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 that are relatively more involved in 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 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. In this paper, we propose 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, facilitated by mortgage servicing, for loan origination and working capital needs (Kim et al., 2018). 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 income that is invariant to 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

[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.

lending.[2] We call this the *mortgage servicing channel* of monetary policy transmission.

The mortgage servicing channel is economically meaningful for two reasons. First, 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.[3] Shadow banks now service a substantial fraction of mortgage debt, and servicing assets are the second largest asset on their balance sheet following mortgages held for sale.[4] Second, the hedging properties of servicing with respect to interest rate shocks, combined with its role in generating non-deposit funding for shadow banks, implies that mortgage servicing has the potential to significantly affect the transmission of monetary policy to nonbank mortgage lenders.

In order to test the mortgage servicing channel, 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 (MCRs) by submitting the Freedom of Information Act (FOIA) requests to state regulators in Washington and Massachusetts.[5] We merge these with data on loan applications from the confidential Home Mortgage Disclosure Act (HMDA) to analyze how involvement in mortgage servicing affects the transmission of monetary 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 the central bank's systematic response to macroeconomic variables (Cristiano et al., 1999; Romer and Romer, 2004). To overcome this identification

[2]E.g., during a period of monetary tightening in spring 2023, 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]See `https://bpi.com/the-impact-of-recent-changes-in-capital-requirements-on-mortgage-servicing-assets/`. In Section 6.2, we provide causal evidence for the announcement of the Basel III capital requirements on MSRs resulting in a reallocation of mortgage servicing from banks to nonbanks.

[4]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`). Among mortgages serviced by the 30 largest servicers in the market, nonbanks accounted for 31% (see `https://www.federalreserve.gov/publications/other-reports/files/effect-capital-rules-mortgage-servicing-assets-201606.pdf`).

[5]See Section 4.1 for details on this dataset.

challenge, we follow Jarociński and Karadi (2020) in using the high-frequency movement of the three-months-ahead federal funds futures around policy 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. We provide evidence that 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. Both effects account for the lower decline in mortgage origination by shadow banks with greater exposure to loan servicing when interest rates rise.

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 as the propensity of borrowers to refinance their mortgages decreases (Eichenbaum et al., 2022; Greenwald, 2018). The origination of new loans declines, but, because the expected duration of existing loans increases, the value of their associated MSRs rises. We exploit detailed information on secured credit lines used by shadow banks to provide direct evidence on the link between their MSR holdings and access to funding. We find that, following a contractionary monetary policy shock, shadow banks with more *ex ante* MSR exposure draw down their credit lines more, receive a higher limit on their credit lines, and pay a lower cost on credit line funding. This evidence supports the role of MSRs in offsetting higher borrowing costs faced by shadow banks during monetary tightening.

The cashflow effect emerges from the particular way in which a loan servicer's income is calculated. This income primarily consists of a mortgage servicing fee that is equal to a fixed share of the mortgage's balance at origination, which is by construction invariant to subsequent fluctuations in interest rates. This makes the total cashflow of shadow banks with high servicing exposure less sensitive to interest rate shocks compared to shadow banks that are more reliant on origination for income. We show that, when monetary policy tightens unexpectedly, these shadow banks become relatively more profitable, increasing internal funds available 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 heterogeneity across the capital ratio and risk exposure of shadow banks. These measure the intensity of adverse selection frictions faced by shadow banks in raising external finance. In the presence of information asymmetry between shadow banks and their financiers, shadow banks with *ex ante* low capital or riskier portfolios may have to pay a lemon's premium in order to secure funding when interest rates rise. Having access to MSRs attenuates the adverse selection problem that shadow banks face in the funding market 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.

An important question to ask is whether the mortgage servicing channel is equally relevant for traditional banks as well as shadow banks, given both operate in the mortgage lending and servicing markets. Our lender-level regressions show that, conditional on having the same *ex ante* exposure to servicing, shadow banks reduce mortgage origination less compared to traditional banks after a contractionary monetary policy shock. This is the result of two key distinctions between banks and shadow banks in this market. Because shadow banks can pledge MSRs as collateral whose value is positively correlated with interest rates, their cost of funding increases relatively less. This is in contrast to traditional banks for whom deposit outflows result in a higher cost of funding when monetary policy tightens (Drechsler et al., 2017). Furthermore, MSRs carry a capital charge for traditional banks, making it costlier for them to retain these assets on their balance sheets. This also weakens the mortgage servicing channel for depository institutions.

The lender-level results suggest that the composition of mortgage servicers is salient for the strength of the monetary transmission mechanism at the aggregate level. However, within a given region, shadow banks' involvement in mortgage servicing and mortgage 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 mortgage servicing rights to generate plausibly exogenous variation in the nonbank share of servicing. Following Irani et al. (2021), identification comes from the largely unanticipated nature of the policy announcement and *ex ante* variation in banks' regulatory capital shortfalls. We show that, in regions where banks had higher capital deficiency prior to the Basel III policy announcement, 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 pass-through of monetary policy weakened more in regions where greater reallocation of servicing towards nonbanks occurred.

Our main results on the mortgage servicing channel are robust to alternate measures of exposure to mortgage servicing, monetary policy shocks, and shadow bank classification. The main findings of the paper underscore the need for policymakers to reconsider the efficacy of monetary policy given the large share of shadow banks in the mortgage market. Because shadow banks typically serve a different clientele compared to traditional banks, monetary policy may also have unintended distributional effects through their lending.

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 nonbank mortgage lenders 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 provides evidence for the relative strength of the mortgage servicing channel for shadow banks versus traditional banks and its implications for the effect of monetary policy on aggregate mortgage lending. Section 7 conducts robustness tests for our main results. Section 8 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.[6] 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

[6]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).

shocks. Our paper provides a first step towards filling this gap.

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, and liquidity)—as key channels of monetary policy transmission to bank lending (Drechsler et al., 2017; Kashyap and Stein, 2000; Van den Heuvel et al., 2002; Wang et al., 2022). Similar to these studies, we document that, for shadow banks, MSRs can alleviate financing frictions 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 are originating 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).[7] Mortgage servicing also provides shadow banks with a relatively stable and predictable income stream because servicing fees depend on loan size at origination. This makes income from servicing existing mortgages invariant to future changes in market interest rates.

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.[8] 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 that is equal to a fixed share—typically 25–50 basis points—of the mortgage balance at origination. The servicing fee is typically included in the borrower's monthly payment rather than paid upfront.[9] 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.

[7]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.

[8]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.

[9]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 a quarterly basis since 2011. Following 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 Figure A.1 and Figure A.2).[10]

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 the quarterly level.[11] We obtain balance sheet variables for shadow banks such as size, capital, liquidity, interest costs, mortgage servicing rights, etc., from the FC segment; funding information such as credit limit, used credit, and credit line provider

[10] 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.

[11] There are two types of Mortgage Call Reports, Standard and Expanded. The RMLA segment is available at the quarterly level for both Standard MCR and Expanded MCR. The FC segment is available at annual level for Standard MCR and at quarterly level for 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 the quarterly level.

names from the company-level RMLA segment; and the FICO distribution of closed loans from the state-specific RMLA segment.[12]

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. The Home Mortgage Disclosure Act 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. The HMDA data contain 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 HMDA data provide the date of origination for each application, conditional on it being approved, whereas the public-use version only contains 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, and supporting schedules for each holding company. We download them from the Wharton

[12]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.

