

US Monetary Policy and Global Banking Flows

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Abstract

This note investigates the impact of US monetary policy on US global bank leverage and cross-border US dollar denominated banking flows, using US monetary policy shocks identified based on narrative sources and the Federal Reserve's Greenbook forecasts (Romer and Romer, 2004). Compared to Bruno and Shin (2015), who employ standard recursive monetary policy identification techniques, we find that leverage declines more quickly and to a much larger extent after a monetary tightening, suggesting that declines in the availability of debt finance play a significant role in the propagation of monetary policy via the banking system. The decline in international flows of dollar denominated bank funding is also larger using the externally identified monetary policy measure, as is the degree of US dollar appreciation. By expanding the baseline model into bilateral VARs for 36 countries, we find that the retrenchment of cross-border banking flows after US monetary contraction is much larger in response to the externally identified monetary policy shocks, which is consistent with the results of the aggregate model. By looking at country groups, it is observed that banking outflows after US monetary contraction are more pronounced in the case of emerging market economies than in the case of advanced economies.

Keywords: US monetary policy shock, Global banking flows, Global bank leverage

JEL Classifications: E52, E58, G24, G15, F34

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1 Introduction

In this note we examine the responses of US global banks to monetary policy shocks. We extend the results of Bruno and Shin (2015) who examine the operation of US global banks in a recursive VAR consisting of the Federal Funds rate, leverage of US global banks, international banking flows, the VIX index and the US dollar exchange rate. Bruno and Shin find that market risk measures (proxied by VIX) rise in response to a US monetary policy tightening, which causes a decline in the leverage of US global banks. This in turn lowers the overall amount of US dollar denominated cross-border banking flows that US global banks intermediate, and brings about an appreciation of the US dollar, so that there is international propagation of US monetary policy.

Bruno and Shin (2015) identify US monetary policy shocks within a recursive VAR. One problem with policy shocks identified in this way is that they do not explicitly control for endogenous movements in interest rates linked to central bank forecasts of future economic conditions; to the extent that such conditions correlate with bank decisions over leverage and credit supply there will be bias in banking sector responses to monetary policy. For instance, suppose a positive recursively identified interest rate shock reflects a central bank forecast for above trend growth and rising inflation. Whilst an interest rate rise is typically expected to reduce bank risk-taking and leverage, the backdrop of strengthening economic activity may encourage the opposite such that the recursively estimated impulse response for bank leverage to monetary policy is attenuated. It is this estimation issue that we tackle using a monetary policy identification due to Romer and Romer (2004) who orthogonalise narratively identified changes to the federal funds rate target against the internal Greenbook forecasts of economic conditions for the next two quarters. In our implementation we use an updated version of the Romer and Romer shock series produced by Barakchian and Crowe (2013). We find that the contraction in bank leverage after a monetary policy tightening is much larger than in previous empirical work. The response of the VIX index of uncertainty is of the same order of magnitude but less precisely estimated, while the flow of funding from global banks to local banks is somewhat stronger than in previous estimates, as is the appreciation of the US dollar.

Then, we examine the influences of US monetary policy on global banking flows in county-level bilateral models. We expand the baseline aggregate (global) model to a set of 31 bilateral models in which the US is the Foreign country and another country is the Home country. We include a small number of Home variables that affect the relative cost of borrowing from international wholesale interbank markets and adopt a block exogeneity assumption that Home variables do not affect Foreign variables, as is common in the literature. We find the responses

of flows of bank funding to US monetary policy shocks across 31 countries are consistent with the main (aggregate) VAR results. We find that the retrenchment of cross-border banking flows after US monetary contraction is much larger in response to the externally identified monetary policy shocks than in response to the shock identified in the recursive framework. Finally, we find that the retrenchment of cross-border banking flows after US monetary contraction is more pronounced in the case of emerging market economies than in the case of advanced economies.

In section 2 of this short paper we briefly set out the econometric specifications used in our analysis and discuss the results. Section 3 summarises our findings.

2 Evidence from VARs

In section 2.1 we compare responses of global bank leverage and global banking flows in two VAR schemes: (1) a standard recursively identified VAR framework as in Bruno and Shin (2015), (2) a reduced form VAR containing the same variables as in (1) plus an externally identified US monetary policy shock. In section 2.2 we report on a set of bilateral VARs, again comparing cross-border banking flows when policy shocks are identified via recursiveness and by use of narrative methods and Greenbook forecasts.

2.1 Structural VAR: Aggregate model

For a baseline regression, we consider a recursive VAR from Bruno and Shin (2015) which consists of five variables as follows.

$$y_t = [FFR, LEV, BF, VIX, REER]'$$

FFR is the effective Federal Funds rate. *LEV* is the log leverage of US global banks. *BF* is the log-difference of banking flows, which are cross-border flows of US dollar denominated wholesale bank funding.¹ *VIX* is the log of the VIX index of perceived market volatility. *REER* represents the log-difference of the US dollar real effective exchange rate. The lag length of endogenous variables is set to two, following Bruno and Shin (2015)'s original work.² The LM test confirms that the VAR model does not have any autocorrelation in the residuals and all

¹The (*LEV*) series is constructed from the US broker dealer sector and is published by the Federal Reserve. The *BF* series is measured as the growth in cross-border US dollar denominated loans of BIS-reporting banks to banking sector counter parties, and is from the BIS Locational Bank Statistics. See Bruno and Shin (2015) for more detail.

