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Credit, Securitization and Monetary Policy:
Watch Out for Unintended Consequences

by Andrea Pescatori and Juan Solé

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I N T E R N A T I O N A L M O N E T A R Y F U N D

IMF Working Paper

Western Hemisphere Department

Credit, Securitization and Monetary Policy: Watch Out for Unintended Consequences

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Authorized for distribution by Nigel Chalk

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Abstract

We show evidence that interest rate hikes slowdown loan growth but lead intermediation to migrate from banks' balance sheets to non-banks via increased securitization activity. As such, higher interest rates have the potential for unintended consequences; raising systemic risk rather than lowering it by pushing more intermediation activity to more weakly regulated sectors. In the past, this increased securitization activity was driven primarily by private-label securitization. On the other hand, the government sponsored entities like Freddie Mac and Fannie Mae appear to react to higher policy rates by cutting back on their securitization activity but expanding loans to the Federal Home Loan Bank system.

JEL Classification Numbers: E5, E43, E52, G2, G21

Keywords: Monetary policy; monetary policy shocks; VAR; proxy VAR; financial intermediation; shadow banking; securitization; GSE; private-label ABS issuers.

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I. INTRODUCTION

The global financial crisis has reignited the debate of whether persistently low interest rates encourage greater risk taking and raise systemic risk. This has led prominent voices to argue for monetary policy to react to financial stability concerns with the presumption that, by slowing down credit growth, higher policy rates can lessen systemic risk and raise welfare, even in spite of the near-term costs to activity and employment. Advocates of such a view (e.g., Stein 2013 and 2014, BIS 2014, the Riksbank¹) argue that, even though the policy rate may not be the best tool to deal with financial stability issues—especially when compared to micro- and macro-prudential tools—it has the advantage of “getting in all of the cracks” of the financial system. Others consider the welfare benefits of such a policy to be more elusive with the short-term costs to growth outweighing any incremental beneficial impact on systemic risk (IMF (2015), Svensson 2014, Ajello et al. 2015).

This paper examines one aspect of that argument by tracing through the effects of higher policy rates on different elements of the U.S. financial system, drawing out the implications for financial system risk. The empirical findings are that higher interest rates do, as expected, rein in overall credit growth but that there is substantial heterogeneity across asset classes and sectors. In particular, while interest rate hikes reduce bank lending they have the opposite effect on securitization activities (Nelson et al. 2015; Herman, Igan and Solé 2015).

The disaggregated data we have compiled on the different components of credit creating flows shines a light on the transmission dynamics of policy rate movements. A monetary policy tightening surprise acts as a liquidity shock for banks that (temporarily) raises their costs of funds, putting pressure on bank profits, cash flow, and liquidity.² This is in line with others findings that higher policy rates induce a fall in reservable deposits, an increase in short-term rates (such as non-reservable deposit rates), a flattening of the yield curve, and a slowdown in loan demand (Christiano et al. 1999, and English 2002).³ The less liquid is the bank’s initial balance sheet, the larger the effect of the monetary policy action (Kashyap and Stein 1995, 2000). However, at the same time, securitization provides a source of funding and liquidity to banks that can mitigate the impact of the rising costs of funding. Loutskina (2011) find that the more assets a bank has that can be securitized the less sensitive it is to policy rate movements. It appears, therefore, that in the face of higher federal funds rates U.S. banks liquefy part of their assets (mostly mortgages) through securitization,

¹ In their external evaluation of the Riksbank’s monetary policy conduct of 2013-14 King and Goofriend noted that “[...] the majority on the Executive Board [of the Riksbank] were concerned about the impact of rising asset prices and indebtedness on the economy [...] The Riksbank, therefore, took it upon itself to allow concerns about financial stability to affect decisions on monetary policy.” (King and Goofriend 2016).

² For a discussion of the different effects of monetary policy shocks after a prolonged period of zero interest rates and unconventional monetary policy see the Section VI.

³ See Peek and Rosengreen (2013) for a survey of the literature on lending view and money view. Section V of this paper shows the response of the volume of deposits and deposit rates to a monetary policy shock.

increasing the flow of credit through that (less regulated) channel.⁴ We test this hypothesis using a proxy-VAR to identify monetary policy shocks and distinguishing between government sponsored enterprises (GSEs), which securitize *conforming* loans, and private-label asset-back-security issuers (ABS issuers, for short), which mostly focus on (less liquid) non-conforming loans; (see diagram 1).⁵

Our main findings can be summarized as follows. After a monetary policy tightening:

- The total supply of mortgages fall, the term spread is reduced, and house price growth slows;
- Securitization activity of conforming loan (i.e., GSE mortgage pools assets) also falls;
- Private-label asset backed mortgage securities rises.
- GSEs expand their assets mostly by extending loans to the Federal Home Loan Bank system.

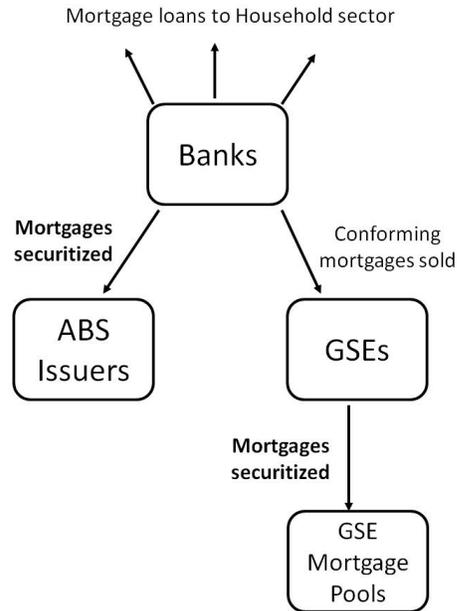
As a result of the heterogeneity of the U.S. financial system, raising rates serves to redistribute flows within the financial system—i.e., from banks to non-banks.⁶ By shifting risky assets and intermediation from the better-regulated and more-understood banks to less regulated structures (i.e., securitization vehicles), higher interest rates have an ambiguous effect on systemic risk. Lower growth of aggregate credit but potentially a more risky composition of intermediation. Today, private-label securitization activity has not recovered yet from the crisis and the bank lending channel may operate differently exiting from unconventional monetary policies, however, a mechanism similar to the one found might operate through other sectors (e.g., ETF, asset management, or life insurance). As such, this should lead us to be cautious in arguing for a monetary policy tighter than otherwise to temper financial stability risks. This is even more so given that past results (e.g. Ajello et al. 2015, Svensson 2014, and Pescatori and Laseen 2016) find an ambiguous effect on welfare even after assuming that higher rates unambiguously lower systemic risks.