Research Data Services' Bank Regulatory Database.

To construct a measure of shadow banks' and traditional banks' 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—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 "independent mortgage bank" following the Avery file.[13] We merge the two datasets using the name and address of shadow banks. There are 426 unique shadow banks in the MCR data, of which 384 are matched to the HMDA data. Our sample period is 2012–2017.

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

[13] 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.

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 ($\leq$ 650) and merge this risk measure with the HMDA dataset.

To test how 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 in Sections 6.2 and 6.3, we use FR Y-9C data to calculate aggregate bank regulatory capital deficiency at the metropolitan statistical area (MSA) level and the GSE datasets to compute the share of mortgages in a given MSA that are serviced by shadow banks.

4.5 Summary Statistics

Our sample covers major shadow banks operating in U.S. mortgage market, such as Nationstar Mortgage and Quicken Loans. Table 1 contains summary statistics for all variables used in the empirical analysis. Panel A of Table 1 summarizes the balance sheet variables for shadow banks. On average, shadow banks hold \$0.49 billion in assets with a standard deviation of \$1.49 billion.[14] Mortgage loans account for 65% of the average shadow bank's assets. Following mortgage loans held for sale, MSRs are the second largest asset. More than 80% of shadow banks have some exposure to MSRs, and they account for 8% and 38% of the average shadow bank's assets and equity, respectively. Shadow banks usually have low leverage, with an average equity ratio of approximately 23%.

Panels B and C of Table 1 report summary statistics on the funding structure of shadow banks. Panel B shows the summary statistics for funding-related variables aggregated at the shadow bank level. In each year-quarter, an average shadow bank in our sample has a total credit limit from banks of \$0.84 billion with an average utilization rate of 52%.

[14] The size distribution of shadow banks is comparable to the size distribution reported in Jiang et al. (2020), where the mean of assets is \$0.47 billion and the standard deviation of assets is \$1.51 billion.

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 20,823 lines of credit for 384 shadow banks and 224 banks. The average credit limit that a shadow bank can get from a bank in our sample is $0.21 billion.

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 Jarociński and Karadi (2020) 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.[16] 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.

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

[16] As a robustness check, we will use other high-frequency monetary policy shock measures, e.g., the policy news shock constructed by Nakamura and Steinsson (2018).

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. These effects both underscore 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 and riskier lending portfolios. 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 weakening the effect of monetary policy on 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

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

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. $\text{MSREquity}_{l,t-1}$ is the lagged share of mortgage servicing rights in total equity for shadow bank l and captures its exposure to mortgage servicing. FFF3m_t is the cumulative change in three-months-ahead federal funds futures in a 30-minute window around FOMC announcements in year-quarter t, discussed in Section 4.6.[17] We add a vector of lagged time-varying lender-level controls $X_{l,t-1}$ from shadow bank balance sheet data.[18] We saturate the model with lender (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. The standard errors are clustered at the lender-county level. The main coefficient of interest is β_1, which captures the differential effect of 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 2 reports the results. Columns 1–4 and 5–8 display regression estimates using log loan count and log loan amount as the dependent variable, respectively. To aid in 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 10.4% increase in the number of originations and a 11.4% increase in loan size.

[17] The monetary policy shock itself does not appear as a separate regressor because it is perfectly collinear with the year-quarter fixed effects.

[18] 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.

5.1.1 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 loan servicing may hedge loan origination from 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 shadow banks with more exposure to MSRs experience a relative increase in their secured funding after a contractionary monetary policy shock. This increase in funding can be reflected in either an increase in a shadow bank's overall credit limit or higher drawdowns of existing credit lines. 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 section of the MCRs to provide direct evidence on the link between shadow banks' MSR exposure and their ability to secure funding during monetary tightening. We begin by aggregating credit line data at the shadow bank level and estimating the regression model

$$\begin{aligned} Y_{l,t} = {} & \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_2 \text{MSREquity}_{l,t-1} + \gamma X_{l,t-1} + FE_l \\ & + FE_t + \epsilon_{l,t}. \end{aligned} \tag{2}$$

The dependent variable $Y_{l,t}$ is log total credit limit, log used credit, or estimated average interest rate for shadow bank l in year-quarter t. Other variables are as previously defined. We saturate the model with lender fixed effects (FE_l) to control for time-invariant lender characteristics and year-quarter fixed effects (FE_t) to control for time-varying credit market conditions. 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 overall credit limit, credit used, and funding cost for shadow banks with heterogeneous exposure to mortgage servicing rights.

Panel A of Table 3 reports the results. Columns 1–3 and 4–6 display regression estimates using log credit limit and log used credit as the dependent variable, respectively. We add lender fixed effects in columns 2 and 5 and year-quarter fixed effects in columns 3 and 6. The coefficient on the interaction term remains positive and significant for credit limit and used credit after the inclusion of these fixed effects. These results indicate that shadow banks with higher exposure to mortgage servicing rights experience an increase in their overall credit limit and draw down their existing credit lines more when monetary policy tightens. 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 shadow banks' external funding cost. 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

$$Y_{l,b,t} = \beta_1 \text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1} + \beta_2 \text{MSREquity}_{l,t-1} + \gamma X_{l,t-1} + FE_l + FE_t + FE_{b,t} + \epsilon_{l,b,t}, \tag{3}$$

where the dependent variable $Y_{l,b,t}$ is now log total credit limit, log used credit, or estimated average interest rate for shadow bank l from financier b in year-quarter t. We aggregate the credit limit and total credit used at the shadow bank-bank pair level. Note that the estimated interest rate does not vary across banks. As in Equation (2), we saturate the model with 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 financier level. In this regression, then, we are exploiting cross-sectional variation across shadow banks that borrow from the *same* bank lender.

Results for the shadow bank-bank pair-level analysis are reported in Panel B of Table 3. Columns 1–3 and 4–6 contain results using log credit limit and log used credit as the dependent variable, respectively. We add lender and year-quarter fixed effects in columns 2 and 5, then additionally include bank-year-quarter fixed effects in in columns 3 and 6. The coefficient on the interaction term remains positive and significant at 1% level and is similar in magnitude across the three columns. These results indicate that, among multiple shadow banks that borrow from the same bank, shadow banks with higher *ex ante* MSR exposure receive a higher credit limit and draw down their existing credit lines relatively more when monetary policy is tightened. 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.

5.1.2 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 through a *cashflow effect*. By design, servicing fees constitute a relatively certain source of income because they are computed on the basis of a mortgage's face value at origination. 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 will likely be 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.

To test this hypothesis, we estimate the regression level in Equation (2), using the return on assets (ROA) 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 ROA of shadow banks with varying exposure to mortgage servicing rights. If higher *ex ante* exposure to MSRs ensures a relatively more stable cashflow for shadow banks after a contractionary monetary policy shock, then β_1 should be positive.

We report regression results in columns 1–3 of Table 5. The coefficient on the interaction term β_1 is positive and statistically significant at the 1% level and similar in magnitude across all specifications. These results indicate that shadow banks with higher *ex ante* MSR-to-equity ratios have greater ROA 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. Higher current cashflows are consistent with the mortgage servicing channel of monetary policy for two reasons. The obvious direct effect 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.