²Information criteria on the selection of lag length suggest either one or two lags. In Appendix III, we provide impulse responses to FFR shocks when the models include one lag and these confirm that the dynamics of responses are robust.

the eigenvalues lie inside the unit circle, satisfying the condition for the model to be stable. The recursive ordering implies that FFR is not affected by other variables instantaneously, but not vice versa. We obtain the impulse responses of all other variables in the VAR systems to FFR shocks from the Cholesky decomposition of the estimated variance-covariance matrix of corresponding reduced-form residuals. The sample comprises quarterly date for the period 1995Q4 – 2007Q4. This sample period excludes the financial crisis, a source of possible structural breaks, and omits the zero lower bound period for which there is no meaningful variation in the federal funds rate.

There are some differences in our implementation relative to Bruno and Shin. First, we use the nominal effective FFR , as is standard in the literature, not the real target FFR (intended target level of FFR – CPI inflation rate) used by Bruno and Shin. Second, our data for leverage of US banks may differ slightly from that of Bruno and Shin due to data revisions. However, as described below, these differences do not seem influential as our results based on the recursive VAR are very similar to those of Bruno and Shin.

Responses to Romer and Romer policy shocks We incorporate the externally identified US monetary policy shock based on Romer and Romer (2004)’s narrative approach into the VAR framework and measure the responses of endogenous variables to the shock. Equation (1) describes this.

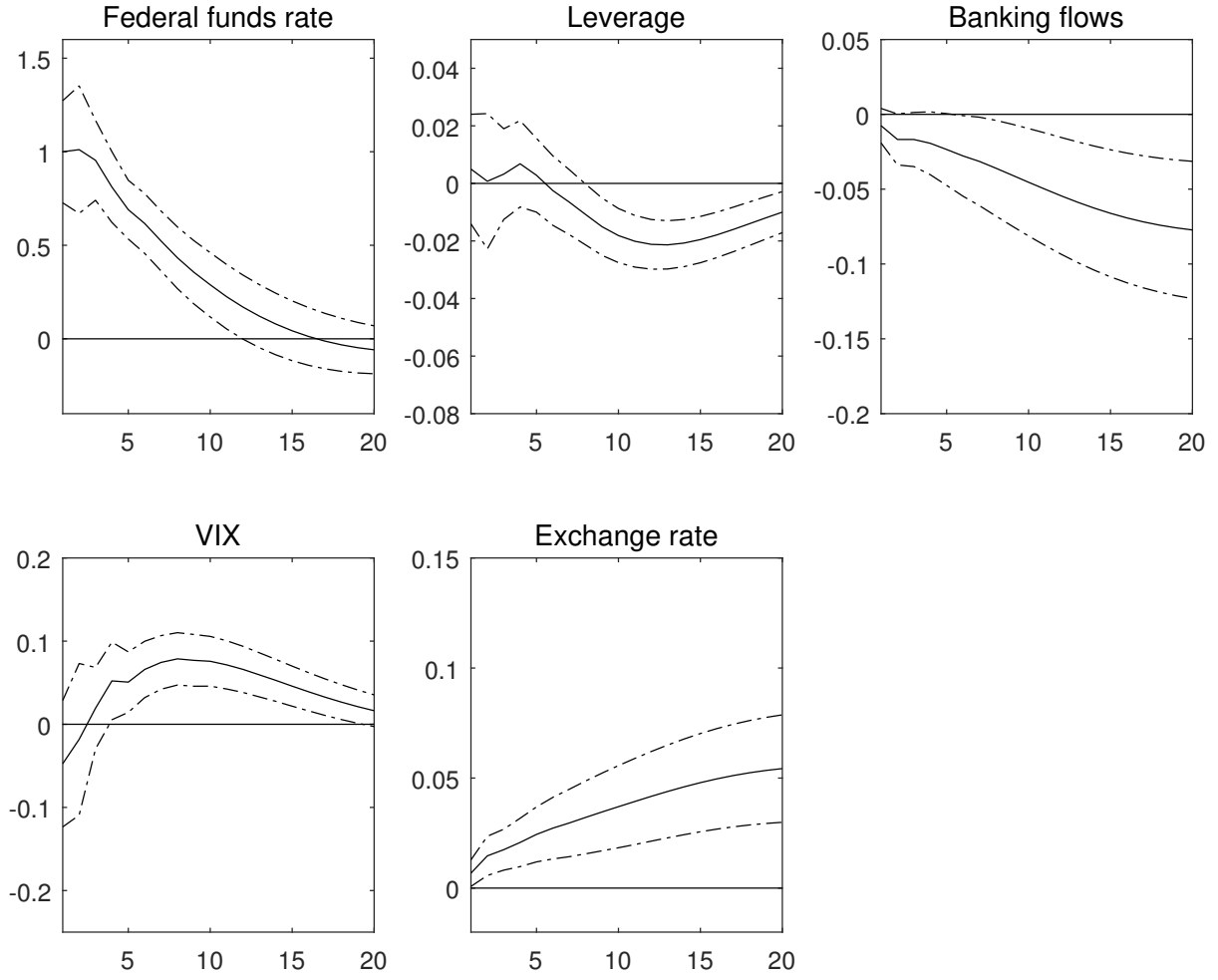
$$y_t = A(L)y_t + B(L)RR_t + e_t \quad (1)$$

Where, RR_t represents the exogenous US monetary policy shock generated by Romer and Romer (2004)’s approach and extended by Barakchian and Crowe (2013).³ The lag length of endogenous variables $A(L)$ is set to two, and that of exogenous RR shock $B(L)$ is set to two.⁴ With these lags, the LM test confirms that the VAR model does not have any autocorrelation in the residuals and all the eigenvalues lie inside the unit circle, satisfying the condition for the model to be stable. In the VAR specification the externally identified policy measure can affect all variables contemporaneously as well as via the lag structure.