⁴ In a different context, Loutskina (2011) also finds evidence that securitization provides banks with an effective channel to transform illiquid assets into liquid ones and thus (by making liquidity shocks less binding) can potentially partly offset the impact of the central bank's policies to contract the loan supply. Similarly, BIS (1992) and Bernanke and Gertler (1995) are two early references admonishing that securitization diminishes the effectiveness of monetary policy as it removes assets from the balance sheet of banks, which is the main transmission mechanism of monetary policy.

⁵ For a definition of conforming loan see Section II.

⁶ Cecchetti et al. (2016) finds that leverage in both banks and nonbanks increases, during monetary policy easing cycles. The definition used for the non-bank sector is, however, less granular than ours.

Diagram 1: Schematic Overview of the Securitization Process



The paper is organized as follows: Section II describes briefly the securitization market, Section III presents our methodology to identify a monetary policy shock, Section IV describes the financial data used in the empirical analysis, Section V presents the results, and Section VI concludes.

II. A BRIEF OVERVIEW OF MORTGAGE SECURITIZATION IN THE U.S.

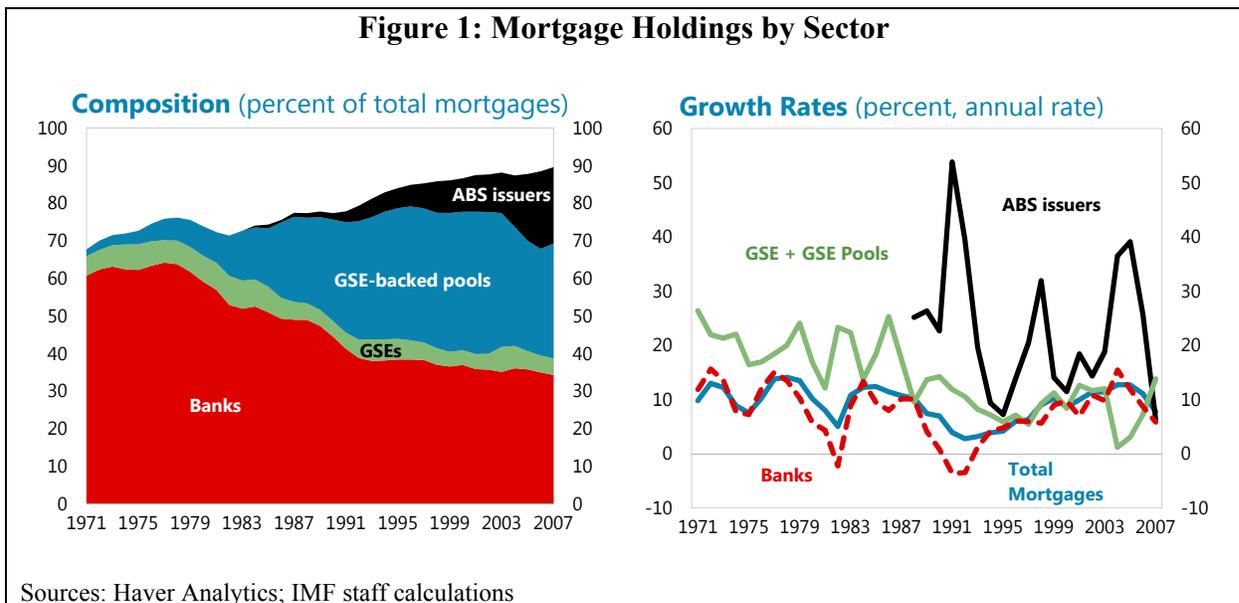
The securitization market grew at very rapid pace in the decades preceding the Great Financial Crisis (GFC) (Figure 1 Panels A and B). Since total loans typically represent about 2/3 of a bank total asset, securitization provides a valuable tool to increase the liquidity of a bank's balance sheet. Home mortgages are the easiest loans to securitize. Indeed, even after the GFC about 80 percent of new home mortgages are being securitized.⁷ The overall value of outstanding securitized mortgages was almost US\$8 trillion in 2014, exceeding the size of the corporate bond market.⁸

⁷ The share of mortgage holdings in total assets climbed over time, it was about 65 percent in 2007 while in 2014 was close to 80 percent.

⁸ We sum Agency- and GSE-backed pools' assets, GSE mortgage holdings, and ABS issuer's mortgage holdings and then divide the sum by total mortgages. We sum GSE-backed pools' assets and GSE mortgage holdings since in 2010 accounting rules forced GSEs to consolidate accounts.

While Government Sponsored Enterprises (GSEs) dominated the securitization market initially, the share of securitized mortgages of private-label ABS issuers grew quickly over time and reached a peak in 2006 at 40 percent of total market. However, the industry unwound in the aftermath of the financial crisis and is virtually non-existent in the current financial structure. That surge in ABS issuance in part reflected the increased origination of loans that did not conform to the parameters set by the FHFA that are required if banks are to be able to sell these mortgages to the GSEs.⁹ It is notable also that two periods of high growth in ABS issuance coincided with monetary policy tightening cycles. In the next sections, we will test the relation between securitization activity and monetary policy more formally.

Figure 1: Mortgage Holdings by Sector



III. IDENTIFICATION STRATEGY OF INTEREST RATE SHOCKS

To study the transmission channel of monetary policy, we first need to isolate exogenous movements in the policy rate. The most traditional approach to identify monetary policy shocks relies on a timing assumption for which innovations to the monetary policy instrument—usually the Federal Funds Rate—have no contemporaneous effects on output and prices (see Christiano et al. 1999). This strategy is easily implemented in a VAR

⁹ Private-label mortgage backed securities are mostly securitized mortgages that do not conform to the criteria set by the Government Sponsored Enterprises Freddie Mac, Fannie Mae and Ginnie Mae. A mortgage is non-conforming if it does not meet some criteria such as exceeding the “Jumbo Loan” threshold (typically \$417,000 today), low credit score (typically a FICO score below 660), 40-year or negative amortization, Alt-A loans, or low documentation. Most mortgages that do not conform are ‘Jumbo Loans’.

framework by using a recursive assumption where the policy instrument is ordered after measures of output and inflation (we will refer to this strategy as CEE identification).