To provide additional support for the cashflow effect, we also estimate Equation (2) with the ratio of servicing income to gross income of shadow bank l in year-quarter t as the dependent variable. This measures the dependence of a shadow bank's cashflow on their servicing business. 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 4–6 in Table 5 display estimates for this regression. The coefficient on the interaction term is positive and statistically significant at the 1% level in the three specifications. This confirms that the cashflow of shadow banks more involved in servicing becomes more dependent on servicing after interest rates increase.

5.1.3 Discussion

Our results on the mortgage servicing channel of monetary policy transmission rely on the negative relationship between interest rates and prepayment risk. When prepayment risk falls, this both increases the value of mortgage servicing rights and the probability that servicing income on existing loans will be paid. It should be noted that a change in interest rates can also affect mortgage servicing through two other channels. First, a rise in interest rates increases discounting. All else equal, higher discounting lowers the value of MSRs, which would decrease their collateral value. Second, when the central bank tightens monetary policy, default risk could increase through an aggregate demand channel. This would decrease the amount of servicing income generated by existing loans as borrowers become delinquent on their loan payments. Both effects should work against finding evidence for the mortgage servicing channel in the data. Our empirical results, however, indicate that these negative 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 fights in dampening the transmission of monetary policy to mortgage lending. We consider two characteristics of shadow banks that could make MSRs a useful hedge against contractionary monetary policy shocks, their capital to asset ratio and their exposure to risky borrowers. These 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 (i.e., shadow banks with *ex ante* low levels of capital and high exposure to risky borrowers) to benefit more from MSR holdings during contractionary monetary policy periods. Hence, the mortgage servicing channel should be stronger for such institutions.

5.2.1 Capital to Asset Ratio

Information asymmetry in the market for short-term debt implies that shadow banks that try 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 attenuates the adverse selection problem that shadow banks face in the funding market and allows 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

$$
\begin{aligned}
Y_{l,c,t} = {} & \beta_1 \text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{l,t-1} + \beta_2 \text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \\
& + \beta_3 \text{FFF3m}_t \times \text{CapitalRatio}_{l,t-1} + \beta_4 \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{l,t-1} \\
& + \beta_5 \text{MSREquity}_{l,t-1} + \gamma X_{l,t-1} + FE_l + FE_{c,l} + FE_{c,t} + \epsilon_{l,c,t},
\end{aligned}
\tag{4}
$$

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. $\text{CapitalRatio}_{l,t-1}$ is the lagged ratio of capital to total assets of shadow bank l. We include the same set of time-varying lender controls from Equation (1). We saturate the model with lender (FE_l), lender-county ($FE_{c,l}$), and county-year-quarter ($FE_{c,t}$) fixed effects. The standard errors are clustered 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.

Rows 1 and 3 of Table 4 contain estimated values for β_1 and β_2 from Equation (4), respectively. Columns 1 and 2 show the results 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 all specifications. The negative coefficient implies that the dampening effect of MSRs on monetary policy transmission is higher for shadow banks with lower capital ratios. This finding suggests that MSRs dampen 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 dampening effect of MSRs on monetary policy to be greater for shadow banks with riskier lending portfolios. To test this hypothesis, we estimate the model

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

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. 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. We include the same set of time-varying lender controls from Equation (1). We saturate the model with lender (FE_l), county-lender ($FE_{c,l}$), and county-year-quarter ($FE_{c,t}$) fixed effects. The standard errors are clustered 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.

Rows 2 and 3 of Table 4 contain estimated values for β_1 and β_2 from Equation (5), respectively. Columns 3 and 4 show results 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 across all specifications, 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 provide evidence for the hypothesis that MSRs weaken the effect of monetary policy shocks on nonbank mortgage lending by alleviating those frictions.

6 The Servicing Channel for Banks versus Nonbanks

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 it is also relevant for traditional banks. This is critical for assessing the broader implications of the reallocation of mortgage servicing from depository to non-depository institutions. 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, however, the strength of the mortgage servicing channel is significantly different for shadow banks and traditional banks, 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 this view. First, we present evidence that the mortgage servicing channel is significantly weaker for traditional banks compared to shadow banks. The hedging role of mortgage servicing is less important for banks because they have access to deposit funding and capital requirements make retaining mortgage servicing rights costly. Motivated by this finding, we next study whether the participation of nonbanks in the mortgage servicing market has attenuated the effects of monetary policy to mortgage lending at the regional (i.e., MSA) level. To address endogeneity concerns, we exploit differences across the regulatory capital of banks prior to the implementation of Basel III capital requirements on MSRs to obtain plausibly exogenous variation in shadow banks' exposure to mortgage servicing. We find that nonbank share in the servicing market rose more in MSAs where traditional banks had greater *ex ante* regulatory capital shortfalls and that it is precisely in those regions that the pass-through of monetary policy to mortgage lending weakened most.

6.1 Comparing the 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 a triple-difference regression model

$$\begin{aligned} Y_{l,c,t} = {} & \beta_1 \text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t} + \beta_2 \text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \\ & + \beta_3 \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t} + \gamma X_{l,t-1} + FE_{nb,t} + FE_{nb,c} \\ & + FE_{c,l} + FE_{c,t} + \epsilon_{l,c,t} \end{aligned} \tag{6}$$

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 remains as previously defined in Section 5. We include a vector of lagged lender-level controls $X_{l,t-1}$ and saturate the model with lender type-year-quarter ($FE_{nb,t}$), lender type-county ($FE_{nb,c}$), county-lender ($FE_{c,l}$), and county-year-quarter ($FE_{c,t}$) fixed effects.[19] 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 6 displays the estimated coefficients with log loan count and log loan amount 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 the same *ex ante* exposure to mortgage servicing, traditional banks reduce their mortgage lending by 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.

6.2 Accounting for the Rise of Shadow Banks in Servicing

The lender-level results in Section 6.1 suggest that the composition of nonbanks and banks in the servicing market is nontrivial for the transmission of monetary policy to the mortgage market. We next investigate the role of mortgage servicing in dampening the transmission of monetary policy through shadow banks at the regional level. However,

[19] The fixed effects absorb the other interaction terms in the triple-difference regression.

[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 (6).

simply regressing aggregate origination volume on nonbank participation in mortgage servicing faces usual endogeneity concerns. The MSR exposure of shadow banks can be correlated with unobservable characteristics, such as loan demand, that ultimately drive an attenuated effect of monetary policy shocks on mortgage lending.

