Lending by Servicing: Monetary Policy Transmission through Shadow Banks*

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Abstract

We propose a new conceptual framework for monetary policy transmission through shadow banks in the mortgage market that highlights the role of mortgage servicing in generating non-deposit funds for lending. We document that mortgage servicing acts as a natural hedge against interest rate shocks and dampens the effect of monetary policy on shadow bank mortgage lending. Higher interest rates reduce prepayment risk, increasing the collateral value of mortgage servicing assets and cashflow from servicing income. This enables shadow banks with greater exposure to mortgage servicing to obtain more funding. The mortgage servicing channel is weaker for traditional banks due to their reliance on deposit funding and the capital charge on mortgage servicing assets. Our estimates imply that the rising share of shadow banks in mortgage servicing has weakened the pass-through of monetary policy to aggregate mortgage lending.

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1 Introduction

The residential mortgage market is the largest consumer credit market in the United States and central to the monetary transmission mechanism. In recent years, shadow banks (i.e., non-depository mortgage lenders) have become increasingly prominent in this market, originating more than 50% of mortgages by volume (Buchak et al., 2018).[1] How shadow banks adjust their lending in response to interest rate changes is therefore of first-order importance when thinking about the effects of monetary policy on aggregate mortgage credit. Despite the rising importance of shadow banks in the U.S. residential mortgage market, we know little about what shapes the transmission of monetary policy to shadow bank credit supply. In this paper, we propose and test a new conceptual framework for monetary policy transmission through shadow banks that incorporates the unique institutional features of shadow banks in the U.S. mortgage market.

This conceptual framework underscores important interactions between mortgage lending and mortgage servicing, the two principal sources of revenue for shadow banks. In contrast to traditional banks that rely on deposits for funding, shadow banks use non-deposit funds for loan origination and working capital needs (Kim et al., 2018; Jiang, 2019). Shadow banks' servicing business significantly affects availability of these non-deposit funds and their ability to originate new mortgages. The transmission of monetary policy to shadow bank mortgage lending depends on how changes in interest rates affect the availability of these non-deposit sources of funding. By owning the claim to service a mortgage for its duration—i.e., a mortgage servicing right (MSR)—a shadow bank holds an asset whose value is positively correlated with interest rates and that can be pledged as collateral for external funding. When interest rates rise, prepayment speeds decline and the expected duration of outstanding loans lengthens, increasing the value of MSRs. At the same time, servicing provides shadow banks with a relatively stable stream of fixed

[1] Following Buchak et al. (2018), we use the term "shadow bank" or "nonbank" to refer to non-depository mortgage lenders, as defined by the Financial Stability Board.

income that is typically unaffected by changes in interest rates. Thus, for shadow banks, servicing acts as a natural hedge against interest rate shocks and attenuates the effects of monetary policy on their mortgage lending.[2] We call this the *mortgage servicing channel* of monetary policy transmission.

The mortgage servicing channel is economically meaningful for two reasons. First, mortgage servicing rights are the second largest asset on shadow banks' balance sheets following mortgages held for sale. The hedging properties of servicing with respect to interest rate shocks thus imply that exposure to mortgage servicing has the potential to significantly affect the transmission of monetary policy to nonbank mortgage lenders. Second, we document that the higher capital charge on MSRs introduced by the Basel III reforms led to a staggering shift of the servicing business from banks to nonbanks, with shadow banks now servicing a substantial fraction of mortgage debt.[3] Despite this, the consequences of shadow banks' involvement in mortgage servicing have been understudied in the literature. By focusing on the business model of shadow banks and linking it to monetary policy transmission, our paper advances the literature on shadow banks as it provides an organizing economic framework to think about differences in monetary policy transmission between banks and nonbanks.

In order to test the mortgage servicing channel of monetary policy, we require data on the balance sheets, funding, and mortgage origination activity of shadow banks. We obtain their balance sheet and funding data from Mortgage Call Reports by submitting Freedom of Information Act requests to state regulators in Washington and Massachusetts. We merge these with data on loan originations from the confidential Home Mortgage Disclosure Act to analyze how involvement in mortgage servicing affects the transmission of monetary

[2]E.g., during a period of monetary tightening in spring 2022, the *Wall Street Journal* wrote, "Mortgage companies have a not-so-secret weapon as they deal with rising interest rates and decreasing volumes: Mortgage-servicing rights" (see https://www.wsj.com/articles/mortgage-firms-antidote-to-rising-rates-11648551600).

[3]In 2016, shadow banks serviced 50% and 70% of conforming and FHA loans, respectively (see https://www.urban.org/sites/default/files/042017_msc_factsheet.pdf).

policy through shadow banks.

Estimating the effects of monetary policy suffers from a well known endogeneity problem: most changes in the Federal Reserve's policy rate reflect its systematic response to macroeconomic variables (Cristiano et al., 1999; Romer and Romer, 2004). To overcome this identification challenge, we follow Gürkaynak et al. (2022) in using the high-frequency movement of the three-months-ahead federal funds futures around policy rate announcements to measure shocks to monetary policy. This is important because, to the extent that changes in monetary policy were anticipated by market participants, they would already be priced into the value of MSRs through their effect on prepayment risk.

Our main empirical finding is that, in response to a contractionary monetary policy shock, shadow banks with a higher *ex ante* share of mortgage servicing rights in total equity reduce their mortgage lending relatively less. This result is robust to varying the definition of lender-level exposure to mortgage servicing, measurement of monetary policy shocks, and classification of lenders into shadow banks. Furthermore, we provide evidence consistent with changes in prepayment risk induced by monetary policy shocks accounting for the mortgage servicing channel.

The active participation of shadow banks in mortgage servicing hedges their balance sheets against interest rate shocks through both a collateral effect and a cashflow effect. The *collateral effect* results from shadow banks' heavy reliance on short-term warehouse funding for their operations, part of which is collateralized by MSRs. When there is an unexpected increase in interest rates, prepayment speeds slow (Eichenbaum et al., 2022; Greenwald, 2018). This increases the duration of existing loans and the value of their associated MSRs. Using detailed information on secured credit lines used by shadow banks, we find that, following a contractionary monetary policy shock, shadow banks with greater *ex ante* exposure to servicing draw down on their credit lines more and pay a lower cost on credit line funding. The *cashflow effect* is due to fact that the servicing income is less volatile with respect to interest rates compared to origination income. When interest

rates rise, origination income likely decreases, but, conditional on a mortgage not being prepaid, the shadow bank continues to receive a monthly fee from servicing the mortgage. We show that shadow banks with greater *ex ante* MSR holdings have relatively higher earnings after a contractionary monetary policy shock, increasing the relative availability of internal funds for new lending. They also receive a higher share of their gross income from servicing. This validates the role of servicing income in stabilizing cashflow.

To provide further support for the mortgage servicing channel, we explore its heterogeneity across the capital, risk exposure, and liquidity of shadow banks. In the presence of information asymmetry between shadow banks and their financiers, shadow banks with *ex ante* low capital or riskier portfolios may pay a lemon's premium in order to secure funding when interest rates rise. Having access to MSRs attenuates this problem and allows them to access funding at a cheaper rate. Hence, the mortgage servicing channel should be stronger for shadow banks with lower *ex ante* capital ratios and riskier portfolios. Our results support this hypothesis. Meanwhile, a shadow bank's stock of liquid assets reflects its ability to use internal funding. If a shadow bank lacks surplus liquidity upon which to draw when interest rates rise, the hedging role of MSRs can be more valuable. We hypothesize that the mortgage servicing channel is stronger for nonbanks with a low stock of liquid assets. Our results are consistent with this hypothesis as well.

An important question to ask is whether the mortgage servicing channel has significant effects on the transmission of monetary policy to *aggregate* mortgage lending. At the intensive margin, it depends on whether the strength of the mortgage servicing channel differs for traditional banks and shadow banks. At the extensive margin, it depends on the composition of lenders in a given region. To study the intensive margin, we use a combined sample of banks and nonbanks to show that, conditional on having the same *ex ante* exposure to servicing, nonbanks reduce mortgage origination less compared to banks after a contractionary monetary policy shock. This is because the marginal value of an additional dollar of mortgage servicing rights is relatively lower for banks. MSRs are not

the marginal source of funding for banks, given their large reliance on deposit funding. Furthermore, MSRs carry a capital charge for banks, making it costlier for them to retain such assets on their balance sheet. Thus, the mortgage servicing channel is weaker for depository institutions.

Because the mortgage servicing channel operates differently for banks and nonbanks, the exact composition of mortgage servicers is relevant for the transmission of monetary policy shocks to aggregate lending. We hypothesize that, in regions with a larger nonbank servicing share, the pass-through of monetary policy shocks to mortgage origination should be weaker. Within a given region, however, shadow banks' involvement in servicing and lending could be simultaneously driven by unobservable shocks. To address this endogeneity concern, we exploit the U.S. implementation of Basel III capital requirements on banks' holdings of mortgage servicing rights to generate plausibly exogenous variation in the nonbank share of servicing (Berrospide and Edge, 2016; Irani et al., 2021). We show that, in regions where banks had higher capital deficiency prior to Basel III, shadow banks increased their share of the servicing market more. Using banks' aggregate capital deficiency as a proxy for shadow bank servicing share, then, we find that the effect of monetary policy on mortgage lending is weaker in regions that experienced greater reallocation of servicing towards nonbanks.

The rest of the paper proceeds as follows. Section 2 connects our paper to the related literature. Section 3 outlines a conceptual framework for the role of mortgage servicing rights in monetary policy transmission through shadow banks and briefly describes institutional features of the mortgage servicing industry. Section 4 describes data used in the empirical analysis. Section 5 presents our main findings on how exposure to mortgage servicing rights dampens the transmission of monetary policy to mortgage lending through shadow banks. Section 6 studies implications of the mortgage servicing channel for aggregate mortgage lending. Section 7 concludes.

2 Related Literature

Our paper first contributes to the literature on the bank lending channel of monetary policy. This literature has traditionally focused on how monetary policy affects credit originated by commercial banks and the central role played by deposit funding in the transmission mechanism (Kashyap and Stein, 2000; Drechsler et al., 2017). We contribute to this literature by developing a new organizing framework to understand the transmission of monetary policy to shadow bank lending in the U.S. residential mortgage market. Just as the bank lending channel of monetary policy operates through banks' deposit funding, our *shadow bank* lending channel of monetary policy operates through shadow banks' non-deposit funding. Our results point to exposure to mortgage servicing as a crucial determinant of access to both internal and external funds for shadow banks operating in the mortgage market.

By underscoring the unique role played by mortgage servicing rights in the transmission of monetary policy, our paper also makes an important contribution towards understanding the mortgage servicing market in the United States. While recent studies have highlighted the growing role of shadow banks in mortgage origination (Buchak et al., 2018, 2020; Fuster et al., 2019; Jiang et al., 2020; Gete and Reher, 2021), less work has been done on their increased involvement in mortgage servicing and its interaction with their origination business, especially in the context of monetary policy transmission.[4,5] A careful consideration of the balance sheet of shadow banks is crucial for policymakers to fully grasp how shadow banks affect the transmission of macroeconomic shocks. Our paper provides a first step towards filling this gap.

[4]The literature has documented a similar increase in the shadow banking lending share in other credit markets in the U.S., including the market for small business loans (Gopal and Schnabl, 2022) and syndicated corporate loans (Irani et al., 2021).

[5]In the context of mortgage servicing, the existing literature has studied servicers' foreclosure decisions during and following the global financial crisis (Aiello, 2021; Agarwal et al., 2017) and their likelihood of offering debt forbearance during the Covid pandemic (Cherry et al., 2022) but has not explored how servicing affects monetary policy transmission.

Recent studies have shown that monetary contraction leads to a shift in credit supply from banks to nonbanks in several consumer and corporate credit markets (Cucic and Gorea, 2021; Elliott et al., 2021). By contrast, our objective is to propose a shadow bank lending channel for the U.S. mortgage market, which makes understanding the balance sheets and financing frictions of nonbank mortgage lenders the primary focus. Our exercise is in the spirit of papers that emphasize the role of various factors—such as bank market power, frictions in raising external finance, or *ex ante* bank characteristics (e.g., size, capital, liquidity, and bank health)—as key channels of monetary policy transmission to bank lending (Drechsler et al., 2017; Indarte, 2022; Van den Heuvel et al., 2002; Wang et al., 2022). Analogous to these studies, we document that MSRs can alleviate financing frictions for shadow banks and influence credit provision after contractionary monetary policy. This finding complements Xiao (2020), which similarly highlights the important role of money market fund shares in the transmission of monetary policy.

3 Conceptual Framework

The conventional bank lending channel of monetary policy operates through the role of deposits in funding loans. As shown by Drechsler et al. (2017), the market power of banks over deposits implies that deposit spreads widen when the central bank tightens monetary policy. This induces an outflow of deposits from the financial system and a contraction of lending. Long-term, fixed-rate mortgages are especially suited for deposit funding because the relative insensitivity of deposit rates to changes in the policy rate requires a source of income that is similarly insensitive in order for banks to effectively hedge against interest rate risk (Drechsler et al., 2021).

The funding structure of nonbank mortgage lenders is qualitatively different because shadow banks, by definition, cannot issue deposits. This suggests that the transmission of monetary policy through the deposits channel to the residential mortgage market may

not be as relevant if shadow banks originate a substantial share of loans. Shadow banks fund loans using secured lines of credit, as well as cash generated by their origination and servicing businesses. While most drawdowns on these credit lines are collateralized by the mortgages they fund, shadow banks can use other assets such as their mortgage servicing rights to secure financing for various purposes, including working capital needs associated with mortgage lending (Kim et al., 2018).[6] Servicing also provides shadow banks with a relatively stable income stream because servicing fees collected from existing mortgages are invariant to future changes in market interest rates. Hence, the servicing business of shadow banks provides diversification benefits and insulates their balance sheets from monetary policy shocks.

A mortgage servicing right is an asset that is created when a primary lender originates a mortgage that is sold on the secondary market and retains the right to service the loan.[7] The servicer (i.e., MSR holder) collects monthly payments from borrowers and distributes them to the relevant investors. In exchange, the servicer is compensated with a fee equal to a fixed share—typically 25–50 basis points—of the outstanding mortgage balance. The servicing fee is typically included in the borrower's monthly payment rather than paid upfront.[8] The fair value of a mortgage servicing right, then, is the present discounted sum of expected revenue from servicing the underlying loan. This value is decreasing in prepayment risk: as the probability of prepayment declines, the expected duration of a loan increases and the MSR holder will receive income from servicing over a longer time horizon. Figure 1 illustrates the flow of funds between borrowers, servicers, and investors in the mortgage servicing market.

[6]For example, United Wholesale Mortgage, LLC—the second largest direct residential and largest wholesale mortgage lender in the U.S.—disclose in their 10-K report for 2020 a $400,000 line of credit used to fund working capital that is secured by their MSRs. See https://www.sec.gov/Archives/edgar/data/1783398/000119312521089716/d143608dex992.htm.

