are representative of what we find with this broader set of variables.

Table 5: Determinants of the Impact of US Policy Easing

		Banks	Insurance	Real Estate	Asset Mangmt	Invt Banks	Other
Financial Depth	Dom. Pol. Easing (α_1)	0.2167** (0.0778)	0.0499* (0.0236)	0.0038 (0.0056)	0.0055* (0.0027)	0.1072** (0.0314)	-0.0023 (0.0107)
	Interaction (γ^{US})	0.3151† (0.1864)	0.2323** (0.0423)	0.0387† (0.0217)	0.0051 (0.0129)	0.1383 (0.1469)	0.0937** (0.0359)
	U.S. Pol. Easing ($\alpha^{US} + \gamma^{US}\bar{Z}$)	0.3706** (0.1048)	0.1004** (0.0245)	0.0238** (0.0077)	0.0078** (0.0028)	0.0960* (0.0379)	0.0387** (0.0114)
Trade Openness	Dom. Pol. Easing (α_1)	0.2184** (0.0772)	0.0505* (0.0241)	0.0039 (0.0056)	0.0055* (0.0026)	0.1072** (0.0305)	-0.0018 (0.0111)
	Interaction (γ^{US})	-0.0760** (0.0251)	-0.0543** (0.0142)	-0.0119* (0.0052)	-0.0017 (0.0059)	-0.0081 (0.0289)	-0.0072 (0.0154)
	U.S. Pol. Easing ($\alpha^{US} + \gamma^{US}\bar{Z}$)	0.3657** (0.1063)	0.1194** (0.0284)	0.0246** (0.0079)	0.0083** (0.0033)	0.0997* (0.0396)	0.0369** (0.0119)
Stock USD claims on country	Dom. Pol. Easing (α_1)	0.2284** (0.0760)	0.0718** (0.0221)	0.00799 (0.00596)	0.00661* (0.00313)	0.1083** (0.0318)	-0.0021 (0.0116)
	Interaction (γ^{US})	-0.0448** (0.0139)	-0.02147** (0.00737)	-0.00857* (0.00250)	-0.00146 (0.00097)	-0.00047 (0.01063)	0.00610 (0.00506)
	U.S. Pol. Easing ($\alpha^{US} + \gamma^{US}\bar{Z}$)	0.3653** (0.1059)	0.1161** (0.0281)	0.0261** (0.0082)	0.00856** (0.00309)	0.0992* (0.0392)	0.0355** (0.0109)
Median Leverage		16.7	8.2	2.1	1.4	5.8	2.4

Estimates, based on equation (5), are for the marginal impact of a one quarter increase in duration on leverage, evaluated at the sample median for leverage, and the sample median for $\bar{Z}$. For Financial Depth, it is an index level of 0.788, for trade openness 55.2% of GDP and for the stock of US dollar claims as a fraction of total credit it is 6.62% of total credit. Robust standard errors, computed using the delta method, are in parentheses.

** Significantly different from zero at the 1 percent level.

* Significantly different from zero at the 5 percent level.

† Significantly different from zero at the 10 percent level.

Finally, the third line of each block in Table 5 reports an estimate of the full marginal effect of an increase in the duration of U.S. monetary policy easing. These estimates are based on $(\hat{\alpha}^{US} + \hat{\gamma}^{US}\bar{Z})$, all evaluated at the sample median value of each candidate interaction, $\bar{Z}$. We find these results unambiguous and similar to those reported in Section III. Without exception, the impact of U.S. policy easing on non-U.S. financial firm leverage is large and significantly different from zero. Furthermore, for all but investment banks, they are uniformly larger than the impact of domestic policy easing.

