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Monetary Policy Transmission with Adjustable and Fixed Rate Mortgages: The Role of Credit Supply[*]

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Abstract

While a higher monetary policy rate increases the payments for borrowers with adjustable-rate mortgages (ARMs) and reduces their disposable income, it increases the interest income of lenders, thereby improving lenders' balance sheets. We find that when monetary policy tightens, banks with a higher share of ARMs experience better stock price performance, exhibit a stronger credit supply, and generate higher interest income compared to banks with a low ARM share. Therefore, our results imply that a higher ARM share might weaken monetary policy transmission through banks. In the event of a banking crisis, for instance, when interest income becomes vital, a decline in policy rates might even prove harmful if the ARM share is high.

Keywords: Monetary policy, Adjustable rate mortgages, Fixed rate mortgages.

J.E.L. Classification: E50; E52; E58

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1 Introduction

When the share of adjustable rate mortgages (ARM) increases in an economy, monetary policy transmission becomes stronger.[1] At least that is the common view. Indeed, when monetary policy tightens, mortgage payments of borrowers with ARMs increase, since interest rates on ARMs are tied to a reference rate and this reference rate moves with the monetary policy rate. For borrowers with fixed-rate mortgages (FRM), however, the payments stay the same. Therefore, the increase in mortgage payments in the case of ARMs reduces borrowers' disposable income, which might lower their consumption, hence a strong monetary policy transmission.

In this paper, we argue that this view is incomplete. The reason is that an increase in mortgage payments, while bad for borrowers, implies higher income for lenders. As lenders face a more favorable outlook for interest income, banks with a higher share of ARMs outperform those with a lower share: their stock prices improve, and they have a greater capacity to increase lending. Based on this mechanism, we argue that banks with a higher proportion of ARMs may weaken monetary policy transmission. However, it is important to note that bank stability may increase, and macroprudential policy-making may be accordingly adjusted. This argument is partly supported by the turmoil witnessed in the banking sector in the US in 2023, which was a response to the persistent rise in inflation and the central bank's policy rates.

We present three sets of results that support our hypothesis. Firstly, we demonstrate that the equity prices of banks with a higher share of ARMs react more positively to a tightening in monetary conditions. Secondly, using bank- and loan-level data, we show that banks with a higher ARM share maintain a relatively higher credit supply compared to banks with a lower ARM share when monetary conditions tighten. Thirdly, we provide evidence that the interest income of banks with a higher ARM share increases more significantly than that of banks with a lower ARM share in response to a tightening in monetary policy.

We start with the bank equity price analysis, where we focus on the role of banks' ARM share in

[1] See for example Mishkin (2007); Garriga et al. (2017).

their equity price responses to surprise changes in monetary policy. These surprises are obtained from high-frequency changes in short-term bond yields around monetary policy announcements. They correspond to unexpected changes in the monetary policy stance, rather than other economic developments. As a result, this approach controls for the endogeneity of monetary policy rates. Another concern is that monetary policy might be transmitted through other bank variables (hence biasing the role of ARM). To alleviate this concern, we control for an extensive set of bank balance sheet variables, including bank liability structure. We also add controls where we interact these bank variables with monetary policy shocks. Finally, we add dependent variable lags, i.e., past bank equity price dynamics, to control for bank-specific pre-shock movements. We also include bank fixed effects to control for time-invariant bank characteristics, and time fixed effects to control for aggregate developments common to all banks. Our results confirm our hypothesis: equity prices of banks with higher ARM shares perform relatively better when monetary policy tightens.

Next, we analyze whether bank ARM shares affect bank lending in response to changes in monetary policy. We expect that the credit supply of banks with higher ARM shares will stay stronger when monetary policy tightens. We estimate an extended version of the model used by Gomez et al. (2021). Similar to Gomez et al. (2021), we use the changes in the federal funds rate (FFR) as our measure of monetary policy stance. This is because while monetary policy shocks from intra-day data provide cleaner identification, they are typically small and do not go back much in time.[2] To mitigate the endogeneity of the FFR, we include other major macroeconomic variables (inflation, GDP growth, housing price growth, and mortgage demand) along with the changes in the FFR. We also include the interactions of the FFR with other bank variables. Our results show that the coefficient of interest is positive and statistically significant, meaning that banks with higher ARM share lower credit less (compared to banks with low ARM share) when interest rates rise. The results are economically significant as well.

The results regarding credit dynamics may be contaminated by credit demand. To better identify the credit supply channel, we use loan-level DealScan data, which allows us to control for loan

[2] We provide robustness with surprise monetary policy shocks in the online appendix, where we show that most of our results remain significant.

demand with firm-time fixed effects. In other words, we can compare bank loans to the same firm from different banks, thereby controlling for observed and unobserved firm characteristics. Our results with DealScan data confirm our earlier findings, suggesting that the credit supply of banks with higher ARM shares stays stronger than the credit supply of banks with low ARM shares when the FFR increases.

Finally, we delve into the mechanisms that explain our results. Our hypothesis is that when monetary policy tightens, the expected interest income of banks with a higher ARM share increases. To test this hypothesis, we use several interest income measures and estimate how they change over time in response to a change in the FFR. We extend our model to the local projection setting developed in Jordà (2005). We find that banks with higher ARM share experience higher interest income on mortgages, and eventually higher net interest income.

The effect of higher ARM shares on interest income might influence interest expenses as well. However, there are opposing forces at work. One mechanism is that higher interest income might improve bank riskiness, which could lower risk premia and, in turn, interest expenses. An opposing mechanism is that improved interest income might increase credit supply (as we showed), which could lead banks to increase their demand for funding, pushing interest expenses higher. We estimate a local projection specification similar to the interest income specification and find that interest expenses rise when the FFR increases, supporting the second mechanism.

Another concern might be that banks with higher ARM shares might be hit with higher non-performing loans (NPLs), mitigating the higher income benefits. To quantify the importance of this channel, we estimate how banks' NPL ratios change in response to changes in the FFR, and how it relates to banks' ARM share. We do not find any significant results. This might be because of the cost of default and the existence of refinancing options as long as house prices do not decline much in response to an increase in the FFR.

The availability of the refinancing option makes FRMs and ARMs similar when interest rates decline since borrowers have a chance to refinance and lower interest payments.[3] This feature

[3] Refinancing costs limit the similarities.

provides a testable implication: we would expect that changes in monetary policy stance should have asymmetric effects, meaning that we would expect to see small or no effects when monetary policy loosens, but larger effects when monetary policy tightens. To test this prediction, we estimate separate coefficients for loosening and tightening events. Our results (for both stock prices and lending) confirm our prediction. The results are mostly insignificant for loosening but significant and positive for tightening episodes.

We perform a battery of robustness tests. For example, we show that our results are not driven by the post-2008 developments or by banks with very high or very low shares of real estate loans. For the lending analysis, we show that using alternative macroeconomic variables does not change our results. We also show that when we use surprise monetary policy shocks obtained from high-frequency data, most of our results related to lending and interest income remain.

Our results have important policy implications. At least since the 2008 crisis, there has been a view that higher ARM shares would have enhanced the effectiveness of monetary policy. However, our results challenge this view. We show that, when interest rates decline, while ARMs benefit borrowers, they harm lenders. Specifically, during a banking crisis, such as the 2008 crisis, when banks suffer large losses and have low equity, they become the marginal agents in the economy. In this situation, a reduction in monetary policy rates might even be counterproductive when ARM shares are high, as lower interest income might push some banks to bankruptcy.

2 Related Literature

We build on several strands of the literature. The most closely related paper to ours is Di Maggio et al. (2017), who show that ARM holders benefited from a significant reduction in mortgage payments (up to 50 percent) as the Federal Reserve lowered its policy rate during the 2008 crisis, which led to a large increase in car purchases (up to 35 percent). They also find that regions with a higher proportion of ARMs experienced a relative decrease in defaults and an increase in house prices, car purchases, and employment in response to lower interest rates.[4] However, unlike their

[4]While we focus on mortgage lending, similar channels are at work with other forms of lending as well. For example, Ippolito et al. (2018) argue that most bank loans to firms have floating rates mechanically tied to monetary

paper, we focus on the lenders and we find that lower rates adversely affect the lenders with higher ARM shares by reducing their interest income.

Our paper aligns closely with the works of English et al. (2018), Gomez et al. (2021), and Paul (2023). Utilizing high-frequency data, English et al. (2018) demonstrate that unanticipated rises in the level or slope of the yield curve lead to significant declines in bank stock prices. However, a substantial maturity mismatch mitigates this response. Paul (2023) uses alternative measures of banks' maturity mismatch, and shows that stock prices of banks with a larger maturity mismatch respond more positively to a rise in term premia. Gomez et al. (2021) present empirical evidence that in response to an increase in the FFR, banks characterized by a larger "income gap" (defined as the disparity between the amount of assets maturing or repricing within a year and the corresponding amount of liabilities maturing or repricing within a year) experience greater profitability and exhibit a relatively smaller reduction in lending compared to other banks. Their analysis controls for the share of ARMs, thereby focusing on the income gap unrelated to ARMs. Our contribution to this literature is that we specifically examine the impact of the ARM share. Conceptually, the ARM share should be correlated with the income gap employed by Gomez et al. (2021) and the maturity mismatch investigated by English et al. (2018): as the ARM share increases, both the income gap and the maturity mismatch should decline. Methodologically, we combine and expand upon the econometric frameworks utilized in these studies.

Our work also relates to Haddad and Sraer (2020). The paper shows that changes in banks' interest rate exposure (measured by the "income gap" as in Gomez et al. (2021)) predict one-period bond excess returns. This might be because banks are investors in fixed-income markets. Our paper, on the other hand, focuses on the effects of ARMs on bank lending behavior.

Our findings have implications for the general equilibrium literature that argues that higher ARMs transmit monetary policy more effectively. Recently, Garriga et al. (2017) construct a

policy rates. Hence, a loosening in monetary policy can directly improve the liquidity and balance sheet strength of firms, a mechanism akin to the findings in Di Maggio et al. (2017). Another related mechanism exists with GDP-indexed bonds (see for example Önder (2022)). However, in Önder (2022) and others, international investors, which corresponds to banks in our paper, are typically risk neutral and the cost of such bonds is not modeled explicitly beyond its effect on default probability.

quantitative model incorporating long-term mortgages, demonstrating the heightened strength of the transmission mechanism under ARMs when compared to FRMs. Calza et al. (2013) use European country-level data and provide evidence that the impact of monetary policy shocks to residential investment and house prices is significantly stronger in those countries with larger flexibility/development of mortgage markets. Their two-sector DSGE model with financial constraints can rationalize those facts. However, none of the papers model bank credit and bank balance sheets explicitly.

Finally, our paper contributes to the existing literature that examines the significance of bank interest rate risk.[5] Drechsler et al. (2017) present empirical findings indicating that banks' net interest margins exhibit a high degree of stability and are relatively insensitive to changes in interest rates, thus suggesting limited vulnerability to monetary policy shocks. Furthermore, they highlight that banks' net worth remains largely insulated from such shocks. However, Hoffmann et al. (2019), utilizing European banking data, argue that although banks' overall exposure to interest rate risk is relatively small, there exists significant heterogeneity across banks due to variations in loan-rate fixation conventions for mortgages among different countries. In our paper, we offer additional evidence that emphasizes the importance of mortgages in generating interest income risk for banks.[6]

3 Institutional Details, Data, and Methodology

3.1 Mortgage Market in the US

The US mortgage market exhibits several notable characteristics. First, FRMs account for over 70 percent of residential mortgages. Second, mortgages are extensively securitized and traded among investors. Fannie Mae and Freddie Mac, two prominent government-supported entities, purchase mortgages that meet specific criteria from issuers, subsequently packaging and selling them to investors. Nevertheless, banks continue to retain a substantial portion of mortgages on

[5] Di Tella and Kurlat (2021) propose a model where banks optimally choose to bear interest rate risk.

[6] Begenau et al. (2015) show that banks' balance sheets in the US are exposed to interest rate risks and hedging is very limited.

their balance sheets. This phenomenon may be attributed to various factors, such as mortgages failing to meet the prescribed criteria, such as exceeding conforming loan limits. Alternatively, banks may find it economically advantageous to retain ownership of these mortgages.

ARMs possess distinctive attributes that are important for our research. One feature is the two-fold composition of an ARM contract, which governs the interest rate: the index and the margin. The index represents a gauge of overall interest rate trends in the economy. Different lenders utilize various indexes for their ARM programs. Commonly used indexes include the U.S. prime rate and the Constant Maturity Treasury rate. The margin is an additional percentage that the lender adds to the index. The specific margin applied depends on the borrower's creditworthiness.

In the US, a typical ARM structure entails an initial fixed term period ranging from 3 to 5 years, after which an adjustable period commences. Within the adjustable period, certain caps are implemented to limit adjustments. The "initial adjustment cap" serves to restrict the extent to which the interest rate can increase during the initial adjustment subsequent to the conclusion of the fixed-rate period. The "subsequent adjustment cap" establishes the maximum increase in the interest rate for subsequent adjustment periods. Typically set at two percent, this cap ensures that the new rate cannot surpass two percentage points above the previous rate. Additionally, the "lifetime adjustment cap" imposes a ceiling on the overall interest rate increase over the entire duration of the loan. Usually set at five percent, this cap stipulates that the rate cannot exceed five percentage points above the initial rate. It is important to note that certain lenders may impose a higher cap.[7]

3.2 Data

We combine several data sets for our analysis.

Center for Research in Security Prices (CRSP) The source of daily stock market prices utilized in our study is the Center for Research in Security Prices (CRSP) at the University of

[7]An ARM with caps of 2/2/5 means: 2 = The rate will not increase or decrease by more than 2 percent for the first adjustment after the fixed period ends. 2 = The rate will not increase or decrease by more than 2 percent for any subsequent rate adjustments. 5 = The rate will never increase by more than 5 percent above the initial starting rate.