To address these concerns, we follow an identification strategy from Irani et al. (2021) and exploit differences across the regulatory capital of *banks* prior to the U.S. implementation of Basel III capital requirements on mortgage servicing rights. In 2012Q2, U.S. regulators announced that the cap on MSRs' contribution to Tier 1 capital would be lowered from 50% to 10% and their risk weight would increase from 100% to 250%. Their treatment of MSRs was more punitive compared to international standards and largely unanticipated by market participants. This, combined with *ex ante* variation in banks' sensitivity to the additional capital charge arising from the Basel III regulations, 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 regional level, $\text{MSR\%}_M$, as servicing-weighted MSRs as a percent of banks' Tier 1 capital in MSA M in 2012Q2,

$$\text{MSR\%}_M = \sum_{b \in M} \left(\frac{MSR_{b_{2012Q2}}}{Tier1Capital_{b_{2012Q2}}} \times \frac{Servicing_{b_{2012Q2}}}{\sum_{d \in M} Servicing_{d_{2012Q2}}} \right) \times 100. \qquad (7)$$

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 associated property. This allows us to observe the shares of banks and nonbanks in the servicing market 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.[21]

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

To document the effect of the Basel III capital requirements on the share of nonbanks in the servicing market, we estimate an event-study regression

$$Y_{M,t} = \sum_{\tau=-10}^{10} (\beta_\tau \text{MSR\%}_M \times \text{Post}_{t+\tau}) + \gamma X_{M,t} + FE_M + FE_t + \epsilon_{M,t}. \quad (8)$$

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 (7), and $\text{Post}_{t+\tau}$ takes a value of 1 if year-quarter is τ periods away from 2012Q2. We include a vector of time-varying MSA-level characteristics $X_{M,t}$, as well as MSA (FE_M) and year-quarter (FE_t) fixed effects. 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. 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

$$Y_{M,t} = \beta_1 \text{MSR\%}_M \times \text{Post}_t + \gamma X_{M,t} + FE_M + FE_t + \epsilon_{M,t}, \quad (9)$$

where Post_t is an indicator variable equal to 1 if year-quarter t is 2012Q2 and other variables are as previously defined. The coefficient of interest β_1 represents the nonbank servicing share in MSAs that were differentially exposed to the change in capital requirements.

We present results in columns 1–4 of Table 7 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 7, we additionally estimate Equation (9) 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 are consistent with our lender-level analysis on the mortgage servicing channel for shadow banks in Section 5.[22]

6.3 Implications for Aggregate Mortgage Lending

Having shown that aggregate bank capital deficiency prior to the announcement of the Basel III capital requirements on MSRs predicts plausibly exogenous and economically meaningful variation in the share of loans serviced by nonbanks, we now address whether the rise of shadow banks in mortgage servicing has dampened the transmission of monetary policy to aggregate mortgage lending. We estimate the regression

$$\begin{aligned} Y_{M,t} = \beta_1 \text{MSR\%}_M \times \text{FFF3m}_t \times \text{Post}_t + \beta_2 \text{MSR\%}_M \times \text{Post}_t + \gamma X_{M,t} + FE_M \\ + FE_t + \epsilon_{M,t}, \end{aligned} \tag{10}$$

where $Y_{M,t}$ is log total loan amount or log total loan count originated in MSA M in year-quarter t and other variables are as previously defined. Crucially, we use the treatment variable $\text{MSR\%}_M$ defined in Equation (7) 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

[22] As a final validation check for our aggregate results, we consider the effect of the Basel III requirements on *bank-level* participation in mortgage servicing. As seen in Table 8 in the appendix, we find that, among a sub-sample of large bank servicers, those with higher *ex ante* capital deficiency decreased their holdings of mortgage servicing rights more after the policy. We restrict our analysis to large bank 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.

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 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 $MSR\%_M$ 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 implementation of more strict capital requirements on mortgage servicing rights, 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 in the aggregate. To place our regression estimates in context, for a given 25bp contractionary monetary policy shock, a MSA with an aggregate bank capital deficiency at the 75th percentile, compared to one at the 50th percentile, had 13.2% more lending in the post-policy period.

7 Robustness Checks

7.1 Alternative Measures of MSR Exposure

We examine whether our results on the mortgage servicing channel of monetary policy transmission for shadow banks in Section 5 vary with the measure of mortgage servicing right exposure. MSR holdings can be normalized by different company characteristics in order to measure lender-level 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.

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 re-estimate Equation (1). Table 10 shows the results. Columns 1–2 and 3–4 have log mortgage count and log mortgage amount as the dependent variable, respectively. We add lender and county-year-quarter fixed effects in column 1 and 3 and lender-county and county-year-quarter fixed effects in column 2 and column 4. The standard errors are clustered at the lender-county level.

The effect of *ex ante* exposure to MSRs on shadow banks mortgage lending during monetary policy tightening is robust to the 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.

7.2 Alternative Measures of Monetary Policy Shocks

In previous tests, we use the surprise movement in the three-months-ahead federal funds future 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 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 11 shows the 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.

7.3 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. The lender classification in Buchak et al. (2018) is the most commonly used classification methodology. In Table 12, we show estimated results for Equation (1) for the sample of shadow banks in Buchak et al. (2018).[23] We find that the coefficient of the interaction term between MSR and monetary policy shock is positive and significant, suggesting that our results are not dependent on our definition of shadow banks.

[23] 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.

8 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 present evidence that the lending of shadow banks with greater involvement in servicing is less affected by monetary policy shocks. The collateral value of mortgage servicing rights and the relative stability of income generated through servicing give rise to a mortgage servicing channel of monetary policy. Because traditional banks have access to deposit funding and must satisfy capital requirements on their holdings of mortgage servicing rights, this channel is significantly stronger for nonbanks. 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.

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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. 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 some fraction of the outstanding loan balance at origination. The value of a mortgage servicing right equals the present discounted value of expected revenue from servicing the loan.

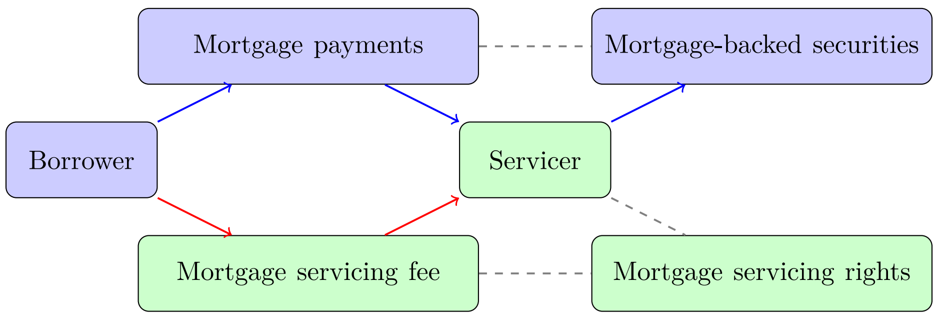

Table 1: Summary Statistics

This table reports summary statistics for all variables used in the empirical analysis for the period 2012-2017. 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 RMLA 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						
	count	mean	std	25%	50%	75%
Assets (billions)	6,502	0.491	1.494	0.038	0.085	0.246
Equity (billions)	6,502	0.082	0.260	0.007	0.017	0.047
MSR to asset ratio	6,502	0.077	0.101	0.000	0.021	0.104
MSR to equity ratio	6,498	0.381	0.382	0.003	0.142	0.492
Capital ratio	6,502	0.236	0.312	0.128	0.189	0.295
Liquidity to asset ratio	6,502	0.098	0.136	0.033	0.061	0.115
Return on equity (ROE)	6,490	0.062	0.197	0.003	0.048	0.124
Share of prime conforming mortgages	6,140	0.492	0.269	0.349	0.520	0.654
Mortgage unpaid balance to asset ratio	6,502	0.647	0.282	0.560	0.740	0.826
Share of mortgages with FICO $\leq$ 650	1,463	0.189	0.221	0.054	0.110	0.226
Panel B: Shadow Bank Funding						
	count	mean	std	25%	50%	75%
Credit limit (billions)	5,676	0.839	6.509	0.052	0.112	0.310
Used credit (billions)	5,676	0.395	2.422	0.026	0.063	0.183
Utilization rate	5,676	0.522	0.210	0.376	0.522	0.675
Interest rate	4,648	0.027	0.021	0.016	0.024	0.035
Panel C: Shadow Bank-Lender Bank Pair Funding						
	count	mean	std	25%	50%	75%
Credit limit (billions)	20,823	0.212	3.436	0.020	0.035	0.075
Used credit (billions)	20,823	0.093	1.228	0.006	0.018	0.044
Utilization rate	20,823	0.508	0.283	0.295	0.520	0.733