³Romer and Romer’s monetary policy shock is generated at the FOMC meeting frequency. The meeting frequency series is transformed to a quarterly frequency by summing all meeting-based shocks in a particular quarter. In Appendix II, we plot the two US monetary policy measures used (RR shock and FFR shock) and provide cross-correlations. We find there exist quite significant divergences between the two measures at times. For example, the US monetary policy stance was contractionary around 1998 based on FFR shock recovered in a VAR, but it was easing at the time according to the RR shock which accounts for information on economic forecasts of policy makers. The correlation between the RR shock and the FFR shock is 0.48.

⁴In Appendix III, we provide impulse responses to RR shocks when one lag is included in the model. The results are robust.

Figure 1: Responses to FFR shock

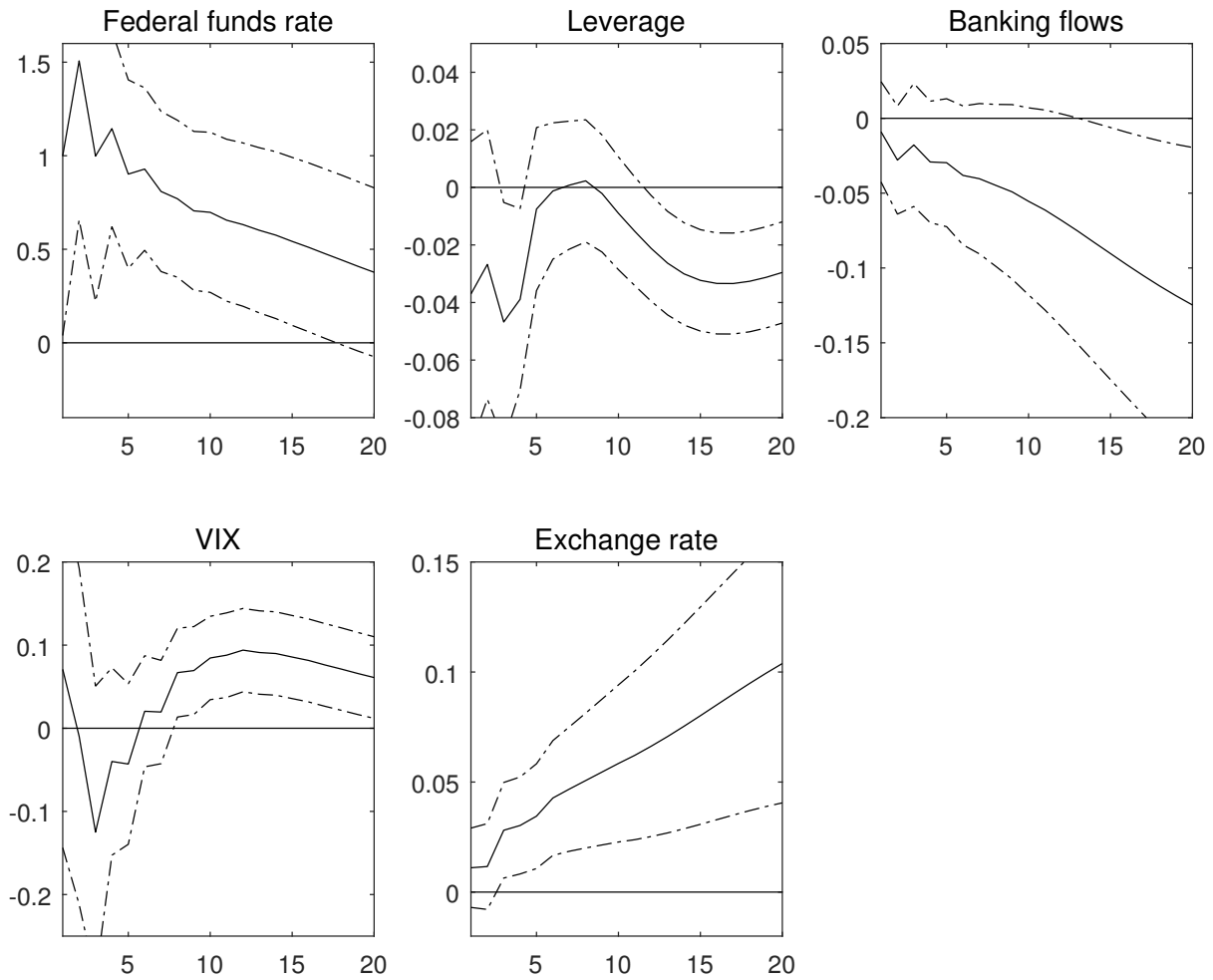


Notes: Solid line represents estimated responses to one unit of FFR shock. FFR shock denotes a US monetary policy shock identified in a recursive VAR. Dashed lines represent two-standard confidence intervals generated from 1,000 bootstrap replications. Scales of responses are adjusted such that the response of FFR is 100bp on impact.

Results 1 Figure 1 shows responses of the endogenous variables to a Federal Funds rate shock of 100 basis points. Dashed lines represent two standard error bands generated from 1,000 bootstrap replications. The responses of banking flows (*BF*) and the exchange rate for the US dollar (*REER*), which are log-differenced in the model, are cumulated responses.