Chicago. Using CRSP data, we calculate the daily changes in stock prices for each bank. We exclude observations from the sample where negative values for stock prices are reported. To link the U.S. Consolidated Reports of Condition and Income filings (Call Reports) data with CRSP data, we use the link file maintained by the Federal Reserve Bank of New York.

In Table I, we present our summary statistics. The number of observations for the benchmark is 44,967. We restrict our analysis to the period where we have high-frequency monetary policy shocks. It is important to note that the CRSP data covers publicly listed banks, resulting in a larger mean bank size compared to the Call Reports data set. The average bank size is 28.9 billion USD and the median bank size is 1.85 billion USD in 2010 prices. Additionally, the mean share of ARMs (relative to total assets) is 5 percent, with the maximum share reaching 31.4 percent, as illustrated in Figure 1.

US Call Reports The bank balance sheet data utilized in our analysis is from the Call Reports, which are submitted by banks subject to regulation by the Federal Reserve System, Federal Deposit Insurance Corporation, and the Comptroller of the Currency. We obtain the data from Wharton Research Data Services (WRDS).

The main variable we construct from the Call Reports is the share of ARMs within bank balance sheets. Specifically, we use "Adjustable rate closed-end loans secured by first liens on 1-4 family residential properties in domestic offices" (RCON5370) as our measure of the volume of ARMs. To ensure comparability across banks, we normalize this variable by dividing it by the respective bank's total assets. Additionally, to assess the robustness of our findings, we conduct supplementary analyses where we normalize the ARM share relative to real estate loans. To address possible effects of outliers, as a robustness exercise, we exclude the bottom and top 10 percent of the shares pertaining to real estate loans/assets.[8]

We use a wide array of balance sheet items to construct a set of additional control variables. Consistent with existing literature on bank lending behavior, we include the bank equity and liquidity ratios (normalized by bank assets) and bank size (the logarithm of bank assets) as key

[8] Some of the results from these robustness checks are presented in the Appendix.

variables. Additionally, to account for the influence of bank balance sheet structure on lending activities and minimize potential omitted variable bias, we introduce controls for the share of balances due from Fed (BdF), as well as the share of core deposits in liabilities, all normalized by assets. Furthermore, to capture the impact of other bank assets that exhibit similar characteristics to ARMs, we include controls for bank assets with a maturity of less than one year (AMY) to further enhance the strength of our analysis. We also control for several bank liability variables. Specifically, we control for bank deposit market power in all specifications. In more saturated regressions, we include additional variables to control for the interest rate sensitivity of liabilities (savings deposits, time-sensitive deposits, and Fed funds repo liabilities). By accounting for these factors, we aim to address potential confounding variables and obtain more reliable estimates of the relationship between ARMs and various outcomes of interest.

For each bank that we include in our analysis, we construct multiple dependent variables. These variables are as follows: (1) The quarterly change in the logarithm of commercial and industrial loans (C&I). (2) The quarterly change in net interest income normalized by lagged total assets. (3) The quarterly change in interest income on residential real estate loans normalized by lagged residential real estate loans. (4) Interest expense on loans normalized by lagged total assets. (5) Nonperforming loans of a specific loan type expressed as a share of that loan type.

We report summary statistics in Table VI. Our data set spans the period from 1997 to 2013, encompassing an average of approximately 3,000 banks per year. The distribution of bank sizes exhibits a noticeable skewness. The average bank size surpasses 15.8 billion USD, while the median stands at around 1.78 billion USD and the minimum is 457 million USD in 2010 prices.[9]

There is significant variation in ARM shares across banks. The average ARM share is 6 percent, with a median of 3 percent. Furthermore, the standard deviation for ARM shares is estimated at 0.075, highlighting the dispersion in the prevalence of ARMs among banks. The average quarterly growth rate of C&I is 2.8 percent. However, changes in interest income, non-interest income, and total earnings demonstrate relatively small magnitudes compared to the banks' total assets.

[9]We follow Gomez et al. (2021) and drop small banks from our sample. They focus on banks that are larger than 1 billion USD. We show that our results are robust to this selection.

DealScan data The loan-level data utilized in our study is from DealScan, a database that captures loan-level information specifically covering syndicated loans within the U.S. market. For a comprehensive description of this data set, we refer to the work of Chava and Roberts (2008), which provides an in-depth description. The Loan Pricing Corporation (LPC) collects this information from Securities and Exchange Commission (SEC) filings as well as lead lenders. Access to this data set is made possible through the WRDS. The DealScan data set provides detailed information on loan amounts, purposes, types, origination dates, maturities, and the presence of financial covenants within the loan contracts. Crucially, the data set includes borrower and lender information, such as names and locations, enabling us to merge this loan data with other relevant data sets, thereby enriching the analytical scope of our study.

In our analysis of lending behavior, we consider the loan amount between a firm and its lender as our dependent variable. It is important to note that the DealScan data set provides flow data, meaning it captures information on loans solely at their origination stage. Consequently, we are unable to directly observe the outstanding loan amount between a firm and its lender within each year of our analysis.

The descriptive statistics of our sample from the DealScan data set are presented in Table XII. This data set comprises a large number of loan-level observations, totaling over 150,177. Notably, the banks included in this data are significantly larger compared to those in the CRSP and Call Reports samples. Specifically, the mean bank size in our DealScan sample is 424.3 billion USD in 2010 prices. Regarding the share of ARMs, it is comparable to the other samples, with a mean of 3.9 percent and a standard deviation of 3.6 percent.

High-Frequency MP shock series Our data comes from Ferrari et al. (2021) (Figure 1 middle panel). It covers monetary policy decisions, releases of minutes of policy meetings, and press releases. The largest category is monetary policy decisions. These statements are released immediately following the policy decision at the FOMC meeting. Minutes of the policy meeting are published with a delay. Press conferences are a relatively new development and were first introduced in April 2011. Table I, the rows under "Shock Variables" give the descriptive statistics for the high-frequency shocks. These shocks, as is well known, are typically small. The minimum is -5 basis points while the maximum is +3.3 basis points (the mean and the median are around zero).

Macro Variables In our lending analysis we use the changes in FFR as the main policy variable (Figure 1 right panel). We use several macro variables in our analysis when we use the changes in FFR to control for endogeneity. We include inflation, GDP growth, housing price index, and mortgage demand to our regressions. Mortgage demand data comes from "Senior Loan Officer Opinion Survey on Bank Lending Practices" survey. The rest of the macro variables come from FRED. In the robustness analysis, we show that when we include more common controls, namely only inflation and GDP growth, our results remain intact.

Hypothesis and Methodology: a road map

Our hypothesis is that banks with higher shares of ARMs experience relatively stronger performance when the Federal Reserve tightens its monetary policy stance. The underlying reason is that these banks are likely to benefit from increased interest income resulting from higher interest rates. To substantiate our hypothesis, we present three sets of evidence.

First, we analyze bank stock prices. According to our hypothesis, when interest rates rise, banks with larger ARM shares should outperform their counterparts in terms of stock prices. To examine this, we utilize monetary policy surprises derived from high-frequency data.

The second implication of our hypothesis is that banks with larger shares of ARM would increase their lending more compared to banks with lower ARM shares in response to rising interest rates at the back of higher anticipated interest income. To verify this implication, we examine how the reaction of bank C&I lending to changes in the FFR differs depending on the banks' ARM share. To test these implications, we utilize both bank-level data from Call Reports and loan-level data from DealScan. In our lending analysis, we use the changes in the FFR as the key monetary policy rate, given the small magnitudes of high-frequency surprises (ranging from a minimum of -5 basis points to a maximum of 3.3 basis points) and the limited time coverage (starting in 2003). To mitigate the endogeneity of changes in the FFR, we incorporate control variables including GDP, inflation, housing price index, and mortgage demand (along with their interactions with the ARM share) in our benchmark regression. Additionally, we conduct robustness checks by including only inflation and GDP growth as they have been the common controls in the literature.

Finally, we employ local projection methods along with data from Call Reports to demonstrate that banks with larger shares of ARM do indeed experience higher interest income in response to an increase in FFR compared to banks with lower ARM shares.

In Appendix A, we present robustness results for the lending analysis and explore the underlying mechanism of interest income using high-frequency monetary policy shocks. Our findings align with and substantiate our initial results.

4 Bank stock price response to surprise monetary policy shocks

We first examine how the responses of banks' stock prices to changes in monetary policy vary depending on the share of ARMs in their balance sheets. The analysis benefits from the ability to measure the impact within a relatively short time frame (daily), which helps to minimize the influence of confounding factors on identification. Moreover, the data quality is also very high, therefore, even the effects of small changes in monetary policy can be identified.

To test our hypothesis, we regress the daily changes in bank stock prices (comparing the day before and after monetary policy events) on the interaction between banks' ARM shares and monetary policy shocks. The estimated equation is as follows:

$$\Delta Y_{it} = \alpha * ARM_{i,t} * MP_{shock,t} + \sum \gamma_i (BV_{i,t} * MP_{shock,t}) + \beta * Y_{i,t-1} + \nu_t + \theta_i + \epsilon_{i,t} \quad (1)$$

where the dependent variable $\Delta Y_{i,t}$ is the percent change in stock prices of bank i between day $t+1$ and $t-1$ where t is the time of monetary policy shock, $ARM_{i,t}$ is the share of ARM loans relative to assets, $MP_{shock,t}$ is the surprise change in short term (1 month) yields around monetary policy events, $BV_{i,t}$ is bank balance sheet variables, $Y_{i,t-1}$ lagged dependent variable.[10] ν_t and $\theta_i$are

[10]For $ARM_{i,t}$and $BV_{i,t}$ we use balance sheet values corresponding to the quarter from Call Reports data.

time and bank fixed effects. For the variables that we include interactions, the model incorporates each variable individually as well. We use lagged dependent variables, specifically the past bank equity price dynamics, to account for bank-specific pre-shock price dynamics. To control for time-invariant bank characteristics, we include bank fixed effects, and to account for aggregate developments common to all banks, we include time fixed effects. Our hypothesis suggests a positive relationship for the interaction term α.

We use monetary policy shock series obtained from high-frequency data.[11] The idea is that high-frequency changes in short-term bond yields around monetary policy announcements correspond to unexpected changes in monetary policy stance, rather than other macro developments. As a result, with this shock series, we do not need to control for other macro developments.

One potential concern in our specification is the presence of omitted variable bias, which arises from the potential correlation between banks' ARM share and other bank characteristics that could independently influence the response of banks' interest income or lending to monetary policy.[12] To alleviate the concerns regarding omitted variables, we include an extensive set of control variables in Equation 1. Notably, these controls are not only directly included but also interacted with the monetary policy shocks ($\mathsf{BV}_{i,t} * \mathsf{MP}_{shock,t}$ in Equation 1). These control variables encompass crucial determinants highlighted in the literature that influence the transmission of monetary policy to bank lending. Specifically, we include variables such as bank size (e.g., Kashyap and Stein (1995)), leverage (e.g., Kishan and Opiela (2000)), local deposit concentration (e.g. Drechsler et al. (2017)), and the share of liquid assets on banks' balance sheets (Kashyap and Stein (2000)). Additionally, we control for other bank assets with a maturity of less than a year, excluding ARMs. In several specifications, we also account for the structure of bank liabilities, as this may be crucial if banks with high ARM shares adjust their liabilities based on their ARM holdings, potentially introducing bias into our results. To address this, we gradually introduce control variables for saving deposits, time-sensitive liabilities, and Fed funds repo liabilities into our model, thereby

[11] See for example English et al. (2018).

[12] Albertazzi et al. (2020) finds that for European countries higher the past inflation volatility and higher correlation between short-term interest rate and unemployment drive lower the ARM share.

capturing the liability structure.

Baseline results Table II presents our findings. In all specifications, we incorporate bank fixed effects, dependent variable lags, and bank controls. We begin with a specification (Column 1) that solely considers the asset side of bank balance sheets, without interacting the monetary policy shocks with other bank variables (other than the ARM share) and without incorporating time fixed effects. Moving to Column 2, we introduce the interaction between monetary policy shocks and other bank balance sheet variables. In Column 3, we include year and month fixed effects. Starting from Column 4, we incorporate time fixed effects. Furthermore, Columns 5 and 6 also account for bank liabilities in the analysis.

Our findings consistently demonstrate that banks with higher ARM shares experience a relatively greater increase in equity prices in response to a positive monetary policy surprise. The results are economically significant, as well. Comparing banks with 75th and 25th percentiles of ARM shares (0.071 vs 0.014), a one standard deviation positive monetary policy shock (0.94 basis point) would raise equity prices by 0.043-0.085 percent more for the former bank. While significant, realize that there is a relatively small variation in the ARM share in our sample. If for example, one were to compare a bank in Europe that has 100 percent residential loans in the form of ARMs (not uncommon), to a bank in the US with zero ARM share, then the effect on bank stock prices would be close to 1 percent.

Asymmetry: The role of refinancing It is reasonable to anticipate that the refinancing option in FRM contracts makes them somewhat comparable to ARM contracts when interest rates decrease. However, it is crucial to recognize that refinancing comes with costs, which distinguishes FRMs from ARMs. Consequently, not all mortgage borrowers opt for refinancing. Nonetheless, we anticipate that the impact of ARM share would be diminished (or insignificant) in the presence of a negative monetary policy shock.

We examine this hypothesis by estimating separate coefficients for positive and negative monetary policy shocks. We report our results in Table III. Our empirical results affirm the validity of our prediction. Specifically, for positive monetary policy surprises, the effects of ARM shares are statistically significant , and they exceed the magnitudes observed in our benchmark results reported in Table II. However, the coefficients for negative monetary policy shocks are statistically insignificant.