Table 2: The Mortgage Servicing Channel

This table reports estimates from Equation (1) at the lender-county level for the sample of U.S. shadow banks for the period 2012–2017. The dependent variables are the quarterly log loan count (columns 1–4) or loan amount (columns 5–8) of mortgages originated by shadow banks in a given county. The main independent variable is $\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$, the interaction between 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 surprise in 3-month federal funds rate future from Jarociński and Karadi (2020) aggregated at the quarterly level. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity. Lender controls include log assets, log equity, ROE, share of unpaid balance of prime conforming loans, share of unpaid balance of mortgages over assets, liquidity–asset ratio and capital ratio. Column 2 and column 6 include county-year-quarter fixed effects, column 3 and column 7 add lender fixed effects, column 4 and column 8 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			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$	0.3391***	0.4603***	0.2852***	0.4157***	0.5105***	0.6079***	0.3275***	0.4598***
	(0.0414)	(0.0368)	(0.0315)	(0.0268)	(0.0478)	(0.0403)	(0.0349)	(0.0307)
$\text{MSREquity}_{l,t-1}$	-0.0395***	-0.0445***	0.0521***	0.0657***	-0.0751***	-0.0831***	0.0431***	0.0583***
	(0.0068)	(0.0058)	(0.0048)	(0.0046)	(0.0077)	(0.0060)	(0.0050)	(0.0049)
FFF3m_t	0.0899***				-0.1565***			
	(0.0426)				(0.0487)			
Fit statistics								
Observations	650,414	650,088	650,087	625,785	650,414	650,088	650,087	625,785
R^2	0.06285	0.30612	0.40550	0.83477	0.04948	0.38690	0.47420	0.82999
Fixed-effects								
County-Year-Quarter		Yes	Yes	Yes		Yes	Yes	Yes
Lender			Yes				Yes	
Lender-County				Yes				Yes
Lender controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3: MSR Exposure and Shadow Bank Funding

This table reports estimates from Equation (2) and (3) for U.S. shadow banks for the period 2012–2017 in Panel A and Panel B, respectively. Panel A shows the results at shadow bank-level and Panel B shows the results at credit line-year level. The dependent variables are the log credit limit (column 1–3), log used credit (column 4–6) and estimated interest rate on credit lines (columns 7–9). The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between 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 surprise in 3-month federal funds future from Jarociński and Karadi (2020) aggregated at the annual level. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity. We standardize the measure for the ease of interpretation. Lender controls include log assets, log equity, ROE, share of unpaid balance of prime conforming loans, share of unpaid balance of mortgages over assets, liquidity ratio, and capital ratio. In Panel A, columns 2, 5, and 8 add lender fixed effects, and columns 3, 6, and 9 add year-quarter fixed effects. In Panel B, columns 2, 5, and 8 add lender fixed effects, and columns 3, 6, 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 CreditLimit			Log UsedCredit			R		
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Shadow Bank-Level Analysis									
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	1.148**	0.8557**	0.6782*	1.602***	1.106***	1.279***	-0.0386***	-0.0381***	-0.0324***
	(0.5110)	(0.3769)	(0.3469)	(0.4357)	(0.3482)	(0.3604)	(0.0082)	(0.0081)	(0.0083)
$\text{MSREquity}_{l,t-1}$	0.1776*	-0.0130	-0.0424	0.0654	0.0227	0.0339	-0.0009	-0.0023**	-0.0014
	(0.0998)	(0.0542)	(0.0538)	(0.0503)	(0.0493)	(0.0468)	(0.0010)	(0.0010)	(0.0010)
FFF3m_{t-1}	0.6358	-0.2708		-0.8545**	-1.656***		0.0275***	0.0252***	
	(0.4515)	(0.2803)		(0.3803)	(0.3185)		(0.0092)	(0.0085)	
Fit statistics									
Observations	4,603	4,603	4,603	4,487	4,487	4,487	4,251	4,251	4,251
R^2	0.64842	0.92506	0.92634	0.73090	0.88117	0.88767	0.05206	0.39660	0.42909
Fixed-effects									
Lender		Yes	Yes		Yes	Yes		Yes	Yes
YearQuarter			Yes			Yes			Yes
Lender controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Credit Line-Level Analysis									
$\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$	0.7774***	0.8075***	0.7224***	1.105***	1.404***	1.212***	-0.0347***	-0.0315***	-0.0299***
	(0.2792)	(0.2330)	(0.2598)	(0.3349)	(0.3107)	(0.3324)	(0.0097)	(0.0096)	(0.0095)
$\text{MSREquity}_{l,t-1}$	0.0950**	-0.0183	-0.0112	0.0509	0.0140	0.0039	-0.0013	-0.0001	-0.0002
	(0.0454)	(0.0471)	(0.0425)	(0.0396)	(0.0497)	(0.0446)	(0.0009)	(0.0014)	(0.0014)
FFF3m_{t-1}	0.3532			-0.5653*			0.0218**		
	(0.2546)			(0.3340)			(0.0096)		
Fit statistics									
Observations	14,638	14,638	14,638	13,999	13,999	13,999	13,668	13,668	13,668
R^2	0.44768	0.60850	0.79469	0.39994	0.51183	0.67509	0.04222	0.39718	0.48776
Fixed-effects									
Lender		Yes	Yes		Yes	Yes		Yes	Yes
YearQuarter		Yes	Yes		Yes	Yes		Yes	Yes
Bank-YearQuarter			Yes			Yes			Yes
Lender controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: Heterogeneity Tests: Capital and Risk Exposure

This table reports estimates from Equation (4) and (5) at the lender-county level for U.S. shadow banks from 2012–2017. The dependent variables are the quarterly level log count (columns 1 and 3) and log amount (columns 2 and 4) of mortgages originated by a shadow bank in a county. The main independent variable in columns 1–2 is $\text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{t-1}$, the triple interaction between monetary policy shock, nonbank exposure to mortgage servicing rights and nonbank capital ratio. The main independent variable in columns 3–4 is $\text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{LowFICO\%}_{l,t-1}$, the triple interaction between monetary policy shock, nonbank exposure to mortgage servicing rights and the fraction of low FICO score (≤ 650) mortgages originated by shadow banks. The monetary policy shock is the high-frequency surprise in 3-month federal funds rate future from Jarociński and Karadi (2020) and aggregated at the quarterly level. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights and equity. Lender controls include log asset, log equity, ROE, share of unpaid balance of prime conforming loans, share of unpaid balance of mortgages over asset and capital ratio. All columns include lender-county fixed effects 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:	Capital		Risk	
	Log Count	Log Amount	Log Count	Log Amount
Model:	(1)	(2)	(3)	(4)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{CapitalRatio}_{l,t-1}$	-0.0170***	-0.0175***		
	(0.0029)	(0.0034)		
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{LowFICO\%}_{l,t-1}$			0.0203***	0.0229***
			(0.0049)	(0.0056)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$	0.7001***	0.7525***	0.1556***	0.1218
	(0.0560)	(0.0645)	(0.0767)	(0.0871)
Fit statistics				
Observations	625,785	625,785	238,184	238,184
R^2	0.83511	0.83023	0.82587	0.82824
Fixed-effects				
Lender-County	Yes	Yes	Yes	Yes
County-Year-Quarter	Yes	Yes	Yes	Yes
Lender controls	Yes	Yes	Yes	Yes