Looking at the results in Table 5 in a bit more detail, we note that an increase in financial development is associated with a rise in the responsiveness of financial firm leverage to U.S. policy easing. This is likely a consequence of the fact that deeper financial markets are more likely to transmit monetary policy across borders, as well as support more interconnected institutions. Focusing on the estimates of γ^{US}, this is more true for banks, insurance companies and real estate firms, and less so for asset managers and investment banks. We suspect that the difference is in part explained by the sophistication of the latter two groups, as well as their improved access to financial markets and counterparties that allow them to hedge their exposure to changes in U.S. policy. [27]

Turning to trade openness, the higher exports plus imports to GDP lowers the response of banks, insurance and real estate firms' leverage to U.S. policy easing. Again, asset managers and investment banks respond differently, and seem to be insensitive to trade links. The earlier explanation that these more sophisticated players have financial links independent of distance and commercial relations continues to seem relevant. While this result may seem puzzling at first, it is important to note that trade openness tends to be highly correlated with financial openness, as measured in our study by U.S. dollar claims – the country sample medians have a correlation of 0.45. Most likely, since a significant fraction trade is invoiced in U.S. dollars, the more a firm trades, the greater access it has to U.S. dollar borrowing.[28]

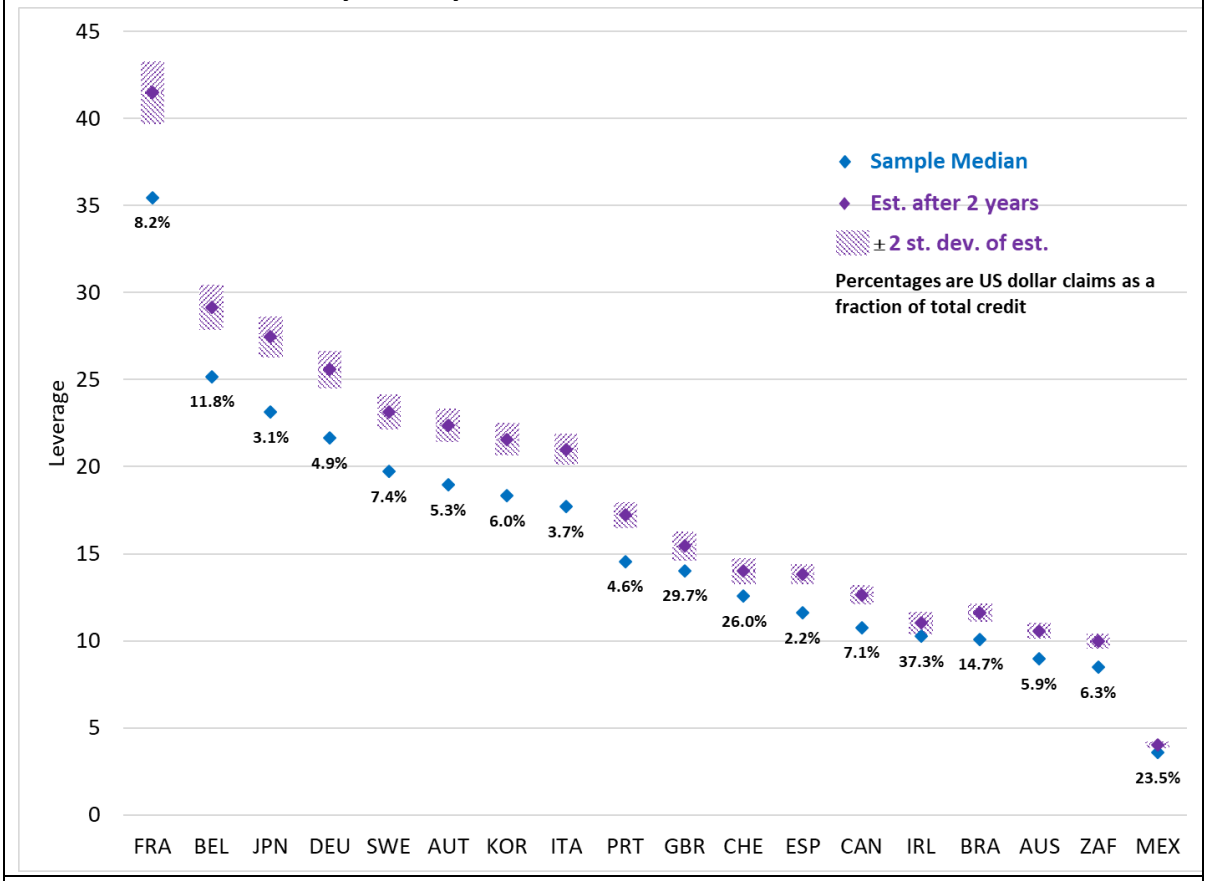
This brings us to U.S. dollar claims. First, we should be clear that these are the U.S. dollar *liabilities* of bank and non-bank borrowers in a particular country to banks in the rest of the world.[29] The results in Table 5 show that, the higher a U.S. dollar claims, the lower the response of banks, insurance and real estate firm leverage to a U.S. policy easing. That is, the estimates of γ^{US} for these sectors are negative (and significantly different from zero at the 1% or 5% level). Once again, investment banks and asset managers behave differently.