Hedging Banks could have hedged their exposure to monetary policy surprises. In that case, we would have found insignificant results. Therefore, our positive and significant results suggest that banks do not hedge their interest risk exposures. In this part of the analysis, we add several controls for hedging. In particular, we include fixed rate swaps, total swaps, net hedging, and gross hedging information available in the Call Reports data. Admittedly, available data is not perfect. For most of the hedging variables, it is not possible to identify which side of the contract the banks are on. For this exercise, we use a highly saturated specification where we include time fixed effects and the interaction of the monetary policy shock with bank variables.

We demonstrate that controlling for hedging does not alter our results (Table IV). The impact of ARM shares remains significant, and the magnitude remains consistent with our benchmark values. The effect of hedging remains similar across different instruments. Surprisingly, the coefficient on fixed-rate swap contracts is also insignificant. This finding is unexpected because fixed-rate swaps are typically considered a potent hedging tool against interest rate risk.

Robustness One concern might be that the 2008 crisis might have affected the ARMs more than the FRMs. In particular, ARMs, which were more prevalent in high house price regions, may have been more affected by the crisis due to larger declines in house prices. Consequently, the supportive monetary policy (and other policies) implemented after 2008 could potentially bias our findings. To mitigate this issue, we narrow our sample to data before 2007. The results of our analysis during the pre-crisis period, as presented in Table V (left three panels), demonstrate that our findings remain robust. The estimated coefficients continue to be statistically significant and even larger than our benchmark estimates.

We also explore whether our results are driven by banks with extremely low or high shares of mortgages. To examine this, we repeat the regressions after trimming the sample to exclude observations below the 1st and above the 9th deciles of real estate loan shares relative to assets. The results, as shown in Table V (right three panels), reveal that all coefficients on the interaction term remain significant and positive. This suggests that our results are not driven by extreme real estate loan shares.

5 Lending analysis: bank level commercial and industrial loans

In this section, we provide additional support from bank lending behavior. This is important since if the ARM shares influence bank lending behavior in response to changes in monetary policy stance, then it has potentially important real economic consequences.

While the utilization of monetary policy shocks derived from high-frequency analysis helps to address several identification challenges, it is important to acknowledge the limitations associated with this approach. Firstly, due to data constraints, these shocks do not extend back to the 1990s. Secondly, as markets often closely anticipate changes in monetary policy, the resulting shocks are typically small in magnitude. Thirdly, high-frequency shocks only capture monetary policy events and do not encompass other unexpected macroeconomic developments, such as market reactions to unexpectedly high inflation. To overcome these limitations, we adopt changes in FFR as our monetary policy variable for the subsequent sections of the paper. At the same time, in Appendix A we provide robustness results with high-frequency monetary policy shocks, which mostly confirms our results with FFR.

For bank lending analysis we estimate the model in Equation 2:

$$\begin{aligned} \Delta CILOANS_{it} = & \sum_{k=0}^{k=4} \alpha_{k,d}(ARM_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \sigma_{k,d}(ARM_{i,t-1} * \Delta Macros) \\ & + \sum_{k=0}^{k=4} \gamma_{i,k,d}(BV_{i,t-1} * \Delta FFR_{t-k}) + \lambda_{k,d} Y_{i,t-k} + \nu_t + \theta_i + \epsilon_{i,t+d}. \end{aligned} \tag{2}$$

where the dependent variable $\Delta CILOANS_{it}$ is the quarterly percent change in quarterly average C&I loans of a bank. The advantage of specifically examining C&I loans is that this category excludes mortgages. If we were to estimate a regression model using total bank loans as the dependent variable, it would include ARMs and introduce potential ambiguity in interpreting the bank lending results. In the model $ARM_{i,t-1}$is the share of ARM loans relative to assets, ΔFFR is the quarterly change in the federal funds rate, $BV_{i,t-1}$ represents the bank balance sheet variables, $Y_{i,t-1}$ lagged dependent variable, and $\Delta Macros$ are macroeconomic variables such as inflation, GDP growth, housing price growth, and mortgage demand. Whenever we have an interaction of two variables, we also include the variables individually as long as it is feasible (not written explicitly in Equation 2).[13] Furthermore, we include time fixed effects (ν_t) to capture economy-wide developments and bank fixed effects (θ_i) to account for time-invariant bank characteristics. By including these fixed effects, we can control for the effects of broader economic trends and the specific attributes of individual banks that may confound our analysis. We account for serial correlation by clustering standard errors at the bank holding company level.[14] Our specification extends the one used by Gomez et al. (2021).[15]

We need to address several identification concerns. One important concern is the potential endogeneity of changes in the FFR. The decision of the Federal Reserve to adjust the policy rate is typically driven mainly by inflation, macroeconomic conditions, and financial developments. It is plausible that these factors, rather than the FFR itself, could be influencing our results. To mitigate this concern, we incorporate major aggregate dynamics (inflation, GDP growth, housing price index, and mortgage demand) and their interactions with ARM share (represented by ($ARM_{i,t-1} * \Delta Macro$ in Equation 2). This allows us to control for the influence of these alternative drivers on our findings.

The other concern (the same concern that we discussed in more detail in Section 4) is that several other bank balance sheet variables are found to be important for monetary policy transmission.

[13]Sometimes it is not feasible. For example, when we use time fixed effects, individual macroeconomic variables drop.

[14]Clustering at the bank holding company and time levels (when we use quarterly fixed effects similar to Gomez et al. (2021)) yields qualitatively similar estimates. We also note that Abadie et al. (2023) show that employing the entire population of clusters and all observations within clusters obviates the need for correcting for clustering and may even be harmful, unless the treatment assignment process itself is clustered.

[15]The specification also similar to the ones used in Kashyap and Stein (1995), Kashyap and Stein (2000), and Campello (2002).

If we exclude them, our coefficient of interest may be biased. To alleviate this concern, in the regressions, we control for commonly used bank balance sheet variables in the literature (see Section 4 for a longer discussion). We also add controls where we interact these bank variables with monetary policy shocks.

Baseline results: We present our results in Table VII. We begin with a baseline specification that includes both time and bank fixed effects while controlling solely for the asset side of the bank balance sheets (Column 1). In Column 2, we introduce the interaction between macroeconomic variables and the bank controls related to the asset side. We include the interaction of the changes in FFR and ARM shares in Column 3. Moving on to Columns 4 and 5, we extend our analysis by incorporating control variables for bank liabilities, specifically savings deposits, time-sensitive deposits, and Fed funds repo liabilities.

The coefficients associated with the interaction term consistently demonstrate a positive relationship across all specifications, in line with our hypothesis. These findings indicate that banks with higher proportions of ARM loans in their balance sheets exhibit a greater increase in C&I lending when the FFR rises relative to banks with lower ARM shares. Moreover, the results suggest economically significant effects. For instance, banks with an ARM share at the 75th percentile (0.083) experience a C&I lending increase of 0.37-0.44 percentage points more compared to banks with an ARM share at the 25th percentile (0.009) when there is a one standard deviation rise in the FFR (0.39 percentage points). This magnitude is noteworthy considering that the average growth in C&I loans in the dataset stands at 2.8 percent.

Asymmetry: In addition to our analysis of the overall impact of ARM shares on bank lending, we also investigate the asymmetric effects of ARM shares during tightening and loosening episodes of monetary policy, similar to our analysis in Section 4. We expect that banks with higher ARM shares would respond positively to tightening episodes by increasing their lending compared to banks with lower ARM shares. However, we anticipate that during loosening episodes, the difference in lending behavior between banks with high and low ARM shares would be diminished or become insignificant.

To examine these predictions, we estimate separate coefficients for tightening and loosening episodes in our regression analysis. The results, as presented in Table VIII, provide empirical support for our hypothesis. Specifically, the coefficient on the interaction term is positive and mostly statistically significant for the tightening episodes, indicating that banks with higher ARM shares indeed increase lending (compared to banks with lower ARMs) during these periods. On the other hand, the coefficient associated with the interaction term is insignificant for the loosening episodes, suggesting that the difference in lending behavior between banks with high and low ARM shares is not observed during periods of monetary policy loosening.

Robustness: To ensure the robustness of our findings, we conduct a series of additional tests, akin to the ones presented in Section 4. One potential concern is the possibility that our results are driven by post-2008 developments, such as the financial crisis. To address this concern, we limit our sample to the period before 2007 and re-estimate our regressions. The results of these analyses are presented in the first three columns of Table IX. Our results remain consistent during the pre-crisis period, reaffirming the robustness of our findings. This suggests that the observed relationship between ARM shares and bank lending behavior is not solely influenced by the post-2008 developments, but rather holds across a broader time frame.

Additionally, we perform regressions using a trimmed sample, where we exclude observations falling below the 1st decile and above the 9th decile of real estate loans relative to assets. This allows us to investigate whether extreme values of real estate loan shares disproportionately impact our results. The results, presented in the right three columns of Table IX, indicate that the coefficients associated with the interaction term remain significant and positive. This further supports the notion that our findings are not driven by outlier observations with extreme real estate loan shares.

To further validate the robustness of our findings, we explore the impact of alternative macroeconomic variables on the relationship between ARM shares and bank lending behavior. Traditionally, the Fed has targeted GDP growth (full employment more precisely) and inflation. Therefore, it is essential to investigate whether our results hold when focusing solely on these traditional indicators. To this end, we conduct additional regression analyses using GDP growth and inflation as the main macroeconomic variables. The results of these alternative specifications are presented in Table X. The coefficients associated with the interaction term exhibit slightly larger magnitudes than our benchmark estimates and maintain their significance, indicating that our findings remain robust.[16]

As another robustness analysis, we consider the inclusion of smaller and larger banks in our sample. Our benchmark specification excludes banks below the seventh decile, aligning close to the sample selection criteria employed by Gomez et al. (2021).[17] To delve deeper into the potential heterogeneity across bank sizes, we divide our sample into two subgroups: "small banks" and "big banks". For the "small banks" sample, we exclude only the banks in the first decile based on their assets, while for the "big banks" sample, we exclude banks below the eighth decile. We present the results in Table XI, where Columns 1-3 correspond to the "small banks" sample, and Columns 4-6 represent the "big banks" sample. Notably, the coefficients associated with the interaction term in both samples are positive, aligning with our initial findings. However, the magnitudes of the coefficients are comparatively larger for the "big banks" sample.

6 Loan level analysis: controlling for loan demand

One potential concern with the previous lending estimations is that it is not clear whether the observed results are driven by changes in credit demand or credit supply. This becomes particularly relevant if banks with higher ARM shares tend to extend more loans to firms that are more sensitive to monetary policy. To address this concern, we employ a strategy that utilizes bank-firm level DealScan data to account for firm loan demand. This approach follows the methodology proposed by Khwaja and Mian (2008), where we examine firms that maintain credit relationships with multiple banks.

Specifically, we incorporate firm*time fixed effects, which effectively control for firm loan demand. By utilizing these fixed effects, we compare the loans provided by different banks to the same

[16] In Appendix C we present results where we also control for the level of the FFR. This might be important since, for example, zero lower bound for the FFR, puts a limit on further declines in ARM rates.

[17] Gomez et al. (2021) choose a sample where they drop the banks with assets lower than one billion USD.

firm within a given time period while adequately accounting for variations in demand. Therefore we can isolate the impact of banks' ARM shares on lending behavior while holding constant the firm-specific factors that drive loan demand. We estimate the following model:

$$\log(L_{ift}) = \delta_{ft} + \sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \sigma_k(ARM_{i,t-1} * \Delta Macro) \quad (3)$$
$$+ \sum_{k=0}^{k=4} \gamma_{i,k}(BV_{i,t-1} * \Delta FFR_{t-k}) + \theta_i + \epsilon_{i,t}$$

where the dependent variable $Log(L)_{ift}$ is the the natural logarithm of a loan from bank i to firm f at the time t, and $\delta_{ft}$is firm*time fixed effects. The rest of the specification is very similar to the one we used in the bank level analysis. $ARM_{i,t}$ is the share of ARM loans relative to assets, ΔFFR is the quarterly change in the federal funds are, $BV_{i,t-1}$ are bank balance sheet variables, and $\Delta Macro$ are macroeconomic variables such as inflation, GDP growth, housing price index, and mortgage demand. θ_i are bank fixed effects. Whenever we have an interaction of two variables, we also include the variables individually as long as it is feasible.[18]

Baseline results: We present our findings in Table XIII. We start with a baseline specification that incorporates firm*time and bank fixed effects while controlling solely for the asset side of bank balance sheets (Column 1). In Column 2, we introduce the interaction of macroeconomic variables with the ARM share to horse-race with the interaction of changes in FFR and ARM share. In Column 3, we further augment the model by including the interaction of the changes in FFR with the bank controls on the asset side. Columns 4 and 5 additionally control for bank liabilities along with their interactions with the changes in FFR. Our results consistently show that all coefficients on the interaction term are positive and significant. This implies that, for a given firm (i.e., loan demand is controlled for), banks with higher ARM shares exhibit a greater increase in loan supply compared to banks with lower ARM shares when the FFR increases. These results hold even after controlling for bank liabilities.

[18] We do not repeat the endogeneity concerns and how we address them here. See Section 5 for a detailed discussion.

The economic magnitude of these effects further underscores the importance of ARM shares in shaping banks' loan supply dynamics within the context of monetary policy. For instance, a bank positioned at the 75th percentile in terms of ARM share (0.054) increases its loan supply by 1.39-2.54 percent more compared to a bank positioned at the 25th percentile in terms of ARM share (0.013) in response to a one standard deviation increase in the FFR (0.39 percent).