The recent monetary policy literature, however, offers various estimated series of monetary policy surprises designed to be orthogonal to output and inflation forecasts (see Romer and Romer 2004, Coibion 2012, Gertler and Karadi 2015). Their orthogonality, in turn, can be used to estimate the causal effects of raising interest rates on economic activity and inflation (Cochrane 2004).¹⁰ Here we choose to blend the traditional recursive identification strategy with the use of the monetary policy surprise data using a proxy VAR.¹¹

The sample period of our proxy-VAR starts in 1970 and ends in the second quarter of 2007 before the beginning of the global financial crisis and the subsequent collapse of most securitization activity. Given the sample period, we rely on Coibion's series of monetary policy surprises which extends back to 1969.^{12 13}

The macroeconomic variables used in the baseline estimation are standard and include an oil dummy, the log-differences of real GDP, the log-differences of the PCE deflator, the series of monetary policy surprises, and the fed funds rate. The 10-year term spread and the log-difference of real house prices are included to capture the transmission mechanism between interest rates and financial markets. Multiple VARs are estimated by adding one set of flow of fund variables at a time. Credit variables are ordered last in the VAR and are, thus, free to react to monetary policy shocks within the same quarter. Hence, as robustness, we also present results where credit variables do not react to the monetary policy surprise contemporaneously. The VAR has been estimated in both differences and levels with little impact on the results.¹⁴

¹⁰ It is also high likely that such policy surprises are, in general, not a response to securitization activity, the object of our study. Indeed, we cannot reject the null hypothesis that changes in various measures of securitization activity do *not* granger-cause our preferred monetary surprise series, within our sample. We have similar results also for total and bank mortgages.

¹¹ A similar approach has been used to estimate fiscal multipliers (see Guajardo et al 2014 and Mertens and Ravn 2014, among others).

¹² Coibion (2012) extends the approach proposed by Romer and Romer (2004) by estimating the Fed's reaction function allowing for heteroscedasticity in the innovations; the estimation stops in 2007 (see Appendix I for further details). Gertler and Karadi (2015), instead, uses futures markets to identify interest rate surprises in relation to FOMC meetings, their sample, however, starts in the '90s. Aggregated at quarterly frequency, however, the Gertler and Karadi shocks do not induce a fall in GDP and inflation, possibly due to lack of power.

¹³ We identify the monetary policy shock as the shock to the series of monetary policy surprises rescaled to raise the fed funds rate by 100 basis points at peak.

¹⁴ The specification in log-differences implicitly allows monetary policy to have permanent effects on real macro variables and credit aggregates. While this might be less defensible for real GDP, theory does not provide a clear guidance in relation to credit aggregates. Indeed, in a broad class of models debt behaves as a quasi random walk (see Marcet and Singleton 1999 or Sargent Ljungqvist 2000 Chapter 17 for example).

IV. DESCRIPTION OF THE DATA

The main source for the data on financial variables is the Financial Accounts (FAs) of the United States (formerly known as Flow of Funds). From this source, we obtain data by sector and instrument. We collect data for total assets, total mortgages, and other subcategories. The sectors we focus on are banks,¹⁵ Government Sponsored Enterprises (GSEs), Agency- and GSE-backed mortgage pools, issuers of asset-backed securities (ABS), Finance Companies, and Life Insurance Companies. We obtain the series of “Other Loans and Advances” from the balance sheet of GSEs to study the behavior of GSEs in response to interest rate shocks.

Private-label securitization activity is measured by the change in mortgages held by ABS issuers, as these mortgages are used to back ABSs’ issuance of mortgage-backed securities (obtained from table L.216 in the FAs).¹⁶ Analogously, to measure non-private securitization we use the total mortgages held by agency- and GSE-backed mortgage pools (obtained from table L.125 in the FAs).¹⁷

For deposit volumes, we use private domestic deposits of US-chartered depository institution and credit union (Table L.204 in the FAs). The interest rates on certificates of deposit (CDs) are an average of dealer bid rates for CDs actively traded in the secondary market and are issued by top-tier banks; interest rates differ by maturity. Bids are generally for CDs issued in denominations of \$1,000,000 or greater.

V. EMPIRICAL RESULTS

A. How Do Interest Rates Affect Financial Intermediaries?

Consistent with other results (e.g., Coibion 2012, Christiano et al. 1999) a monetary policy tightening shock of a 100bp increase in the federal funds rate reduces output growth and inflation by about 0.9 percent and 0.4 percent, respectively, after three quarters (Figure 2). House prices and total mortgages decline persistently, consistently with a reduction in household demand for credit. A slowdown in lending and the fall in the term spread suggest banks’ interest margin decline as a result of the monetary tightening (Borio et al. 2015).¹⁸ While not modeled here, lower equity prices would additionally contribute to exacerbate

¹⁵ The category ‘banks’ is referred to in the FAs as ‘private depository institutions’, and comprises U.S.-chartered depository institutions, foreign banking offices in the United States, banks in U.S.-affiliated areas, and credit unions.

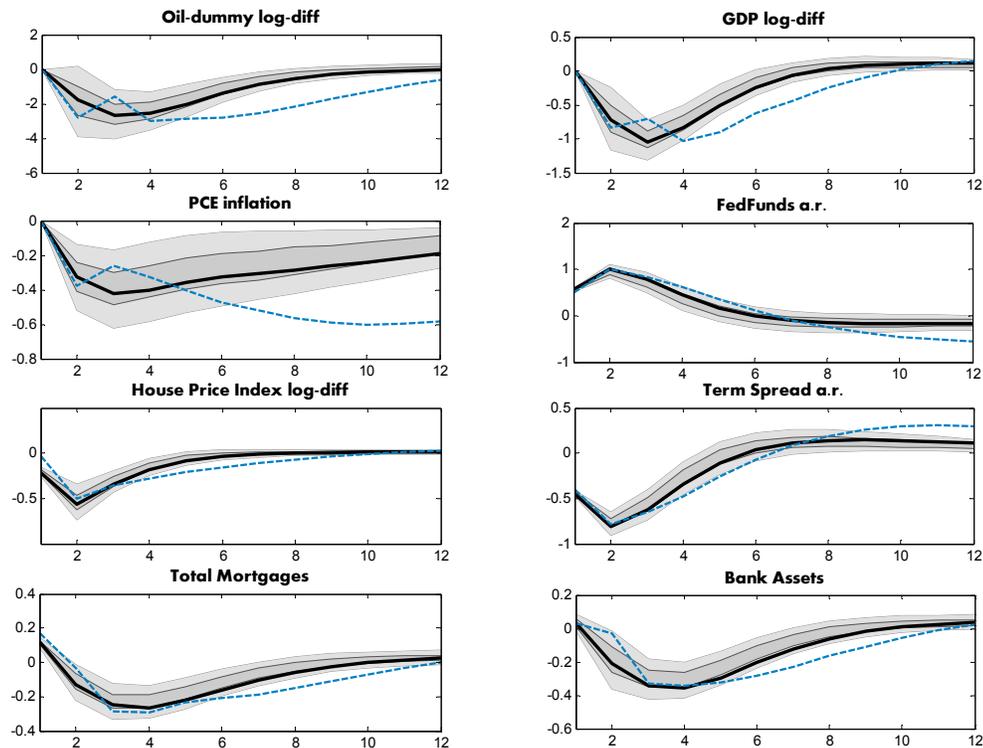
¹⁶ We drop the first two years of non-zero observations of the ABS series since they are extremely volatile.