Overall, the results replicate Bruno and Shin's (2015) findings. Leverage (*LEV*) shows positive responses for the first five quarters and then begins declining. It reaches its minimum of minus 2% about 13 quarters after the shock. Banking flows (*BF*) decrease when the shock occurs and further decrease subsequently, the response becoming significant at longer horizons. In total (accumulated sum), *BF* declines about 7.7% during the first 20 quarters after the shock. VIX shows an initial puzzle, decreasing for the first two quarters (though the effects is insignificant), then rising and reaching a maximum of about 7.9% about 8 quarters after the shock. The US dollar (*REER*) appreciates on impact and the total appreciation is about 5.4% after 20

Figure 2: Responses to RR shock



Notes: Solid line represents estimated responses to one unit of RR shock. RR shock denotes a US monetary policy shock identified based on narrative sources and the Federal Reserve's Greenbook forecasts. Dashed lines represent two-standard confidence intervals generated from 1,000 bootstrap replications. Scales of responses are adjusted such that the response of FFR is 100bp on impact.

quarters.

Results 2 The responses to a 100 basis point RR shock are shown in Figure 2 (as before, dashed lines represent two standard error bands derived from bootstrapping). Table 1 summarises maximum responses and their timings for key endogenous variables, for both FFR and RR shocks. A key point that we emphasise is that the leverage of US global banks declines more quickly and to a larger extent in response to the RR shock than the equivalent FFR shock considered in Figure 1. In the face of a 100 basis point shock, leverage declines 3.7% on impact and by 4.7% after 3 quarters. This is consistent with our expectation that US monetary policy shocks purged of forecast information would elicit more powerful estimates of deleveraging because they isolate monetary policy effects from those associated with forecasts of prospective economic conditions.

The cumulated (levels) responses of banking flows and the US dollar exchange rate are larger in response to the RR shock compared to the FFR shock. This is consistent with the leverage finding. In response to US banks deleveraging it is likely that they offer less funding to overseas banks, and as a result of the reduced flow of dollar funding to banks outside the US the dollar appreciates by a larger amount. These results indicate that banking sector adjustment may play a role in the international propagation of externally identified monetary policy shocks as documented in Bluedorn and Bowdler (2011).

The final comparison that we highlight concerns the response of the VIX index to a monetary tightening. In response to both FFR and RR increases the index falls rather than rises during the first year. The expected increase in volatility perceptions then occurs, with the maximum effect at around 10 quarters in each case. The maximum increase in the VIX index is slightly larger in results based on RR than in those based on FFR, though the difference is small compared to those seen for other variables. These results suggest that the larger effects of externally identified policy shocks on bank leverage, the flow of US dollar funding for banks and the US dollar real exchange rate may be driven by channels other than changing volatility perceptions in the aftermath of monetary policy decisions.

Table 1: Responses to US monetary policy shocks

	FFR shock			RR shock		
	Max	S.E.	Qrt.	Max	S.E.	Qrt.
Leverage (<i>LEV</i>)	-2.14 %	0.42	13	-4.68 %	2.08	3
Banking flows (<i>BF</i>)	-7.73 %	2.36	20	-12.47 %	5.26	20
VIX (<i>VIX</i>)	7.87 %	1.64	8	9.40 %	3.34	12
Value of \$US (<i>REER</i>)	5.43 %	1.23	20	10.39 %	3.17	20

Notes: 1) Figures are the maximum impulse response to US monetary policy shocks within 20 quarters after the shock, the standard error, and the quarter in which the maximum response occurs. 2) FFR shock denotes a US monetary policy shock identified in a recursive VAR, while RR shock denotes a US monetary policy shock identified based on narrative sources and the Federal Reserve's Greenbook forecasts. 3) In case of *BF* and *REER* which are log-differenced in the VAR, the figures denote maximum values in the series obtained from cumulating the differences.

2.2 Bilateral models

We expand the baseline (aggregate) model to a set of 31 bilateral VARs. This is to verify the results from the aggregate (global) model. In addition, it is to consider possible country level heterogeneity in responses of cross-border flows of bank funding to US monetary policy shocks.⁵

⁵The countries in the analysis are those from Dedola, Rivolta and Stracca (2017), but excluding 4 countries (Austria, Belgium, Denmark, and Portugal) due to lack of data availability and 1 country (Greece) due to instability in the initial VAR estimates. This leaves the following 31 countries: Australia, Brazil, Canada, Chile, China, Colombia, Czech Republic, Estonia, Finland, France, Germany, Hungary, India, Italy, Japan, Latvia, Lithuania, Malaysia,

To measure the influence of US monetary policy precisely, it is necessary to control for local economic conditions that might influence reliance on international interbank funding. The variables in our bilateral VAR models are therefore as follows:

$$y_t = [FFR, LEV, VIX, MMR^*, BF^*, EXCH^*]'$$

The first three variables are the US, or Foreign country, variables included in the previous aggregate VAR model. The local or Home country variables that we now include are: local interest rates, measured as money market rates (MMR^*), the change in the log of dollar denominated bank funding flows to the Home country (BF^*), and the change in the log of the bilateral exchange rate ($EXCH^*$, national currency per US dollar). Money market rates are from International Financial Statistics (IFS) of IMF (in cases in which IFS does not provide monetary market rates, the IFS lending rates were used). As before, banking flows data are from BIS Locational banking statistics.

We estimate the model for 31 country pairs, once using FFR as the measure of US monetary policy and once using RR. The lag length of all variables is set to two. We treat each of the Home economies as small open economies versus the US and therefore impose block exogeneity so that local variables do not affect US variables (this follows Cushman and Zha 1997, Canova 2005, Maćkowiack 2007).⁶

Results 3 Results from bilateral VARs are reported in Table 2 and Figure 3. Table 2 provides the average of the maximum responses within 20 quarters for Home variables following shocks to both the FFR and RR measures of monetary policy, amongst advanced economies, emerging market economies, and amongst all countries. Figure 3 plots histograms of maximum responses within 20 quarters of Home variables for the 31 countries. We find larger responses of banking flows in response to the RR shock compared to the FFR shock, which is consistent with the aggregate (global) VAR exercise. The mean response for the 31 countries is -9.1% for the FFR shock, and -24.8% for the RR shock. For both cases, average responses of banking flows are larger than those in the corresponding aggregate model results, and we find the difference is more pronounced in the case of the RR shock.