Asymmetry: Table XIV presents our findings from estimating separate coefficients for monetary policy tightenings and loosenings. These results provide further confirmation of our hypothesis and earlier findings. Specifically, we observe that banks with higher ARM shares, in comparison to banks with low ARM shares, exhibit a significant and positive response in credit supply during monetary policy tightenings. However, their response to monetary policy loosenings is not significant.

Robustness: We conduct a series of robustness tests. Firstly, we restrict our sample to periods before 2007 to examine whether our results were influenced by post-2008 developments. The results, presented in Table XV, indicate that our findings are not driven solely by these post-crisis dynamics. Furthermore, we exclude variables such as house price growth and mortgage demand, and we re-estimate our specification with GDP growth and inflation. We consistently find that the coefficient on the interaction term between ARM shares and changes in the FFR remains significant and positive, as shown in Table XVI.[19]

7 The Mechanism

In this section, we aim to provide empirical evidence that demonstrates the direct impact of changes in the monetary policy rate on the interest income of banks with a larger ARM share. Given that ARM contracts are long-term in nature and that the adjustments on mortgage payments take time, the effects of monetary policy rate changes on interest income are expected to materialize over the medium to long term. To analyze this dynamic relationship, we adopt the local projection methodology proposed by Jordà (2005), which offers a suitable framework for our analysis.

[19] In Appendix C we present results where we also control for the level of the FFR.

To estimate the effects at various horizons, we use the model from our earlier specification in Equation 2. Specifically, we estimate following model:

$$\Delta Y_{i,t+d} = \sum_{k=0}^{k=4} \alpha_{k,d}(ARM_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \sigma_{k,d}(ARM_{i,t-1} * \Delta Macros) \\ + \sum_{k=0}^{k=4} \gamma_{i,k,d}(BV_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \lambda_{k,d} Y_{i,t-k} + \nu_t + \theta_i + \epsilon_{i,t+d}) \tag{4}$$

where the dependent variable $\Delta Y_{i,t+d}$ is several measures of interest income and interest expenses. As with earlier specifications, $ARM_{i,t-1}$ is the share of ARM loans relative to assets, ΔFFR is the quarterly change in monetary policy rates, $BV_{i,t-1}$ are bank balance sheet variables, $Y_{i,t-1}$ lagged dependent variable, and $\Delta Macros$ are macroeconomic variables. We denote time and bank fixed effects as ν_t and $\theta_i$are. For the variables that we include as interactions, we also include them individually.

This specification as well suffers from the same concerns that we needed to address in Section 5. As we did in Section 5 to alleviate omitted variable concerns, we include an extensive set of bank control variables (e.g. bank leverage, size, deposit concentration, liquid assets etc.) directly and their interactions with current and four lags of interest rate changes ($BV_{i,t-1} * \Delta FFR_{t-k}$ in Equation 4). To control for the endogeneity of the changes in FFR, we include major aggregate dynamics, and their interactions with ARM-shares and other bank variables in the regression ($ARM_{i,t-1} * \Delta Macros$ in Equation 4). Finally, we include time fixed effects to control for economy wide developments and bank fixed effects to control time invariant bank characteristics. We cluster standard errors at the bank holding company level to control for serial correlation.

Results: We provide our results in Figure 2. We plot the coefficient $\sum_{k=0}^{k=4} \alpha_{k,d}$ for different d quarters for various interest income and expense measures. In the upper-left panel of our analysis, we examine the impact of changes in FFR on banks' interest income on residential real estate loans relative to the size of their residential real estate loans. In the initial quarters, ranging from the first to the twelfth, an increase in interest rates leads to a relative decline in bank interest income for banks with higher ARM shares. In later periods, the coefficient on the interaction term between FFR and ARM-shares becomes positive and significant, indicating that higher ARM-share banks experience a subsequent increase in their interest income. We further explore the effect of monetary policy changes on banks' net interest income relative to assets, and interest income on loans relative loans (upper middle and right panels). We find that the positive relationship between interest rate changes and these measures of interest income also holds.

Our results imply economically large effects: the net interest income of a bank positioned at the 75th percentile in terms of ARM share (0.054) increases by an additional 0.5 basis points (from quarter 11 to quarter 24) compared to a bank positioned at the 25th percentile in terms of ARM share (0.013) in response to a one standard deviation increase in the FFR (0.39 percent). Moreover, since interest income is a flow variable, the total effect on bank interest income is additive. Therefore, the total effect exceeds 6 basis points. Another way to gauge the economic significance is to compare our estimates with changes in net interest income over 24 quarters (again we compare the banks with 75 and 25 percentiles). Our estimates correspond to on average 1.2 percent of the changes in net interest income over this horizon.

Additionally, we investigate interest income on non-mortgage loans, as depicted in the lower-left panel. We do not find an increase in interest income for banks with higher ARM-share when considering non-mortgage loans. This suggests that the positive effect of interest rate changes on interest income is specific to mortgage-related assets, highlighting the crucial role of ARM in driving the observed relationship between interest rate changes and bank interest income.

An alternative mechanism that we explore is the potential impact of the interaction between ARM-share and changes in the FFR on banks' interest expenses. The underlying mechanism is that this interaction may influence the level of interest expenses incurred by banks. One possibility is that banks with higher ARM shares, anticipating an increase in interest income in the future, may experience a decline in their interest expenses. This decline could be attributed to factors such as a reduction in bank risk, leading to lower borrowing costs. However, it is also plausible that banks with higher ARM shares might offer higher interest rates to attract more funding, thereby potentially increasing their interest expenses.

To empirically test this prediction, we employ interest expenses relative to assets, and interest expenses on deposits relative to deposits as the dependent variables in our analysis. In Figure 2, the lower middle and right panels display the findings from our analysis. These results align with the second mechanism. Specifically, as interest rates increase, banks with higher ARM shares experience a decline in their borrowing costs relative to other banks, particularly during the initial stages of the interest rate hike. However, over time, we observe a gradual increase in their interest expenses.

Overall, our analysis provides strong evidence of the differential impact of interest rate changes on banks' interest income and expenses depending on the share of ARMs on bank balance sheets. These findings underscore the importance of considering the medium- to long-term effects and the specific composition of banks' assets when examining the consequences of interest rate changes on their financial performance.

7.1 Non-performing Loans

A potential concern regarding the impact of a rise in interest rates on banks with higher ARM shares is the possibility of increased mortgage defaults by households. While it is true that higher interest payments from mortgages can benefit these banks, the potential default risk associated with households choosing to default on their mortgages may counteract these benefits. However, it is important to note that defaulting on mortgages incurs significant costs, which suggests that the effects from this channel are expected to be relatively small.

To quantitatively assess this mechanism, we estimate the same regression specification as presented in Equation 2, but with a different dependent variable. In this case, we use the changes in nonperforming loans on residential real estate loans as our dependent variable. We estimate the following model:

$$\begin{aligned} \Delta NPL_{it} = &\sum_{k=0}^{k=4} \alpha_{k,d}(ARM_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \sigma_{k,d}(ARM_{i,t-1} * \Delta Macro) \\ &+ \sum_{k=0}^{k=4} \gamma_{x,k,d}(BV_{i,t-1} * \Delta FFR_{t-k}) + \lambda_{k,d} Y_{i,t-k} + \nu_q + \theta_i + \epsilon_{i,t+d}. \end{aligned} \tag{5}$$

We present our findings in Table XVII.[20] We conduct estimations using both the full sample and a subsample before 2007, allowing us to account for changes in dynamics following the 2008 financial crisis.

Our results show no significant effects of changes in the FFR on NPLs in any of our estimates. There are several potential reasons for these findings. One possibility is that, despite the rise in mortgage costs payment, the costs associated with defaulting on mortgages are acting as a deterrent, limiting the response of households in defaulting on their loans. This suggests that the potential benefits from rising interest rates, such as increased interest payments from mortgages, may not be outweighed by the associated costs of default. Another possible explanation for the lack of significant effects is related to the changes in the FFR not generating sufficient declines in house prices. Negative equity, where homeowners owe more on their mortgages than the value of their homes, is a key driver of mortgage defaults. If changes in the FFR are not substantial enough to trigger significant declines in house prices, households may not be pushed into negative equity, thereby reducing the likelihood of defaults.

8 Conclusion

In this study, we have delved into examining the impact of ARMs on the transmission of monetary policy. While previous research has primarily focused on the effects of monetary policy on borrowers through changes in mortgage payments and disposable income, we argue that this perspective overlooks the crucial aspect of lenders' involvement. Therefore, in this paper, our emphasis lies on the lenders' role and investigates how banks with a higher proportion of ARMs contribute to the overall transmission of monetary policy.

When borrowers have ARMs, changes in monetary policy stance directly influence their mortgage payments, resulting in significant adjustments to their disposable income. Consequently, this change in disposable income has the potential to influence consumer spending. This mechanism is absent in the case of FRMs, as they do not experience immediate changes. As a result, from the

[20] For the definitions of the variables, and the discussion of identification see Section 5

perspective of this mechanism, the effectiveness of monetary policy transmission strengthens as the prevalence of ARMs increases.

Our research challenges this viewpoint by examining the role of lenders. We demonstrate that banks with a higher share of ARMs mitigate the transmission of monetary policy. For instance, when monetary policy tightens, these banks with a higher proportion of ARMs exhibit better equity price performance and engage in higher lending activities compared to their counterparts with lower ARM shares. Our analysis reveals that these outcomes can be attributed to changes in expected mortgage interest income for these banks.

Therefore, the overall impact of ARMs on monetary policy transmission depends on whether the lenders or borrowers are the marginal agents at a given time. Consequently, during periods of banking crises, such as the one witnessed in 2008, a higher prevalence of ARMs may even impede economic activity and amplify risks to financial stability when monetary policy is loosened. This is because banks on the brink of failure may encounter considerable difficulties when mortgage payments decrease due to lower interest rates, potentially pushing them toward closure. Hence, this mechanism suggests that the role of ARMs in monetary policy transmission is likely to be time-varying and contingent on the relative strengths of borrowers' and lenders' balance sheets.

The structure of the US mortgage market might influence some of our results. In particular, extensive securitization in the US mortgage market, and the existence of Fannie Mae and Freddie Mac (two government-sponsored enterprises), lower the size of the mortgages in bank balance sheets. And the investors that hold these mortgage securities might have balance sheets different from banks. As a result, the total effect of ARMs on monetary policy transmission is likely to be different than the ones implied by our estimates. However, our point that the investors who hold ARMs will suffer from lower rates remains.

We have not studied the question in a cross-country setup since we think the identification is stronger with bank-level data. However, the large variation in ARM shares across countries as documented in Albertazzi et al. (2020) suggests that the effects that we find here might exist at the country-level as well.

References

Abadie, A., S. Athey, G. W. Imbens, and J. M. Wooldridge (2023): "When should you adjust standard errors for clustering?" *The Quarterly Journal of Economics*, 138, 1–35.

Albertazzi, U., F. Fringuellotti, and S. Ongena (2020): "Fixed rate versus adjustable rate mortgages: evidence from euro area banks," *Swiss Finance Institute Research Paper*.

Begenau, J., M. Piazzesi, and M. Schneider (2015): "Banks' risk exposures," Tech. rep., National Bureau of Economic Research.

Calza, A., T. Monacelli, and L. Stracca (2013): "Housing finance and monetary policy," *Journal of the European Economic Association*, 11, 101–122.

Campello, M. (2002): "Internal capital markets in financial conglomerates: Evidence from small bank responses to monetary policy," *The Journal of Finance*, 57, 2773–2805.

Chava, S. and M. R. Roberts (2008): "How does financing impact investment? The role of debt covenants," *The Journal of Finance*, 63, 2085–2121.

Di Maggio, M., A. Kermani, B. J. Keys, T. Piskorski, R. Ramcharan, A. Seru, and V. Yao (2017): "Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging," *American Economic Review*, 107, 3550–88.

Di Tella, S. and P. Kurlat (2021): "Why are banks exposed to monetary policy?" *American Economic Journal: Macroeconomics*, 13, 295–340.

Drechsler, I., A. Savov, and P. Schnabl (2017): "The deposits channel of monetary policy," *The Quarterly Journal of Economics*, 132, 1819–1876.

English, W. B., S. J. Van den Heuvel, and E. Zakrajšek (2018): "Interest rate risk and bank equity valuations," *Journal of Monetary Economics*, 98, 80–97.

Ferrari, M., J. Kearns, and A. Schrimpf (2021): "Monetary policy's rising FX impact in the era of ultra-low rates," *Journal of Banking and Finance*, 129, 106142.

Garriga, C., F. E. Kydland, and R. Šustek (2017): "Mortgages and monetary policy," *The Review of Financial Studies*, 30, 3337–3375.

Gomez, M., A. Landier, D. Sraer, and D. Thesmar (2021): "Banks exposure to interest rate risk and the transmission of monetary policy," *Journal of Monetary Economics*, 117, 543–570.

Haddad, V. and D. Sraer (2020): "The banking view of bond risk premia," *The Journal of Finance*, 75, 2465–2502.

Hoffmann, P., S. Langfield, F. Pierobon, and G. Vuillemey (2019): "Who bears interest rate risk?" *The Review of Financial Studies*, 32, 2921–2954.

Ippolito, F., A. K. Ozdagli, and A. Perez-Orive (2018): "The transmission of monetary policy through bank lending: The floating rate channel," *Journal of Monetary Economics*, 95, 49–71.

Jordà, Ò. (2005): "Estimation and inference of impulse responses by local projections," *American Economic Review*, 95, 161–182.

Kashyap, A. K. and J. C. Stein (1995): "The impact of monetary policy on bank balance sheets," in *Carnegie-Rochester Conference Series on Public Policy*, Elsevier, vol. 42, 151–195.

——— (2000): "What do a million observations on banks say about the transmission of monetary policy?" *American Economic Review*, 90, 407–428.