Table 5: MSR Exposure and Shadow Bank Income

This table reports estimates from Equation (2) for U.S. shadow banks for the period 2012–2017. The dependent variables are the net income over asset (column 1–3) and servicing income over gross income (column 4–6). The main independent variable is $\text{FFF3m}_{t-1} \times \text{MSREquity}_{l,t-1}$, the interaction between 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 surprise in 3-month federal funds future from Jarociński and Karadi (2020) aggregated at the annual level. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity. We standardize the measure for the ease of interpretation. Lender controls include log assets, log equity, ROE, share of unpaid balance of prime conforming loans, share of unpaid balance of mortgages over assets, liquidity ratio, and capital ratio. Columns 2 and 5 add lender fixed effects, and columns 3 and 6 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:		$\frac{\text{Net Income}}{\text{Asset}}$			$\frac{\text{Servicing Income}}{\text{Gross Income}}$	
Model:	(1)	(2)	(3)	(4)	(5)	(6)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$	0.0545***	0.0621***	0.0838***	0.4939***	0.5447***	0.5044***
	(0.0137)	(0.0130)	(0.0143)	(0.1221)	(0.1134)	(0.1101)
$\text{MSREquity}_{l,t-1}$	-0.0020	-0.0059***	0.0010	0.0091	0.0290***	0.0281**
	(0.0012)	(0.0017)	(0.0016)	(0.0121)	(0.0109)	(0.0119)
FFF3m_t	0.0513***	0.0285**		0.3734***	0.4315***	
	(0.0143)	(0.0131)		(0.0770)	(0.0649)	
Fit statistics						
Observations	5,067	5,067	5,067	5,056	5,056	5,056
R^2	0.01301	0.38320	0.45714	0.43978	0.75703	0.76982
Fixed-effects						
Lender		Yes	Yes		Yes	Yes
Year-Quarter			Yes			Yes
Lender controls	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Heterogeneous Strength of MSR Channel on Banks and Nonbanks

This table reports estimates from Equation (6) at the lender-county level for U.S. mortgage lenders banks from 2012–2017. The dependent variables are the log loan count (columns 1–4) or log loan amount (columns 5–8) of mortgages originated by a lender in a given county and year quarter. The main independent variable is $\text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t}$, the interaction between monetary policy shock (FFF3m_t), nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$) and shadow bank dummy($\text{Nonbank}_{l,t}$). The monetary policy shock is the high-frequency surprise in 3-month federal funds rate future from Jarociński and Karadi (2020) aggregated at the quarterly level. The nonbank exposure to mortgage servicing rights is measured as the ratio of mortgage servicing rights to equity. The nonbank dummy ($\text{Nonbank}_{l,t}$) is 1 if the lender is classified as a independent mortgage company in the Avery file. Lender controls include log assets, log equity, ROE, liquidity–asset ratio and capital ratio. All columns add Lender Type × year-quarter fixed effects. Columns 2 and 6 include Shadow × county fixed effects. Columns 3 and 7 add county × year-quarter fixed effects. Columns 4 and 8 add county-lender fixed effects. Standard errors clustered at the county-lender level are reported in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	Log Loan Count				Log Loan Amount			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1} \times \text{Nonbank}_{l,t}$	0.4847***	0.5066***	0.5044***	0.2071***	0.4857***	0.5007***	0.5011***	0.2109***
	(0.0351)	(0.0320)	(0.0326)	(0.0248)	(0.0397)	(0.0353)	(0.0359)	(0.0289)
$\text{Nonbank}_{l,t} \times \text{FFF3m}_t$	-0.0152***	-0.0137***	-0.0141***	0.0041	-0.0139***	-0.0139***	-0.0144***	0.0029
	(0.0032)	(0.0030)	(0.0030)	(0.0045)	(0.0034)	(0.0031)	(0.0031)	(0.0048)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$	-0.4794***	-0.4995***	-0.4974***	-0.1996***	-0.4782***	-0.4899***	-0.4910***	-0.2025***
	(0.0351)	(0.0319)	(0.0326)	(0.0248)	(0.0397)	(0.0353)	(0.0358)	(0.0289)
Fixed-effects								
Lender Type × Year-Quarter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender Type × County		Yes	Yes	Yes		Yes	Yes	Yes
County × Year-Quarter			Yes	Yes			Yes	Yes
County × Lender				Yes				Yes
Fit statistics								
Observations	874,284	874,282	874,161	874,149	874,284	874,282	874,161	874,149
R^2	0.09683	0.30975	0.31776	0.45530	0.05564	0.35843	0.36756	0.49824
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

This figure plots point estimates and 95% confidence intervals for β_τ, with $\tau \in \{-10, -9, ..., 9, 10\}$, from the event-study regression in Equation (2). The x is the year-quarter. The dashed black line denotes 2012Q2 (i.e., $\tau = 0$), when the U.S. implementation of Basel III capital requirements on mortgage servicing rights were announced. The y axis represents the share of mortgages services by shadow banks for MSA that were differentially exposed to the Basel III requirements.