[7]A secondary market for mortgage servicing rights exists, so a primary lender may also choose to sell the mortgage servicing right to another intermediary, who would then be responsible for servicing the loan.

[8]A servicer may also earn revenue through late payment fees, float income, and other ancillary income. See https://www.federalregister.gov/documents/2021/12/23/2021-27641/mortgage-servicing-assets.

4 Data and Methodology

4.1 Shadow Bank Balance Sheets and Funding Sources

We obtain shadow bank balance sheet data and credit line data from Mortgage Call Reports (MCRs) filed under the Nationwide Multistate Licensing System (NMLS). Pursuant to the S.A.F.E. Mortgage Licensing Act of 2008, shadow banks that hold a state license or state registration to conduct mortgage origination have been required to file a call report in each state in which they perform lending activities on an annual or quarterly basis since 2011. Following existing studies that have used shadow bank call reports data (Jiang et al., 2020), we submit Freedom of Information Act requests to the states of Washington and Massachusetts. As long as a shadow bank is registered in either Washington or Massachusetts, i.e., it does business in these states, we can obtain its MCR data at the mortgage company level regardless of where it is headquartered. Sampling these two states allows for an extensive coverage of nearly 80% of total mortgage volume originated by U.S. shadow banks (see Figures A.1 and A.2).[9]

MCRs have two segments, Financial Condition (FC) and Residential Mortgage Loan Activity (RMLA). The FC segment provides data on standard balance sheet variables at the mortgage company level, while the RMLA segment collects information on loan applications, closed loans, the identity of the individual mortgage loan originator, lines of credit, servicing, and repurchases by state for each mortgage company. Both segments are available at quarterly frequency.[10] We obtain balance sheet variables for shadow banks such as size, capital, liquidity, interest costs, mortgage servicing rights, etc., from the FC

[9]Each state has its own public disclosure law. Washington and Massachusetts are the two states that allow disclosure of Financial Condition (balance sheet) data of shadow banks. Other states, such as Florida, prohibit the disclosure of these data to the public.

[10]There are two types of Mortgage Call Reports, Standard and Expanded. The RMLA segment is available at quarterly frequency for both the Standard MCR and Expanded MCR. The FC segment is available at annual frequency for the Standard MCR and quarterly frequency for the Expanded MCR. Fannie Mae and Freddie Mac seller/servicers or Ginnie Mae issuers must submit an Expanded MCR. Companies should complete either the Expanded or Standard MCR, not both for any period. We use Financial Condition data from Expanded MCR, which is at quarterly frequency.

segment; funding information such as credit limit, used credit, and credit line provider names from the company-level RMLA segment; and the FICO distribution of closed loans from the state-specific RMLA segment.[11]

4.2 Mortgage Origination

To observe the mortgage origination activity of shadow banks and traditional banks, we use loan application data from the confidential Home Mortgage Disclosure Act (HMDA) dataset. HMDA requires financial institutions satisfying minimum asset and loan origination thresholds to disclose information about the mortgage loan applications they receive, making the resultant dataset the most comprehensive source of information on the U.S. residential mortgage market. It contains a rich set of characteristics about the lender, borrower, and mortgage itself at the application level. For example, we observe the location, income, race, ethnicity, and gender of borrowers. For lenders, we observe their name and address, as well as a unique lender identifier.

Critically for our empirical analysis, the confidential version of the dataset discloses the date of origination for each application, conditional on it being approved, whereas the public-use version only discloses the year in which a loan is originated. We are thus able to aggregate origination activity to quarterly frequency. This is needed to credibly identify the effects of monetary policy shocks on mortgage lending.

4.3 Other Data

To obtain comparable information on the balance sheets of traditional banks, we use Form FR Y-9C reports that collect consolidated financial data for domestic bank holding companies at quarterly frequency. The reports contain a balance sheet, income statement,

[11]The RMLA component reports line of credit and servicing data at the company level and other information at the state level by company. We have the state-specific RMLA data for Washington and Massachusetts.

and supporting schedules for each holding company. We download them from the Wharton Research Data Services' Bank Regulatory Database.

To construct a measure of nonbank and bank shares of mortgage servicing at a regional level, we use the Fannie Mae and Freddie Mac Single Family Loan-Level Datasets. These datasets provide characteristics of mortgage originations purchased or guaranteed by the GSEs—including the identity of the financial institution servicing the loan and the MSA of the mortgaged property—at quarterly frequency.

4.4 Sample Construction

To obtain our main results on the mortgage servicing channel in Section 5, we merge data from the Mortgage Call Reports and the Home Mortgage Disclosure Act. We identify a lender in HMDA as a shadow bank if it is classified as an "independent mortgage bank" following the Avery file.[12] We merge the two datasets using the name and address of shadow banks. This yields a sample of 346 shadow banks over the period 2012–2019.[13] It includes major shadow banks operating in the U.S. mortgage market, such as Nationstar Mortgage and Quicken Loans.

To investigate the role of exposure to mortgage servicing rights on the external funding of shadow banks, we merge line of credit data from the Residential Mortgage Loan Activity segment of the MCR with balance sheet data from Financial Condition segment. For each active line of credit reported by a shadow bank, the RMLA segment reports the lender name, credit limit, and the remaining credit available. We assign a lender ID to the lender name by manually matching the lender name with its FDIC ID from the FDIC website.

[12] See https://sites.google.com/site/neilbhutta/data for the Avery file. All results reported in this paper are robust to including lenders classified as "independent mortgage bank affiliated with a depository institution" in our sample. These affiliated shadow banks make up only a small fraction of lenders under this broader definition.

[13] The 2018 Q4 Financial Condition data are largely missing and only available for 34 mortgage companies. The reason is that our FC data were generated from the NMLS system in January 2019, when most of mortgages companies had not filed their Q4 reports. All results remain unchanged if we use interpolated data for this quarter.

We aggregate the credit line data at the shadow bank-lender bank pair level and merge the credit line data with the FC segment for shadow banks.

To measure the risk profile of shadow banks' lending portfolio, we obtain the FICO distribution of closed loans from the RMLA segment. For each mortgage company, we can observe the amount and count of mortgages originated in each FICO category in a state at quarterly frequency. We compute the fraction of mortgages with low FICO scores (i.e., ≤ 650) and merge this risk measure with the HMDA dataset.

To test if the mortgage servicing channel differs across banks and nonbanks, we construct a combined sample of both types of financial institutions using the MCR, HMDA, and FR Y-9C datasets. To estimate how the increased share of nonbanks on mortgage servicing has affected the pass-through of monetary policy shocks to aggregate mortgage lending, we use the FR Y-9C and GSE datasets to calculate aggregate bank regulatory capital deficiency and the share of mortgages serviced by shadow banks, respectively, at the metropolitan statistical area (MSA) level.

4.5 Summary Statistics

To provide a description of shadow banks' balance sheets and funding variables more generally, Table 1 contains summary statistics from the shadow bank Mortgage Call Reports for the period 2012–2019. Panel A of Table 1 summarizes the balance sheet variables from the Financial Condition segment. On average, shadow banks hold \$0.51 billion in assets with a standard deviation of \$1.38 billion.[14] Mortgage loans account on average for 57% of their assets. Following mortgage loans held for sale, mortgage servicing rights are the second largest asset. More than 80% of shadow banks have some exposure to

[14]We compare our shadow bank call reports data with Jiang et al. (2020), which also uses shadow banks call reports data for the period 2011–2017. We find that, over the period 2012–2017, the size distribution of shadow banks in our sample is comparable to the size distribution reported in Jiang et al. (2020). Shadow banks in our sample hold an average \$0.49 billion in assets with a standard deviation of \$1.49 billion during 2012–2017, whereas, in Jiang et al. (2020), the mean and standard deviation of assets are \$0.47 billion and \$1.51 billion, respectively.

MSRs, and they account on average for 8% and 32% of their assets and equity, respectively. The average shadow bank has an equity ratio of 28%.

Panels B and C of Table 1 report summary statistics on the funding structure of shadow bank from the Residential Mortgage Loan Activity segment. Panel B shows summary statistics for funding-related variables aggregated at the shadow bank level. In each year-quarter, a shadow bank in our sample has a mean total credit limit from banks of $0.86 billion with a utilization rate of 52%. The average estimated annualized interest rate on credit lines is 2.7%.[15] Panel C displays summary statistics on funding at the shadow bank-lender bank pair level. During our sample period, our data contains 27,137 lines of credit for 384 shadow banks and 224 banks. The average credit limit that a shadow bank receives from a bank in our sample is $0.21 billion.

Table 2 contains summary statistics for the merged data set of Mortgage Call Reports and the Home Mortgage Disclosure Act for the period 2012–2019 that we use in our empirical analysis. Panel A of Table 2 summarizes the merged dataset at shadow bank-county level. On average, shadow banks originate 3.27 mortgages and $632,700 of new mortgage lending in a county in a year-quarter. Panel B of Table 2 summarizes the merged dataset at the lender-county level, where lenders include both banks and shadow banks. On average, lenders originate of 3.60 mortgages and $658,523 of new mortgage lending in a county in a year-quarter. Compared to shadow banks, banks originate more mortgages and slightly larger mortgages.

[15] Following Jiang et al. (2020), we estimate the interest rate using the following formula: $\text{Expense}_{i,q} = \left(1 + r_{i,t}^{\text{daily}} + \text{Qave\_Libor}_{i,q}\right)^{90} \times \text{LineUsage}_{i,q} - \text{LineUsage}_{i,q}$, where $\text{Expense}_{i,q}$ is shadow bank i's total warehouse interest expense in quarter q, $\text{Qave\_Libor}_{i,q}$ is the average overnight LIBOR rate in quarter q, and $\text{LineUsage}_{i,q}$ is the sum of shadow bank i's usage of all credit lines in quarter q. We obtain the quarterly LIBOR data from the Federal Reserve Bank of St. Louis. We annualize $r_{i,t}^{\text{daily}}$ to obtain the annual interest cost for a shadow bank i in quarter q.

4.6 Monetary Policy Shocks

Higher interest rates lower borrowers' incentives to refinance, which in turn affect the valuation of mortgage servicing rights by increasing the expected duration of outstanding loans. To the extent that market participants anticipate future changes in monetary policy, the current value of MSRs should already reflect those expectations and not respond to observed changes in the policy rate. To capture the unanticipated component of changes in monetary policy, we use the surprise movement in the three-months-ahead federal funds futures from Gürkaynak et al. (2022) from 2012–2019 as our monetary policy shock.

This measure employs the high-frequency identification strategy based on the assumption that monetary policy news dominates other factors within a 30-minute window around the U.S. Federal Open Market Committee (FOMC) policy announcements. To match the frequency of the shadow bank balance sheet and HMDA data, we convert the surprises from meeting-by-meeting to quarterly frequency by summing all meeting surprises within a year-quarter.

5 Results on the Mortgage Servicing Channel

In this section, we present evidence that shadow banks with higher exposure to mortgage servicing reduce their mortgage lending less after a contractionary monetary policy shock. Next, we document that this mortgage servicing channel of monetary policy transmission operates through a collateral effect and a cashflow effect. Both effects illustrate how participation in mortgage servicing hedges the origination business of shadow banks against interest rate shocks. Finally, we show that the mortgage servicing channel is stronger for shadow banks with *ex ante* lower capital ratios, riskier lending portfolios, and lower stock of liquid assets. These results are consistent with mortgage servicing rights alleviating the frictions that shadow banks face in raising external finance.

5.1 The Mortgage Servicing Channel for Shadow Banks

The distinct funding structure of shadow banks and the institutional features of the mortgage servicing market suggest a role for servicing in affecting the transmission of monetary policy to nonbanks' mortgage lending. When interest rates rise, MSRs appreciate in value. Shadow banks that hold MSRs on their portfolio can either pledge them as collateral to obtain secured funding or sell them for cash. Furthermore, cashflows from servicing existing loans should be relatively insulated from changes in current interest rates because servicing fees are predetermined. In either case, we expect that the mortgage lending of shadow banks with higher *ex ante* holdings of MSRs should be less negatively affected by a contractionary monetary policy shock. This is the mortgage servicing channel of monetary policy transmission.

To test this hypothesis, we estimate the regression model

$$\begin{aligned} Y_{l,c,t} = \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_2 \text{FFF3m}_{t-1} + \beta_3 \text{MSREquity}_{l,t-1} \\ + \gamma X_{l,t-1} + FE_l + FE_t + FE_{c,t} + FE_{c,l} + \epsilon_{l,c,t}, \end{aligned} \tag{1}$$

where $Y_{l,c,t}$ is the log loan count or log loan amount originated by shadow bank l in county c in year-quarter t. FFF3m_{t-1} is the lagged cumulative change in the three-months-ahead federal funds futures in a 30-minute window around FOMC announcements, discussed in Section 4.6. $\text{MSREquity}_{l,t-1}$ is the lagged share of mortgage servicing rights in total equity of shadow bank l and captures its exposure to mortgage servicing. We add a vector of lagged time-varying lender-level controls $X_{l,t-1}$ from shadow bank balance sheet data.[16] We saturate the model with lender (FE_t), year-quarter (FE_l), and county-year-quarter ($FE_{c,t}$) fixed effects. We further add lender-county fixed effects ($FE_{c,l}$) to control for the selection of shadow bank entry into different counties. We cluster standard errors at the lender-county level. The coefficient of interest is β_1, which captures the differential effect of

[16] These include assets, equity, return on equity, share of unpaid mortgage balances held in prime conforming loans, ratio of unpaid mortgage balances to assets, liquidity ratio, and capital ratio.

exposure to MSRs on the transmission of monetary policy shocks to shadow bank mortgage lending. If the mortgage servicing channel holds in the data, we expect β_1 to be positive.

Table 3 reports the results. Columns 1–3 and 4–6 display regression estimates using log loan count and log loan amount as the dependent variable, respectively. To aid the economic interpretation of our results, we standardize $\text{MSREquity}_{l,t-1}$ to a mean of 0 and a standard deviation of 1 when estimating the regressions presented in this section. The coefficient on the interaction term between the monetary policy shock and shadow bank MSR exposure is positive and statistically significant across all specifications and for both measures of mortgage origination. This indicates that credit supplied by shadow banks with higher *ex ante* exposure to MSRs is less negatively affected by contractionary monetary policy compared to shadow banks with lower MSR exposure. The estimated coefficients imply that, for a given 25bp contractionary monetary policy shock, raising the MSR-to-equity ratio of a shadow bank by one standard deviation leads to a 13.4% increase in the number of originations and a 13.0% increase in loan volume.