To help build intuition, we illustrate these results in Figure 6. We focus on variation created by U.S. dollar claims on the leverage of foreign banks. In each case, we have chosen to compute the impact starting at the sample median for each country – both for bank leverage and for U.S. dollar claims. We plot the country median in blue (♦), the point estimate of the impact of U.S. policy easing after 2 years in purple (♦), two standard deviation bands on the estimate impact as the shaded area (▨), and the median level of

[27]As suggested in footnote 26, these results hold for the component parts of the financial development index that we use.
[28]It is worth noting that net claims have virtually no impact. Consistent with work of Obstfeld (2012) and others, we find that gross stocks are what matters.
[29]We note that the data only include banks in countries that report to the BIS locational banking statistics. The list, along with the dates when each country began reporting, is here: https://www.bis.org/statistics/rep_countries.htm .

each country's U.S. dollar claims (as a percentage of total nonfinancial private credit) as the number below the sample median (e.g., for Austria, this is 5.3%).

Figure 6: Impact of US Policy Easing after 2 Years
By country based on US dollar bank claims



The vertical axis measures leverage, computed as the market value of equity divided by the sum of the market value of equity and the book value of liabilities. Blue diamonds (♦) are the sample median for banking system leverage in each country. Purple diamonds (♦) are the point estimate of the impact of sustained U.S. policy easing after 2 years. The shaded areas represent plus and minus 2 standard deviations of the estimated impact computed using the delta method. The numbers are the sample average values of US dollar claims on each country's banking system, as a percentage of total credit in the country. All estimates are based on text equation (5), with estimates reported in Table 5.

Figure 6 shows that, with the exception of countries with very high levels of U.S. dollar claims – specifically, Ireland (IRL) and Mexico (MEX) – the impact of U.S. monetary policy easing increases banking system leverage substantially. In roughly three-quarters of the cases, the increase after two years of consecutive easing in the U.S. is more than 10 percent from the baseline. For Italy, that means a rise from 17.7 to 21.0; for Canada, from 10.8 to 12.6; and for Korea from 18.3 to 21.6.

C. Further Understanding the Cross-Country Variation in Spillover: Exchange Rates

As we noted in the introduction, monetary policy easing in the U.S. can have several effects on foreign leverage, some pushing it down and others pushing it up. Firms will see the domestic currency value of dollar liabilities decrease following looser U.S. monetary policy, to the extent the dollar depreciates. In and of itself, this decreases leverage of borrowing firms. What happens next depends on the relative strength of supply and demand effects. On the demand side, firms may wish to lock in capital gains and thus maintain lower leverage, or they may decide to accept greater foreign lending at presumably better rates, and increase leverage. Thus, responses are likely to differ across sectors. On the supply side, lenders of dollars will seek to increase credit to all firms irrespective of sectors, to search for yield.

The fact that higher dollar claims reduce the effect of U.S. monetary policy easing on foreign leverage—but that the effect remains positive—suggests that demand effects partly counter supply effects. This implies that firms that realize higher capital gains following U.S. monetary policy easing will increase leverage by less.

To examine this possibility, we add the bilateral U.S. dollar exchange rate to equation (5) and estimate

$$ln(Y_{ikt}) = \alpha_0 + \alpha_1 D_{kt} + \alpha^{US} D_t^{US} + \gamma^{US} Z_{kt-4} D_t^{US} + \delta FX_{kt} + \beta X_{k,t-1} + c_{ki} + \varepsilon_{ikt}, \qquad (6)$$

where FX_{kt} is an index of the bilateral U.S. dollar exchange rate for country k.