Khwaja, A. I. and A. Mian (2008): "Tracing the impact of bank liquidity shocks: Evidence from an emerging market," *American Economic Review*, 98, 1413–42.

Kishan, R. P. and T. P. Opiela (2000): "Bank size, bank capital, and the bank lending channel," *Journal of Money, Credit and Banking*, 121–141.

Mishkin, F. S. (2007): "Housing and the monetary transmission mechanism," Tech. rep., National Bureau of Economic Research.

Önder, Y. K. (2022): "Optimal GDP-indexed Bonds," *Available at SSRN 4288346*.

Paul, P. (2023): "Banks, maturity transformation, and monetary policy," *Journal of Financial Intermediation*, 53, 101011.

9 Tables and Figures

Table I – **Descriptive Statistics for CRSP Data**

Variables	Definition	# Obs.	Mean	Median	Sd	Min	Max
Dependent Variables							
% Change in Stock Prices	Percent change in stock prices of bank b between day t+1 and t-1	44967	0.002	0.000	4.143	-36.845	35.667
Bank Variables							
ARM/Assets	The ratio of adjustable rate mortgages (RCON5370) to total assets (RCFD2170)	44967	0.050	0.032	0.053	0.000	0.314
Real Estate Loans /Assets	The ratio of real estate loans (RCFD1410) to total assets	44967	0.498	0.514	0.157	0.000	0.863
Assets	Assets in billions (in 2010 USD)	44967	28.898	1.845	182.255	0.050	2626.679
Log Assets	The natural logarithm of bank total assets (in 2010 USD)	44967	14.766	14.428	1.586	10.819	21.689
Equity/Assets	The ratio of equity (RCFD3210) to total assets	44967	0.102	0.098	0.027	0.013	0.335
Liquidity/Assets	The ratio of liquid assets (RCFD1773+RCFD1754) to total assets	44967	0.257	0.237	0.119	0.024	0.747
NPL/Assets	The ratio of nonperforming loans (RCFD1407+RCFD1403) to total loass	44967	0.023	0.012	0.029	0.000	0.233
BdF/Assets	The ratio of balances due from Fed (RCFD0090) to total assets	44967	0.012	0.001	0.028	0.000	0.262
HHI	Herfindahl-Hirschman Index at the county level for the deposit market	44967	0.187	0.175	0.083	0.000	0.871
Deposits/Assets	The ratio of deposits (RCON3485) to total assets	44967	0.767	0.789	0.102	0.273	0.945
AMY /Assets	The ratio of assets with a maturity of less than one year (RCFDA247) to total assets	44967	0.156	0.141	0.098	0.000	0.555
Saving Deposits/Assets	The ratio of saving deposits (RCON2389) to total assets	44967	0.364	0.362	0.145	0.020	0.747
Time Sensitive Deposits/Assets	The ratio of time sensitive deposits (RCONA579+ RCONA580+ RCONA584+ RCONA585+ RCFDF055+RCFDF060) to total assets	44967	0.221	0.206	0.108	0.005	0.684
Fed Repo /Assets	The ratio of Fed repo (RCFDB993+RCFDB995) to total assets	44967	0.036	0.021	0.045	0.000	0.335
Hedging Bank Variables (%)							
Fixed Rate Swaps/Assets	The ratio of fixed rate swaps (RCONA589) to total assets	44967	0.303	0.000	1.232	0.000	15.158
Total Swaps/Assets	The ratio of total swaps (RCON3450) to total assets	44967	1.271	0.000	3.517	0.000	32.511
Net Hedging/Assets	The ratio of net hedging (RCONA589 -(RCON3450-RCONA589)) to total assets	44967	-0.577	0.000	2.479	-19.085	14.032
Gross Hedging/Assets	The ratio of gross hedging (RCON8725+RCON8729) to total assets	44967	1.915	0.000	4.752	0.000	48.332
Shock Variables							
MP_{shock}	High-frequency identification around monetary policy events	44967	-0.037	0.000	0.940	-5.000	3.300
Positive MP_{shock}	Positive high-frequency shocks, otherwise zero	44967	0.233	0.000	0.538	0.000	3.300
Negative MP_{shock}	Negative high-frequency shocks, otherwise zero	44967	-0.269	0.000	0.685	-5.000	0.000

FIGURE 1 – ARM Shares and Monetary Policy Shocks

This figure plots three main variables that we use in the paper. The left panel plot the distribution of ARM share relative to real estate loans. The middle panel plots the surprise monetary policy shocks obtained from high-frequency intra-day data. The right panel plots the quarterly changes in Federral Funds Rate.

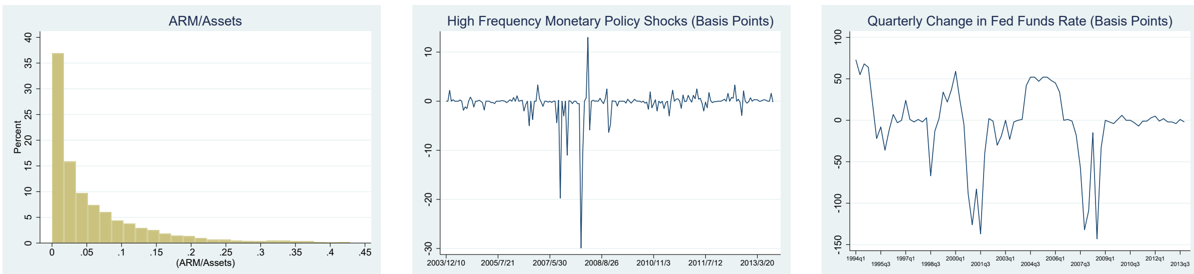


Table II – **Bank Stock Price Reactions to High-Frequency Shocks**

Dependent Variable: Change in bank stock prices						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha * ARM_{i,t} * MP_{shock}$	0.015***	0.008*	0.011**	0.011**	0.012***	0.012***
standard errors	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
TIME FE	N	N	N	Y	Y	Y
YEAR*MONTH FE	N	N	Y	-	-	-
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS $* MP_{shock}$	N	Y	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	N	Y	Y
BANK LIABILITY CONTROLS $* MP_{shock}$	N	N	N	N	Y	Y
BANK FED FUNDS LIABILITY	N	N	N	N	N	Y
BANK FED FUNDS LIABILITY $* MP_{shock}$	N	N	N	N	N	Y
Impact of 1 SD increase in MP_{shock} (bp) Low vs High ARM Banks (Difference between 75th and 25th percentiles)	0.082	0.043	0.060	0.0680	0.0685	0.065
Observations	25008	25008	25008	25008	25008	25008
R-squared	0.159	0.161	0.314	0.367	0.367	0.367

Notes: The table reports estimates for the Equation 1 from ordinary least squares regressions. The dependent variable is the % change in bank stock prices between day t+1 and t-1 where monetary policy shock is realized at time t. Table I contains the definition of all variables and the summary statistics for each included variable. The main independent variable is the monetary policy shock, MP_{shock}, obtained from high-frequency identification around monetary policy events. The coefficient of interest is the interaction of MP_{shock}, with the ratio of adjustable rate mortgages (ARM) to bank assets. It measures how ARM mortgage share changes the effect of the changes in MP_{shock},. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls, after Column 5, include saving deposits and time sensitive deposits instead of deposits used in Columns 1-3. Column 6 includes Fed funds repo liabilities in addition to the bank variables used. Analysis covers the period of 2003:Q4 – 2013:Q4, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the BHC and quarter level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

TABLE III – **Bank Stock Price Reactions—Asymmetric Effects of Tightening and Loosening**

Dependent Variable: Change in bank stock prices						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha^{+} * ARM_{i,t} * MP^{+}_{shock}$	0.026***	0.019*	0.02**	0.02**	0.021**	0.021**
standard errors	(0.01)	(0.011)	(0.01)	(0.01)	(0.01)	(0.01)
$\alpha^{-} * ARM_{i,t} * MP^{-}_{shock}$	-0.004	-0.013	-0.008	-0.008	-0.007	-0.007
standard errors	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
TIME FE	N	N	N	Y	Y	Y
YEAR*MONTH FE	N	N	Y	-	-	-
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS $* MP^{+,-}_{shock}$	N	Y	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	N	Y	Y
BANK LIABILITY CONTROLS $* MP^{+,-}_{shock}$	N	N	N	N	Y	Y
BANK FED FUNDS LIABILITY	N	N	N	N	N	Y
BANK FED FUNDS LIABILITY $* MP^{+,-}_{shock}$	N	N	N	N	N	Y
Observations	7906	7906	7906	7906	7906	7906
R-squared	0.257	0.27	0.399	0.399	0.399	0.399

Notes: The table reports estimates for the Equation 1 from ordinary least squares regressions where we estimate separate coefficients for positive and negative shocks. The dependent variable is the % change in bank stock prices between day t+1 and t-1 where monetary policy shock is realized at time t. Table I contains the definition of all variables and the summary statistics for each included variable. Positive MP_{shock}, is defined as the positive shocks, obtained from high-frequency identification around monetary policy events, otherwise zero. Negative MP_{shock}, is similarly defined as the negative shocks, otherwise zero.The coefficient of interest is the interaction of positive and negative MP_{shock}, with the ratio of ARM to bank assets. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Column 4 offers full sets of fixed effects along with double interactions for those bank variables. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 5. Column 6 includes Fed funds repo liabilities. Analysis covers the period of 2003:Q4 – 2013:Q4, however we exclude 2007 and 2008, the housing crises period. We trim positive and negative MP_{shock}, which are smaller than absolute value of 0.4. Standard errors are two-way clustered at the BHC and quarter level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table IV – **Bank Stock Price Reactions—Hedging**

Dependent Variable: Change in bank stock prices								
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\alpha * \mathsf{ARM}_{i,t} * \mathsf{MP}_{shock}$	0.011**	0.011**	0.011**	0.011**	0.011***	0.012***	0.012***	0.012***
standard errors	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
TIME FE	Y	Y	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y	Y	Y
BANK CONT. $* \mathsf{MP}_{shock}$	Y	Y	Y	Y	Y	Y	Y	Y
BANK LIAB. CONT.	N	N	N	N	Y	Y	Y	Y
BANK LIAB. CONT. $* \mathsf{MP}_{shock}$	N	N	N	N	Y	Y	Y	Y
FIXED RATE SWAPS	Y	N	N	N	Y	N	N	N
TOTAL SWAPS	N	Y	N	N	N	Y	N	N
NET HEDGING	N	N	Y	N	N	N	Y	N
GROSS HEDGING	N	N	N	Y	N	N	N	Y
Observations	25008	25008	25008	25008	25008	25008	25008	25008
R-squared	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367

Notes: The table reports estimates for the Equation 1 from ordinary least squares regressions. The dependent variable the % change in bank stock prices between day t+1 and t-1 where monetary policy shock is realized at time t. Table I contains the definition of all variables and the summary statistics for each included variable. The main independent variable is the monetary policy shock, MP_{shock},, obtained from high-frequency identification around monetary policy events. The coefficient of interest is the interaction of MP_{shock}, with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in MP_{shock},. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 5. Alternative hedging variables are included interchangeably in all columns along with their MP_{shock}, interactions. Analysis covers the period of 2003:Q4 – 2013:Q4, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the BHC and quarter level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table V – **Bank Stock Price Reactions—Robustness: Before 2007 and Exclusion of Lower and Upper Deciles of ARM/A**

Dependent Variable: Change in bank stock prices						
	Before 2007			Trimmed Sample		
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha * \mathsf{ARM}_{i,t} * \mathsf{MP}_{shock}$	0.011**	0.011**	0.011**	0.017***	0.016**	0.017**
standard errors	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS $* \mathsf{MP}_{shock}$	Y	Y	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	Y	Y	N	Y	Y
BANK LIABILITY CONTROLS $* \mathsf{MP}_{shock}$	N	Y	Y	N	Y	Y
BANK FED FUNDS LIABILITY	N	N	Y	N	N	Y
BANK FED FUNDS LIABILITY $* \mathsf{MP}_{shock}$	N	N	Y	N	N	Y
Observations	7497	7497	7497	14920	14920	14920
R-squared	0.415	0.416	0.416	0.373	0.373	0.373

Notes: The table reports estimates for the Equation 1 from ordinary least squares regressions. The dependent variable is the % change in bank stock prices between day t+1 and t-1 where monetary policy shock is realized at time t. Table I contains the definition of all variables and the summary statistics for each included variable. The main independent variable is the monetary policy shock, MP_{shock}„ obtained from high-frequency identification around monetary policy events. The coefficient of interest is the interaction of MP_{shock}, with the ratio of adjustable rate mortgages (ARM) to bank assets. It measures how ARM mortgage share changes the effect of the changes in MP_{shock},. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits instead of deposits. Fed funds repo liabilities in addition to the bank variables. Columns 1-3 provide results for the period of 2003:Q4 – 2006:Q4, excludes the period after 2007, the housing crises and low-interest rate period. Columns 4-6 represent results for the period of 2003:Q4 – 2013:Q4 with exclusion of 2007 and 2008, the housing crises period, and lower and upper deciles of ARM/A. Standard errors are two-way clustered at the BHC and quarter level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table VI – **Descriptive Statistics for Call Reports (Bank Level) Data**