Mexico, Netherlands, Norway, Philippines, Poland, Russia, South Africa, South Korea, Spain, Sweden, Thailand, Turkey, United Kingdom. Among these countries, the 13 with the highest income levels are classified as advanced economies, and the rest are classified as emerging market economies. In 2007 banking flows to the 13 advanced economies and to the 18 emerging markets account for 53.4% and 3.0% respectively of the global total.

⁶To be specific, we divide variables for the bilateral VAR, y_t , into two parts: y_{1t} consisting of the US variables $y_{1t} = [FFR, LEV, VI]'$, and y_{2t} consisting of the Home (local) variables $y_{2t} = [MMR^*, BF^*, EXCH^*]'$. Then, the restriction on a partition matrix of $A(L)$, $A_{12}(L) = 0$ is imposed, which implies that the second block y_{2t} does not affect the first block y_{1t} contemporaneously or with lags. Using the block exogeneity assumption, the reduced-form VAR system is estimated by Seemingly Unrelated Regression (SUR).

Table 2: Responses of Home (local) variables to US monetary policy shocks

	AEs (13 countries)	EMEs (18 countries)	All countries
<i>FFR shock</i>			
Money market rate (<i>MMR*</i>)	0.3%p	1.4%p	1.0%p
Banking flows (<i>BF*</i>)	-4.9%	-12.2%	-9.1%
Exchange rate (<i>EXCH*</i>)	9.0%	10.0%	9.6%
<i>RR shock</i>			
Money market rate (<i>MMR*</i>)	0.4%p	1.9%p	1.3%p
Banking flows (<i>BF*</i>)	-13.9%	-32.7%	-24.8%
Exchange rate (<i>EXCH*</i>)	19.0%	18.4%	18.7%

Notes: The figures represent the maximum cumulated responses of each of Home variables in the bilateral VARs for 31 countries in response to FFR shock and RR shock. This is the maximum absolute responses in the first 20 quarters after a shock.

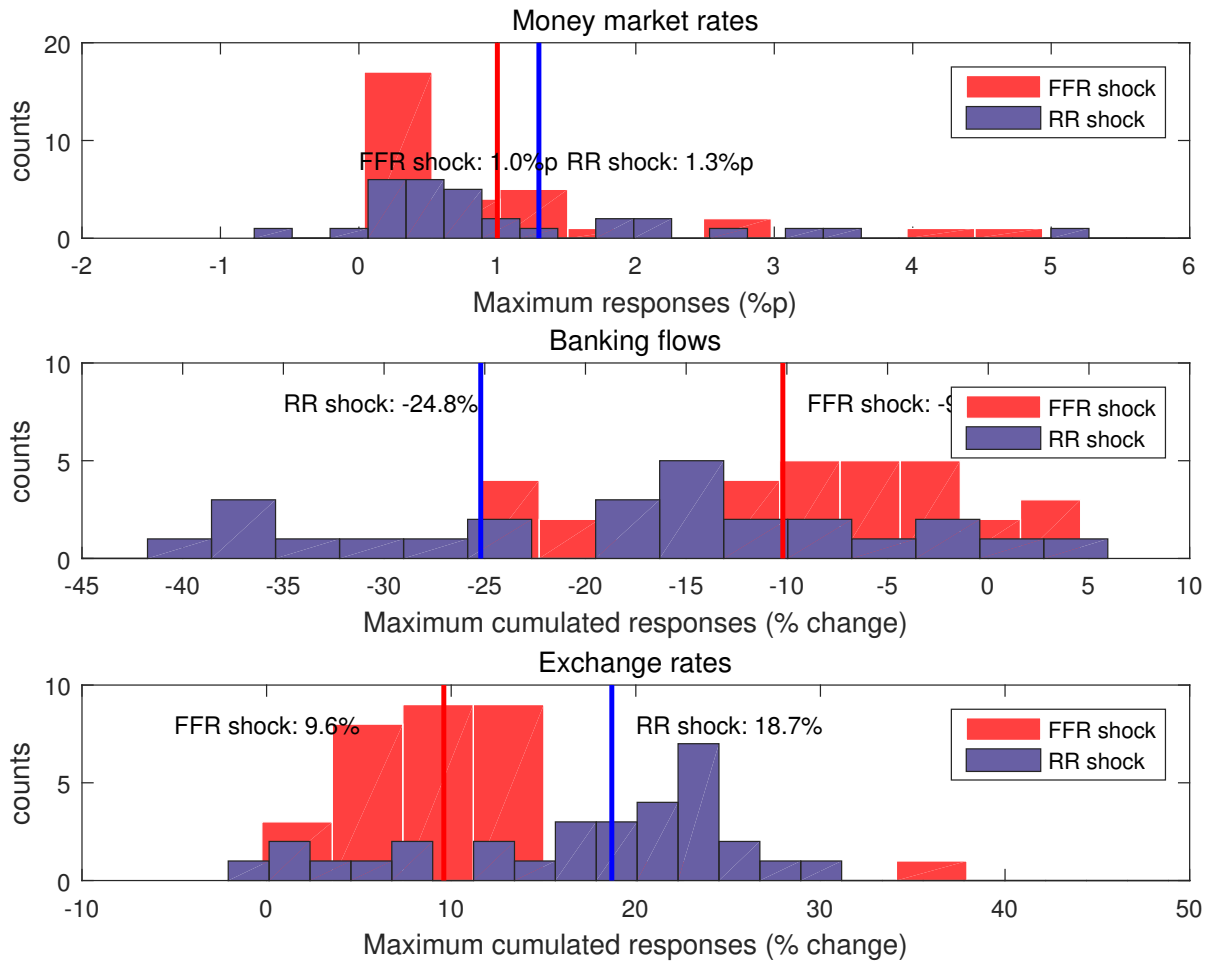
Next, we find that the retrenchment of cross-border banking flows after a tightening of US monetary policy is more pronounced amongst emerging market economies than amongst advanced economies.⁷ The mean reduction amongst advanced economies (AEs) using the FFR shock is -4.9% whilst that amongst emerging market economies (EMEs) is -12.2%. The corresponding figures using the RR shock measure are -13.9% and -32.7%. Thus, using both measures of monetary policy, there is evidence that US monetary policy shocks affect emerging market economies to a greater extent than advanced economies. Similar findings have been documented elsewhere for macro aggregates such as GDP, see Dedola, Luca and Stracca 2017, Iacoviello and Navarro 2018. In this study we document that the stronger transmission of US monetary policy to emerging market economies is also observed in respect of international flows of US dollar denominated bank funding. Furthermore, the contrast between the effects on advanced economies and emerging markets is greatest using a policy measure identified using the Greenbook forecasts of the Federal Reserve.