5.1.1 Robustness Checks

We conduct a number of robustness tests regarding the mortgage servicing channel of monetary policy transmission; a full description of these results are in Section A.1 of the appendix. Our main result is robust to using the ratio of mortgage servicing rights to total assets as a measure of lender-level to mortgage servicing. It survives using alternative measures of the monetary policy shock. Finally, the main result is also robust to an alternative classification of shadow banks.

Our results on the mortgage servicing channel rely on the negative relationship between interest rates and prepayment risk. Borrowers' repayment incentives are largely determined by differences between current interest rates on new loans and predetermined interest rates on outstanding loans (Berger et al., 2021; Eichenbaum et al., 2022). Because fixed-rate loans have accounted for around 90% of U.S. residential mortgages over our sample

period, monetary policy can influence prepayment speeds by affecting interest rates on new mortgage lending while rates on existing loans remain largely unchanged.

To study the effect of monetary policy on mortgage prepayment—and, by extension, the latter's role in accounting for the mortgage servicing channel—we estimate the regression equation

$$\begin{aligned} Y_{l,c,t} = \beta_1 \widehat{\text{MR}}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_2 \widehat{\text{MR}}_{t-1} + \beta_3 \text{MSREquity}_{l,t-1} \\ + \gamma X_{l,t-1} + FE_l + FE_t + FE_{c,t} + FE_{c,l} + \epsilon_{l,c,t}, \end{aligned} \tag{2}$$

where $\widehat{\text{MR}}_{t-1}$ is the lagged change in the interest rate on 30-year fixed-rate mortgages predicted by the monetary policy shock FFF3m_{t-1}. Under the assumption that interest rates on existing mortgages are fixed, $\widehat{\text{MR}}$ is a proxy for the change in prepayment incentives induced by unexpected movements in the policy rate.[17] Other variables remain as defined in Equation (1). If the effect of nonbanks' exposure to mortgage servicing on loan origination in response to monetary policy shocks is indeed driven through a prepayment channel, then the coefficient β_1 should be positive. Table A.8 presents regression results that confirm this hypothesis.

5.1.2 The Collateral Effect of Mortgage Servicing Rights

Having established the existence of the mortgage servicing channel for shadow banks, we now consider two mechanisms through which participation in servicing may hedge loan origination against interest rate shocks. First, we hypothesize that exposure to mortgage servicing rights affects lending through a *collateral effect*. Over 70% of shadow bank funding comes from credit lines provided by banks (Jiang et al., 2020). These credit lines can be secured by mortgages and mortgage servicing rights. When monetary policy tightens, the value of MSRs increases, making them more attractive as collateral. We hypothesize that

[17] We obtain $\widehat{\text{MR}}$ by using estimated coefficients from the regression $\text{MR}_t = \alpha + \beta \text{FFF3m}_t + \epsilon_t$. See Table A.7 for regression estimates.

shadow banks with more exposure to MSRs experience a relative increase in their secured funding after a contractionary monetary policy shock. To the extent that collateral can mitigate adverse selection frictions in the funding market, we also expect to see a lower cost of borrowing on credit lines used by shadow banks with greater holdings of MSRs on their balance sheet.

To test these hypotheses, we use the detailed credit line data from the RMLA segment of the Mortgage Call Reports to provide direct evidence on the link between shadow banks' MSR exposure and their ability to secure funding during monetary tightening. To begin, we aggregate credit line data at the shadow bank level and estimate the regression model

$$\begin{aligned} Y_{l,t} = \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_2 \text{FFF3m}_{t-1} + \beta_3 \text{MSREquity}_{l,t-1} \\ + \gamma X_{l,t-1} + FE_l + FE_t + \epsilon_{l,t}. \end{aligned} \tag{3}$$

The dependent variable $Y_{l,t}$ is log used credit, utilization rate, or estimated average interest rate on credit lines paid by shadow bank l in year-quarter t. Other variables are as previously defined in Equation (1). We saturate the model with lender (FE_l) and year-quarter (FE_t) fixed effects to control for time-invariant lender characteristics and time-varying credit market conditions, respectively. The standard errors are clustered at the lender level. Our variable of interest remains the interaction term between the monetary policy shock and a shadow bank's *ex ante* holdings of MSRs. The coefficient β_1 captures the effect of a monetary policy shock on the used credit, utilization rate, or funding cost of shadow banks with heterogeneous exposure to mortgage servicing rights.

Panel A of Table 4 reports the results. Columns 1–3 and 4–6 display regression estimates for log used credit and utilization rate as the dependent variable, respectively. The coefficient on the interaction term is positive and statistically significant at the 1% level for credit limit and used credit across all specifications. These results indicate that, relative to shadow banks with lower *ex ante* exposure to mortgage servicing rights, those

with higher exposure draw down on their credit lines more. Because credit line drawdowns are typically done to originate mortgages, this provides direct evidence that shadow banks with more MSRs can supply relatively more credit after a contractionary monetary policy shock. Columns 7–9 display results on the effect of monetary policy shocks on the external funding cost of shadow banks with varying MSR exposure. The estimated coefficient on the interaction term is negative and statistically significant across all three specifications. This implies that shadow banks with more MSRs on their balance sheet can access external funding at relatively lower cost after an unexpected monetary contraction.

One possible concern with estimating this regression at the shadow bank level is that non-random matching between shadow banks and banks may interfere with interpretation of the results. Shadow banks choose the banks from which they borrow, and it may be that shadow banks that are relatively more involved in mortgage servicing obtain credit lines from banks that experience positive credit supply shocks. To address the selection problem, we also conduct our analysis at the shadow bank-bank pair level. Specifically, we estimate the equation

$$\begin{aligned} Y_{l,b,t} = \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_2 \text{FFF3m}_{t-1} + \beta_3 \text{MSREquity}_{l,t-1} \\ + \gamma X_{l,t-1} + FE_l + FE_t + FE_{b,t} + \epsilon_{l,b,t}, \end{aligned} \tag{4}$$

where the dependent variable $Y_{l,b,t}$ is now log used credit, utilization rate, or estimated average interest rate paid by shadow bank l from financier b in year-quarter t. We aggregate used credit and utilization rates at the shadow bank-bank pair level. Note that the estimated interest rate does not vary across banks. As in Equation (3), we saturate the model with shadow bank lender (FE_l) and year-quarter (FE_t) fixed effects. More importantly, we add bank-year-quarter fixed effects ($FE_{b,t}$) to control for the time-varying supply of credit at the financier level. In this regression, then, we are exploiting cross-sectional variation across shadow banks that borrow from the *same* bank lender.

We report results for the shadow bank-bank pair-level analysis in Panel B of Table 4. Columns 1–3 and 4–6 contain results using log used credit and utilization rate as the dependent variable, respectively. The coefficient on the interaction term remains positive, significant at 1% level, and similar in magnitude across all specifications. These results indicate that, among multiple shadow banks that borrow from the same bank, shadow banks with higher *ex ante* MSR exposure draw down on their credit lines more when monetary policy is tightened compared to those with lower exposure. Similarly, results in columns 7–9 show that the cost of borrowing increases less for shadow banks with higher *ex ante* holdings of MSRs after a contractionary monetary policy shock. These results validate the underlying mechanism: shadow banks with greater exposure to mortgage servicing obtain relatively more funding when monetary policy tightens.

5.1.3 The Cashflow Effect of Mortgage Servicing Rights

A second mechanism by which exposure to mortgage servicing may attenuate the pass-through of monetary policy to shadow bank lending is a *cashflow effect*. By design, servicing fees are a relatively certain source of income because they are equal to fixed share of a mortgage's outstanding balance. Conditional on the mortgage not being prepaid, this makes the size of the servicing fee invariant to future changes in interest rates. By contrast, income generated through loan origination is likely more sensitive to interest rate fluctuations. Thus, we hypothesize that shadow banks with higher exposure to MSRs should experience an increase in their net income relative to shadow banks with lower exposure to MSRs when there is a contractionary monetary policy shock as origination income is negatively affected by higher interest rates and shadow banks with MSR exposure are relatively insulated from this negative effect on income.

To test this hypothesis, we estimate the lender-level regression in Equation (3) using net income scaled by total assets of shadow bank l in year-quarter t as our dependent variable and measure of cashflow. The coefficient of interest remains β_1, which represents the

differential effect of a monetary policy shock on the earnings of shadow banks with varying exposure to mortgage servicing rights. If higher *ex ante* exposure to MSRs insulates shadow banks' cashflow from contractionary monetary policy shock, then β_1 should be positive.

We report regression results in columns 1–2 of Table 5. The coefficient on the interaction term β_1 is positive, statistically significant, and similar in magnitude across all specifications. These results indicate that shadow banks with higher *ex ante* MSR-to-equity ratios have relatively higher earnings following an unexpected monetary tightening. They confirm our hypothesis that participation in mortgage servicing helps insulate the cashflow of shadow banks against interest rate shocks.[18] These results are in the spirit of Gelman et al. (2022), who show that banks with more diversified assets have more resilient lending and are better able to absorb negative shocks.

To provide additional support for the cashflow effect, we also estimate Equation (3) with the ratio of servicing income to gross income of shadow bank l in year-quarter t as the dependent variable. To the extent that shadow banks with more holdings of MSRs can offset declines in other sources of income with revenue from servicing, we expect their current income to become relatively more reliant on servicing. Columns 3–4 in Table 5 display estimates for this regression. The coefficient on the interaction term is positive and statistically significant in both columns, corroborating the findings in columns 1–2.

5.1.4 Discussion

It should be noted that, in addition to the collateral and cashflow effects described above, a change in interest rates can also affect shadow banks through their involvement in mortgage servicing in two other ways. First, higher interest rates increase discounting. All else equal, higher discounting lowers the expected present value of servicing income and, in turn, the value of mortgage servicing rights as collateral. Through the discounting effect, higher *ex*

[18]The obvious direct effect of MSR exposure is that more funds are available for loan origination. A more subtle indirect effect is that higher cashflow today implies higher expected net worth in the future, all else equal. This may also alleviate constraints on shadow bank funding.

ante exposure to servicing should amplify the effect of monetary policy shocks on shadow bank mortgage lending as their MSRs depreciate in value when interest rates rise.

Second, when the central bank tightens monetary policy, default risk could increase through an aggregate demand channel. As borrowers become delinquent on their mortgage payments, servicing income generated by outstanding loans decreases. At the same time, the cost of servicing non-performing loans is greater than that of servicing performing loans.[19] Through the delinquency effect, shadow banks with greater participation in the mortgage servicing market might cut their lending by more after a monetary contraction as higher cost of servicing negatively affects their profits.

Together, these two effects should work against finding evidence for the mortgage servicing channel of monetary policy transmission in the data. Our empirical results, however, show that the lending of shadow banks with higher *ex ante* exposure to mortgage is in fact more insulated from monetary policy shocks. This suggests that the discounting and delinquency effects are more than offset by the value of MSRs as a source of collateral and cashflow for shadow banks.

5.2 Heterogeneity Tests

In this section, we conduct several heterogeneity tests to provide further evidence on the role of shadow banks' exposure to mortgage servicing rights in dampening the transmission of monetary policy to mortgage lending. We consider three characteristics of shadow banks that could make MSRs a useful hedge against contractionary monetary policy shocks: their capital to asset ratio, exposure to risky borrowers, and stock of liquid assets. The first two characteristics measure the intensity of adverse selection frictions faced by shadow banks in raising external finance. We expect shadow banks facing higher adverse selection frictions to benefit more from MSR holdings during contractionary monetary policy periods. Thus, the mortgage servicing channel should be stronger for such lenders. The third characteristic

[19] See https://www.urban.org/sites/default/files/042017_msc_factsheet.pdf.

captures a shadow bank's capacity to use internal funding. We expect shadow banks with less liquidity to benefit more from exposure to mortgage servicing when interest rates rise, so the servicing channel should be stronger for these institutions as well.

5.2.1 Capital to Asset Ratio

Information asymmetry in the market for short-term debt implies that shadow banks trying to raise external finance to fund mortgages will face adverse selection frictions and should be more negatively affected by contractionary monetary policy. This is especially true for nonbanks with low capital, as they may have to pay a lemon's premium in order to secure funding when interest rates rise. Having access to MSRs can attenuate the adverse selection problem that shadow banks face in the funding market and allow them to access funding at a cheaper rate. If this is true, we expect the dampening effect of MSRs to be stronger for shadow banks with low *ex ante* capital ratios.

To test this hypothesis, we estimate the regression model

$$\begin{aligned} Y_{l,c,t} = {} & \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{l,t-1} \\ & + \beta_2 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_3 \text{FFF3m}_{t-1} \times \text{CapitalRatio}_{l,t-1} \\ & + \beta_4 \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{l,t-1} + \beta_5 \text{FFF3m}_{l,t-1} + \beta_6 \text{MSREquity}_{l,t-1} \\ & + \beta_7 \text{CapitalRatio}_{l,t-1} + \gamma X_{l,t-1} + FE_l + FE_t + FE_{c,t} + FE_{c,l} + \epsilon_{l,c,t}, \end{aligned} \tag{5}$$

where $\text{CapitalRatio}_{l,t-1}$ is the lagged ratio of capital to total assets of shadow bank l. All other variables are as previously defined in Equation (1), and we cluster standard errors at the lender-county level. The coefficient on the triple interaction term, β_1, captures how a shadow bank's *ex ante* capital ratio affects the strength of the mortgage servicing channel.

Columns 1–2 in Table 6 contain estimates for Equation (5) using log loan count and log loan amount as the dependent variable, respectively. The coefficient on the triple interaction term is negative and statistically significant. This implies that the dampening

effect of MSRs on monetary policy transmission is greater for shadow banks with lower capital ratios. This suggests that MSRs weaken monetary policy transmission by alleviating adverse selection frictions faced by shadow banks in the external funding market.

5.2.2 Exposure to Risky Borrowers

Shadow banks that lend to riskier borrowers should face higher adverse selection frictions while raising external finance. Because MSRs can attenuate adverse selection frictions, we expect the mortgage servicing channel to be greater for shadow banks with riskier lending portfolios. To test this hypothesis, we estimate the model

$$\begin{aligned} Y_{l,c,t} = {} & \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{LowFICO\%}_{l,t-1} \\ & + \beta_2 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_3 \text{FFF3m}_{t-1} \times \text{LowFICO\%}_{l,t-1} \\ & + \beta_4 \text{MSREquity}_{l,t-1} \times \text{LowFICO\%}_{l,t-1} + \beta_5 \text{FFF3m}_{t-1} + \beta_6 \text{MSREquity}_{l,t-1} \\ & + \beta_7 \text{LowFICO\%}_{l,t-1} + \gamma X_{l,t-1} + FE_l + FE_t + FE_{c,t} + FE_{c,l} + \epsilon_{l,c,t}, \end{aligned} \tag{6}$$

where $\text{LowFICO\%}_{l,t-1}$ is the lagged share of mortgages originated by shadow bank l to borrowers with a FICO score less than or equal to 650 and measures its exposure to risky borrowers. All other variables are as previously defined in Equation (1), and we cluster standard errors at the lender-county level. Our coefficient of interest β_1 captures how the *ex ante* riskiness of a shadow bank's lending portfolio affects the strength of the mortgage servicing channel.