Variables	Definition	# Obs.	Mean	Median	Sd	Min	Max
Dependent Variables							
% Change in Commercial Loans	Change of logarithm of commercial and industrial loans of bank b between t and t-1	30519	0.028	0.018	0.143	-1.766	1.074
Change NPL for RE Loans/L.RE Loans (%)	Change in the NPL for real estate loans divided by the lagged of real estate loans	14325	0.003	0.000	0.100	-1.202	1.160
Change in (Int. Income RE Loans/L.RE Loans) (%)	Change in the ratio of interest income from real estate loans to lagged of real estate loans	29907	-0.009	-0.004	0.441	-4.665	4.613
Change in (Int. Income Loans/L.Loans) (%)	Change in the ratio of interest income from total loans to lagged of total loans	30470	-0.019	-0.003	0.275	-2.665	1.665
Change in (Net Int. Income /L.Loans) (%)	Change in the ratio of net interest income to lagged of total loans	30470	-0.035	-0.008	0.395	-4.770	1.636
Change in (Int Exp on Deposits /L.Deposits) (%)	Change in the ratio of interest expenditure of deposits to lagged of deposits	30469	-0.006	-0.002	0.118	-0.741	0.743
Change in (Int Exp on Deposits /L.Assets) (%)	Change in the ratio of interest expenditure of deposits to lagged of assets	30470	-0.004	-0.002	0.099	-0.607	0.630
Bank Variables							
ARM/Assets	The ratio of adjustable rate mortgages to total assets	30519	0.060	0.030	0.075	0.000	0.428
Real Estate Loans /Assets	The ratio of real estate loans to total assets	30519	0.418	0.426	0.179	0.000	0.836
Assets	Assets in billions (in 2010 USD)	30519	15.772	1.778	88.987	0.457	1873.869
Log Assets	The natural logarithm of bank total assets (in 2010 USD)	30519	14.782	14.391	1.397	13.033	21.351
Equity/Assets	The ratio of equity to total assets	30519	0.096	0.088	0.040	0.025	0.784
Liquidity/Assets	The ratio of liquid assets to total assets	30519	0.278	0.259	0.138	0.010	0.876
NPL/Assets	The ratio of nonperforming loans to total loans	30519	0.013	0.007	0.021	0.000	0.202
BdF/Assets	The ratio of balances due from Fed (RCFD0090) to total assets	30519	0.012	0.003	0.031	0.000	0.527
HHI	Herfindahl-Hirschman Index for the deposit market	30519	0.178	0.167	0.089	0.042	0.899
Deposits/Assets	The ratio of deposits to total assets	30519	0.739	0.778	0.150	0.001	0.945
AMY/Assets	The ratio of assets with a maturity of less than one year (AMY) to total assets	30519	0.157	0.141	0.108	0.000	0.610
Saving Deposits/Assets	The ratio of saving deposits to total assets	30519	0.308	0.300	0.144	0.000	0.945
Time Sensitive Deposits/Assets	The ratio of time sensitive deposits to total assets	30519	0.238	0.231	0.115	0.000	0.818
Fed Repo /Assets	The ratio of Fed repo to total assets	30519	0.052	0.033	0.056	0.000	0.204
Macro Variables							
Changes in Fed Funds Rate	Quarterly change in federal funds rate	30519	0.020	0.010	0.387	-1.370	0.590
Inflation	Percent change in CPI (quarterly)	30519	0.006	0.006	0.004	-0.007	0.015
% Change in GDP	Percent change in GDP (quarterly)	30519	3.044	3.600	2.862	-8.400	7.500
Change in Housing Prices	Change in housing price index (quarterly)	30519	0.012	0.014	0.012	-0.028	0.038
Mortgage Demand Index	Change in mortgage demand index (quarterly)	30519	-3.858	-5.800	33.880	-63.500	63.500

Table VII – **The Response of Commercial and Industrial Loans at Bank Level**

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.153***	0.134**	0.133**	0.136**	0.129**
standard errors	(0.052)	(0.069)	(0.067)	(0.067)	(0.067)
TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Impact of 1 SD increase in FFR (pp) Low vs High ARM Banks (Difference between 75th and 25th percentiles)	0.453	0.397	0.394	0.403	0.382
Observations	27825	27825	27825	27825	27825
R-squared	0.114	0.115	0.117	0.118	0.118

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes inΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

TABLE VIII – **The Response of Commercial and Industrial Loans at Bank Level—Asymmetric Effects of Tightening and Loosening**

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k^{+}(ARM_{i,t-1} * \Delta FFR_{t-k}^{+})$	0.161	0.386+	0.386+	0.396*	0.389+
standard errors	(0.121)	(0.244)	(0.244)	(0.247)	(0.246)
$\sum_{k=0}^{k=4} \alpha_k^{-}(ARM_{i,t-1} * \Delta FFR_{t-k}^{-})$	0.116	-0.022	-0.022	-0.018	-0.021
standard errors	(0.075)	(0.097)	(0.097)	(0.097)	(0.097)
TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k^{+,-}(\text{BANK CONT.} * \Delta FFR_{t-k}^{+,-})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k^{+,-}(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k}^{+,-})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k^{+,-}(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k}^{+,-})$	N	N	N	N	Y
Observations	27825	27825	27825	27825	27825
R-squared	0.114	0.116	0.116	0.115	0.116

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable.The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k} Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%. +Significant at 11%.

Table IX – **The Response of Commercial and Industrial Loans at Bank Level—Robustness: Before 2007 and Exclusion of Lower and Upper Deciles of ARM/A**

Dependent Variable: Change in Commercial Loans						
	Sample Before 2007			Trimmed Sample		
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.198**	0.197**	0.188**	0.149*	0.144*	0.132+
standard errors	(0.082)	(0.081)	(0.081)	(0.09)	(0.089)	(0.09)
TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	Y	Y	Y	Y	Y	Y
MACROS	-	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	Y	Y	Y	Y	Y	Y
BANK LIABILITY CONT.	N	Y	Y	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	Y	Y	N	Y	Y
BANK FED FUNDS LIAB.	N	N	Y	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	Y	N	N	Y
Observations	22634	22634	22634	22615	22615	22615
R-squared	0.117	0.117	0.118	0.134	0.135	0.135

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable.The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits instead of deposits. Fed funds repo liabilities in addition to the bank variables. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Columns 1-3 provide results for the period of 1994:Q1 – 2006:Q4, excludes the period after 2007, the housing crises and low-interest rate period. Columns 4-6 represent results for the period of 1994:Q1 – 2013:Q4 with exclusion of 2007 and 2008, the housing crises period, and lower and upper deciles of ARM/A. All analysis is done using quarterly data. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%. $^{+}$Significant at 13%.

Table X – **The Response of Commercial and Industrial Loans at Bank Level—Robustness: Alternative Macro Variables**

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.153***	0.155**	0.154**	0.157**	0.15**
standard errors	(0.052)	(0.071)	(0.068)	(0.068)	(0.068)
TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	27825	27825	27825	27825	27825
R-squared	0.114	0.115	0.116	0.117	0.117

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 inludes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table XI – **The Response of Commercial and Industrial Loans at Bank Level—Robustness: Small and Large Banks**

Dependent Variable: Change in Commercial Loans						
	Small Banks			Large Banks		
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.081*	0.084**	0.081*	0.181*	0.194**	0.188**
standard errors	(0.044)	(0.044)	(0.044)	(0.1)	(0.097)	(0.097)
TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	Y	Y	Y	Y	Y	Y
MACROS	-	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	Y	Y	Y	Y	Y	Y
BANK LIABILITY CONT.	N	Y	Y	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	Y	Y	N	Y	Y
BANK FED FUNDS LIAB.	N	N	Y	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	Y	N	N	Y
Observations	59433	59433	59433	19252	19252	19252
R-squared	0.106	0.106	0.107	0.123	0.124	0.124

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits instead of deposits. Fed funds repo liabilities in addition to the bank variables. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Columns 1-3 provide results for the banks excluding the first decile of banks. Columns 3-6 represent results for the banks excluding up to seventh decile of banks. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table XII – **Descriptive Statistics for DealScan (Loan Level) Data**

Variables	Definition	#Obs	Mean	Median	Sd	Min	Max
Dependent Variables							
$Log(Loans)_{ibt}$)	The natural log. of total loans of firm i from bank b at time t.	150177	16.946	16.884	1.252	5.145	23.153
Bank Variables							
ARM/Assets	The ratio of adjustable rate mortgages to total assets	150177	0.039	0.029	0.036	0.000	0.335
Real Estate Loans /Assets	The ratio of real estate loans to total assets	150177	0.245	0.259	0.123	0.000	0.804
Assets	Assets in billions (in 2010 USD)	150177	424.302	160.683	496.721	0.493	1873.869
Log Assets	The natural logarithm of bank total assets (in 2010 USD)	150177	19.054	18.895	1.410	13.109	21.351
Equity/Assets	The ratio of equity to total assets	150177	0.089	0.085	0.023	0.042	0.290
Liquidity/Assets	The ratio of liquid assets to total assets	150177	0.238	0.225	0.109	0.012	0.803
NPL/Assets	The ratio of nonperforming loans to total loans	150177	0.018	0.010	0.018	0.000	0.132
BdF/Assets	The ratio of balances due from Fed (RCFD0090) to total assets	150177	0.016	0.003	0.036	0.000	0.527
HHI	Herfindahl-Hirschman Index for the deposit market	150177	0.187	0.178	0.077	0.048	0.815
Deposits/Assets	The ratio of deposits to total assets	150177	0.531	0.545	0.172	0.070	0.932
AMY/Assets	The ratio of assets with a maturity of less than one year (AMY) to total assets	150177	0.167	0.158	0.084	0.000	0.608
Saving Deposits/Assets	The ratio of saving deposits to total assets	150177	0.310	0.293	0.143	0.000	0.911
Time Sensitive Deposits/Assets	The ratio of time sensitive deposits to total assets	150177	0.113	0.106	0.058	0.001	0.790
Fed Repo /Assets	The ratio of Fed repo to total assets	150177	0.076	0.065	0.055	0.000	0.204
Macro Variables							
Change in Fed Funds Rate	The change in effective federal funds rate	150177	0.015	0.000	0.390	-1.370	0.590
Inflation	Percent change in consumer price index	150177	0.006	0.006	0.004	-0.007	0.015
% Change in GDP	Percent change in GDP	150177	2.954	3.200	2.385	-8.400	7.500
Change in Housing Prices	Change in housing price index	150177	0.012	0.014	0.012	-0.028	0.038
Mortgage Demand Index	Change in mortgage demand index	150177	-0.930	-1.900	31.080	-63.500	63.500

TABLE XIII – **Bank-Firm Level (DealScan) Evidence—Controlling for Loan Demand**

Dependent Variable: Change in loans of borrower i from bank b					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.868***	1.585**	1.275*	1.378*	1.184*
standard errors	(0.327)	(0.773)	(0.72)	(0.789)	(0.708)
BORROWER*TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Impact of 1 SD increase in FFR (pp) Low vs High ARM Banks (Difference between 75th and 25th percentiles)	1.396	2.548	2.050	2.216	1.904
Observations	47877	47877	47877	47877	47877
R-squared	0.779	0.78	0.78	0.78	0.78

Notes: The table reports estimates for the Equation 3 from ordinary least squares regressions. The dependent variable is the logarithm of total loans of borrower i from bank b at time t. Table XII contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. We control loan demand using borrower*time fixed effects. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the bank and borrower level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

TABLE XIV – **Bank-Firm Level (Dealscan) Evidence —Asymmetric Effects of Tightening and Loosening**

Dependent Variable: Change in loans of borrower i from bank b						
	Whole Period			Trimmed Sample		
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\sum_{k=0}^{k=4} \alpha_k^{+}(ARM_{i,t-1} * \Delta FFR_{t-k}^{+})$	4.264**	5.01***	4.534***	4.197***	4.405***	4.875***
standard errors	(2.062)	(1.897)	(1.677)	(1.323)	(1.427)	(1.697)
$\sum_{k=0}^{k=4} \alpha_k^{-}(ARM_{i,t-1} * \Delta FFR_{t-k}^{-})$	-0.867	-0.897	-0.941	-0.811	-0.769	-1.058
standard errors	(1.154)	(1.067)	(1.134)	(1.26)	(1.175)	(1.264)
BORROWER*TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k^{+,-}(\text{BANK CONT.} * \Delta FFR_{t-k}^{+,-})$	Y	Y	Y	Y	Y	Y
MACROS	-	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	Y	Y	Y	Y	Y	Y
BANK LIABILITY CONT.	N	Y	Y	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k^{+,-}(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k}^{+,-})$	N	Y	Y	N	Y	Y
BANK FED FUNDS LIAB.	N	N	Y	N	N	Y
$\sum_{k=0}^{k=4} \delta_k^{+,-}(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k}^{+,-})$	N	N	Y	N	N	Y
Observations	47877	47877	47877	27635	27635	27635
R-squared	0.781	0.781	0.781	0.822	0.822	0.822

Notes: The table reports estimates for the Equation 3 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table XII contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes inΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits instead of deposits. Fed funds repo liabilities in addition to the bank variables. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Columns 1-3 provide results for the banks excluding the first decile of banks. Columns 3-6 represent results for the banks excluding up to seventh decile of banks. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table XV – **Bank-Firm Level (Dealscan) Evidence—Robustness: Before 2007 and Exclusion of Lower and Upper Deciles of ARM/A**

Dependent Variable: Change in loans of borrower i from bank b						
	Sample Before 2007			Trimmed Sample, Whole Period		
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	1.715**	1.773**	1.716**	1.232**	1.476**	1.429**
standard errors	(0.748)	(0.751)	(0.733)	(0.621)	(0.629)	(0.639)
BORROWER*TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	Y	Y	Y	Y	Y	Y
MACROS	-	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	Y	Y	Y	Y	Y	Y
BANK LIABILITY CONT.	N	Y	Y	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	Y	Y	N	Y	Y
BANK FED FUNDS LIAB.	N	N	Y	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	Y	N	N	Y
Observations	38308	38308	38308	27635	27635	27635
R-squared	0.772	0.772	0.772	0.821	0.821	0.821

Notes: The table reports estimates for the Equation 3 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table XII contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits instead of deposits. Fed funds repo liabilities in addition to the bank variables. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Columns 1-3 provide results for the banks excluding the first decile of banks. Columns 3-6 represent results for the banks excluding up to seventh decile of banks. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table XVI – **Bank-Firm Level (DealScan) Evidence—Robustness: Alternative Macro Variables**

Dependent Variable: Change in loans of borrower i from bank b					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.868***	1.615**	1.263*	1.405*	1.192*
standard errors	(0.327)	(0.745)	(0.693)	(0.769)	(0.668)
BORROWER*TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	47877	47877	47877	47877	47877
R-squared	0.779	0.779	0.78	0.78	0.78

Notes: The table reports estimates for the Equation 3 from ordinary least squares regressions. The dependent variable is the logarithm of total loans of borrower i from bank b at time t. Table XII contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. We control loan demand using borrower*time fixed effects. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index.. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the bank and borrower level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Figure 2 – **Local Projections—Interest Income and Expenses**

This figure plots the results from regressions of Equation 4 where the dependent variables are changes in several measures of bank interest income and expenses. Specifically, we present the specification in Column 4 in Table VII (the others look very similar). The main independent variable is the changes in the Fed funds rate, and its interaction with the share of ARM's in bank's residential real estate loans. Red dotted lines represent the 90-percent confidence bands. See the text for details.