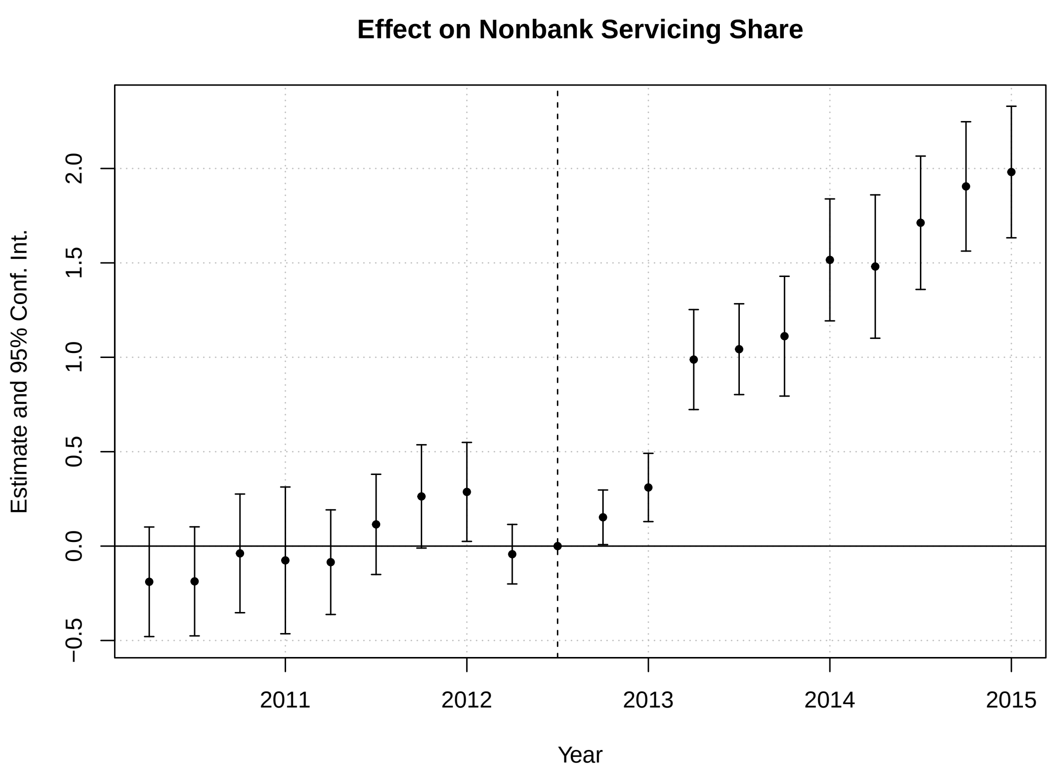

Table 7: Bank Capital Requirement on Mortgage Servicing

This table reports estimates from Equation (9) at the MSA level for U.S. shadow banks from 2010–2017. The dependent variables are the nonbank servicing share (columns 1–4) or nonbank origination share (columns 5–8) of mortgages originated in a given MSA and year quarter. The main independent variable is $MSR\%_M \times Post_t$, the interaction between MSA level exposure to capital requirement on mortgage servicing rights ($MSR\%_M$) and post dummy ($Post_t$). The exposure measure is constructed following Equation (7) at the MSA level. The post dummy ($Post_t$) is 1 for year-quarter after 2012Q2. MSA controls include lagged MSA level industrial employment share from Quarterly Census of Employment and Wages (QCEW), local financial health measure following Loutskina and Strahan (2015), local demographics (fraction of male, fraction of 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 include MSA fixed effects. 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			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MSR\%_M \times Post_t$	1.997***	2.113***	1.838***	1.899***	1.575***	1.733***	1.519***	1.578***
	(0.1750)	(0.1860)	(0.1801)	(0.1700)	(0.1856)	(0.1981)	(0.1899)	(0.1864)
$Post_t$	2.229***	-1.314	-7.497***		2.088***	-0.8582	-5.326***	
	(0.7725)	(0.9034)	(0.8222)		(0.7984)	(0.9538)	(0.8822)	
$MSR\%_M$	0.3168*	-0.0732			0.8370***	0.4701**		
	(0.1615)	(0.1904)			(0.1893)	(0.2299)		
Fixed-effects								
MSA			Yes	Yes			Yes	Yes
Year-Quarter				Yes				Yes
Fit statistics								
Observations	10,733	9,510	9,510	9,510	10,730	9,510	9,510	9,510
R^2	0.39644	0.49038	0.77249	0.82210	0.33215	0.39638	0.72421	0.77110
Controls		Yes	Yes	Yes		Yes	Yes	Yes

Table 8: Effect of Basel III on Bank Servicing Holdings

This table reports regression estimates from a model explaining the relation between servicing and capital deficiency as of 2012:Q2 and bank servicing assets using the public Y-9C data and covering the period 2005-2017. The dependent variable is either MSR equity ratio or MSR asset ratio, lender servicing rights scaled by equity or by assets. Lender controls include log assets, log equity, ROE, liquidity ratio and capital ratio. Standard errors are clustered at the lender level. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$.

Dependent Variables:	MSR/Equity	MSR/Asset
Model:	(1)	(2)
$FFF3m_t \times MSREquity_{l,t-1}$	-0.4854***	-0.0266***
	(0.0870)	(0.0079)
Fit statistics		
Observations	523	523
R^2	0.76252	0.78068
Fixed-effects		
Lender	Yes	Yes
Year-Quarter	Yes	Yes
Lender controls	Yes	Yes

Table 9: Mortgage Servicing and Monetary Policy Transmission

This table reports estimates from Equation (10) at the MSA level for U.S. shadow banks from 2010–2017. The dependent variables are the log loan count (columns 1–4) or log loan amount (columns 5–8) of mortgages originated in a given MSA and year quarter. The main independent variable is $\text{MSR\%}_M \times \text{FFF3m}_t \times \text{Post}_t$, the interaction between MSA level exposure to capital requirement on mortgage servicing rights ($\text{MSR\%}_M$), monetary policy shock (FFF3m_t) and post dummy (Post_t). The exposure measure is constructed following (7) at the MSA level. The monetary policy shock is the high-frequency surprise in 3-month federal funds rate future from Jarociński and Karadi (2020) aggregated at the quarterly level. The post dummy is 1 for year quarter after 2012:Q2. MSA controls include lagged MSA level industrial employment share from Quarterly Census of Employment and Wages(QECW), local financial health measure following (Loutskina and Strahan, 2015), local demographics (fraction of male, fraction of 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 include MSA fixed effects. 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			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{MSR\%}_M \times \text{FFF3m}_t \times \text{Post}_t$	3.5181***	3.5307***	3.6981***	3.1976***	3.9709***	3.9138***	4.1477***	3.6584***
	(0.3192)	(0.4705)	(0.2966)	(0.2949)	(0.3571)	(0.5012)	(0.3214)	(0.3247)
$\text{MSR\%}_M \times \text{FFF3m}_t$	-4.4253***	-4.3845***	-4.3255***	-3.8131***	-5.0115***	-4.8002***	-4.8449***	-4.3460***
	(0.3522)	(0.4995)	(0.3174)	(0.3160)	(0.3868)	(0.5366)	(0.3395)	(0.3428)
$\text{FFF3m}_t \times \text{Post}_t$	-11.1931***	-11.6803***	-13.6756***		-13.5945***	-12.7068***	-15.1282***	
	(0.3014)	(1.0341)	(0.3418)		(0.3410)	(1.1689)	(0.3688)	
FFF3m_t	12.4736***	12.7604***	13.7717***		14.5312***	13.7935***	15.3864***	
	(0.3082)	(0.8034)	(0.3549)		(0.3428)	(0.8836)	(0.3798)	
Post	-0.0373**	-0.0136	0.1387***		0.0308*	-0.0229	0.1360***	
	(0.0158)	(0.0630)	(0.0097)		(0.0178)	(0.0719)	(0.0110)	
$\text{MSR\%}_M$	0.0708	-0.0171			0.1734***	0.0525		
	(0.0511)	(0.0403)			(0.0572)	(0.0429)		
Fixed-effects								
MSA			Yes	Yes			Yes	Yes
Year-Quarter				Yes				Yes
Fit statistics								
Observations	9,686	9,097	9,097	9,097	9,686	9,097	9,097	9,097
R^2	0.01020	0.51588	0.95419	0.98450	0.02554	0.57102	0.95701	0.98491
Controls		Yes	Yes	Yes		Yes	Yes	Yes