Columns 3–4 in Table 6 contain estimates for Equation (6) using log loan count and log loan amount as the dependent variable, respectively. The coefficient on the triple interaction term is positive and statistically significant, suggesting that the mortgage servicing channel is stronger for shadow banks with a riskier lending portfolio. We expect such shadow banks to encounter more severe adverse selection frictions in the external finance market. Thus, our findings again support the hypothesis that MSRs weaken the

effect of monetary policy shocks on nonbank mortgage lending by alleviating those frictions.

5.2.3 Stock of Liquid Assets

When interest rates rise, external funding becomes more expensive and may induce induce shadow banks to curtail lending. This can be somewhat mitigated for shadow banks with a high *ex ante* stock of liquid assets, such as cash or short-term securities, which can be used as a source of internal funding for new mortgages. For highly liquid shadow banks, exposure to mortgage servicing may not provide much additional insulation. For shadow banks with less liquidity, however, MSRs could enable them to originate relatively more mortgages by servicing as an imperfect substitute for liquid assets during monetary tightening.

To test this hypothesis, we estimate the regression model

$$\begin{aligned} Y_{l,c,t} = {} & \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{LiquidityRatio}_{l,t-1} \\ & + \beta_2 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_3 \text{FFF3m}_{t-1} \times \text{LiquidityRatio}_{l,t-1} \\ & + \beta_4 \text{MSREquity}_{l,t-1} \times \text{LiquidityRatio}_{l,t-1} + \beta_5 \text{FFF3m}_{t-1} + \beta_6 \text{MSREquity}_{l,t-1} \\ & + \beta_7 \text{LiquidityRatio}_{l,t-1} + \gamma X_{l,t-1} + FE_l + FE_t + FE_{c,t} + FE_{c,l} + \epsilon_{l,c,t}, \end{aligned} \tag{7}$$

where $\text{LiquidityRatio}_{l,t-1}$ is the lagged ratio of liquid assets to total assets of shadow bank l. All other variables are as previously defined in Equation (1), and we cluster standard errors at the lender-county level. Our coefficient of interest β_1 captures how the *ex ante* liquidity of a shadow bank's balance sheet affects the strength of the mortgage servicing channel.

Columns 5–6 in Table 6 contain estimates for Equation (7) using log loan count and log loan amount as the dependent variable, respectively. The coefficient on the triple interaction term is negative and statistically significant across both specifications, suggesting that the mortgage servicing channel is weaker for shadow banks with more liquidity. This finding supports our hypothesis that participation in mortgage servicing

weakens the pass-through of monetary policy to new lending by providing an alternative source of financing for shadow banks with comparatively less internal funding.

6 Implications for Aggregate Lending

Having established the existence of the mortgage servicing channel of monetary policy transmission for shadow banks in Section 5, we now widen our empirical analysis and ask if this channel is relevant for the transmission of monetary policy to *aggregate* mortgage lending. This is critical for assessing the broader implications of the reallocation of mortgage servicing from banks to nonbanks. If the marginal effect of exposure of mortgage servicing is the same for both types of lenders, then the composition of financial institutions in mortgage servicing is irrelevant for the transmission of monetary policy. If the strength of the mortgage servicing channel differs across banks and nonbanks, though, then the rise of shadow banks as servicers suggests the transmission of monetary policy to the mortgage market has dampened at the aggregate level.

Our results support the latter view. To begin, we document that the mortgage servicing channel is significantly weaker for traditional banks compared to shadow banks. Motivated by this, we next quantify the extent to which the change in the composition of financial institutions in the mortgage servicing market has influenced the transmission of monetary policy to mortgage lending at the regional (i.e., MSA) level. We find weaker pass-through of monetary policy to lending in regions with larger increases in the nonbank share of mortgage servicing. Our estimates therefore imply that shadow banks have attenuated the transmission of monetary policy to aggregate mortgage lending.

6.1 Comparing the Mortgage Servicing Channel for Banks and Shadow Banks

To test if the strength of the mortgage servicing channel of monetary policy transmission differs for banks and nonbanks, we estimate the triple-difference regression model

$$\begin{aligned} Y_{l,c,t} = {} & \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t} \\ & + \beta_2 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_3 \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t} \\ & + \beta_4 \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t} + \beta_5 \text{FFF3m}_{t-1} + \beta_6 \text{MRSEquity}_{l,t-1} \\ & + \beta_7 \text{Nonbank}_{l,t} + \gamma X_{l,t-1} + FE_l + FE_t + FE_{c,t} + FE_{c,l} + FE_{nb,t} + FE_{nb,c} + \epsilon_{l,c,t} \end{aligned} \tag{8}$$

for a combined sample of bank and nonbank lenders. The dependent variable $Y_{l,c,t}$ is now the log loan count or log loan amount originated by lender l in county c in year-quarter t. $\text{MSREquity}_{l,t-1}$ is the lagged MSR to equity ratio of lender l, and $\text{Nonbank}_{l,t}$ is an indicator variable that takes a value of 1 if lender l is a shadow bank in year-quarter t and 0 otherwise. The monetary policy shock FFF3m_{t-1} remains as previously defined in Section 5. We include a vector of lagged time-varying lender-level controls $X_{l,t-1}$ and saturate the model with lender (FE_l), year-quarter (FE_t), county-year-quarter ($FE_{c,t}$), lender-county ($FE_{c,l}$), lender type-year-quarter ($FE_{nb,t}$), and lender type-county ($FE_{nb,c}$) fixed effects. Standard errors are clustered at the lender-county level. β_1 is the coefficient of interest and captures the difference in the strength of the mortgage servicing channel for nonbanks relative to banks.

Table 7 displays the estimated coefficients with log loan count and log loan amount as the dependent variable in columns 1–4 and 5–8, respectively.[20] The coefficient of interest β_1 is positive and statistically significant in all specifications, implying that the mortgage servicing channel is stronger for nonbanks than banks. In other words, conditional on

[20] Because the mean MSR to equity ratio for banks and nonbanks differs substantially, we do not standardize $\text{MSREquity}_{l,t-1}$ when estimating Equation (8).

the same *ex ante* exposure to mortgage servicing, traditional banks reduce their mortgage lending more relative to shadow banks following an unexpected monetary contraction. From a funding perspective, the collateral and cashflow effects of mortgage servicing rights documented in Section 5 are less important for traditional banks due to their reliance on deposit funding for loan origination. Mortgage servicing is also costly for banks due to capital requirements on MSRs in place during our period of study. If a bank has higher *ex ante* holdings of MSRs on its balance sheet, then originating an additional mortgage and retaining the associated mortgage servicing asset incurs a capital charge. This further weakens the mortgage servicing channel for traditional banks.

6.2 Accounting for the Rise of Shadow Banks in Servicing

The evidence on the differential strength of the MSR channel for banks and nonbanks from Section 6.1 suggests that the composition of servicers in the mortgage market is nontrivial for the transmission of monetary policy to aggregate mortgage lending. Next, we quantify the dampening of monetary policy transmission attributable to the rising share of shadow banks in mortgage servicing. To do this, we use MSA-level data on the share of shadow banks in mortgage servicing. Our approach is to exploit MSA-level heterogeneity in shadow banks' share in mortgage servicing and see if it differentially affects the transmission of monetary policy to regional mortgage lending. One concern with this approach is that the MSA-level heterogeneity in shadow bank servicing exposure could be correlated with unobservable characteristics, such as MSA-level loan demand, that simultaneously affect shadow bank servicing share and mortgage lending in a given region.

To address this concern, we exploit differences across the regulatory capital of *traditional banks* prior to the U.S. implementation of Basel III capital regulation to predict variation in shadow banks' participation in servicing across MSAs.[21] In 2012Q2, U.S. regulators

[21] Irani et al. (2021) use differences in regulatory treatment of MSRs in Basel III to study the implications for loan sales by banks.

announced a decrease in the cap on MSRs' contribution to Tier 1 capital from 50% to 10% and an increase in their risk weight from 100% to 250%. Their treatment of MSRs was more punitive compared to international standards and largely unanticipated by market participants (Berrospide and Edge, 2016; Irani et al., 2021). This increase in capital requirement on banks' MSR holdings, combined with *ex ante* variation in banks' sensitivity to the additional capital charge arising from Basel III, yields plausibly exogenous variation in the MSR holdings of *shadow banks*. We hypothesize that, in regions where banks had relatively higher regulatory capital shortfalls in the pre-policy period, shadow banks increased their share of the servicing market more.

We define our treatment variable at the MSA level, $\text{MSR}\%_M$, as servicing-weighted MSRs as a percent of traditional banks' Tier 1 capital in MSA M in 2012Q2,

$$\text{MSR}\%_M = \sum_{b \in M} \left(\frac{MSR_{b_{2012Q2}}}{Tier1Capital_{b_{2012Q2}}} \times \frac{Servicing_{b_{2012Q2}}}{\sum_{b \in M} Servicing_{b_{2012Q2}}} \right) \times 100, \tag{9}$$

where $\frac{MSR_{b_{2012Q2}}}{Tier1Capital_{b_{2012Q2}}}$ is the share of MSRs in Tier 1 capital of traditional bank b in 2012Q2 and measures the exposure of bank b to the regulatory change in the capital treatment of MSRs. We aggregate bank-level exposure to Basel III to the MSA level by using bank b's servicing share in a given MSA, $\frac{Servicing_{b_{2012Q2}}}{\sum_{b \in M} Servicing_{d_{2012Q2}}}$.

We construct this treatment variable using the GSE single-family loan-level datasets because they disclose the identity of the servicer, as well as the MSA of the mortgaged property property. This allows us to observe the shares of banks and nonbanks in regional servicing markets over time. While these data do not capture the full universe of the residential mortgage market, loans purchased or guaranteed by the GSEs have accounted for around two-thirds of originations since the global financial crisis.[22]

To document the effect of the Basel III capital requirements on the share of nonbanks

[22]See https://www.urban.org/sites/default/files/publication/102776/august-chartbook-2020.pdf.

in the servicing market, we estimate an event-study regression

$$Y_{M,t} = \sum_{\tau=-10}^{10} (\beta_\tau \text{MSR\%}_M \times \text{Post}_{t+\tau}) + \gamma X_{M,t-1} + FE_M + FE_t + \epsilon_{M,t}. \tag{10}$$

The dependent variable $Y_{M,t}$ is the share of mortgages serviced by shadow banks in MSA M in year-quarter t. $\text{MSR\%}_M$ is the treatment variable defined in Equation (9), and $\text{Post}_{t+\tau}$ equals 1 if year-quarter t is τ periods away from 2012Q2.[23] We include a vector of lagged time-varying MSA-level characteristics $X_{M,t-1}$, as well as MSA (FE_M) and year-quarter (FE_t) fixed effects.[24] The standard errors are clustered at the MSA level. If the Basel III capital requirements led to a reallocation of servicing away from traditional banks towards shadow banks, we should expect that $\beta_\tau > 0$ for $\tau \geq 1$.

Figure 2 plots estimated values of β_τ, with $\tau = 0$—i.e., the quarter in which the Basel III capital requirements on mortgage servicing rights were announced—as the omitted category. This figure visually confirms that, prior to the policy, the nonbank servicing share did not vary significantly with respect to the aggregate MSR-to-Tier 1 capital ratio of banks across MSAs. After the policy, greater reallocation of servicing towards nonbanks occurred in more heavily treated MSAs.

To capture the average effect of the Basel III capital requirements on shadow banks' involvement in regional servicing markets, we also estimate the difference-in-differences regression

$$\begin{aligned} Y_{M,t} = \beta_1 \text{MSR\%}_M \times \text{Post}_t + \beta_2 \text{MSR\%}_M + \beta_3 \text{Post}_t \\ + \gamma X_{M,t-1} + FE_M + FE_t + \epsilon_{M,t}, \end{aligned} \tag{11}$$

where Post_t is an indicator variable equal to 1 if year-quarter t is 2012Q3 or later and other variables are as previously defined in Equation (10). The coefficient of interest β_1

[23] In undocumented results, we estimate Equation (10) using an alternate treatment measure — Basel III Tier 1 shortfall, which is the difference between a given traditional bank's Tier 1 capital and the regulatory capital announced in the U.S. implementation of Basel III — and find similar results. We thank Jose Berrospide for kindly sharing his data on capital shortfalls of traditional banks.

[24] See Table A.2 for summary statistics of variables used in the MSA-level analysis.

represents the effect of the Basel III capital requirements on MSRs on nonbank servicing shares in MSAs that were differentially exposed to the policy.

We present results in columns 1–4 of Table 8 using the share of mortgages serviced by nonbanks in MSA M in year-quarter t as the dependent variable. Consistent with the event-study analysis, the estimate for β_1 is positive and statistically significant at the 1% level in all the specifications. In columns 5–8 of Table 8, we additionally estimate Equation (11) with the share of mortgages originated by shadow banks in MSA M in year-quarter t as the dependent variable. The coefficient of interest is also positive and statistically significant in these regressions, indicating that shadow banks increased their share in the lending market more in MSAs where banks had higher regulatory capital shortfalls prior to the implementation of Basel III. These aggregate results provide evidence of a significant reallocation of servicing from banks to nonbanks after the Basel III reforms.[25] These results, combined with our lender-level analysis on the mortgage servicing channel for shadow banks in Section 5 suggest there could be significant changes in the transmission of monetary policy after the Basel III policy.

6.3 The Dampening Effect of the Mortgage Servicing Channel on Monetary Policy Transmission

Having shown that aggregate bank capital deficiency prior to the announcement of the Basel III capital requirements on mortgage servicing rights predicts plausibly exogenous and economically meaningful variation in the share of loans serviced by nonbanks, we now quantify the contribution of the rise of shadow banks in mortgage servicing to the dampening of monetary policy transmission. To do so, we estimate the triple-difference

[25] As a validation check for our aggregate results, we consider the effect of the Basel III capital requirements on *bank-level* participation in mortgage servicing. We find that, among a sub-sample of large bank servicers, those with greater ex ante capital deficiency decreased the holdings of mortgage servicing rights more after the implementation of Basel III. Details are provided in Section A.2 of the appendix.

regression

$$
\begin{aligned}
Y_{M,t} = {} & \beta_1 \text{MSR\%}_M \times \text{FFF3m}_{t-1} \times \text{Post}_t + \beta_2 \text{MSR\%}_M \times \text{FFF3m}_{t-1} \\
& + \beta_3 \text{MSR\%}_M \times \text{Post}_t + \beta_4 \text{FFF3m}_{t-1} \times \text{Post}_t + \beta_5 \text{MSR\%}_M + \beta_6 \text{FFF3m}_{t-1} \\
& + \beta_7 \text{Post}_t + \gamma X_{M,t-1} + FE_M + FE_t + \epsilon_{M,t},
\end{aligned} \tag{12}
$$

where $Y_{M,t}$ is log total loan count or log total loan amount originated in MSA M in year-quarter t and other variables are as previously defined in Equation (10). Crucially, we use the treatment variable $\text{MSR\%}_M$ from Equation (9) as a proxy for nonbank participation in aggregate mortgage servicing in order to alleviate endogeneity concerns. The coefficient of interest on the triple interaction term β_1 captures pass-through of monetary policy shocks to aggregate mortgage lending in MSAs that vary in the participation of nonbanks in servicing markets. Consistent with our lender-level results on the mortgage servicing channel, we hypothesize that the transmission of monetary policy has weakened more in MSAs where banks were more affected by the Basel III capital requirements and the reallocation of servicing towards nonbanks was strongest.