3 Conclusion

This study suggests that the influences of US monetary policy on global bank leverage and global banking flows could be larger than previously reported. Our starting point is that past estimates of the effects of monetary policy use FFR shocks from a VAR, that does not control

⁷We also group the results of each countries by other criteria suggested by Dedola et al. (2017), and the results are presented in Appendix IV. We find cross-border interbank capital flows are more affected in the countries with dollar pegging, and those with lower capital or trade openness, and those with lower dollar exposure, and those not exporting commodities. However, the differences are only marginal in the case of country classifications based on exchange rate regimes and capital openness.

Figure 3: Responses of Home variables in bilateral VARs



Notes: 1) This histogram represents the maximum responses of each of three Home variables for 31 countries in response to FFR shocks and RR shocks. In the cases of Banking flows and Exchange rates, the responses are cumulated ones. The bars represent the maximum absolute responses in the first 20 quarters after a shock.

for central bank reactions to forecasts of economic activity. When these forecasts are correlated with bank decisions concerning leverage and international lending, responses to FFR shocks are likely to be attenuated. The externally identified policy measure due to Romer and Romer (2004) is likely to be free of such biases, leading to the results documented in this note. By expanding the baseline model into bilateral VARs for 36 countries, we verify that the results from the main analysis hold, after controlling for country-level variables. The retrenchment of cross-border banking flows after US monetary contraction is much larger in response to the externally identified monetary policy shocks than in response to the shock identified from the recursive VAR. By looking at the results by country groups, we find the impact of US monetary policy on bank funding flows is greater for emerging market economies than for advanced economies. This supports previous literature which concludes spillovers from US monetary policy are more pronounced amongst emerging market economies.

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APPENDIX

I. Data sources

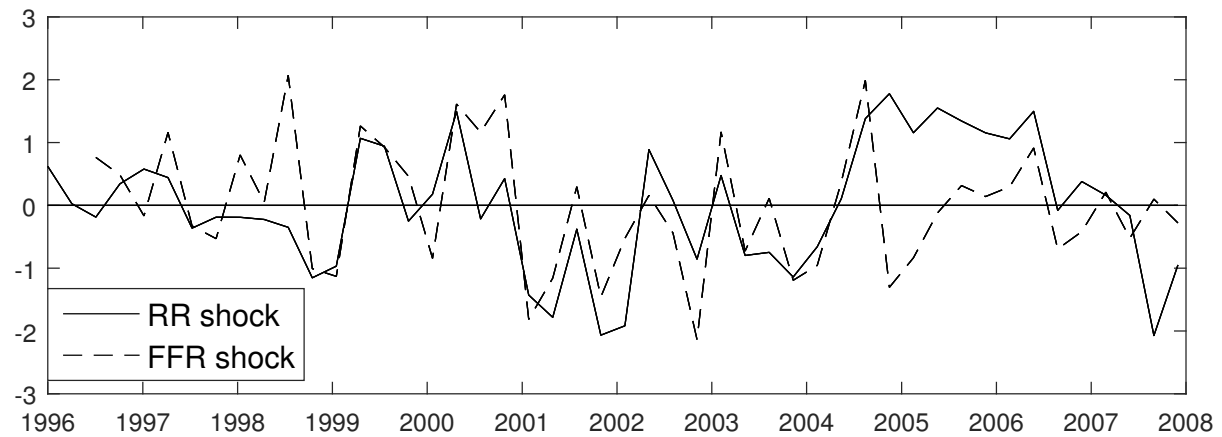
Aggregate model: Banking flows is quarterly difference of cross-border inter-bank loan outstanding from all BIS-reporting banks (Basel International Settlement, Locational Banking Statistics). Leverage is the leverage of the US global banking sector, and calculated by using "Security Brokers and dealers sector" in Federal Reserve Flow of Funds statistics (Financial Accounts). Leverage is defined as $2/(2 - 1)$, where, (1) is "total liabilities" (FL664190005.Q) and (2) is "total liabilities and equity" (FL664194005.Q). US dollar exchange rate is real effective exchange rate (International Monetary Fund, International Financial Statistics). VIX index is CBOE implied volatility on the S&P index (The Federal Reserve Bank of St. Louis, VIXCLS). Effective Federal Funds rate is from the Federal Reserve Bank of St. Louis (DFF).