¹⁷ Mortgages represent the totality of agency- and GSE-backed mortgage pools’ assets.

¹⁸ In an analysis on UK banks Alessandri and Gambacorta (2015) find that, in the short run, increases in market rates compress interest margins, consistent with the presence of non-negligible loan pricing frictions.

capital requirements intensifying the need to liquefy part of the banks' balance sheet (Adrian and Shin 2010, Bernanke and Kuttner 2005, and Van den Heuvel 2002); (Figure 2 and 3).^{19 20}

Figure 2: Response to a Monetary Tightening Surprise. Baseline One and Two Lags.



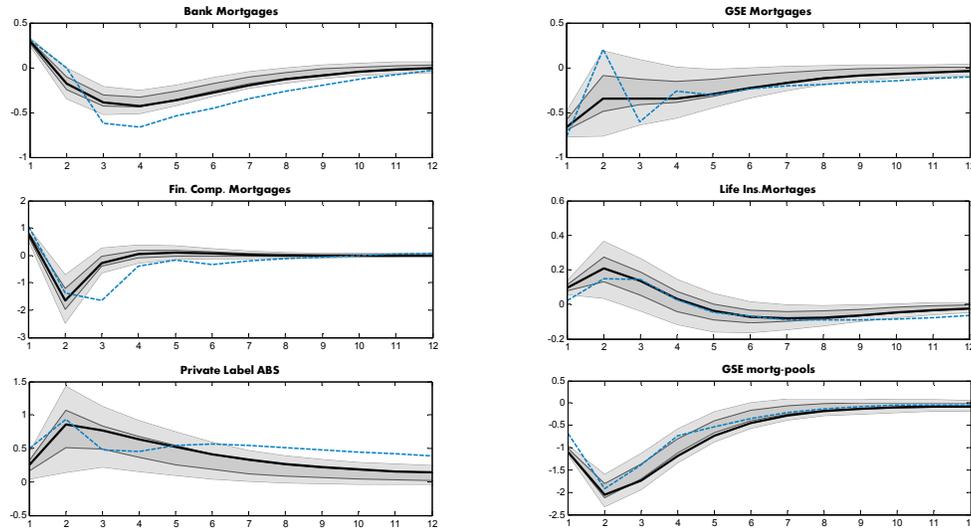
Black solid line is the proxy-VAR in differences and with 1 lag. Shaded areas represent 15% and 33% bootstrapped intervals. The dash-blue line is the point-estimate using 2 lags.

¹⁹ Bernanke and Kuttner (2005) finds that, on average, an unanticipated 25-basis-point rise in the federal funds rate target is associated with about a one percent decline in broad stock indexes. Adrian and Shin (2010), instead, argues that (bank) equity issuance is sticky, hence, under marked-to-market accounting a decline in asset values increases bank leverage.

²⁰ Van den Heuvel (2002) shows how a risk-based capital requirements introduces a 'bank capital channel' by which monetary policy affects bank lending through its impact on bank equity capital. This mechanism—more applicable to large bank holdings—does not rely on any particular role of bank reserves and thus falls outside the conventional 'bank lending channel'.

Banks react to higher policy rates by cutting back lending and shrinking their balance sheets, lowering their total assets. The growth decline starts in the second quarter and peaks 1 year after the shock, while the level declines by about 0.8 percent after 3 years. Much of this retrenchment takes place through a decline in mortgage lending growth, which falls by almost 0.5 percentage points after 3 quarters (Figure 3).

Figure 3: Response to a Monetary Tightening Surprise. Baseline One and Two Lags.

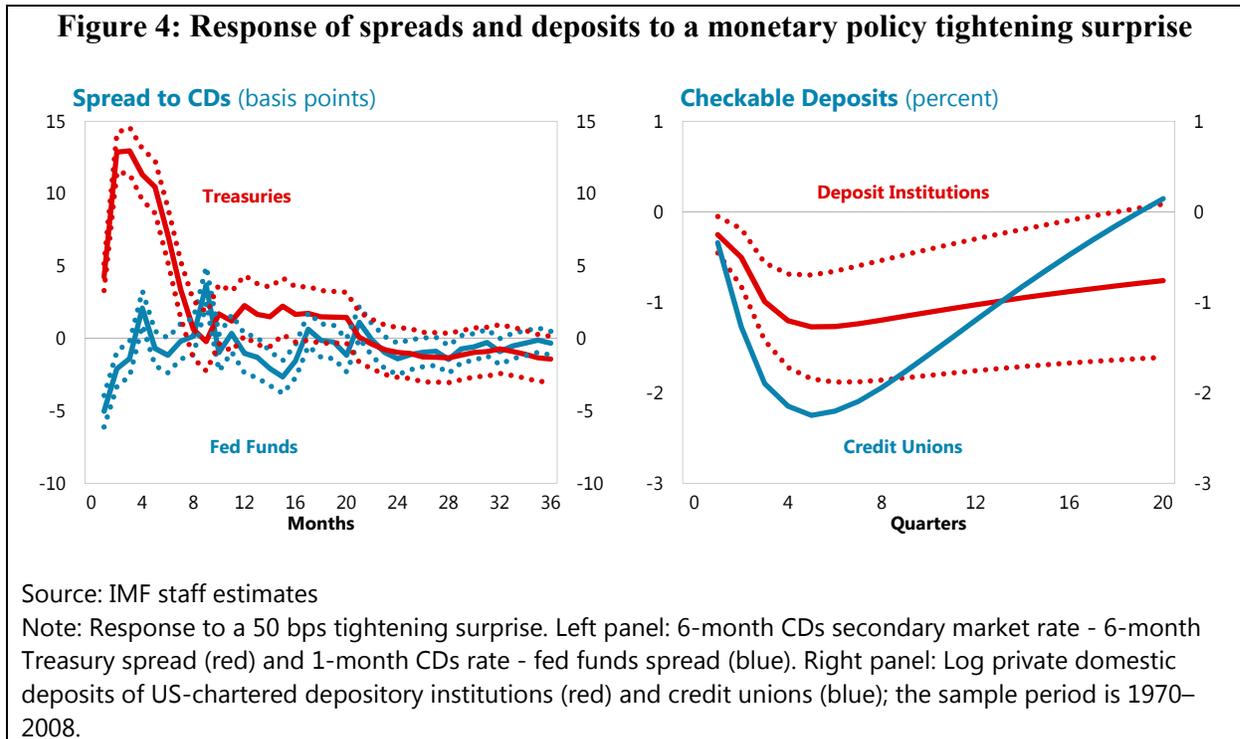


Black solid line is the baseline proxy-VAR in differences and with 1 lag. Shaded areas represent 15% and 33% bootstrapped intervals. The dash-blue line is the point-estimate using 2 lags. FA variables are added one at a time while total mortgages, bank assets, and GSE assets (not shown) are present as endogenous control variables in the proxy-VAR.