We present our regression estimates in Table 9. For ease of interpretation, we standardize the treatment variable $\text{MSR\%}_M$ to a mean of 0 and a standard deviation of 1. Columns 1–4 and 5–8 report results using log loan count and log loan amount as the dependent variable, respectively. In all the specifications we consider, the coefficient on the triple interaction term is positive and statistically significant at the 1% level. This indicates that, after the announcement of more strict capital requirements on MSRs, mortgage lending declined less after a contractionary monetary policy shock in MSAs where there was more nonbank involvement in the servicing market. This is consistent with our hypothesis that the mortgage servicing channel of monetary policy that we have already documented at the individual lender level also holds at the regional level.

Using our MSA-level estimates from Table 9, we follow Gete and Reher (2021) to

calculate the aggregate effect of the Basel III-induced reallocation of servicing to nonbanks on mortgage origination in response to a given monetary policy shock.[26] Specifically, we quantify the extent to which the rise of nonbanks in servicing due to Basel III reduced the contractionary effect of higher interest rates on mortgage lending. To obtain this estimate, we make two assumptions. First, we assume that monetary policy transmission is unaffected by the Basel III reform in MSAs where banks' MSRs as a share of their Tier 1 capital, $\text{MSR}\%_M$, falls below a certain threshold. As in Gete and Reher (2021), we need this assumption because our treatment variable is continuous and the threshold separates MSAs into treatment and control groups. We set our threshold to the 1st percentile of $\text{MSA}\%_M$ but obtain similar results using other definitions. Second, we assume that the aggregate effect of the Basel III reform on monetary policy transmission is equal to the average of the MSA-level effects weighted by the respective size of their mortgage markets in 2012Q2. These assumptions imply that, because of the Basel III-induced reallocation of mortgage servicing from banks to shadow banks, mortgage lending was 2.6% greater than it would have been in response to a 25bp contractionary monetary policy shock. In dollar terms, this translates into $7.4 billion of additional new mortgage lending in the quarter following the contractionary monetary policy shock.[27]

7 Conclusion

This paper proposed a new conceptual framework for the transmission of monetary policy through shadow banks in the U.S. mortgage market. This framework highlights the importance of shadow banks' involvement as mortgage servicers in generating non-deposit funding for loan origination and the sensitivity of mortgage servicing rights to changes in interest rates. We presented evidence that the lending of shadow banks with greater exposure to mortgage servicing is less affected by monetary policy shocks. The collateral

[26] We provide details of this calculation in Section A.3 in the appendix.
[27] $7.4 billion is 2.6% of total mortgage origination volume in 2012Q2.

value of mortgage servicing rights and the relative stability of income generated through servicing give rise to a mortgage servicing channel of monetary policy.

We showed that, relative to nonbanks, the mortgage servicing channel is weaker for traditional banks, which have access to deposit funding for new lending and must satisfy capital requirements on their holdings of mortgage servicing rights. Combined with the increase in the share of mortgages being serviced by shadow banks induced by those capital requirements, this implies that mortgage lending has become relatively more insulated from unexpected changes in interest rates.

A crucial takeaway from our results is that the composition of lenders operating in the mortgage servicing market is relevant for the ability of monetary policy authorities to shape real outcomes. Just as Drechsler et al. (2022) show that higher interest rates between 2003–2006 had minimal impact on mortgage lending because the contraction in banks' portfolio lending was offset by an increase in privately securitized mortgages, our findings suggest that the monetary tightening that began in 2022 may be less effective given the dominant role of shadow banks in the mortgage market. Because shadow banks typically serve a different clientele compared to traditional banks, monetary policy could also have unintended distributional consequences that depend on the composition of lenders operating within a given region. We leave this question open for future research.

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Figures and Tables

Figure 1: Structure of the U.S. Mortgage Servicing Market

This figure presents a simplified description of the U.S. mortgage servicing market. A mortgage servicing right is created when a mortgage is sold on the secondary market, with rights to servicing retained. A borrower makes a stream of monthly mortgage payments that are ultimately received by investors that own the mortgage-backed security in which the borrower's loan has been packaged. A servicer (i.e., MSR holder) is responsible for collecting payments from borrower and disbursing funds to investors. In exchange, the servicer collects a mortgage servicing fee from the borrower equal to a fixed, predetermined share of the outstanding loan balance. The value of a mortgage servicing right equals the present discounted value of expected revenue from servicing the loan.

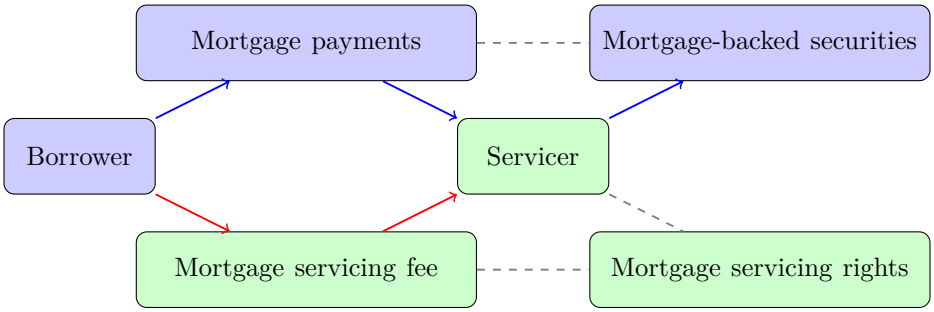

Figure 2: The Effect of Basel III Capital Requirements on Nonbank Servicing Share

This figure reports estimates and 95% confidence intervals for $\{\beta_\tau\}_{\tau=-10}^{10}$ from Equation (10) for MSAs for the period 2010–2015. The dependent variable is the share of mortgages serviced by nonbanks in MSA M in year-quarter t. The main independent variables are $\{\text{MSR}\%_M \times \text{Post}_{t+\tau}\}_{\tau=-10}^{10}$, the interaction between MSA-level exposure to the Basel III capital requirements on mortgage servicing rights ($\text{MSR}\%_M$) and the post dummy variable ($\text{Post}_{t+\tau}$). MSA-level exposure to Basel III is measured as the servicing-weighted average of banks' ratio of mortgage servicing rights to Tier 1 capital in MSA M in 2012Q2. The post dummy variable takes a value of 1 if year-quarter t is τ periods away from 2012Q2 and 0 otherwise. The dashed black line denotes 2012Q2 (i.e., $\tau = 0$), when the U.S. implementation of Basel III capital requirements on mortgage servicing rights was announced.

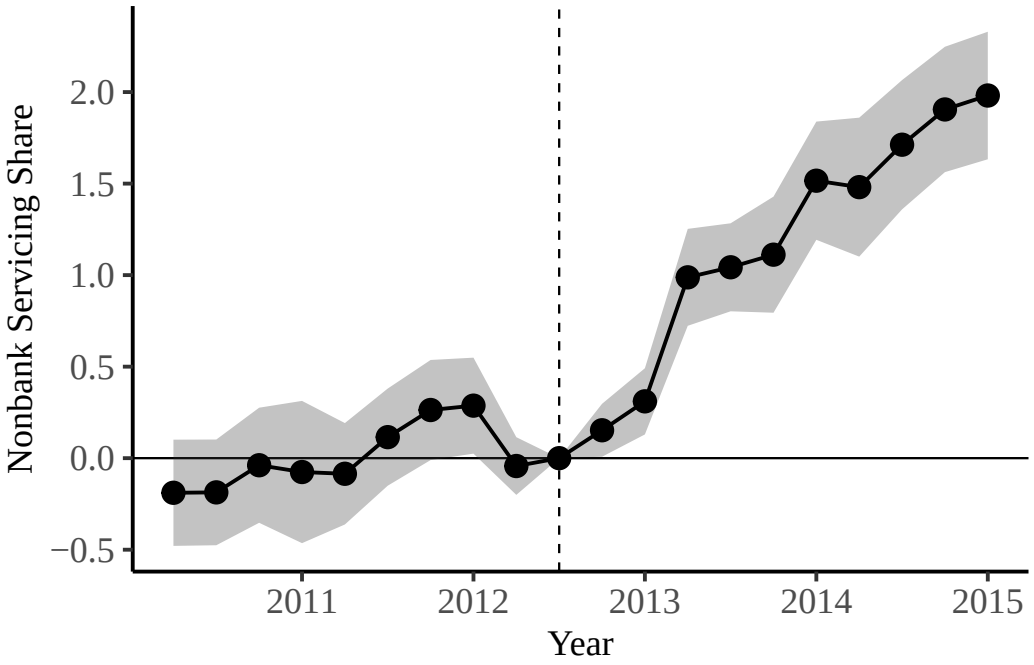

Table 1: Summary Statistics: Shadow Banks

This table reports summary statistics for all variables used in the empirical analysis for the period 2012–2019 using quarterly data from Mortgage Call Reports (MCRs). Panel A shows the summary statistics for balance sheet variables from the Financial Condition segment of the MCRs. Panel B and C show summary statistics for funding-related variables for shadow banks from the Residential Mortgage Loan Activity segment of the MCRs. Panel B shows the summary statistics at the shadow bank level, while Panel C shows the summary statistics at the shadow bank-lender bank pair level.

Panel A: Shadow Bank Balance Sheet Variables

Variable	N	Mean	SD	25%	50%	75%
Assets (Billions)	9,549	0.51	1.38	0.03	0.08	0.26
Equity (Billions)	9,549	0.09	0.24	0.01	0.02	0.05
MSR/Equity (%)	9,537	31.98	43.91	0.00	12.02	51.00
MSR/Assets (%)	9,546	8.33	14.01	0.00	1.90	11.02
Return on Equity (%)	9,537	6.02	14.81	0.00	4.51	12.27
Capital Ratio (%)	9,546	27.70	21.51	13.24	20.26	34.42
Liquidity Ratio (%)	9,546	11.32	15.41	3.19	6.06	12.18
Prime Conforming/Total Mortgages (%)	8,297	48.24	27.81	32.69	51.60	65.08
Mortgage Unpaid Balance/Assets (%)	9,546	57.32	31.71	36.27	70.64	81.74
% Mortgages with FICO $\leq$ 650	1,461	18.46	22.01	5.27	10.59	21.45

Panel B: Shadow Bank Funding

Variable	N	Mean	SD	25%	50%	75%
Credit Limit (Billions)	7,643	0.86	6.90	0.06	0.12	0.34
Used Credit (Billions)	7,269	0.42	2.84	0.03	0.07	0.19
Utilization Rate (%)	7,269	51.98	21.09	37.37	52.07	67.34
Interest Rate (%)	4,648	2.74	2.06	1.58	2.43	3.50

Panel C: Shadow Bank-Lender Bank Pair Funding

Variable	N	Mean	SD	25%	50%	75%
Credit Limit (Billions)	27,137	0.22	3.69	0.02	0.04	0.10
Used Credit (Billions)	27,137	0.10	1.48	0.01	0.02	0.05
Utilization Rate (%)	27,137	50.50	28.17	29.18	51.47	72.89

Table 2: Summary Statistics: Lender-county Level

This table reports summary statistics of variables used in the main empirical analysis, covering the period 2012–2019 at a quarterly frequency. Panel A contains summary statistics of variables for the sample of shadow banks at the lender-county level. Panel B contains summary statistics of variables for the combined sample of banks and shadow banks at the lender-county level.

Panel A: Summary Statistics for Shadow Banks at the Lender-County Level

Variable	N	Mean	SD	25%	50%	75%
Log Loan Count	1,173,900	1.17	1.29	0.00	0.69	1.95
Log Loan Amount	1,173,900	6.45	1.46	5.35	6.14	7.33
MSR/Equity (%)	1,173,900	52.36	50.55	9.20	38.60	81.57
Monetary Policy Shock (bps)	1,111,580	-0.69	2.77	-2.00	0.00	1.00
Log Total Assets	1,173,900	19.76	1.74	18.59	19.69	20.92
Log Equity	1,173,900	18.02	1.76	16.86	18.04	19.11
Return on Equity (%)	1,173,900	7.34	13.15	0.31	4.96	12.94
Liquidity Ratio (%)	1,173,900	6.22	6.47	2.71	4.26	7.52
Capital Ratio (%)	1,173,900	20.00	11.32	12.22	17.47	24.57
Prime Conforming/Total Mortgages (%)	1,173,900	48.23	25.00	35.16	51.45	63.98
Mortgage Unpaid Balance/Assets (%)	1,173,900	67.60	19.61	59.19	72.27	81.81
% Mortgages with FICO $\leq$ 650	330,087	14.26	15.53	4.85	9.86	19.03

Panel B: Summary Statistics for Banks and Shadow Banks at the Lender-County Level

Variable	N	Mean	SD	25%	50%	75%
Log Loan Count	1,814,441	1.28	1.36	0	0.69	2.08
Log Loan Amount	1,814,441	6.49	1.54	5.35	6.21	7.44
MSR/Equity (%)	1,814,441	35.11	47.21	1.00	9.58	57.24
Monetary Policy Shock (bps)	1,814,441	-0.77	2.65	-2.00	0	1.00
Log Total Assets	1,814,441	18.85	2.29	17.65	19.17	20.33
Log Equity	1,814,441	16.94	2.44	15.79	17.32	18.50
Return on Equity (%)	1,814,441	5.58	11.10	1.34	2.95	8.05
Liquidity Ratio (%)	1,814,441	9.74	8.69	3.34	7.07	14.37
Capital Ratio (%)	1,814,441	17.07	10.36	10.79	13.43	20.49