The results, now focusing only on the case of U.S. dollar claims, are in Table 6. For ease of comparison, the first two columns reproduce a part of Table 5. In the next four columns, we report the estimates of equation (6). We draw three conclusions. First, the results suggest that both domestic and U.S. policy easing drives up leverage. Second, the impact of the bilateral U.S. dollar exchange rate is substantial. For example, looking at banks, we find that a 10 percent appreciate results in an increase in banking system leverage equivalent to that of a roughly 5 quarter domestic or 4 quarter U.S. policy easing.

We interpret these estimates as confirming that U.S. policy has a mechanical valuation effect on leverage, at least in part. First, a dollar depreciation unambiguously decreases leverage in all industries. That is the mechanical effect on leverage stemming from the re-valuation of dollar-denominated liabilities. Second, once we control for this effect, the value of γ^{US} is no longer significant for banks. This suggests demand effects are neutral; in other words, banks attempt to keep leverage constant following valuation effects on their balance sheet. Leverage does increase in the end, but equally across banks (the positive estimated semi-elasticity, α^{US}), as a result of the supply-side effect. By contrast, insurance and real-

estate firms exhibit countercyclical leverage. That is, after controlling for the valuation effect, firms with larger dollar claims tend to reduce leverage at the margin. But in this case as well, in the end leverage increases due to supply-side effects. Investment banks, interestingly, show the opposite effect. After controlling for valuation effects, investment banks with larger dollar claims—thus larger valuation effects on leverage—take on even more leverage. This is analogous to the Adrian and Shin (2008, 2011) results, except in a cross-border context.

Table 6: Impact of US Policy Easing, US Dollar Claims

	Excluding the Exchange Rate		**Including the Exchange Rate**			
	Interaction (γ^{US})	U.S. Pol. Easing ($\alpha^{US} + \gamma^{US}\overline{Z}$)	Dom. Pol. Easing (α_1)	Bilateral USD FX (δ^{US})	Interaction (γ^{US})	U.S. Pol. Easing ($\alpha^{US} + \gamma^{US}\overline{Z}$)
Banks	-0.00061** (0.00019)	0.3236** (0.0958	0.2423** (0.0595)	1.2702** (0.2267)	-0.00025 (0.00025)	0.3165** (0.0869)
Insurance	-0.00030** (0.0001)	0.1275** (0.0314)	0.0767** (0.0190)	0.1908* (0.0909)	-0.00024* (0.00011)	0.1154** (0.0299)
Real Estate	-0.00014** (0.00004)	0.0374** (0.0113)	0.0123* (0.0062)	0.0830** (0.0226)	-0.00011** (0.00004)	0.0329** (0.0106)
Asset Management	0.00003 (0.00002)	0.0119** (0.0046)	0.0111** (0.0035)	0.0451** (0.0129)	0.00001 (0.00002)	0.0087* (0.0041)
Investment Banks	-0.00001 (0.00018)	0.1103* (0.0466)	0.1456** (0.0262)	0.8633** (0.0933)	0.0003† (0.0002)	0.0686 (0.0388)
Other	0.00010 (0.00009)	0.0333** (0.0135)	0.00019 (0.01327)	0.0697 (0.0475)	0.00013 (0.00009)	0.0300* (0.0136)

Estimate of Equation 5 with and without the bilateral nominal exchange rate, evaluated at the sample median value for the stock of US dollar claims as a fraction of total credit, 7.7%, the sample median value of leverage for each sector, and for an exchange rate appreciation of 10 percent.
(see Table 5). Numbers in parentheses are robust standard errors.
** Significantly different from zero at the 1 percent level.
* Significantly different from zero at the 5 percent level.
† Significantly different from zero at the 10 percent level.

Finally, we note that the significance of the interaction term γ^{US} for investment banks increases when we lag duration further than four quarters, and the estimate on asset managers also becomes positive. This speaks to the persistence of the effect, and reinforces the fact that asset managers and investment banks respond differently from banks, real estate firms, and asset managers to U.S. monetary policy.