Similar to bank behavior, mortgages held by financial companies also decline after an interest rate shock. Mortgages held by life insurers, however, increase slightly after the shock possibly reflecting the different composition of their liabilities relatively to most other financial intermediaries (Figure 3). Even though life insurers only accounts for about 5 percent of total mortgages and the impulse response is not precisely estimated, this result could point to an additional shift of intermediation to this sector.

Private label securitization, on the other hand, expands in response to the tighter liquidity environment. The increase in the level of ABS activity lasts around two years and adds around 1 percentage point to growth in the second quarter after the shock. (Figure 3).

In a separate exercise,²¹ we corroborate that rates on bank liabilities (such as rates on Eurodollar deposits and high-denomination CDs) rise one-to-one and almost immediately with the fed funds after a monetary policy shock. The volume of (reservable) banks' checkable deposits falls as expected (Figure 4).²² These results are in line with (Christiano et al. 1999, and Kashyap and Stein 1995, 2000), and are robust to excluding the sample period when regulation-Q was in force (i.e., pre-1982).²³ This tends to support the finding that a monetary policy shock puts pressure on bank cash flow and liquidity raising their need to liquefy assets through securitization.



²¹ We use a smaller proxy-VAR with Eurodollar rate, the 1-month CD rate vs. fed funds spread, the 6-month CD rate vs. 6-month Treasury spread, at monthly frequency. At quarterly frequency, we add credit unions and U.S. depository institution checkable deposits.

²² Currently, transaction accounts (e.g., checking accounts) are subject to a 10 percent reserve requirements, approximately. High denomination CDs and Eurodollar deposits are exempt from the reserve requirement since at least 1990 in the U.S.

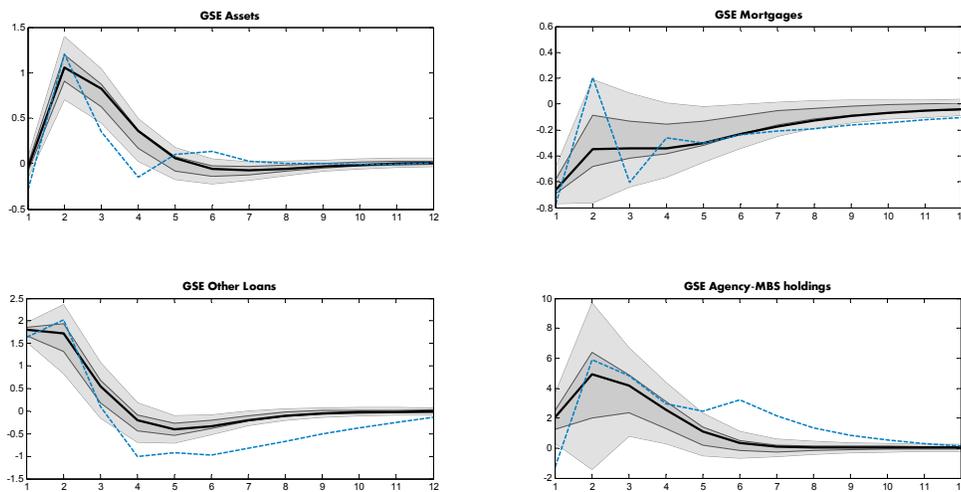
²³ Under Regulation Q of the Banking Act of 1933, interest rates on saving and checking accounts were capped in order to limit potentially harmful deposit competition among thrifts institution. The rise of money market mutual funds reshaped the industry and led to the dismantling of Regulation Q (Garn-St. Germain Act 1982).

B. What about GSE Behavior?

GSE securitizations are affected by higher interest rates in a similar way to banks. Assets of GSE mortgage pools decrease for around 4 quarters and by around 1 percentage point (Figure 3). This means that taken together, private and GSE securitization activity declines in response to interest rate shocks (since GSE-mortgage pools historically have been substantially larger than ABS issuers).

However, perhaps counterintuitively, the growth rate of total assets held by GSEs rises for around 1½ years after an interest rate shock, converging to a 1.5 percent higher level than the pre-shock level (Figure 5). The magnitude of the positive movement is considerable and larger in dollar terms than the contractionary impact of higher policy rates on banks.

Figure 5: Response to a Monetary Tightening Surprise. Baseline One and Two lags.



Black solid line is the baseline proxy-VAR in differences and with 1 lag. Shaded areas represent 15% and 33% bootstrapped intervals. The dash-blue line is the point-estimate using 2 lags. FA variables are added one at a time while total mortgages (not shown), bank assets, and GSE assets are always present as endogenous control variables in the proxy-VAR.

To understand the counterintuitive reaction of GSEs to a monetary policy shock we break down the total assets of GSEs into various subcategories. Figure 3 and 5 show that both bank mortgages and GSE mortgages (i.e., conforming mortgages) decline in response to a monetary policy shock, as expected (while holdings of GSE agency MBS increases but it is not precisely estimated).