Table 10: Robustness: Alternative MSR Exposure Measure

This table reports estimates from Equation (1) at lender-county level for U.S. shadow banks for the period 2012–2017. The dependent variables are the log loan count (columns 1–2) or loan amount (columns 3–4) of mortgages originated by a shadow bank in a given county and year quarter. The main independent variable is $\text{FFF3m}_t \times \text{MSRAsset}_{l,t-1}$, the interaction between monetary policy shock (FFF3m_t) and nonbank exposure to mortgage servicing rights ($\text{MSRAsset}_{l,t-1}$). The monetary policy shock is the high-frequency surprise in 3-month federal funds future from Jarociński and Karadi (2020) aggregated at the quarterly level. The nonbank exposure to mortgage servicing right is measured as the ratio of mortgage servicing rights to assets. Lender controls include log assets, log equity, ROE, share of unpaid balance of prime conforming loans, share of unpaid balance of mortgages over asset, liquidity ratio, and capital ratio. Column 1 and 3 include lender and county-year-quarter fixed effects, columns 2 and 4 include 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	
Model:	(1)	(2)	(3)	(4)
$\text{FFF3m}_t \times \text{MSRAsset}_{l,t-1}$	0.2434***	0.3467***	0.2890***	0.3956***
	(0.0332)	(0.0291)	(0.0370)	(0.0334)
$\text{MSRAsset}_{l,t-1}$	-0.0087*	-0.0115***	-0.0100***	-0.0128***
	(0.0046)	(0.0044)	(0.0049)	(0.0048)
Fit statistics				
Observations	650,087	625,785	650,087	625,785
R^2	0.40537	0.83458	0.47413	0.82987
Fixed-effects				
Lender	Yes		Yes	
County-Year-Quarter	Yes	Yes	Yes	Yes
Lender-County		Yes		Yes
Lender controls	Yes	Yes	Yes	Yes

Table 11: Robustness: Alternative Monetary Policy Shock

This table reports estimates from Equation (1) at the lender-county level for U.S. shadow banks from 2012–2017. The dependent variables are the log loan count (columns 1–2) or loan amount (columns 3–4) of mortgages originated by a shadow bank in a given county and year quarter. The main independent variable is $\text{NS}_t \times \text{MSREquity}_{l,t-1}$, the interaction between monetary policy shock (NS_t) and nonbank exposure to mortgage servicing rights ($\text{MSREquity}_{l,t-1}$). The monetary policy shock is from Nakamura and Steinsson (2018) aggregated at the quarterly level. The nonbank exposure to mortgage servicing right is measured as the ratio of mortgage servicing rights to equity. Lender controls include log assets, log equity, ROE, share of unpaid balance of prime conforming loans, share of unpaid balance of mortgages over assets, liquidity ratio, and capital ratio. Columns 1 and 3 include lender and county-year-quarter fixed effects, columns 2 and 4 include 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	
Model:	(1)	(2)	(3)	(4)
$\text{NS}_t \times \text{MSREquity}_{l,t-1}$	0.2254***	0.2933***	0.2521***	0.3198***
	(0.0261)	(0.0225)	(0.0290)	(0.0258)
$\text{MSREquity}_{l,t-1}$	0.0527***	0.0604***	0.0433***	0.0527***
	(0.0047)	(0.0045)	(0.0050)	(0.0048)
Fit statistics				
Observations	680,531	655,917	680,531	655,917
R^2	0.41253	0.83478	0.47919	0.82996
Fixed-effects				
Lender	Yes		Yes	
County-Year-Quarter	Yes	Yes	Yes	Yes
Lender-County		Yes		Yes
Lender controls	Yes	Yes	Yes	Yes

Table 12: Robustness: Shadow Bank Definition from Buchak et al. (2018)

This table reports estimates from Equation (1) at the lender-county level for U.S. shadow banks for the period 2012–2017. We define shadow banks following Buchak et al. (2018). The dependent variables are the log loan count (columns 1–2) or loan amount (columns 3–4) of mortgages originated by a shadow bank in a given county and year quarter. The main independent variable is $\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$, the interaction between 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 surprise in 3-month federal funds future from Jarociński and Karadi (2020) aggregated at the quarterly level. The nonbank exposure to mortgage servicing right is measured as the ratio of mortgage servicing rights to equity. Lender controls include log assets, log equity, ROE, share of unpaid balance of prime conforming loans, share of unpaid balance of mortgages over assets, liquidity ratio, and capital ratio. Columns 1 and 3 include lender and county-year-quarter fixed effects, column 2 and column 4 include 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	
Model:	(1)	(2)	(3)	(4)
$\text{FFF3m}_t \times \text{MSREquity}_{l,t-1}$	0.3369***	0.5025***	0.3695***	0.5417***
	(0.0362)	(0.0302)	(0.0397)	(0.0343)
$\text{MSREquity}_{l,t-1}$	0.0637***	0.0753***	0.0531***	0.0660***
	(0.0054)	(0.0050)	(0.0057)	(0.0053)
Fit statistics				
Observations	489,899	475,552	489,899	475,552
R^2	0.42914	0.84105	0.49115	0.83675
Fixed-effects				
Lender	Yes		Yes	
County-Year-Quarter	Yes	Yes	Yes	Yes
Lender-County		Yes		Yes
Lender controls	Yes	Yes	Yes	Yes

A Appendix

Figure A.1: Sample Coverage by Year

This figure shows the number of mortgages originated by banks, shadow banks and shadow banks in our sample by year. The blue bar shows the number of mortgages originated by banks, the orange bar shows the number of mortgages originated by shadow banks, and the green bar shows the number of mortgages originated by shadow banks covered in our sample.

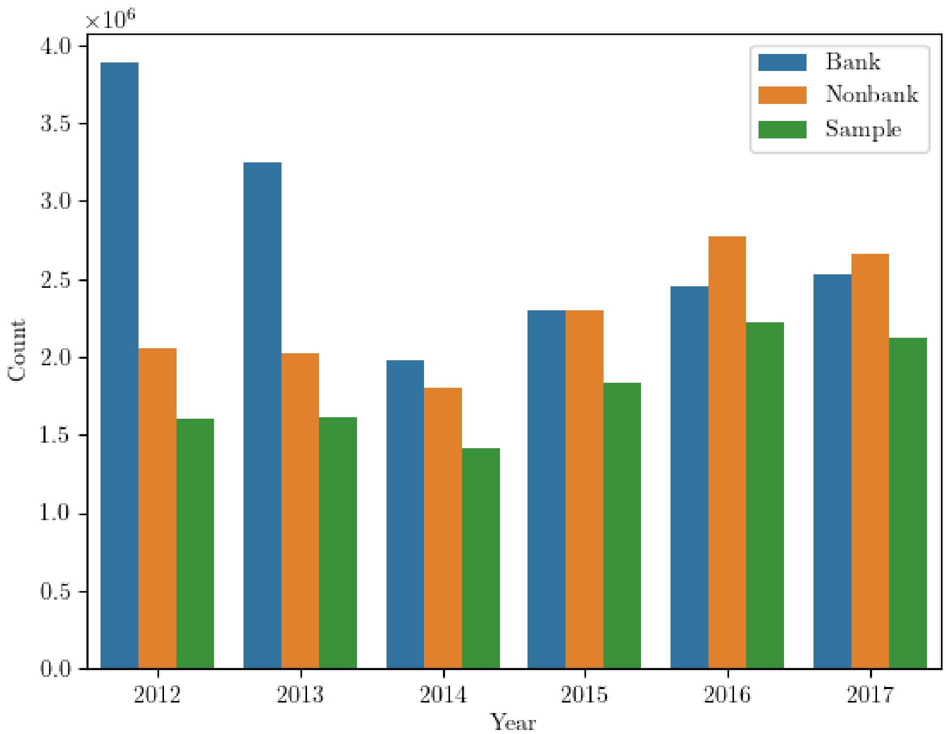

Figure A.2: Sample Size Distribution

This figure compares the size distribution of shadow banks in our sample and in HMDA. The x axis is the log total dollar amount of mortgages originated by shadow banks during 2012–2017. The gray bar shows the size distribution of shadow banks in HMDA and the green bar shows the size distribution of shadow banks that are in our sample.