Table 3: The Mortgage Servicing Channel

This table reports estimates from Equation (1) for U.S. shadow banks for the period 2012–2019. The dependent variables are the log loan count (columns 1–3) and log loan amount (columns 4–6) of mortgages originated by shadow bank l in county c in year-quarter t. The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between the lagged monetary policy shock (FFF3m_{t-1}) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. Columns 1 and 4 include lender and year-quarter fixed effects; columns 2 and 5 add county-year-quarter fixed effects; and columns 3 and 6 add lender-county fixed effects. Standard errors clustered at the lender-county level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count			Log Loan Amount		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	0.2601***	0.3707***	0.5359***	0.2105***	0.3609***	0.5186***
	(0.0288)	(0.0270)	(0.0256)	(0.0334)	(0.0298)	(0.0287)
$\text{MSREquity}_{l,t-1}$	0.0353***	0.0818***	0.1363***	0.0201***	0.0807***	0.1358***
	(0.0039)	(0.0035)	(0.0033)	(0.0043)	(0.0036)	(0.0034)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Year-Quarter FE		Yes	Yes		Yes	Yes
Lender × County FE			Yes			Yes
Observations	1,173,900	1,172,478	1,119,593	1,173,900	1,172,478	1,119,593
R^2	0.1356	0.4109	0.8117	0.1292	0.4834	0.8118

Table 4: The Collateral Effect of Mortgage Servicing Rights

This table reports estimates from Equations (3) and (4) for U.S. shadow banks for the period 2012–2019 in Panel A and Panel B, respectively. Panel A shows the results at shadow bank-year-quarter-level and Panel B shows the results at credit line-year-quarter level. The dependent variables are log used credit (columns 1–3), utilization rate (columns 4–6), and estimated interest rate on credit lines (columns 7–9) of shadow bank l in year-quarter t. The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between the lagged monetary policy shock (FFF3m_{t-1}) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. In Panel A, columns 1, 4, and 7 do not include any fixed effects; columns 2, 5, and 8 add year-quarter fixed effects; and columns 3, 6, and 9 add lender fixed effects. In Panel B, columns 1, 4, and 7 add year-quarter fixed effects; columns 2, 5, and 8 add lender fixed effects; and columns 3, 6, and 9 add bank-year-quarter fixed effects. Standard errors clustered at the lender level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Used Credit			Utilization Rate			R		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Panel A: Shadow Bank-Level Analysis								
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	1.035**	1.030**	0.8061**	0.1193	0.3056***	0.2715***	-0.0450***	-0.0352***	-0.0383***
	(0.4323)	(0.4525)	(0.3136)	(0.0879)	(0.0835)	(0.0768)	(0.0104)	(0.0110)	(0.0103)
$\text{MSREquity}_{l,t-1}$	0.1241**	0.1217**	0.1756***	0.0112	0.0154**	0.0045	-0.0011	-0.0008	-0.0016
	(0.0583)	(0.0569)	(0.0514)	(0.0079)	(0.0076)	(0.0089)	(0.0010)	(0.0010)	(0.0011)
FFF3m_{t-1}	-1.792***			-0.8243***			0.0263**		
	(0.3880)			(0.0910)			(0.0112)		
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE		Yes	Yes		Yes	Yes		Yes	Yes
Lender FE			Yes			Yes			Yes
Observations	6,515	6,515	6,515	6,515	6,515	6,515	4,251	4,251	4,251
R^2	0.66767	0.68142	0.87162	0.15527	0.23884	0.44392	0.05221	0.09428	0.42780
	Panel B: Credit Line-Level Analysis								
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	0.8078*	0.8167*	0.7100*	0.2757***	0.2427***	0.2797***	-0.0288**	-0.0381***	-0.0360***
	(0.4238)	(0.4207)	(0.4033)	(0.0950)	(0.0899)	(0.1015)	(0.0135)	(0.0124)	(0.0126)
$\text{MSREquity}_{l,t-1}$	0.0909**	0.0869*	0.0663*	0.0307***	0.0023	-0.0008	-0.0012	-0.0003	-0.0003
	(0.0421)	(0.0447)	(0.0396)	(0.0080)	(0.0095)	(0.0091)	(0.0009)	(0.0014)	(0.0015)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE		Yes	Yes		Yes	Yes		Yes	Yes
Bank × Year-Quarter FE			Yes			Yes			Yes
Observations	20,799	20,799	20,799	21,696	21,696	21,696	13,668	13,668	13,668
R^2	0.38368	0.51253	0.67488	0.12669	0.22839	0.38515	0.09363	0.39509	0.48626

Table 5: The Cashflow Effect of Mortgage Servicing Rights

This table reports estimates from Equation (3) for U.S. shadow banks for the period 2012–2019. The dependent variables are net income relative to assets (columns 1–2) and servicing income relative to gross income (columns 3–4) for shadow bank l in year-quarter t. The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between the lagged monetary policy shock (FFF3m_{t-1}) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures from Gürkaynak et al. (2022) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. Columns 1 and 3 add year-quarter fixed effects; and columns 2 and 4 add lender fixed effects. Standard errors clustered at the lender level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Net Income/Assets		Servicing Income/Gross Income	
	(1)	(2)	(3)	(4)
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	0.0271***	0.0229**	0.1772*	0.2205**
	(0.0100)	(0.0096)	(0.0969)	(0.0909)
$\text{MSREquity}_{l,t-1}$	-0.0010	0.0011	0.0147	0.0328***
	(0.0010)	(0.0015)	(0.0120)	(0.0093)
Lender Controls	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Lender FE		Yes		Yes
Observations	7,724	7,724	7,711	7,711
R^2	0.10485	0.40812	0.42532	0.74010

Table 6: Heterogeneity Tests: Capital, Risk Exposure, and Liquidity

This table reports estimates from Equations (5), (6), and (7) for U.S. shadow banks for the period 2012–2019. The dependent variables are log loan count (columns 1, 3, and 5) and log loan amount (columns 2, 4, and 6) of mortgages originated by shadow bank l in county c in year-quarter t. The main independent variable in columns 1–2 is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{t-1}$, the triple interaction between the lagged monetary policy shock, nonbank exposure to mortgage servicing rights, and nonbank capital ratio. The main independent variable in columns 3–4 is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{LiquidityRatio}_{l,t-1}$, the triple interaction between the lagged monetary policy shock, nonbank exposure to mortgage servicing rights, and nonbank liquidity ratio. The main independent variable in columns 5–6 is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{LowFICO\%}_{l,t-1}$, the triple interaction between the lagged monetary policy shock, nonbank exposure to mortgage servicing rights, and the fraction of low FICO score (i.e, $\leq$ 650) mortgages originated by shadow banks. The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. All columns include lender, year-quarter, lender-county, and county-year-quarter fixed effects. Standard errors clustered at the lender-county level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Count	Log Amount	Log Count	Log Amount	Log Count	Log Amount
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{l,t-1}$	-0.0425***	-0.0450***				
	(0.0027)	(0.0031)				
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{LowFICO\%}_{l,t-1}$			0.0330***	0.0295***		
			(0.0045)	(0.0051)		
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{LiquidityRatio}_{l,t-1}$					-0.0235***	-0.0277***
					(0.0040)	(0.0054)
$\text{FFF3m}_{t-1} \times \text{CapitalRatio}_{l,t-1}$	0.0185***	0.0133***				
	(0.0024)	(0.0028)				
$\text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{l,t-1}$	-0.0041***	-0.0034***				
	(0.0002)	(0.0002)				
$\text{FFF3m}_{t-1} \times \text{LowFICO\%}_{l,t-1}$			0.0274***	0.0274***		
			(0.0035)	(0.0039)		
$\text{MSREquity}_{l,t-1} \times \text{LowFICO\%}_{l,t-1}$			-0.0007***	-0.0000		
			(0.0002)	(0.0002)		
$\text{FFF3m}_{t-1} \times \text{LiquidityRatio}_{l,t-1}$					0.0445***	0.0398***
					(0.0041)	(0.0054)
$\text{MSREquity}_{l,t-1} \times \text{LiquidityRatio}_{l,t-1}$					-0.0057***	-0.0065***
					(0.0003)	(0.0003)
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	1.3229***	1.3337***	0.4299***	0.5492***	0.7797***	0.7833***
	(0.0534)	(0.0623)	(0.0795)	(0.0901)	(0.0324)	(0.0371)
$\text{MSREquity}_{l,t-1}$	0.1962***	0.1870***	0.0938***	0.0778***	0.1552***	0.1569***
	(0.0042)	(0.0045)	(0.0068)	(0.0071)	(0.0034)	(0.0036)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender × County FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,119,593	1,119,593	314,747	314,747	1,119,593	1,119,593
R^2	0.8119	0.8119	0.8216	0.8249	0.8119	0.8119

Table 7: The Mortgage Servicing Channel for Banks and Nonbanks

This table reports estimates from Equation (8) for the combined sample of U.S. banks and shadow banks for the period 2012–2019. The dependent variables are the log loan count (columns 1–4) and log loan amount (columns 5–8) of mortgages originated by lender l in county c in year-quarter t. The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t}$, the triple interaction between the lagged monetary policy shock (FFF3m_{t-1}), lender exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$), and a shadow bank dummy variable ($\text{Nonbank}_{l,t}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The lender exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity. The shadow bank dummy variable equals 1 if lender l is classified as an independent mortgage company in the Avery file in year-quarter t. Lender controls include log assets, log equity, ROE, liquidity-asset ratio, and capital ratio. All columns include lender type-year-quarter fixed effects, lender type-county, and lender-fixed effects. Columns 2 and 6 add year-quarter fixed effects; columns 3 and 7 add county-year-quarter fixed effects; and columns 4 and 8 add county-lender fixed effects. Standard errors clustered at the lender-county level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count				Log Loan Amount			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t}$	0.2750***	0.2750***	0.2916***	0.2088***	0.3111***	0.3111***	0.3282***	0.2397***
	(0.0166)	(0.0166)	(0.0171)	(0.0141)	(0.0189)	(0.0189)	(0.0193)	(0.0170)
$\text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t}$	0.0214***	0.0214***	0.0216***	0.0071**	0.0315***	0.0315***	0.0319***	0.0261***
	(0.0030)	(0.0030)	(0.0031)	(0.0029)	(0.0032)	(0.0032)	(0.0034)	(0.0034)
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	-0.2679***	-0.2679***	-0.2854***	-0.1995***	-0.3042***	-0.3042***	-0.3225***	-0.2310***
	(0.0166)	(0.0166)	(0.0171)	(0.0141)	(0.0189)	(0.0189)	(0.0193)	(0.017)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender Type × Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender Type × County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE		Yes	Yes	Yes		Yes	Yes	Yes
County × Year-Quarter FE			Yes	Yes			Yes	Yes
County × Lender FE				Yes				Yes
Observations	1,814,383	1,814,383	1,813,436	1,730,064	1,814,383	1,814,383	1,813,436	1,730,064
R^2	0.3858	0.3858	0.3944	0.7980	0.4420	0.4420	0.4516	0.7768

Table 8: The Effect of Basel III Capital Requirements on Nonbank Servicing and Lending Shares

This table reports estimates from Equation (11) estimated at the MSA level over the period 2010–2019. The dependent variables are the nonbank servicing share (columns 1–4) and nonbank origination share (columns 5–8) of mortgages originated in MSA M in year-quarter t. The main independent variable is $\text{MSR\%}_M \times \text{Post}_t$, the interaction between MSA-level exposure to the Basel III capital requirements on mortgage servicing rights ($\text{MSR\%}_M$) and the post dummy variable (Post_t). MSA-level exposure to Basel III is measured as the servicing-weighted average of banks' ratio of mortgage servicing rights to Tier 1 capital in MSA M in 2012Q2 and defined in Equation (9). The variable is standardized with mean of 0 and standard deviation of 1. The post dummy variable equals 1 if year-quarter t is 2012Q3 or later. MSA-level controls include lagged level industrial employment share, local financial health measures, local demographics (fraction of population who are male, fraction of population who are white, fraction of population with age over 65, fraction of population with age under 19), and local economic development (unemployment rate, per capita income, GDP growth). Columns 2 and 6 add MSA controls; columns 3 and 7 add MSA fixed effects; and columns 4 and 8 add year-quarter fixed effects. Standard errors clustered at the MSA level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Nonbank Servicing Share				Nonbank Origination Share			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{MSR\%}_M \times \text{Post}_t$	4.187***	3.416***	2.989***	2.978***	3.312***	2.725***	2.369***	2.373***
	(0.2690)	(0.2665)	(0.2531)	(0.2327)	(0.2705)	(0.2712)	(0.2566)	(0.2465)
Post_t	18.18***	7.550***	-0.9092**		14.13***	6.404***	0.3894	
	(0.2778)	(0.5117)	(0.3559)		(0.2726)	(0.4764)	(0.3588)	
$\text{MSR\%}_M$	0.4247*	-0.1442			1.122***	0.5725*		
	(0.2164)	(0.2800)			(0.2537)	(0.3187)		
MSA Controls		Yes	Yes	Yes		Yes	Yes	Yes
MSA FE			Yes	Yes			Yes	Yes
Year-Quarter FE				Yes				Yes
Observations	16,835	11,238	11,238	11,238	16,831	11,238	11,238	11,238
R^2	0.38287	0.51469	0.81420	0.86065	0.36571	0.43407	0.75875	0.80545

Table 9: Mortgage Servicing and Monetary Policy Transmission

This table reports estimates from Equation (12) for MSAs for the period 2011–2019. The dependent variables are the log loan count (columns 1–4) and log loan amount (columns 5–8) of mortgages originated in MSA M in year-quarter t. The main independent variable is $\text{MSR\%}_M \times \text{FFF3m}_{t-1} \times \text{Post}_t$, the interaction between the MSA-level exposure to Basel III capital requirements on mortgage servicing rights ($\text{MSR\%}_M$), lagged monetary policy shock (FFF3m_{t-1}), and post dummy variable (Post_t). MSA-level exposure to Basel III is measured as the servicing-weighted average of banks' ratio of mortgage servicing rights to Tier 1 capital in MSA M in 2012Q2 and defined in Equation (9). The variable is standardized with mean of 0 and standard deviation of 1. The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The post dummy variable equals 1 if year-quarter t is 2012Q3 or later. MSA-level controls include lagged level industrial employment share, local financial health measures, local demographics (fraction of population who are male, fraction of population who are white, fraction of population with age over 65, fraction of population with age under 19), and local economic development (unemployment rate, per capita income, GDP growth). Columns 3 and 7 add MSA fixed effects; and columns 4 and 8 add year-quarter fixed effects. Standard errors clustered at the MSA level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count				Log Loan Amount			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{MSR\%}_M \times \text{FFF3m}_{t-1} \times \text{Post}_t$	4.3111***	3.5417***	3.4002***	3.1012***	5.1715***	4.2729***	4.1650***	3.8630***
	(0.5576)	(0.6193)	(0.4185)	(0.4217)	(0.5807)	(0.6544)	(0.4421)	(0.4435)
$\text{MSR\%}_M \times \text{FFF3m}_{t-1}$	-4.8335***	-4.0338***	-3.6333***	-3.2889***	-5.7918***	-4.7740***	-4.4287***	-4.0838***
	(0.6036)	(0.6888)	(0.444)	(0.4466)	(0.6341)	(0.7319)	(0.4736)	(0.4749)
$\text{FFF3m}_{t-1} \times \text{Post}_t$	-8.5581***	-7.7583***	-6.8077***		-10.8603***	-9.3970***	-8.4657***	
	(0.4288)	(0.5252)	(0.3894)		(0.4643)	(0.5612)	(0.3979)	
FFF3m_{t-1}	6.9632***	6.1726***	5.4517***		8.4888***	7.3472***	6.6653***	
	(0.417)	(0.4383)	(0.3742)		(0.4468)	(0.4491)	(0.3811)	
Post	0.0039	0.0075	-0.0035		0.0928***	0.0172	0.0117	
	(0.0192)	(0.0515)	(0.0126)		(0.0214)	(0.0577)	(0.0136)	
$\text{MSR\%}_M$	0.1087**	-0.0053			0.2144***	0.0639		
	(0.0507)	(0.0406)			(0.0563)	(0.0428)		
MSA Controls		Yes	Yes	Yes		Yes	Yes	Yes
MSA FE			Yes	Yes			Yes	Yes
Year-Quarter FE				Yes				Yes
Observations	12,361	11,682	11,682	11,682	12,361	11,682	11,682	11,682
R^2	0.01133	0.41575	0.95162	0.98354	0.0325	0.47426	0.95461	0.98387

A Appendix

A.1 Robustness Checks

A.1.1 Alternative Measure of MSR Exposure

We examine whether our results on the mortgage servicing channel of monetary policy transmission for shadow banks in Section 5.1 are sensitive to the measure of mortgage servicing rights exposure. MSR holdings can be normalized by different balance sheet characteristics in order to capture shadow banks' exposure to mortgage servicing. Throughout our empirical analysis, we normalize MSR holdings by equity to in order to capture the importance of mortgage servicing relative to capital. Another natural candidate for the denominator is assets, as large shadow banks may hold more MSRs than small ones. Normalizing by assets allows us to control for the effect of size.