VI. Conclusion and Policy Implications

In this paper, we explore the links between the duration of monetary easing and the build-up of leverage in nearly 1,000 publicly listed financial firms in 21 countries from 1998 to 2014. Given the dominant role that U.S. dollar plays in the global trading and financial system, we ask whether the duration of U.S. monetary policy easing also affects leverage of financial firms in other countries, over and above the effects of home country monetary easing.

While it is straightforward to explain why domestic policy easing raises domestic leverage, understanding why foreign monetary policy might have an analogous effect is more challenging. We highlight several possible channels for such spillovers. On the supply side, lower funding costs, as well as search for yield motives can push lenders with access to dollars to lend more abroad. On the demand side, as U.S. monetary policy eases and the U.S. dollar depreciates, the balance sheets of financial firms that have borrowed in U.S. dollars strengthen and their leverage mechanically decreases. This eases financing constraint making lenders more willing to extend them credit. Financial firms can passively benefit from the decline in leverage brought on by appreciation of their domestic currency; or based on their now stronger balance sheet, increase their borrowing. Hence, whether domestic financial firms increase their leverage or not in response to U.S monetary policy easing is an empirical question.

Broadly speaking, we find that the leverage of financial firms increases substantially in reaction to both domestic and U.S. monetary policy easing. In particular, domestic policy easing increases leverage in banks, insurance, asset management and investment banks—a desired effect in the short-run, but one that can increase financial stability risks should the easing be prolonged.

Perhaps surprisingly, we estimate that the impact of U.S. monetary easing on leverage is even stronger than that of domestic monetary easing. We conjecture that this is a result of the extraordinary status of the U.S. dollar in financial and international trade transactions. In contrast, euro area monetary easing has minimal effect on financial firms in non-euro area countries.

Throughout, we distinguish among different types of financial firms—banks, insurance companies, real estate firms, asset management companies, investment banks, and a residual category, other. We find that the impact differs across types of firms, as well as across countries.

We find large cross-country variation in the response of leverage to U.S. monetary policy easing. First, leverage rises more in countries with higher levels of financial development.

This is likely because transmission mechanisms are more efficient and there are greater opportunities for risk-taking behavior when financial markets and institutions are more developed. And second, leverage rises much less in countries that are more financially integrated and are more open to trade. These countries' financial and nonfinancial firms have more dollar liabilities, which tend to decline as U.S. policy easing leads to domestic currency appreciation, putting downward pressure on their leverage.

Looking across sectors, we estimate that the cumulative impact of lower interest rates and balance sheet effects due to U.S. dollar depreciation is higher for banks, insurance companies, and investment banks than for the other three groups. In all sectors, the common effect of U.S. easing across firms is positive and significant, suggesting sizable supply-side effects. On the demand side, asset management companies and investment banks appear to increase leverage following favorable valuation effects, as opposed to firms in other sectors which either decrease leverage or maintain it unchanged. Our intuition is that this procyclical behavior arises because either these firms are simply more aggressive in expanding during booms, or they have better access to sophisticated markets and products that allows them to hedge changes in U.S. monetary policy.

Taken as a whole, these results lead us to ask what should or could recipient countries do in response to the financial stability risks arising from monetary policy. Prudential policies would seem an appropriate first line of defense against the effects of domestic monetary policy on leverage. Importantly, however, policies need to be deployed across the entire financial sector, including the various non-bank intermediaries who tend to increase their leverage in the wake of a policy easing. Our results are further evidence for the view that focusing prudential policies on bank capital requirements alone misses the wider financial stability risks inherent in monetary policy expansion.

The cross-border dimension introduces further complexity for policymakers. If easing of monetary policy in the U.S. increases leverage elsewhere, these other countries could respond by tightening domestic monetary policy. However, this creates its own problems as higher domestic interest rates could intensify capital inflows, driving leverage up even further, defeating the purpose of the response. Reacting to this concern, countries have a tendency to turn to prudential measures to ensure financial system resilience. Countries employ three classes of policies, each of which can be either structural and permanent or time-varying and temporary. First, regulators impose capital requirements on financial firms, restricting their ability to increase leverage. Second, policymakers implement policies that limit borrowing by the nonfinancial sector through loan-to-value or debt-service to income restrictions on households or leverage limits on firms. And third, governments move to restrict cross-border financial flows. Regardless of the combination authorities choose, it is important that the framework be comprehensive, or activities will escape the regulatory perimeter and put the system at risk.