Bilateral model: Country level money market rates, and nominal exchange rates (national currency per US dollar, period-average) are from International Financial Statistics of International Monetary Fund. Country level banking flows corresponds to the global banking flows used in the aggregate model from the same data source.

II. US Monetary policy shocks

Figure 4 plots two measures of US monetary policy used in the analysis. Table 3 presents correlations across measures of US monetary policy.

Figure 4: US monetary policy measures



Notes: Both measures of US monetary policy shock are standardized using their own mean and standard deviation.

Table 3: Correlations among US monetary policy measures

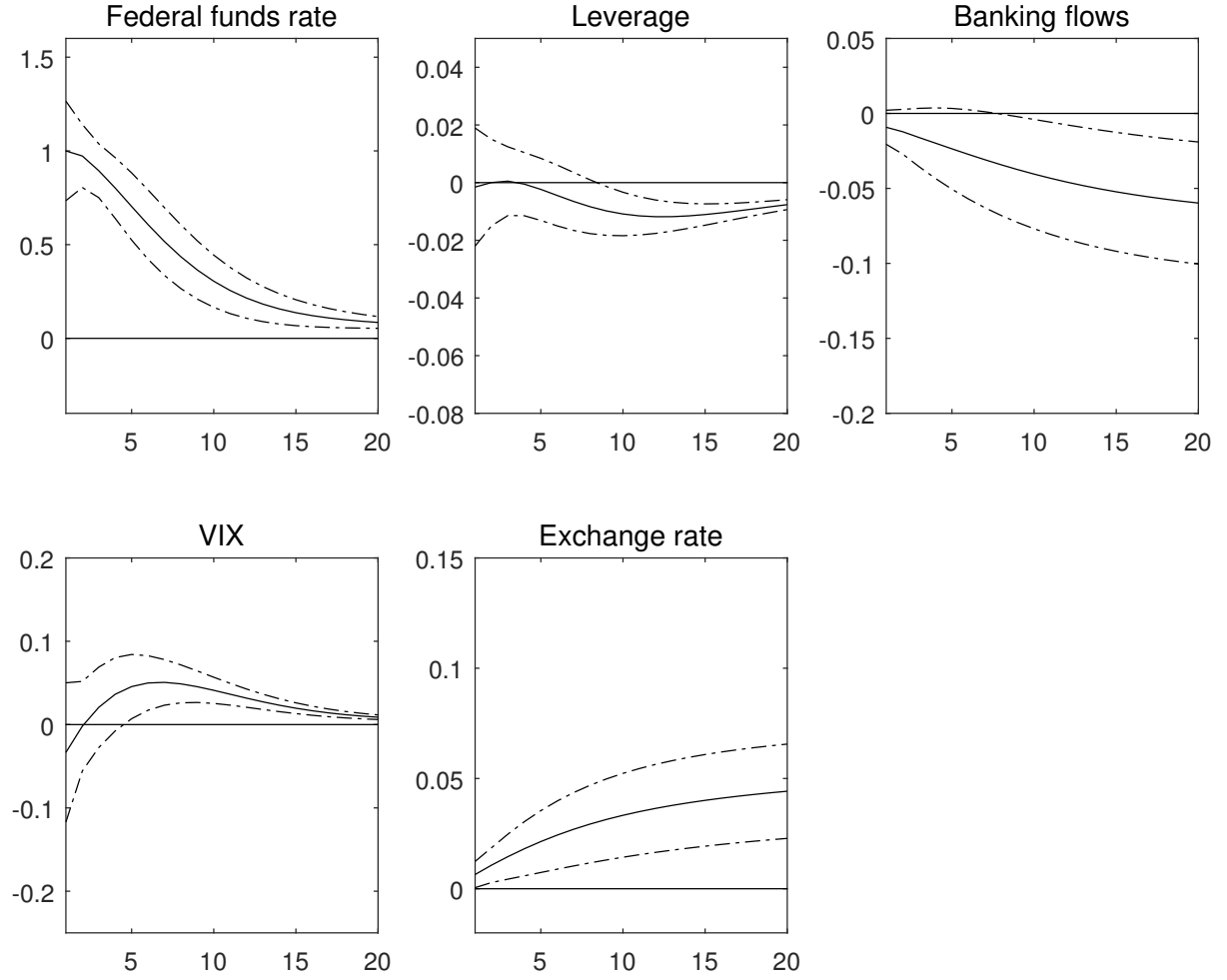
	RR shock	FFR shock	Δ FFR
RR shock	1		
FFR shock	0.48	1	
Δ FFR	0.47	0.07	1

Notes: The figures are correlations among three measures of US monetary policy shocks. Δ FFR denotes difference of effective federal funds rate.

III. Results with alternative lags

Figure 5 presents impulse responses of the five endogenous variables in a recursive VAR with lag length one.