Therefore, we re-estimate Equation (1) using lagged MSRs scaled by assets of shadow bank l ($\text{MSRAsset}_{l,t-1}$) as our proxy for its exposure to mortgage servicing. We present results in Table A.3. The effect of *ex ante* exposure to MSRs on shadow banks mortgage lending during monetary policy tightening is robust to our choice of MSR exposure measure. The coefficients on the interaction term between the lagged MSR to asset ratio and the monetary policy shock are positive and statistically significant in all specifications. This indicates that shadow banks with higher MSR exposure relative to their size originate relatively more mortgages than those with lower MSR exposure during monetary policy tightening.

A.1.2 Alternative Measures of Monetary Policy Shocks

We check if our main result on the mortgage servicing channel is robust to using the contemporaneous surprise change in the three-months-ahead federal funds futures. This addresses the concern that nonbank mortgage lending may respond to an unexpected

change in monetary policy within the same quarter. Table A.4 displays results when we estimate Equation (1) using FFF3m_t as our measure of monetary policy shocks. The coefficient on the interaction term remains positive and statistically significant across all specifications, indicating our result is robust to using contemporaneous instead of lagged monetary policy shocks.

In all empirical analyses, we use the surprise movement in the three-months-ahead federal funds futures as our measure for the unanticipated component of changes to the Federal Reserve's policy rate. To address the concern that this measure captures only a specific aspect of the unanticipated change in monetary policy, we check if our results are sensitive to our choice of monetary policy shock.

An alternative measure of unexpected changes to monetary policy is the "policy news shock" from Nakamura and Steinsson (2018). The policy news shock is the scaled first principal component of price changes over a 30-minute window around scheduled FOMC announcements of five interest rate futures: the fed funds future for the current month; fed funds future for the month of next FOMC meeting; and 3-month Eurodollar future at horizons of 2Q, 3Q, and 4Q. Consistent with our previous approach, we use the cumulative sum of shocks within a given year-quarter as our monetary policy shock, denoted by NS. Table A.5 displays results when we estimate Equation (1) using NS_{t-1} as our monetary policy shock measure. Our results remains robust to the choice of monetary policy shock: the coefficient of the interaction term between the monetary policy shock and MSR exposure remains positive and significant across all specifications.

A.1.3 Alternative Definition of Shadow Banks

We test if our results are robust to our classification of shadow banks. Due to the complex industrial organization of the U.S. mortgage market, classifying mortgage lenders into depository versus non-depository institutions is a nontrivial task. In our baseline analysis, we used the Avery file, which classifies financial institutions as bank, thrift institution,

credit union, or independent mortgage bank based on their self-identification in their HMDA filing and from a match to the National Information Center (NIC) structure database. We consider a financial institution a shadow bank if it is listed as an independent mortgage bank in the Avery file.

For robustness, we follow the definition of shadow banks from Buchak et al. (2018) and see if our main results are sensitive to this definition, which is the most commonly used classification methodology in the literature on nonbank mortgage lenders. In Table A.6, we show results when estimating Equation (1) for the sample of shadow banks in Buchak et al. (2018).[28] We find that the coefficient on the interaction term between MSR exposure and the monetary policy shock is positive and significant, suggesting that our results are not dependent on our definition of shadow banks.

A.2 Effect of Basel III on Bank-Level MSR Holdings

To provide validation of our MSA-level evidence on the effect of Basel III capital requirements on the nonbank share of mortgage servicing in Section 6.2, we estimate its effects on bank-level mortgage servicing for a subsample of large bank servicers. We focus on large servicers because, even if small bank servicers reduce their holdings of MSRs significantly after the implementation of Basel III, their adjustments would have minimal impact on the composition of servicers within a given MSA. Specifically, we estimate the regression equation

$$\begin{aligned} Y_{l,t} = \beta_1 \text{MSRCapital}_l \times \text{Post}_t + \beta_2 \text{MSRCapital}_{l,t-1} + \beta_3 \text{Post}_t \\ + \gamma X_{l,t-1} + FE_l + FE_t + \epsilon_{l,t}, \end{aligned} \tag{A.1}$$

[28] There are 253 shadow banks in Buchak et al. (2018). We manually match shadow bank names to their identifiers (NMLS ID) in Nationwide Multistate Licensing System & Registry (NMLS). We can find 247 NMLS IDs for these shadow banks and the merged sample has 161 shadow banks.

where the dependent variable $Y_{l,t}$ is the MSR-to-equity or MSR-to-asset ratio of bank l in year-quarter t. The ratio of mortgage servicing rights to Tier 1 capital, MSRCapital_l, measures the exposure of bank l to the Basel III capital requirements in 2012Q2, and Post_t is a dummy variable equal to 1 if year-quarter t is 2012Q3 or later. $X_{l,t-1}$ is a set of lagged time-varying lender-level controls, and we include lender (FE_l) and year-quarter (FE_t) fixed effects.[29] Standard errors are clustered at the lender level.

If the implementation of Basel III capital requirements led large bank servicers to reduce their involvement in mortgage servicing, the coefficient on the interaction term β_1 should be negative. We report estimates in Table A.9. β_1 is negative and statistically significant at the 1% level in both specifications, indicating that large bank servicers with greater *ex ante* capital deficiency decreased their holdings of MSRs—regardless of whether they are scaled by equity or assets—more after the implementation of Basel III.

A.3 Counterfactual Exercise

To calculate the additional lending associated with the Basel III-induced reallocation of mortgage servicing from banks to nonbanks in response to a given 25bp monetary policy shock, we proceed with the following steps. To simplify notation, let $\%\Delta L_{M,t}$ be the percentage change in loan amount for a 25bp increase in the monetary policy shock, relative to a 0bp change, for MSA M in year-quarter t. The additional lending in MSA M due to a 25bp monetary policy shock in the post-policy period is

$$\begin{aligned}\%\Delta L_{M,t\geq 2012Q2} = &\left(\hat{\beta}_1 + \hat{\beta}_2\right) \times 0.25 \times \max\left\{\text{MSR}\%_M - P_1\left(\text{MSR}\%_M\right), 0\right\} \\ &+ \left(\hat{\beta}_4 + \hat{\beta}_6\right) \times 0.25,\end{aligned} \tag{A.2}$$

where $P_1\left(\text{MSR}\%_M\right)$ is the 1st percentile of the treatment variable $\text{MSR}\%_M$ defined in Equation (9) and the estimated regression coefficients are from column 8 of Table 9. Next,

[29] See Table A.1 for summary statistics.

the additional lending in MSA M due an increase in the monetary policy shock from 0bp to 25bp in the pre-policy period is

$$\%\Delta L_{M,t<2012Q2} = \hat{\beta}_2 \times 0.25 \times \max\left\{\text{MSR}\%_M - P_1\left(\text{MSR}\%_M\right), 0\right\} + \hat{\beta}_6 \times 0.25. \tag{A.3}$$

Then, the change in the effect of 25bp increase in the monetary policy shock in MSA M due to the Basel III reform is the difference between Equations (A.2) and (A.3),

$$\begin{aligned} \beta_M &\equiv \%\Delta L_{M,t\geq 2012Q2} - \%\Delta L_{M,t<2012Q2} \\ &= \hat{\beta}_1 \times 0.25 \times \max\left\{\text{MSR}\%_M - P_1\left(\text{MSR}\%_M\right), 0\right\} + \hat{\beta}_4 \times 0.25. \end{aligned} \tag{A.4}$$

Note that, for control MSAs—i.e., those for which $\text{MSR}\%_M < P_1\left(\text{MSR}\%_M\right)$—the effect of the policy from Equation (A.4) is $\hat{\beta}_4 \times 0.25$. Our assumption that the Basel III-induced reallocation of mortgage servicing to shadow banks did not have an effect on the transmission of monetary policy to mortgage lending in control MSAs implies that this term equals 0. Therefore, Equation (A.4) reduces to $\beta_M = \hat{\beta}_1 \times 0.25 \times \max\left\{\text{MSR}\%_M - P_1\left(\text{MSR}\%_M\right), 0\right\}$.

Finally, to obtain the aggregate percent change in mortgage lending due to the Basel III-induced rise in shadow bank servicing in response to an increase in the monetary policy shock from 0bp to 25bp, we compute

$$\frac{\sum_M \beta_M L_{M,t=2012Q2}}{\sum_M L_{M,t=2012Q}}, \tag{A.5}$$

where $L_{M,t=2012Q2}$ is the dollar amount of mortgage origination in MSA M in 2012Q2.

A.4 Figures and Tables

Figure A.1: Shadow Bank Sample Coverage by Year

This figure shows the number of mortgages originated by shadow banks in the Home Mortgage Disclosure Act (HMDA) sample compared to those in our sample. The blue bar shows the number of mortgages originated by all shadow banks in HMDA and the red bar shows the number of mortgages originated by the shadow banks covered in our sample.

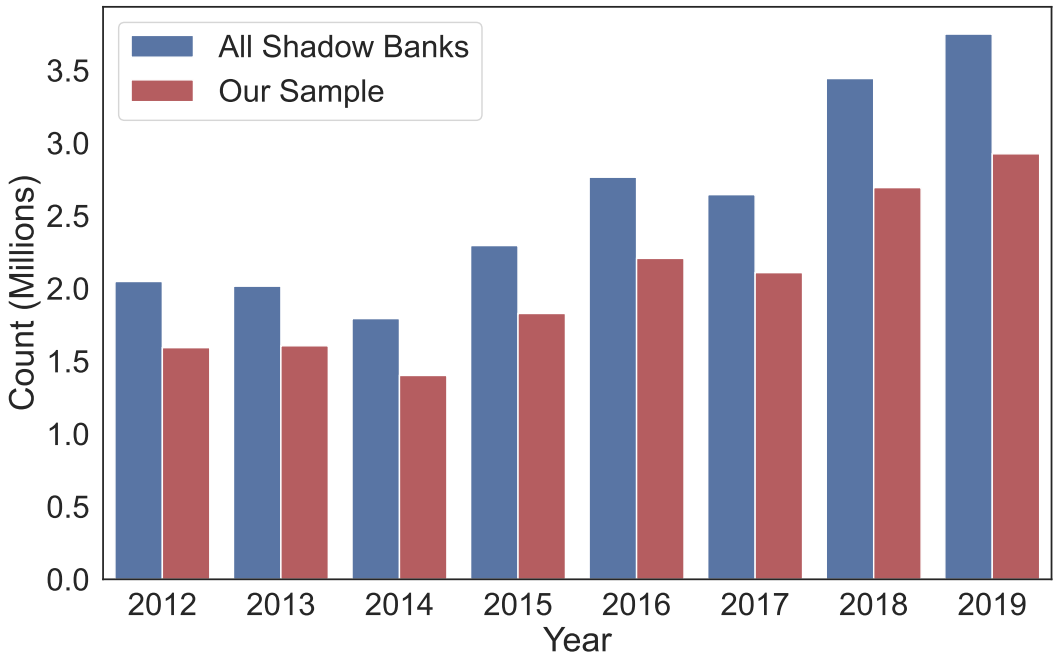

Figure A.2: Sample Size Distribution

This figure compares the size distribution of shadow banks in our sample and in the Home Mortgage Disclosure Act (HMDA). The x axis is the log total dollar amount of mortgages originated by shadow banks during 2012–2019. The gray bar shows the size distribution of shadow banks in HMDA and the green bar shows the size distribution of shadow banks in our sample.

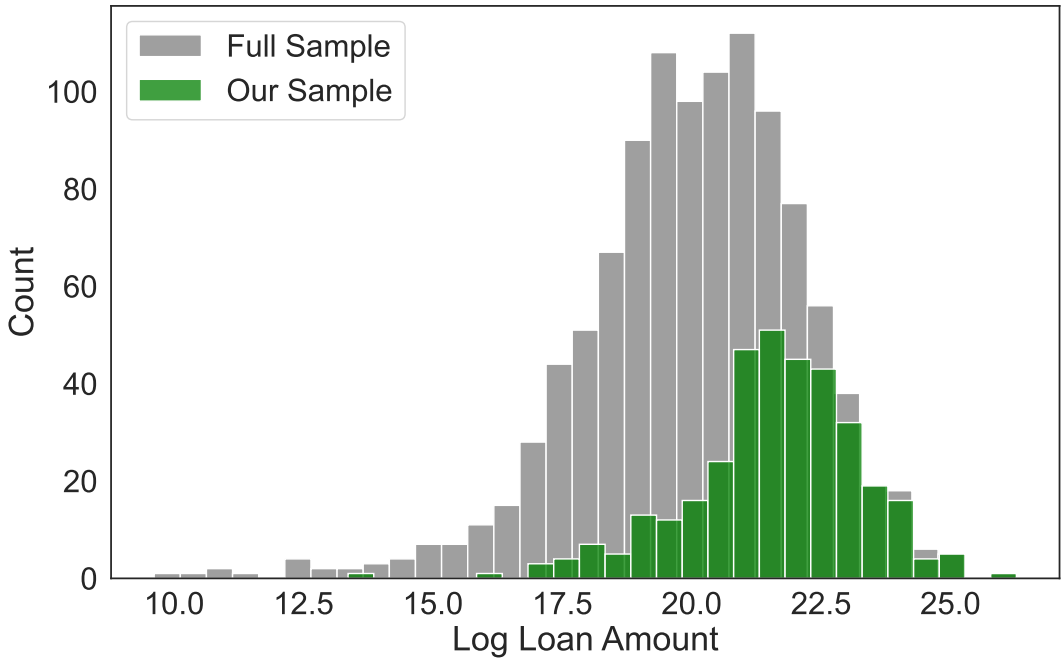

Table A.1: Summary Statistics: Large Bank Servicers

This table reports additional summary statistics for the main variables used in estimating the effect of Basel III on the MSR exposure of a subsample of large bank servicers in Section A.2.