A second question that arises is how should recipient countries prepare or respond when the tide turns? That is, what should they do when easing turns to tightening, leading the local currency to depreciate and balance sheets to worsen? If the corporate, household, or public sector have accumulated substantial debt during the U.S. monetary easing years, they may be hit by both higher interest rates and more expensive U.S. dollar. The situation is a lot worse when the timing of U.S. monetary policy is unanticipated and larger than expected.

Finally, our work lends some support for concerns raised by emerging markets that U.S. monetary policy spillovers, especially prolonged periods of easing, complicate domestic policy making. This brings us to the final question this paper raises: in view of international spillovers of U.S. monetary policy, is there a role for monetary and macroprudential policy coordination at the global level that might be improve outcomes for all countries?

APPENDIX: DATA SOURCES AND DEFINITIONS

The analysis is conducted using a panel data set of publicly listed financial firms in 21 countries from 1998 Q1 to 2014 Q4. It covers the whole financial sector based on Global Industry Classification Standard, which are further classified into six industries: banks, insurance companies, investment banks, asset managers, and other financials. Our sample countries consist of 17 advanced economies (Austria, Australia, Belgium, Canada, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Portugal, Republic of Korea, Spain, Sweden, Switzerland, the United Kingdom, and the U.S.) and three emerging market economies (Brazil, Mexico, and South Africa).

Our firm-level financial data come from the Worldscope (Thomson Reuters), which harmonizes definitions for cross-country analysis. It is important to use such harmonized data because accounting presentations and terminologies differ across countries. Firm-level data are merged with country-level macroeconomic indicators. The firm-country unbalanced panel data set covers a total of 988 listed financial firms available in the Worldscope. In our sample, there are 37,896 firm-quarter observations based on 994 firms whose indicators of financial vulnerabilities are available. Appendix Table A1 summarizes data sources and definitions for each variable.

The novelty of our firm-level panel data set is that it covers both the banking and the nonbank financial sector. Including all financial industries allows us to conduct a comprehensive analysis to examine potentially different effects of monetary policy on different industries. In addition, the data set provides ample variations across firms and countries, which enable us to identify the effect of the duration of monetary policy easing on vulnerability of financial institutions.

Table A1. Definitions and Sources		
Variable	Description	Source
Firm-level variables		
Leverage ratio	Calculated as the sum of total liabilities and market capitalization divided by market capitalization.	Authors' Computation
Risk-adjusted return on equity	The returns on equity divided by its standard deviation over the past 8 quarters (t-7 to t).	Authors' computation
Total liability	All short and long term obligations expected to be satisfied by the company (Field 03351).	Worldscope
Market capitalization	The share price multiplied by the number of ordinary shares in issue (Field MV).	Datastream
Returns on equity	Net income divided by total equity (Field 08301).	Worldscope
Country-level macroeconomic variables		
Real GDP growth	The year-on-year percent change of the real GDP.	WEO
Growth of stock price index	The year-on-year percent change of the natural log of the main stock indicator.	Datastream
Volatility index	Estimated time-varying volatility of the main stock indicator using a GARCH(1,1).	Datastream
Sovereign bond rating	Moody's Local Currency Long-Term Debt Rating. The values from 1 to 22 are assigned to the rating category so that a higher value indicates a better rating (e.g., 22 indicates "AAA").	Bloomberg
Inflation	Year-on-year percent change of the Consumer Price Index (CPI).	Haver
Financial Development Index	A relative ranking of countries on the depth, access and efficiency of financial institutions and markets	IMF Financial Development Index database
Trade Openness	The ratio of exports plus imports to GDP	World Bank
USD dollar claims	US dollar liabilities of bank and non-bank borrowers in a non-U.S. country to banks located in the rest of the world	BIS Locational Banking Statistics
Euro claims	Euro liabilities of bank and non-bank borrowers in a non-euro-area country to banks located in the rest of the world	BIS Locational Banking Statistics
Total Credit	Credit to the nonfinancial sector	BIS
Exchange Rate	Bilateral nominal US Dollar exchange rate	IMF IFS

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