However, the ‘Other loans and advances’ category exhibits a clear and positive response after a tightening shock growing by almost 2 percentage points faster at impact and in the next quarter. This subcategory represented about 30 percent of total GSEs’ assets in 2007 and it mostly consists of loans extended by GSEs to Federal Home Loan Banks (FHLBs). It appears that, in the face of tighter funding conditions, mortgage demand moves to FHLB

providers and GSEs react by financing FHLB banks. As such, GSEs indirectly increase their role as a funding source for a variety of conforming and nonconforming mortgages of FHLB member banks.²⁴

Table 1: GSEs and FHLB Balance Sheets

GSEs Balance Sheet (2007)	Share of Total Assets	Bi\$
Other loans and advances	29.7%	943
of which: to FHLB	27.3%	867
Agency- and GSE-backed securities	22.1%	703
Mortgages	20.3%	643
Miscel.	27.9%	887
total assets		3176
FHLB Balance Sheet (2007)	%	Bi\$
tot assets		1,016,469
of which: advances	63.0%	640,681
tot liabilities		1,016,469
of which: consolid. debt obligations	91.9%	934,214

²⁴ The FHLB website states that “The FHLBanks serve their members by providing a sure and steady flow of funding that helps members support housing, homeownership and economic development in their communities.” (cf. www.fhlbanks.com). Members of FHLBanks include banks and saving institutions, credit unions, and insurance companies among others. The FHLBanks make loans, called “advances,” to their members on the security of mortgages and other collateral pledged by the borrowing member. Advances generally are collateralized by mortgages held in member portfolios. Because portfolio lenders may originate loans that they are unwilling or unable to sell in the secondary mortgage market, FHLBank advances can serve as a funding source for a variety of conforming and nonconforming mortgages. FHLBank advances support important housing markets, including those focused on low- and moderate-income households. For those members that choose to sell or securitize their mortgages, FHLBank advances can provide interim funding.

VI. CONCLUSIONS

We have presented evidence suggesting that different means of financial intermediation do not react uniformly to policy rate shocks. Specifically, as interest rates increase financial activity migrates from banks' balance sheets to the less-monitored non-bank sector via securitization activity. In this case, higher interest rates may have the unintended consequence of raising rather than reducing systemic risk even as the growth in credit aggregates slows.

Also, our analysis seems to suggest that loans of GSEs to other government-sponsored entities – most notably the FHLB – may increase after an interest rate hike. This response likely stems from the GSEs and FHLB mandates to foster lending to the housing market and may be clouded by implicit guarantees and public policy objectives.

The concerns raised here regarding the negative implications of interest rate hikes for financial stability need to be taken also in the current context. While this may have been a channel for risk migration in the past, the fact that the private-label securitization activity has not recovered since the crisis may allay some of the concerns. Given that securitization markets have low volume, it seems unlikely that a substantial amount of systemic risk will be flushed from banks to non-banks via this channel—at least as long as interest rates remain historically low. However, at the same time, new channels have opened up in the nonbank sector in the aftermath of the global financial crisis and the impact of monetary policy decisions on activities in these new nonbank areas merits careful analysis.

Finally, with the structural changes in the securitization industry post crisis, it is likely that the bank lending channel of monetary policy may operate very differently today during the tightening cycle than it did in the past. Partly this is due to the substantial amount of excess reserves that are currently present in the system which may dampen the effects of higher federal funds rates on bank liquidity needs and lending decisions. Second, the nature of the substitution of intermediation through nonbank channels is likely to be completely different today than in the past with uncertain implications for systemic risk. When assessing the usefulness and welfare gains of having monetary policy decisions react to signs of financial instability it will be critical to both take into account these effects and measure their relative magnitude.

VII. APPENDIX

The Estimation Methodology

Consider a n -dimensional vector \mathbf{y}_t , l lags, and matrices of coefficients $\boldsymbol{\beta}$ and \mathbf{B}_i such that

$$\mathbf{y}_t = \boldsymbol{\beta} + \sum_{i=1}^l \mathbf{B}_i \mathbf{y}_{t-i} + \mathbf{e}_t.$$

It is possible to estimate by OLS the innovation vector \mathbf{e}_t , which we assume is related to a vector of possibly structural shocks by the following relation

$$\mathbf{e}_t = \mathbf{A}_0^{-1} \boldsymbol{\varepsilon}_t = \mathbf{B}_0 \boldsymbol{\varepsilon}_t$$

where the matrix \mathbf{A}_0 links the reduced form to the structural VAR representation

$$\mathbf{A}_0 \mathbf{y}_t = \boldsymbol{\alpha} + \sum_{i=1}^l \mathbf{A}_i \mathbf{y}_{t-i} + \boldsymbol{\varepsilon}_t,$$

In a proxy-VAR \mathbf{y}_t includes a series of policy surprises that are supposedly orthogonal to output and inflation forecasts. That series is a noisy indicator of the underlying shocks so it can be used as an external instrument for isolating the effects of movements in the fed funds rate on the economy.²⁵ In our baseline case, we introduce the policy surprise series before the fed funds rate but after the oil price dummy, output, and core inflation. The identification requirement does not require the surprise series to be orthogonal to past and current values of output, core inflation, and oil prices. For example, a positive shock to the oil price dummy generates a positive movement in the surprise series suggesting that during a period of unanchored long-term inflation expectations oil price shocks may have induced the Federal Reserve to tighten (adding the period of NBR targeting, which encompasses the second oil price shock, magnifies this result).

Excluding the NBR targeting period seems to improve identification possibly due to the imprecision of the monetary policy surprise estimates for that period.²⁶ Indeed, a positive shock to the oil dummy has a significant positive effect on the monetary policy surprises, which suggests that in the pre-inflation targeting period the Federal Reserve was paying a special attention to oil price movements.²⁷

²⁵ The monetary policy surprise of Coibion (2012) are based on a GARCH estimation of the change in the targeted fed-funds rate over its previous level and past, current, and expected inflation, real output growth, and unemployment.

²⁶ We exclude the period from 1979Q3 to 1982Q2 by zeroing the series of monetary policy surprises.