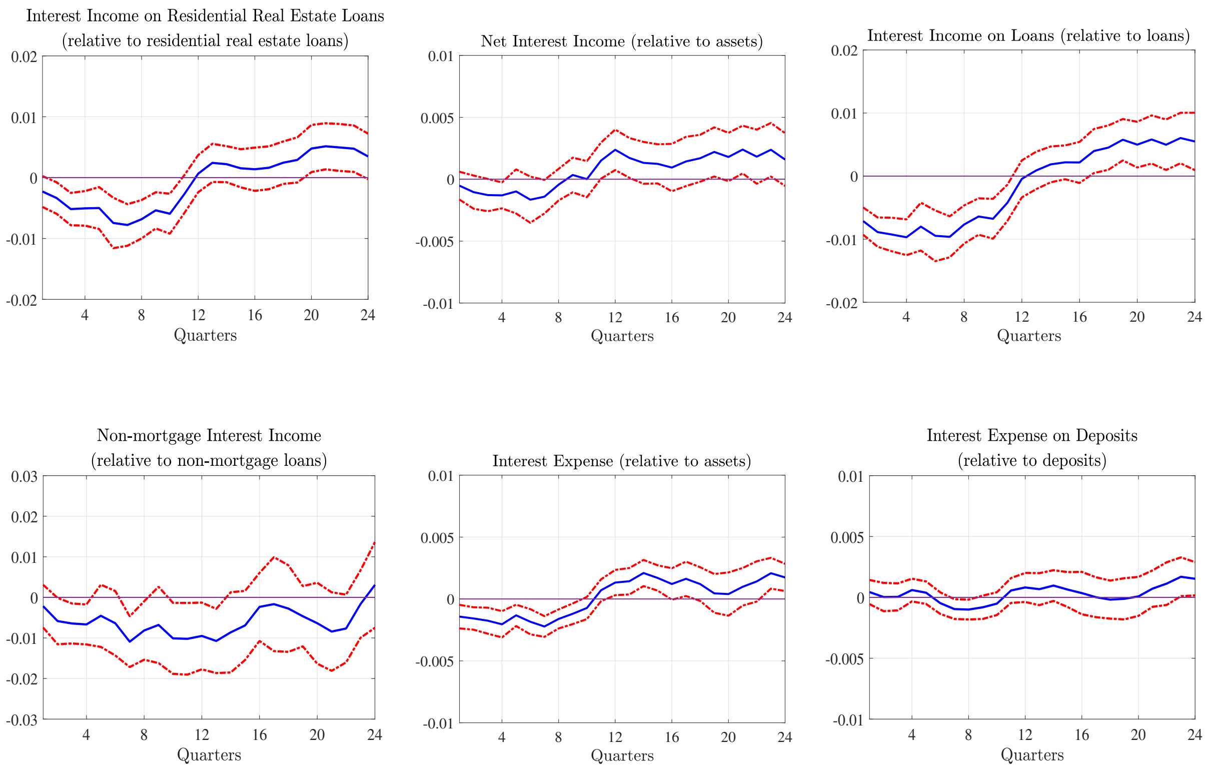


Table XVII – **Nonperforming Loans for Residential Real Estate Loans at Bank Level**

Dependent Variable: Change in NPL for Real Estate Loans/Real Estate Loans	Whole Period			Before 2007		
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})$	-0.016	-0.016	-0.016	0.003	0.003	0.003
standard errors	(0.011)	(0.011)	(0.011)	(0.003)	(0.003)	(0.003)
TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k (\text{BANK CONT.} * \Delta FFR_{t-k})$	Y	Y	Y	Y	Y	Y
MACROS	-	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k (ARM_{i,t-1} * MACROS_{t-k})$	Y	Y	Y	Y	Y	Y
BANK LIABILITY CONT.	N	Y	Y	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k (\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	Y	Y	N	Y	Y
BANK FED FUNDS LIAB.	N	N	Y	N	N	Y
$\sum_{k=0}^{k=4} \delta_k (\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	Y	N	N	Y
Observations	12256	12256	12256	7053	7053	7053
R-squared	0.077	0.079	0.079	0.168	0.168	0.169

Notes: The table reports estimates for the Equation 5 from ordinary least squares regressions. The dependent variable is the change of NPL ratio for real estate loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits instead of deposits. Fed funds repo liabilities in addition to the bank variables. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Columns 1-3 provide results for of the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Columns 4-6 represent results for the period of 1994:Q1 – 2006:Q4, excludes the period after 2007, the housing crises and low-interest rate period. All analysis is done using quarterly data. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

ONLINE APPENDIX

ONLINE APPENDIX

A High-frequency shocks instead of Fed Funds Rate

In this section, we report the results of lending and local projection analysis with monetary policy surprises obtained from high-frequency analysis. We start with local projection analysis to show that the main mechanism, i.e., interest income is still significant. Then, we report the results of the lending analysis.

A.1 Interest income with surprise monetary policy shocks

We repeat our analysis with monetary policy shocks identified from high-frequency methods. The advantage of this approach is that monetary policy shocks are exogenous to macroeconomic developments. The disadvantage is that the shocks are very small and the shocks do not go back beyond 2003.

Specifically, we estimate the following equation for different horizons:

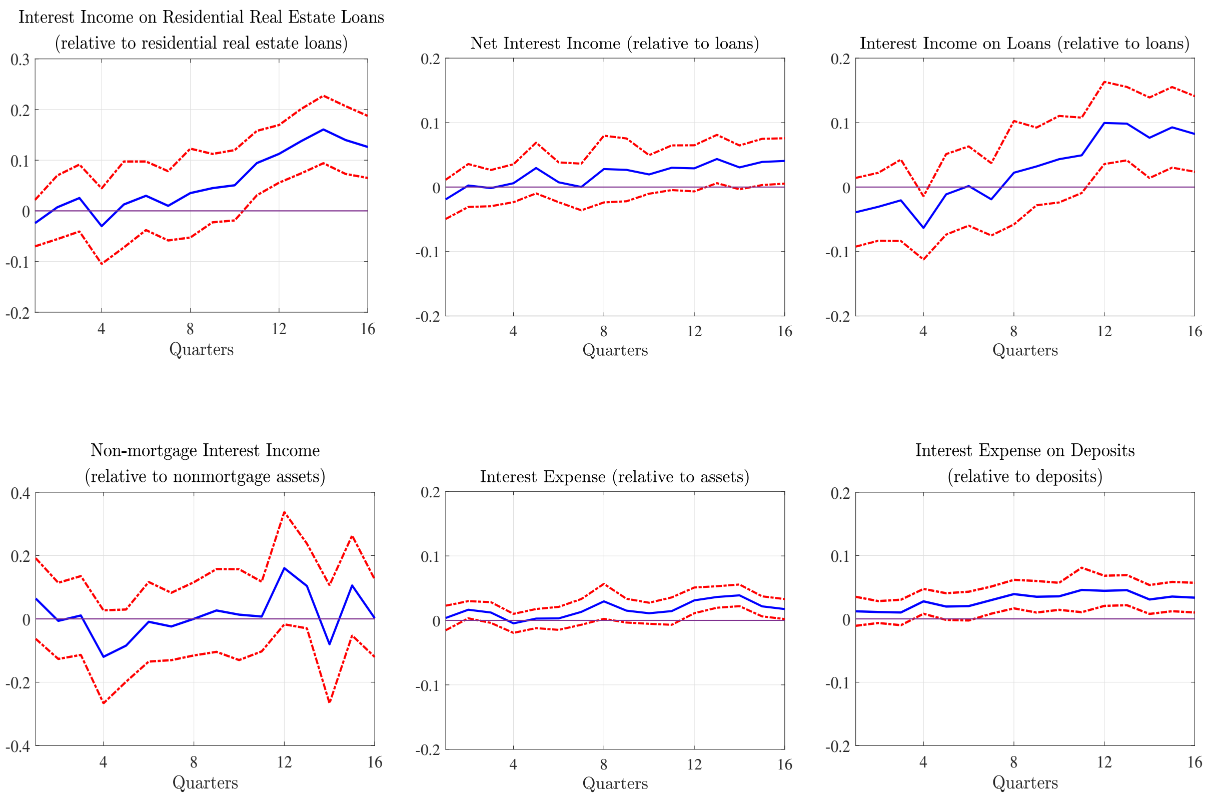
$$\Delta Y_{i,t+d} = \sum_{k=0}^{k=4} \alpha_{k,d}(ARM_{i,t-1} * MP_{shock,t}) + \\ + \sum_{k=0}^{k=4} \gamma_{x,k,d}(BV_{i,t-1} * MP_{shock,t}) + \sum_{k=0}^{k=4} \lambda_{k,d} Y_{i,t-k} + \nu_q + \theta_i + \epsilon_{i,t+d}. \quad (6)$$

where $ARM_{i,t}$ is the share of ARM loans relative to assets, $MP_{shock,t}$ is the sum of surprise changes in short term (3 month) yields around monetary policy events in a quarter, $BankVars_{x,t}$ are bank balance sheet variables, $Y_{i,t-k}$ are lagged dependent variables. ν_t and θ_i are time and bank fixed effects. In the above equation we use several interest income variables as dependent variables, $\Delta Y_{i,t+d}$, where d is the horizon in quarters. Our hypothesis would imply a positive value for the interaction term $\sum_{k=0}^{k=4} \alpha_{k,d}$. We analyze the response of interest income on real estate loans, interest income on loans, net interest income, non-mortgage interest income and two measures of interest expenses.

Our results, shown in Figure 3 confirm our earlier findings that the interest income of banks with higher ARM shares increase relatively more compared to the banks with less ARM loans. The effects become stronger and more positive over time, however, they are as significant as the results where we used FFR. These findings support our findings in 2 and suggest that modeling the changes in monetary policy stance with changes in FFR (while controlling for economic developments) is appropriate for our analysis.

Figure 3 – **Local Projections—Interest Income and Expenses with High-Frequency Shocks**

This figure plots the results from regressions of Equation 6 where the dependent variables are changes in several measures of bank interest income. Specifically, we present the specification in Column 5 in Table II (the others look very similar). The main independent variable is the monetary policy shock, $\mathsf{MP}_{\mathsf{shock}}$, obtained from high-frequency identification around monetary policy events, and its interaction with the share of ARM's in bank's residential real estate loans. Red dotted lines represent the 90-percent confidence bands.



A.2 Lending Analysis with surprise monetary policy shocks

For the lending analysis we estimate a specification similar to Equation 1. However, since our dependent variables are quarterly, we aggregate the monetary policy surprises to quarterly by simply adding the surprises that happened in that quarter. Table XVIII reports the results for bank C&I loan lending. The results confirm our main findings. The coefficient on the interaction term is positive and significant, implying that the banks with higher ARM shares lend more relative to banks with lower ARM share when interest rates increase. Table XIX reports the lending results where we use DealScan data to control for firm loan demand. The results become insignificant. We suspect that this is because the high-frequency shocks are small (becomes even smaller than the ones we use in the bank stock price analysis since we aggregate in a quarter), and banks do not pass the effect of the shocks to the large firms (remember that DealScan data features large firms). This might be because of relatively strong relations between banks and larger firms.

Table XVIII – **The Response of Commercial and Industrial Loans at Bank Level—with High-Frequency Shocks**

Dependent Variable: Change in Commercial Loans						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * MPshock_{t-k})$	4.106*	4.188*	3.986*	3.966+	4.016*	4.105+
standard errors	(2.342)	(2.463)	(2.332)	(2.486)	(2.326)	(2.569)
TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k (\text{BANK CONT.} * MPshock_{t-k})$	N	Y	N	Y	N	Y
BANK LIABILITY CONTROLS	N	N	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \mu_k (\text{BANK LIABILITY CONT.} * MPshock_{t-k})$	N	N	N	Y	N	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \delta_k (\text{BANK FEDFUNDS LIAB.} * MPshock_{t-k})$	N	N	N	N	N	Y
Observations	10026	10026	10026	10026	10026	10026
R-squared	0.186	0.191	0.186	0.191	0.186	0.192

Notes: The table reports estimates a version of Equation 1 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, MP_{shock}, obtained from high-frequency identification around monetary policy events. The coefficient of interest is the interaction of MP_{shock} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in MP_{shock}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 3. Column 5 includes Fed funds repo liabilities. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%. +Significant at 11%.