Summary Statistics for Banks						
Variable	N	Mean	SD	25%	50%	75%
MSR/Equity (%)	602	4.84	3.39	2.65	4.54	6.33
MSR/Assets (%)	602	0.49	0.33	0.25	0.48	0.64
MSR/Tier 1 Capital (%)	602	5.08	2.52	3.57	5.30	5.70
Log Total Assets	602	19.35	0.43	18.99	19.71	19.71
Log Equity	602	17.04	0.39	16.79	17.33	17.33
Return on Equity (%)	602	2.25	2.43	1.76	2.52	3.19
Liquidity Ratio (%)	602	17.35	7.80	13.60	15.75	18.07
Capital Ratio (%)	602	10.25	1.84	9.01	10.46	11.54

Table A.2: Summary Statistics: MSA-Level Analysis

This table reports summary statistics for the main variables used in the MSA-level analysis for the period 2012–2019. The mortgage count and amount are from the confidential Home Mortggae Disclosure Act (HMDA) dataset. MSA-level industrial employment shares are from the Quarterly Census of Employment and Wages (QCEW). The local financial health measures (deposit-weighted asset growth rate, deposit-weighted capital ratio, deposit-weight log assets) are constructed following Loutskina and Strahan (2015). Local demographics (fraction of population who are male, fraction of population who are white, fraction of population with age over 65, fraction of population with age under 19) data are from the United States Census Bureau. Unemployment rate data are from the Bureau of Labor Statistics. Per capita income and GDP growth are from the Bureau of Economic Analysis.

Summary Statistics for MSA-Level Analysis						
Variable	N	Mean	SD	25%	50%	75%
Log Loan Count	12,361	7.05	1.13	6.24	6.88	7.75
Log Loan Amount	12,361	12.16	1.27	11.25	11.98	12.94
MSR/Tier 1 Capital (%)	12,361	3.93	1.35	2.94	4.08	4.99
Monetary Policy Shock (bps)	12,361	-0.48	2.43	-1	0	1
Post	12,361	0.84	0.37	1	1	1
Industry - Mining (%)	12,262	2.59	5.38	0.37	0.83	1.94
Industry - Construction (%)	12,262	5.18	2.52	3.96	5.10	6.48
Industry - Manufacture (%)	12,262	11.95	7.69	6.74	11.02	16.49
Industry - Trade (%)	12,262	24.28	4.55	21.62	23.72	26.17
Industry - Information (%)	12,262	1.42	1.01	0.84	1.36	1.92
Industry - Finance (%)	12,262	5.33	2.53	3.92	5.06	6.56
Industry - Business (%)	12,262	12.70	4.78	9.81	12.28	15.53
Industry - Education (%)	12,262	19.31	5.90	16.19	19.27	22.40
Industry - Leisure (%)	12,262	13.91	4.83	11.37	13.02	15.81
Deposit-Weighted Asset Growth Rate (%)	12,324	9.90	100.69	3.69	5.85	9.14
Deposit-Weighted Capital Ratio (%)	12,324	10.98	1.28	10.44	11.06	11.63
Deposit-Weighted Log Total Assets	12,324	19.42	0.99	18.97	19.60	20.13
Male (%)	12,346	49.32	1.04	48.65	49.16	49.87
White (%)	12,346	83.73	11.05	78.72	86.98	91.79
Population Below 19 (%)	12,346	25.89	3.15	24.19	25.75	27.27
Population Above 65 (%)	12,346	15.30	4.35	12.76	14.75	16.90
Log Per Capita Income	12,266	10.62	0.19	10.49	10.60	10.72
GDP Growth Rate (%)	12,266	3.44	4.05	1.56	3.35	5.15
Unemployment Rate (%)	11,830	5.56	2.63	3.76	5.02	6.73
Growth Rate of Unemployment Rate (%)	11,830	-9.44	9.86	-15.29	-10.20	-3.84

Table A.3: Robustness: Alternative Measure of Exposure to Mortgage Servicing Rights

This table reports estimates from Equation (1) for U.S. shadow banks for the period 2012–2019. The dependent variables are the log loan count (columns 1–3) and log loan amount (columns 4–6) of mortgages originated by shadow bank l in county c in year-quarter t. The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSRAsset}_{l,t-1}$, the interaction between the lagged monetary policy shock (FFF3m_{t-1}) and nonbank exposure to mortgage servicing rights ($\text{MSRAsset}_{l,t-1}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to assets and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. Columns 1 and 4 include lender and year-quarter fixed effects; columns 2 and 5 add county-year-quarter fixed effects; and columns 3 and 6 add lender-county fixed effects. Standard errors clustered at the lender-county level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count			Log Loan Amount		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{FFF3m}_{t-1} \times \text{MSRAsset}_{l,t-1}$	0.1153***	0.1902***	0.3018***	0.0320	0.1434***	0.2551***
	(0.0293)	(0.0275)	(0.0254)	(0.0340)	(0.0302)	(0.0284)
$\text{MSRAsset}_{l,t-1}$	0.0055	0.0327***	0.0599***	0.0021	0.0380***	0.0657***
	(0.0038)	(0.0036)	(0.0036)	(0.0042)	(0.0038)	(0.0038)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Year-Quarter FE		Yes	Yes		Yes	Yes
Lender × County FE			Yes			Yes
Observations	1,173,900	1,172,478	1,119,593	1,173,900	1,172,478	1,119,593
R^2	0.1356	0.4105	0.8109	0.1292	0.4831	0.8111

Table A.4: Robustness: Contemporaneous Monetary Policy Shock

This table reports estimates from Equation (1) for U.S. shadow banks for the period 2012–2019. The dependent variables are the log loan count (columns 1–3) and log loan amount (columns 4–6) of mortgages originated by shadow bank l in county c in year-quarter t. The main independent variable is $\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$, the interaction between the contemporaneous monetary policy shock (FFF3m_t) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. Columns 1 and 4 include lender and year-quarter fixed effects; columns 2 and 5 add county-year-quarter fixed effects; and columns 3 and 6 add lender-county fixed effects. Standard errors clustered at the lender-county level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count			Log Loan Amount		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$	0.1735***	0.2477***	0.3288***	0.1463***	0.2496***	0.3326***
	(0.0259)	(0.0238)	(0.0217)	(0.0305)	(0.0264)	(0.0247)
$\text{MSREquity}_{l,t-1}$	0.0379***	0.0831***	0.1341***	0.0227***	0.0815***	0.1332***
	(0.0039)	(0.0036)	(0.0034)	(0.0044)	(0.0037)	(0.0036)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Year-Quarter FE		Yes	Yes		Yes	Yes
Lender × County FE			Yes			Yes
Observations	1,111,580	1,110,324	1,058,785	1,111,580	1,110,324	1,058,785
R^2	0.1381	0.4098	0.8136	0.1316	0.4814	0.8129

Table A.5: Robustness: Alternative Monetary Policy Shock from Nakamura and Steinsson (2018)

This table reports estimates from Equation (1) for U.S. shadow banks for the period 2012–2019. The dependent variables are the log loan count (columns 1–3) and log loan amount (columns 4–6) of mortgages originated by shadow bank l in county c in year-quarter t. The main independent variable is $\text{NS}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between the lagged monetary policy shock (NS_{t-1}) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is the policy news shock from Nakamura and Steinsson (2018) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. Columns 1 and 4 include lender and year-quarter fixed effects; columns 2 and 5 add county-year-quarter fixed effects; and columns 3 and 6 add lender-county fixed effects. Standard errors clustered at the lender-county level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count			Log Loan Amount		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{NS}_{t-1} \times \text{MSREquity}_{l,t-1}$	0.1502***	0.1617***	0.2112***	0.1377***	0.1515***	0.2004***
	(0.0171)	(0.0160)	(0.0154)	(0.0203)	(0.0180)	(0.0176)
$\text{MSREquity}_{l,t-1}$	0.0269***	0.0642***	0.1123***	0.0140***	0.0625***	0.1110***
	(0.0036)	(0.0033)	(0.0032)	(0.0040)	(0.0034)	(0.0034)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Year-Quarter FE		Yes	Yes		Yes	Yes
Lender × County FE			Yes			Yes
Observations	1,234,720	1,233,135	1,179,131	1,234,720	1,233,135	1,179,131
R^2	0.1339	0.4117	0.8095	0.1275	0.4847	0.8102

Table A.6: Robustness: Shadow Bank Definition from Buchak et al. (2018)

This table reports estimates from Equation (1) for U.S. shadow banks for the period 2012–2019. We define shadow banks following Buchak et al. (2018). The dependent variables are the log loan count (columns 1–3) and log loan amount (columns 4–6) of mortgages originated by shadow bank l in county c in year-quarter t. The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between the lagged monetary policy shock (FFF3m_{t-1}) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures around FOMC meetings from Gürkaynak et al. (2022) aggregated to quarterly frequency. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. Columns 1 and 4 include lender and year-quarter fixed effects; columns 2 and 5 add county-year-quarter fixed effects; and columns 3 and 6 add lender-county fixed effects. Standard errors clustered at the lender-county level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count			Log Loan Amount		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	0.3246***	0.4655***	0.6490***	0.2937***	0.4754***	0.6485***
	(0.0343)	(0.0320)	(0.0301)	(0.0393)	(0.0350)	(0.0333)
$\text{MSREquity}_{l,t-1}$	0.0412***	0.0957***	0.1504***	0.0235***	0.0942***	0.1487***
	(0.0043)	(0.0039)	(0.0036)	(0.0049)	(0.0040)	(0.0038)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Year-Quarter FE		Yes	Yes		Yes	Yes
Lender × County FE			Yes			Yes
Observations	881,383	879,678	847,489	881,383	879,678	847,489
R^2	0.1205	0.4404	0.8193	0.1045	0.5050	0.8192

Table A.7: First-Stage Regression: Transmission of Monetary Policy Shocks to the 30-Year Mortgage Rate

This table reports estimates from regressing the change in the 30-year mortgage rate on the monetary policy shock. The dependent variable is the change in the 30-year mortgage rate in two-week window around FOMC meetings. The 30-year mortgage rate data are from the Federal Reserve Bank of St. Louis. The independent variable is the high-frequency movement in three-months-ahead federal funds future around FOMC meetings from Gürkaynak et al. (2022) aggregated to monthly frequency. Column 1 reports the regression results using the full sample (1990–2019), and column 2 reports the regression results using the sample period 2012–2019. The projected change in the 30-year mortgage rate used to estimate Equation (2) is computed using the coefficient estimate from column 1. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variable:	Change in 30-Year Mortgage Rate	
	(1)	(2)
FFF3m	0.2742*	1.926**
	(0.1490)	(0.9094)
Constant	-0.0181**	0.0090
	(0.0088)	(0.0142)
Observations	262	60
R^2	0.01286	0.07179

Table A.8: The Role of Prepayment Risk in Accounting for the Mortgage Servicing Channel

This table reports estimates from Equation (2) for U.S. shadow banks for the period 2012–2019. The dependent variables are the log loan count (columns 1–3) and log loan amount (columns 4–6) of mortgages originated by shadow bank l in county c in year-quarter t. The main independent variable is $\widehat{\text{MR}}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between the lagged change in the 30-year mortgage rate projected on the monetary policy shock ($\widehat{\text{MR}}_{t-1}$) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is the high-frequency movement in the three-months-ahead federal funds futures from Gürkaynak et al. (2022) aggregated to quarterly frequency, and the projected change in the 30-year mortgage rate is obtained by estimating the first-stage regression $\text{MR}_t = \alpha + \beta \text{FFF3m}_t + \epsilon_t$. Results from the first stage are reported in Table A.7 of the appendix. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity and is standardized with mean of 0 and standard deviation of 1. Lender controls include log assets, log equity, ROE, prime conforming share of unpaid loan balances, share of unpaid balance of mortgages in assets, liquidity-to-asset ratio, and capital ratio. Columns 1 and 4 add lender and year-quarter fixed effects; columns 2 and 5 add county-year-quarter fixed effects; and columns 3 and 6 add lender-county fixed effects. Standard errors are clustered at the lender-county level and reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count			Log Loan Amount		
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{\text{MR}}_{t-1} \times \text{MSREquity}_{l,t-1}$	0.9486***	1.3517***	1.9542***	0.7675***	1.3159***	1.8912***
	(0.1051)	(0.0985)	(0.0933)	(0.1219)	(0.1087)	(0.1046)
$\text{MSREquity}_{l,t-1}$	0.0696***	0.1306***	0.2070***	0.0479***	0.1282***	0.2041***
	(0.0057)	(0.0053)	(0.0051)	(0.0065)	(0.0057)	(0.0055)
Lender Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Year-Quarter FE		Yes	Yes		Yes	Yes
Lender × County FE			Yes			Yes
Observations	1,173,900	1,172,478	1,119,593	1,173,900	1,172,478	1,119,593
R^2	0.1356	0.4109	0.8117	0.1292	0.4834	0.8118

Table A.9: Effect of Basel III Capital Requirements on Banks' Exposure to Mortgage Servicing Rights

This table reports estimates from Equation (A.1) for large bank servicers for the period 2005–2019. The dependent variables are the MSR-to-equity ratio (column 1) and MSR-to-asset ratio (column 2) of bank l in year-quarter t. The main independent variable is $\text{MSRCapital}_l \times \text{Post}_t$, the interaction between the ratio of MSRs to Tier 1 capital of bank l in 2012Q2 (MSRCapital_l) and a post dummy variable (Post_t). The post dummy variable equals 1 if year-quarter t is after 2012Q2. Lender controls include log assets, log equity, ROE, liquidity-asset ratio, and capital ratio. Both specifications include lender and year-quarter fixed effects. Standard errors clustered at the lender level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	MSR/Equity	MSR/Asset
	(1)	(2)
$\text{MSRCapital}_l \times \text{Post}_t$	-0.4629***	-0.0268***
	(0.0827)	(0.0074)
Lender Controls	Yes	Yes
Lender FE	Yes	Yes
Year-Quarter FE	Yes	Yes
Observations	602	602
R^2	0.76189	0.78271