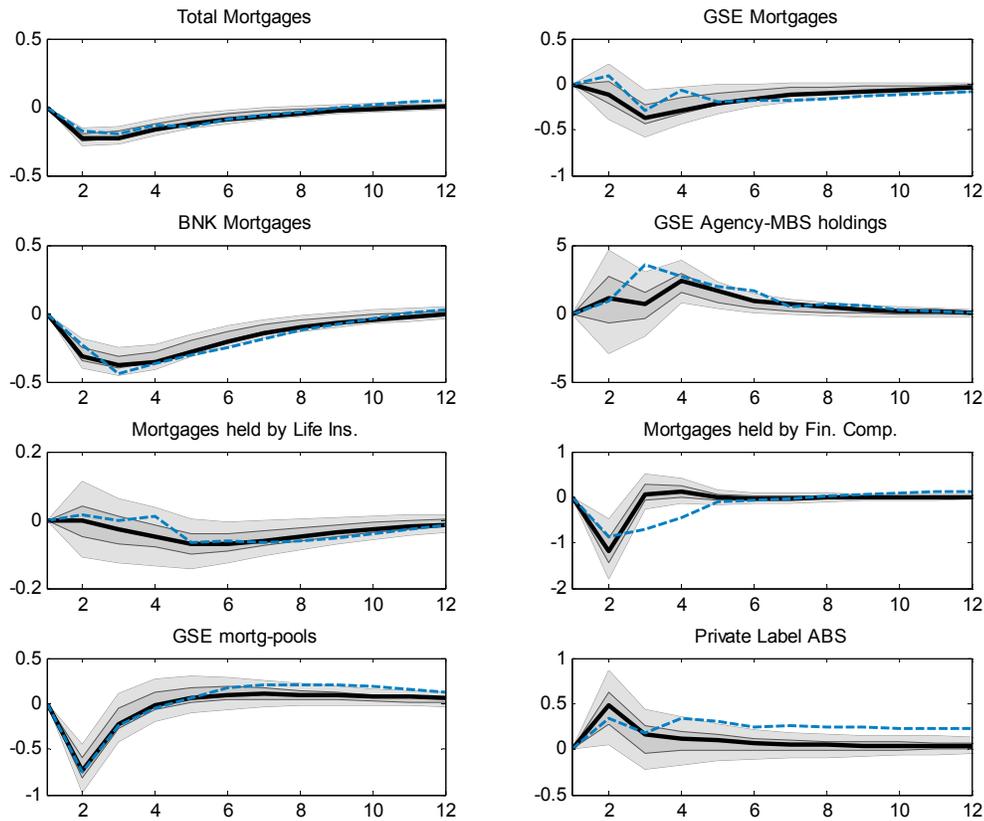
²⁷ The oil dummy—useful to alleviate the price puzzle—is equal to the change in refiner acquisition cost of crude oil before 1986 than is zero. It is supposed to capture the Fed’s reaction to movements in long-term inflation expectations due to sharp oil price movements in a period where inflation expectations were not well anchored. Results are robust to replacing headline with core PCE inflation.

Our sample starts in 1970 and ends in 2007 to avoid the most recent period of zero interest rates and the disruption of the ABS market following the great financial crisis. In all our charts the vector \mathbf{y}_t , in addition to the macro-variables, includes total mortgages, bank assets, and GSE assets while adding the additional FA variables one at a time. We tested different combinations of FA variables relatively to the ones used and found no meaningful difference with the results presented.

Finally, we compute confidence bands using a bootstrap Monte Carlo procedure as in Christiano et al. (1999). In all figures, we use 1000 random drawings with replacements and show the 15th and 33th percentile.

Predetermined Financial Account Variables

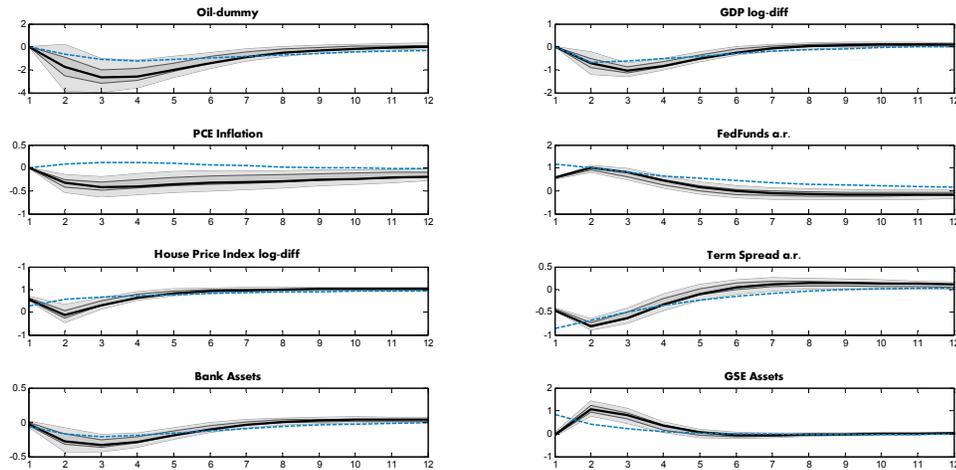
Figure A-1 shows results when FAs' variables are predetermined to the monetary policy shock. Excluding mortgages held by life insurers, which become not significant, other responses are broadly in line with the baseline specification. In particular, the overall fall in total mortgages, bank mortgages, and bank assets (not shown) is bigger than in the baseline case.

Figure A.1: Response to a Monetary Tightening Surprise. One vs. two lags.

Black solid line is the proxy-VAR in differences and with 1 lag. FA variables are all predetermined to the monetary policy shock. Shaded areas represent 15% and 33% bootstrapped intervals. The dash-blue line is the point-estimate using 2 lags. FA variables are added one at a time while total mortgages (not shown), bank assets, and GSE assets are always present as endogenous control variables in the proxy-VAR.

CEE's Identification Strategy

Results using the more tradition CEE's identification strategy are not qualitatively different from the ones in the baseline specification (figure A-2). It is noticeable that the fed funds rate no longer has a hump shaped reaction to the monetary policy surprise, which clearly affects also the shape of the response of all other variables. Differently from the baseline case, however, the CEE identification suffers from the price puzzle notwithstanding the oil dummy.

Figure A.2: Response to a Monetary Tightening Surprise. Baseline vs. CEE.

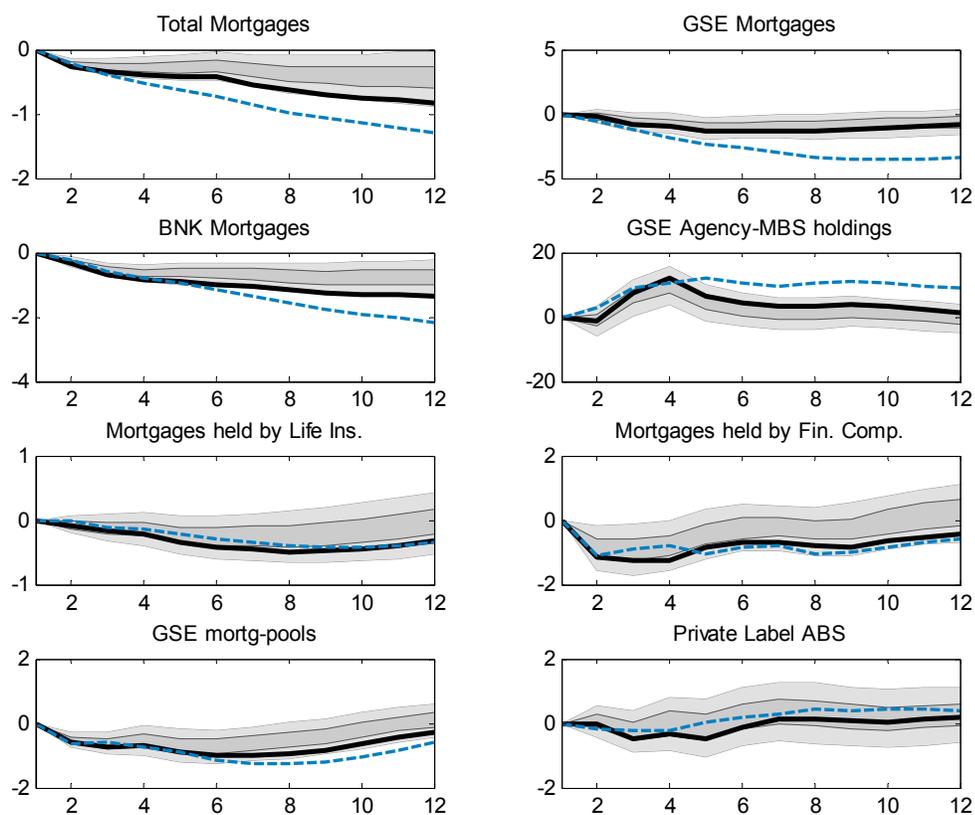
Black solid line is the proxy-VAR in differences and with 1 lag. FA variables are all predetermined to the monetary policy shock. Shaded areas represent 15% and 33% bootstrapped intervals. The dash-blue line is the point-estimate using CEE identification.