TABLE XIX – **Bank-Firm Level (DealScan) Evidence—Controlling for Loan Demand with High-Frequency Shocks**

Dependent Variable: Change in loans of borrower i from bank b						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * MPshock_{t-k})$	-1.328	3.072	-2.257	1.026	-1.806	-2.094
standard errors	(12.136)	(13.653)	(11.644)	(13.171)	(12.089)	(12.714)
BORROWER*TIME FE	Y	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * MPshock_{t-k})$	N	Y	N	Y	N	Y
BANK LIABILITY CONTROLS	N	N	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * MPshock_{t-k})$	N	N	N	Y	N	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FEDFUNDS LIAB.} * MPshock_{t-k})$	N	N	N	N	N	Y
Observations	16927	16927	16927	16927	16927	16927
R-squared	0.814	0.815	0.814	0.815	0.814	0.815

Notes: The table reports estimates a version of Equation 1 from ordinary least squares regressions. The dependent variable is the logarithm of total loans of borrower i from bank b at time t. Table XI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, MPshock, is obtained from the change in effective federal funds rate. The coefficient of interest is the interaction of MPshock with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in MPshock. We control loan demand using borrower*time fixed effects. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation and GDP growth. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the bank and borrower level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

B Robustness with respect to ARM share definitions

In this section first, we re-estimate our main results where we use different measures of ARM share. We do not report the local projection results, but they remain similar to our benchmark results. In Section B.1 we use the average of the past 8 quarters banks' ARM share as the main ARM share measure. This analysis helps us to partially overcome the identification challenge that we do not have an IV for the ARM share. Since past ARM shares can be considered as exogenous to current decisions. The tables below show that our results are robust to using this measure.[21] In Section B.2 we use ARM shares relative to real estate loans as an alternative to ARM shares relative to assets that we used in our benchmark analysis. Results show that our findings are robust to alternative definitions of ARM share.

[21] Estimates with 2-year lagged ARM shares give similar results.

B.1 ARM-share is average of past 8 quarters

TABLE XX – **Bank Stock Price Reactions to High-Frequency Shocks—Average ARM**

Dependent Variable: Change in bank stock prices						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha * \mathsf{ARM}_{i,t} * \mathsf{MP}_{shock}$	0.015***	0.007+	0.011**	0.013***	0.013***	0.013***
standard errors	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
TIME FE	N	N	N	Y	Y	Y
YEAR*MONTH FE	N	N	Y	-	-	-
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS $* \mathsf{MP}_{shock}$	N	Y	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	N	Y	Y
BANK LIABILITY CONTROLS $* \mathsf{MP}_{shock}$	N	N	N	N	Y	Y
BANK FED FUNDS LIABILITY	N	N	N	N	N	Y
BANK FED FUNDS LIABILITY $* \mathsf{MP}_{shock}$	N	N	N	N	N	Y
Observations	24056	24056	24056	24056	24056	24056
R-squared	0.162	0.164	0.317	0.369	0.369	0.369

Notes: The table reports estimates for the Equation 1 from ordinary least squares regressions. The dependent variable is the % change in bank stock prices between day t+1 and t-1 where monetary policy shock is realized at time t. Table I contains the definition of all variables and the summary statistics for each included variable. The main independent variable is the monetary policy shock, MP_{shock}, obtained from high-frequency identification around monetary policy events. ARM is the average of lagged eight quarter values. The coefficient of interest is the interaction of MP_{shock} with the ratio of adjustable rate mortgages (ARM) to bank assets. It measures how ARM mortgage share changes the effect of the changes in MP_{shock}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls, after Column 5, include saving deposits and time sensitive deposits instead of deposits used in Columns 1-3. Column 6 includes Fed funds repo liabilities in addition to the bank variables used. Analysis covers the period of 2003:Q4 – 2013:Q4, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the BHC and quarter level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table XXI – **The Response of Commercial and Industrial Loans at Bank Level—Average ARM**

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})$	0.149***	0.131**	0.13**	0.136**	0.129**
standard errors	(0.05)	(0.069)	(0.066)	(0.065)	(0.065)
TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k (\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k (ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k (\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k (\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	27763	27763	27763	27763	27763
R-squared	0.115	0.116	0.118	0.119	0.119

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. ARM is the average of lagged eight quarter values. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 inludes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

TABLE XXII – **Bank-Firm Level (DealScan) Evidence-Controlling for Loan Demand—Average ARM**

Dependent Variable: Change in loans of borrower i from bank b					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.643*	1.548*	1.192+	1.336+	1.085+
standard errors	(0.371)	(0.958)	(0.856)	(0.925)	(0.817)
BORROWER*TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	47721	47721	47721	47721	47721
R-squared	0.779	0.78	0.78	0.78	0.78

Notes: The table reports estimates for the Equation 3 from ordinary least squares regressions. The dependent variable is the logarithm of total loans of borrower i from bank b at time t. Table XII contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is obtained from the change in effective federal funds rate. ARM is the average of lagged eight quarter values. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. We control loan demand using borrower*time fixed effects. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 inludes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the bank and borrower level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%, +Significant at 18%.

B.2 Robustness: ARM share is ARM/Real Estate Loans

Table XXIII – **Bank Stock Price Reactions to High-Frequency Shocks—ARM/Real Estate Loans**

Dependent Variable: Change in bank stock prices						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha * \mathsf{ARM}_{i,t} * \mathsf{MP}_{shock}$	0.007***	0.007***	0.007***	0.007***	0.007***	0.007***
standard errors	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
TIME FE	N	N	N	Y	Y	Y
YEAR*MONTH FE	N	N	Y	-	-	-
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS $* \mathsf{MP}_{shock}$	N	Y	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	N	Y	Y
BANK LIABILITY CONTROLS $* \mathsf{MP}_{shock}$	N	N	N	N	Y	Y
BANK FED FUNDS LIABILITY	N	N	N	N	N	Y
BANK FED FUNDS LIABILITY $* \mathsf{MP}_{shock}$	N	N	N	N	N	Y
Observations	23935	23935	23935	23935	23935	23935
R-squared	0.162	0.164	0.312	0.365	0.365	0.365

Notes: The table reports estimates for the Equation 1 from ordinary least squares regressions. The dependent variable is the % change in bank stock prices between day t+1 and t-1 where monetary policy shock is realized at time t. Table I contains the definition of all variables and the summary statistics for each included variable. The main independent variable is the monetary policy shock, $\Delta\mathsf{FFR}_{t-k}$, obtained from high-frequency identification around monetary policy events. The coefficient of interest is the interaction of $\Delta\mathsf{FFR}_{t-k}$ with the ratio of adjustable rate mortgages (ARM) to bank real estate loans. It measures how ARM mortgage share changes the effect of the changes in $\Delta\mathsf{FFR}_{t-k}$. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls, after Column 5, include saving deposits and time sensitive deposits instead of deposits used in Columns 1-3. Column 6 includes Fed funds repo liabilities in addition to the bank variables used. Analysis covers the period of 2003:Q4 – 2013:Q4, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the BHC and quarter level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

TABLE XXIV – **The Response of Commercial and Industrial Loans at Bank Level—ARM/Real Estate Loans**

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.087***	0.089***	0.078**	0.075**	0.071**
standard errors	(0.026)	(0.033)	(0.032)	(0.032)	(0.032)
TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	25626	25626	25626	25626	25626
R-squared	0.122	0.123	0.125	0.125	0.126

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank real estate loans. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

TABLE XXV – **Bank-Firm Level (DealScan) Evidence-Controlling for Loan Demand —ARM/Real Estate Loans)**

Dependent Variable: Change in loans of borrower i from bank b					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})$	0.284*	0.369**	0.555***	0.686***	0.637***
standard errors	(0.161)	(0.175)	(0.204)	(0.232)	(0.229)
BORROWER*TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k (\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k (ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k (\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k (\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	29387	29387	29387	29387	29387
R-squared	0.814	0.814	0.815	0.815	0.815

Notes: The table reports estimates for the Equation 3 from ordinary least squares regressions. The dependent variable is the logarithm of total loans of borrower i from bank b at time t. Table XII contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is obtained from the change in effective federal funds rate. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank real estate loans. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. We control loan demand using borrower*time fixed effects. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the bank and borrower level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%. + Significant at 12%.

C Controlling the level of FFR

TABLE XXVI – **Bank Stock Price Reactions to High-Frequency Shocks—Controlling FFR Level**

Dependent Variable: Change in bank stock prices						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha * \mathsf{ARM}_{i,t} * \mathsf{MP}_{shock}$	0.016***	0.008*	0.011**	0.011**	0.012***	0.012***
standard errors	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
TIME FE	N	N	N	Y	Y	Y
YEAR*MONTH FE	N	N	Y	-	-	-
BANK FE	Y	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y	Y
BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS $* \mathsf{MP}_{shock}$	N	Y	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	N	Y	Y
BANK LIABILITY CONTROLS $* \mathsf{MP}_{shock}$	N	N	N	N	Y	Y
BANK FED FUNDS LIABILITY	N	N	N	N	N	Y
BANK FED FUNDS LIABILITY $* \mathsf{MP}_{shock}$	N	N	N	N	N	Y
Observations	25008	25008	25008	25008	25008	25008
R-squared	0.159	0.161	0.317	0.367	0.367	0.367

Notes: The table reports estimates for the Equation 1 from ordinary least squares regressions. The dependent variable is the % change in bank stock prices between day t+1 and t-1 where monetary policy shock is realized at time t. Table 1 contains the definition of all variables and the summary statistics for each included variable. The main independent variable is the monetary policy shock, MP_{shock}, obtained from high-frequency identification around monetary policy events. The coefficient of interest is the interaction of MP_{shock} with the ratio of adjustable rate mortgages (ARM) to bank assets. It measures how ARM mortgage share changes the effect of the changes in MP_{shock}. We include the levels of federal funds rate along with all relevant interactions to effectively manage interest rates that can impact lending behavior and the ARM strategy of banks. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls, after Column 5, include saving deposits and time sensitive deposits instead of deposits used in Columns 1-3. Column 6 includes Fed funds repo liabilities in addition to the bank variables used. Analysis covers the period of 2003:Q4 – 2013:Q4, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the BHC and quarter level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table XXVII – **The Response of Commercial and Industrial Loans at Bank Level—Controlling FFR Level**

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k(ARM_{i,t-1} * \Delta FFR_{t-k})$	0.16***	0.124*	0.133*	0.134*	0.127*
standard errors	(0.049)	(0.073)	(0.074)	(0.073)	(0.073)
TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k(\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k(ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k(\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k(\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	27825	27825	27825	27825	27825
R-squared	0.114	0.115	0.118	0.119	0.119

Notes: The table reports estimates for the Equation 2 from ordinary least squares regressions. The dependent variable is the change of logarithm of commercial and industrial loans of banks between t and t-1. Table VI contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is the sum of changes in effective federal funds rate between time t and t-4. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. We include the five quarter average of federal funds rate along with all relevant interactions to effectively manage interest rates that can impact lending behavior and the ARM strategy of banks. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are one-way clustered at the BHC. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Y" indicates set of characteristics or fixed effects. "N" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%.

Table XXVIII – **Bank-Firm Level (DealScan) Evidence-Controlling for Loan Demand—Controlling FFR Level**

Dependent Variable: Change in loans of borrower i from bank b					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})$	0.884***	1.493**	0.879*	0.934*	0.749+
standard errors	(0.328)	(0.671)	(0.555)	(0.598)	(0.552)
BORROWER*TIME FE	Y	Y	Y	Y	Y
BANK FE	Y	Y	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y	Y	Y
BANK CONT.	Y	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k (\text{BANK CONT.} * \Delta FFR_{t-k})$	N	N	Y	Y	Y
MACROS	-	-	-	-	-
$\sum_{k=0}^{k=4} \mu_k (ARM_{i,t-1} * MACROS_{t-k})$	N	Y	Y	Y	Y
BANK LIABILITY CONT.	N	N	N	Y	Y
$\sum_{k=0}^{k=4} \mu_k (\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	N	N	Y	Y
BANK FED FUNDS LIAB.	N	N	N	N	Y
$\sum_{k=0}^{k=4} \delta_k (\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	N	N	Y
Observations	47877	47877	47877	47877	47877
R-squared	0.779	0.78	0.781	0.781	0.781

Notes: The table reports estimates for the Equation 3 from ordinary least squares regressions. The dependent variable is the logarithm of total loans of borrower i from bank b at time t. Table XII contains the definition of all variables and the summary statistics for each included variable. The monetary policy shock, ΔFFR_{t-k}, is obtained from the change in effective federal funds rate. ARM is the average of lagged eight quarter values. The coefficient of interest is the interaction of ΔFFR_{t-k} with the ratio of ARM to bank assets. It measures how ARM mortgage share changes the effect of the changes in ΔFFR_{t-k}. We include the five quarter average of federal funds rate along with all relevant interactions to effectively manage interest rates that can impact lending behavior and the ARM strategy of banks. We control loan demand using borrower*time fixed effects. Control variables and fixed effects are indicated at the bottom of each column. Level of ARM as well as all relevant double interactions are included in the model. Bank controls are equity, liquidity, nonperforming loans ratio, BdF, deposit market HHI, deposits, and AMY. Bank Liability controls include saving deposits and time sensitive deposits which replace deposits after Column 4. Column 5 includes Fed funds repo liabilities. Macro variables include inflation, GDP growth, change in housing price index, and change in mortgage demand index. Analysis covers the period of 1994:Q1 – 2013:Q4 for the quarterly data, however we exclude 2007 and 2008, the housing crises period. Standard errors are two-way clustered at the bank and borrower level. Coefficients are listed in the first row, robust standard errors are reported in the row below, and the corresponding significance levels are placed adjacently. "Yes" indicates set of characteristics or fixed effects. "No" indicates set of characteristics or fixed effects is not included. "-" indicates that the set of characteristics or fixed effects are comprised in the wider included set of fixed effects. ***Significant at 1%, ** Significant at 5%, *Significant at 10%. + Significant at 12%.