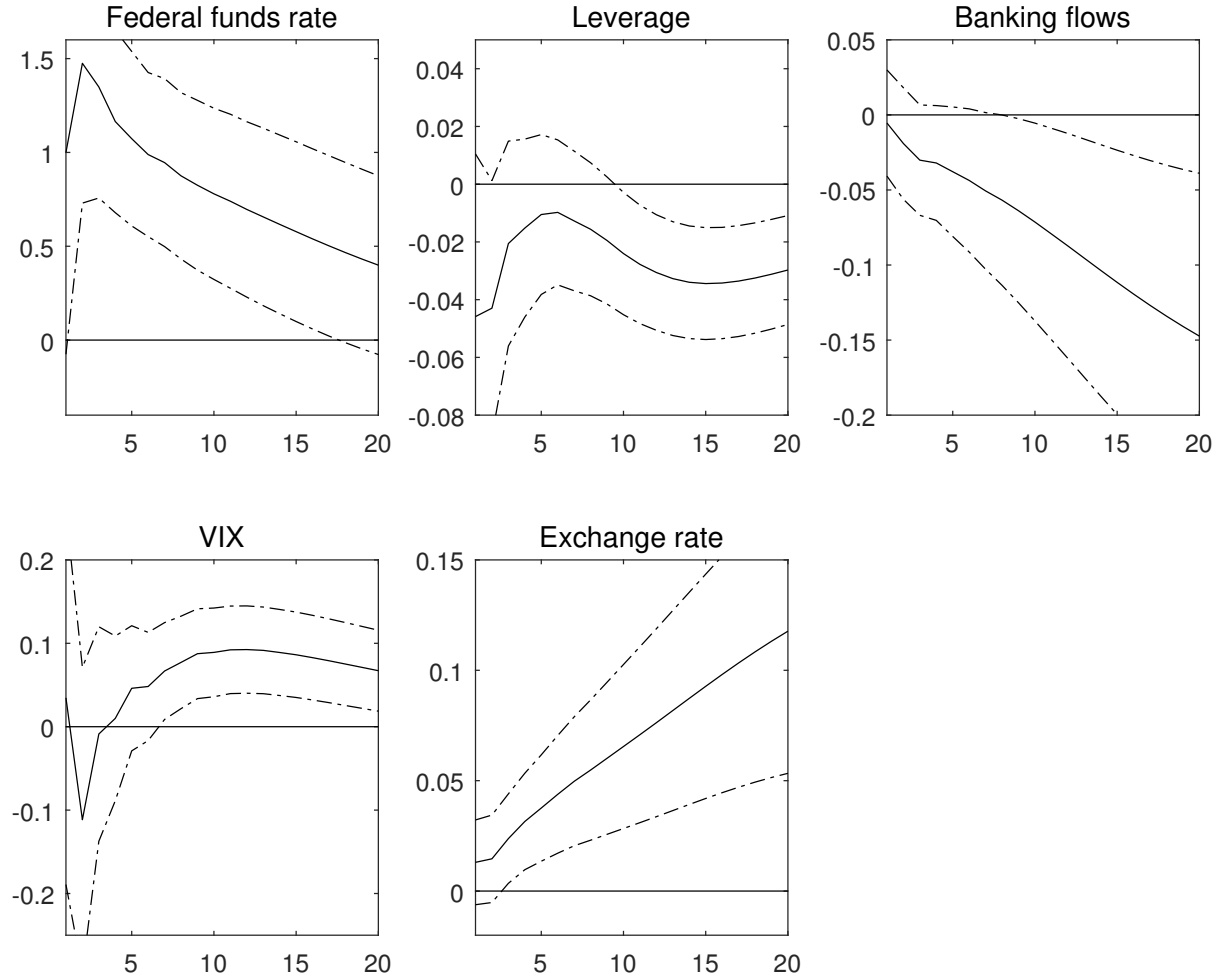
Figure 5: Responses to FFR shock: Lag length of endogenous variables 1



Notes: 1) Solid line represents estimated responses to one unit of FFR shock. FFR shock denotes a US monetary policy shock identified in a recursive VAR. Dashed lines represent two-standard confidence intervals generated from 1,000 bootstrap replications. Scales of responses are adjusted such that the response of FFR is 100bp on impact. 2) Lag length of endogenous variables, $A(L)$ is set to 1, instead of 2 in the main text.

Figure 6 presents impulse responses of the five endogenous variables to RR shock with lag length one of RR shock and lag length two of endogenous variables.

Figure 6: Responses to RR shock: Lag length of RR 1, Lag length of endogenous variables 2



Notes: 1) Solid line represents estimated responses to one unit of RR shock. RR shock denotes a US monetary policy shock identified based on narrative sources and the Federal Reserve's Greenbook forecasts. Dashed lines represent two-standard confidence intervals generated from 1,000 bootstrap replications. Scales of responses are adjusted such that the response of FFR is 100bp on impact. 2) Lag length of external US monetary policy shocks, $B(L)$ is set to 1, instead of 2 in the main text, while $A(L)$ is unchanged.

IV. Alternative country classification

Table 4 presents averages of responses of banking flows to US monetary policy contractions grouped across alternative country classifications as suggested by Dedola et al. (2017).

Table 4: Responses of Banking flows across country groups

	Num. of Countries	FFR shock	RR shocks
<i>Income level</i>			
Advanced	13	-4.9 %	-13.9 %
Emerging	18	-12.2 %	-32.7 %
<i>Exchange rate regime</i>			
Floaters	25	-8.0 %	-24.7 %
Dollar Pegs	6	-13.8 %	-25.3 %
<i>Capital openness</i>			
More	15	-7.1 %	-24.7 %
Less	16	-11.1 %	-24.9 %
<i>Dollar exposure</i>			
More	16	-8.9 %	-19.6 %
Less	15	-9.3 %	-30.4 %
<i>Trade openness</i>			
More	16	-7.1 %	-15.1 %
Less	15	-11.6 %	-36.6 %
<i>Commodity exporters</i>			
Exporters	8	-8.1 %	-21.4 %
Non-exporters	23	-9.5 %	-26.0 %
All countries	31	-9.1 %	-24.8 %

Notes: 1) Figures are averages across countries of the maximum impulse response to US monetary policy shocks within 20 quarters. 2) See Dedola et al.(2017) for further information on the country classifications.