Estimation in Levels

Figure A-3 shows the results when all variables are expressed in (log) levels. FA variables are predetermined since stocks tend to react slowly. The estimation in levels can give rise to unstable roots, which pose problems especially for the computation of confidence bands. In general, the specification in differences seems a safer approach when FA variables are introduced.

Qualitatively, however, results are broadly in line with the baseline. GSE mortgage pool securitization drops substantially while the level of private-label securitization slowly increases after 6 quarters—even though the response is not precisely estimated. When private-label securitization is free to react to the shock (not shown), the initial response is again positive.

Figure A.3: Response to a Monetary Tightening Surprise. Levels. Proxy-VAR vs CEE.



Black solid line is the proxy-VAR in log-levels and with 4 lags. Shaded areas represent 15% and 33% bootstrapped intervals. The dash-blue line is the point-estimate using CEE identification. FA variables are predetermined and added one at a time while total mortgages, bank assets, and GSE assets (not shown) are always present as endogenous control variables in the proxy-VAR.

VIII. REFERENCES

- Adrian, Tobias, and Hyun Song Shin. "Liquidity and leverage." *Journal of financial intermediation* 19.3 (2010): 418-437.
- Ajello, Andrea, et al. "Financial stability and optimal interest-rate policy." Federal Reserve Board paper presented at the Federal Reserve Bank of San Francisco conference 'The New Normal for Monetary Policy', San Francisco. 2015.
- Alessandri, Piergiorgio, and Benjamin D. Nelson. "Simple banking: profitability and the yield curve." *Journal of Money, Credit and Banking* 47.1 (2015): 143-175.
- Bank for International Settlements, 1992, "Asset transfers and securitization." Basel Committee on Banking Supervision Paper No. 124 (Basel: Bank for International Settlements).
- Bernanke, Ben S., and Kenneth N. Kuttner. "What explains the stock market's reaction to Federal Reserve policy?" *The Journal of Finance* 60.3 (2005): 1221-1257.
- Borio, Claudio EV, Leonardo Gambacorta, and Boris Hofmann. "The influence of monetary policy on bank profitability." (2015).
- Cantor, Richard and Stanislas Rouyer, 2000, "Another Perspective on Credit Risk Transfer and Asset Securitization." *Journal of Risk Finance* 1, no. 2 (Winter), p. 37-47.
- Coibion, Olivier. "Are the Effects of Monetary Policy Shocks Big or Small?" *American Economic Journal: Macroeconomics* (2012): 1-32.
- Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans. "Monetary policy shocks: What have we learned and to what end?" *Handbook of macroeconomics* 1 (1999): 65-148.
- English, William B. "Interest rate risk and bank net interest margins." *BIS Quarterly Review* 10 (2002): 67-82.
- Gertler, Mark, and Peter Karadi. "Monetary Policy Surprises, Credit Costs, and Economic Activity." *American Economic Journal: Macroeconomics* 7.1 (2015): 44-76.
- Herman, Alex, Deniz Igan, and Juan Solé, 2015, "The Macroeconomic Relevance of Credit Flows: An Exploration of U.S. Data." IMF Working Paper WP/15/143 (Washington: International Monetary Fund).
- IMF, 2015, "Monetary Policy and Financial Stability" IMF Policy Paper, (Washington: International Monetary Fund).

- Kashyap, Anil K., and Jeremy C. Stein. "The impact of monetary policy on bank balance sheets." *Carnegie-Rochester Conference Series on Public Policy*. Vol. 42. North-Holland, 1995.
- Kashyap, Anil K., and Jeremy C. Stein. "What do a million observations on banks say about the transmission of monetary policy?" *American Economic Review* (2000): 407-428.
- King and Goofriend (2016), "A Review of the Riksbank's monetary policy 2010-2015", The Riksdag (Swedish parliament) Committee on Finance Third external evaluation of the Riksbank's monetary policy.
- Loutskina, Elena. "The role of securitization in bank liquidity and funding management." *Journal of Financial Economics* 100.3 (2011): 663-684.
- Marcet, Albert, and Kenneth J. Singleton. "Equilibrium asset prices and savings of heterogeneous agents in the presence of incomplete markets and portfolio constraints." *Macroeconomic Dynamics* 3.02 (1999): 243-277.
- Mertens, Karel, and Morten O. Ravn. "A reconciliation of svar and narrative estimates of tax multipliers." *Journal of Monetary Economics* 68 (2014): S1-S19.
- Pescatori, Andrea and Stefan Laseen (2016), "Financial Stability and Interest-Rate Policy: A Quantitative Assessment of Costs and Benefits" IMF WP. Forthcoming.
- Svensson, Lars EO. "Inflation targeting and leaning against the wind." *International Journal of Central Banking* 10.2 (2014): 103-114.
- Ljungqvist, Lars, and Thomas J. Sargent. *Recursive macroeconomic theory*. MIT press, 2004.
- Stein, Jeremy, 2013, "Overheating in Credit Markets: Origins, Measurement, and Policy Responses", speech given at the "Restoring Household Financial Stability after the Great Recession: Why Household Balance Sheets Matter" research symposium sponsored by the Federal Reserve Bank of St. Louis, St. Louis, Missouri, available at: <http://www.federalreserve.gov/newsevents/speech/stein20130207a.htm>
- Van den Heuvel, Skander J. "The bank capital channel of monetary policy." The Wharton School, University of Pennsylvania, mimeo (2002).