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Essays on Monetary Policy and Financial Markets

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Essays on Monetary Policy and Financial Markets

Abstract

This dissertation consists of three essays on the monetary policy pass-through to financial markets and bank balance sheets. I use frontier econometric methods combined with rich micro and macro-level datasets to examine the effect of monetary policy on financial markets and banks' balance sheets, focusing on how specific bank and market characteristics amplifies the monetary policy transmission mechanism. Moreover, I show that monetary policy transmits to real economic outcomes through financial markets and banks' balance sheets. Finally, I complement my empirical findings with theoretical models to identify the underlying monetary policy transmission mechanisms.

The first chapter of my dissertation studies the effect of market power on monetary policy transmission to banks' funding dynamics, lending, and profitability by comprehensively studying the interactions among the deposit, wholesale funding, and credit markets, which is missing in the literature. In this chapter, I document the heterogeneous impact of monetary policy on banks' deposit, wholesale funding, and lending spreads depending on the degree of their bank market power. Specifically, I show that after an increase in the policy rate, banks with higher market power increase their deposit and loan rates less and access wholesale funding markets at a relatively lower cost compared to other banks. Hence, banks with higher market power counterbalance the fall in their deposit inflows by increasing their reliance on wholesale funding, and their lending decreases less than other banks following a monetary contraction. This *"wholesale funding channel"* dampens the adverse effect of contractionary monetary policy on their lending and profitability. I further show that bank market power affects monetary policy transmission to the real economy through its impact on bank-level lending. In particular, aggregate lending and employment decrease less in areas served by banks with higher market power after an increase in the policy rate. Finally, I rationalize my empirical findings by building a theoretical model with monopolistic competition. In the model, banks with higher market power access wholesale funding markets at a lower cost, which generates imperfect pass-through of monetary policy.

The second chapter of my dissertation provides a new channel of monetary policy-pass-through to bank lending and lending rates, *"bank liquidity channel"*. In particular, I evaluate monetary

policy pass-through conditional on bank liquidity using rich bank-level balance sheets and income statement data. I find that after an increase in the policy rate, funding inflows of banks decreases and constrain banks' loan originations. However, banks with less liquid balance sheets reduce their loan supply more due to their liquidity constraints. In particular, these banks start to shrink their balance sheets by reducing their loan originations as they don't have enough buffer stock liquidity to deplete when they face an adverse shock. Second, I document that banks with less liquid balance sheets increase their loan rates more than other banks following a monetary contraction. Lastly, I build a theoretical model with heterogeneous banks that explains the underlying mechanism. In the model, bank liquidity constraints combined with monopolistic competition impose frictions on monetary policy pass-through to bank lending rates, where there is no deposit rate dispersion among banks based on their liquidity position.

Finally, Chapter 3 studies the impact of maturity mismatch between banks' assets and liabilities on monetary policy transmission to bank profitability and asks whether the role of the maturity mismatch channel has changed during the zero lower bound (ZLB) environment. Using high-frequency monetary policy surprises that allow me to separate the effects of conventional and unconventional monetary policy, I first show that bank stock prices decrease significantly after contractionary federal funds rate and forward guidance shocks. That is, the indirect effects of contractionary monetary policy (e.g., the signaling impact of a weaker economy, higher default probabilities, and a weak bank balance sheet performance) outweigh its direct effect (the expected improvement in net interest margins) on banks' stock prices. I then document that banks with larger maturity mismatch are affected less negatively from the contractionary monetary policy surprises as their expected net interest margins rise more after an increase in the level and slope of the yield curve. Turning to the zero lower bound (ZLB) environment, I show that large-scale asset purchases (LSAP) that decrease the long-term yields affect bank stock prices positively during this period. However, the maturity mismatch channel ceased to exist in the ZLB environment. Specifically, the response of bank stock prices stopped varying depending on the maturity structure of their balance sheets, indicating a limitation to unconventional monetary policy.

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CHAPTER 1

Market Power, Bank Funding and the Transmission of the Monetary Policy

1.1. Introduction

Striking economic phenomenons of the recent decade in the U.S. banking industry have been the decrease in the banking competition and the growth of money market funds which are the leading players in the U.S. wholesale funding markets. In particular, the market share of the top five banks has increased significantly from less than 25% in the 1990s to over 45% in the last few years. Moreover, the total assets of money market funds nearly tripled during the same time, as shown in Figure 1.1. However, the current literature studied the effect of market power in isolation, focusing only on its impact on deposit and credit markets separately, and the role of market power on banks' cost of accessing wholesale funding and wholesale funding reliance is overlooked. Thus, a full understanding of how market power mediates monetary policy transmission to bank lending and profitability has been missing.

This paper examines how bank market power affects monetary policy transmission to banks' funding dynamics, lending, and profitability. First, I explore how monetary policy alters banks' funding composition between deposits and wholesale funding and whether bank market power is associated with variation in banks' exposure to monetary policy.[1] I further investigate how the change in banks' funding dynamics, in other words, change in their funding spreads and the funding composition, affects monetary pass-through to bank lending spreads, interest margins, and bank profitability depending on the degree of banks' market power. In doing so, I provide novel evidence on the impact of bank market power on the transmission of monetary policy to the U.S. banking sector by jointly studying the deposit, wholesale funding, and credit markets which is critical to reaching accurate insights on the monetary policy transmission mechanism to banks' balance sheets as these markets are highly interconnected. Moreover, I show that bank market power affects the

[1] Wholesale funding refers to banks' funding sources other than retail deposits.

transmission of monetary policy to the macroeconomic outcomes through its impact on bank-level lending. Thus, my results have important implications for how we should think about monetary policy transmission mechanism to the real economy.

The first main contribution of this paper is documenting the dispersion in the response of banks' deposit and wholesale funding spreads to monetary policy depending on the banks' market power.[2] I show that monetary policy changes the funding composition of the banks by creating a wedge in deposit and wholesale funding spreads among banks with different levels of market power. In particular, after monetary policy tightening, deposit and wholesale funding spreads increase more for banks with higher market power operating in highly concentrated local banking markets. In other words, these banks do not fully transmit the increase in interest to their depositors and access wholesale funding markets at a comparatively lower cost. As deposit spreads widen, households switch to products that offer higher yields, with deposit inflows decreasing slightly more for banks with market power as a result. At the same time, these banks considerably increase their wholesale funding dependence and compensate for the decrease in their deposit inflows through wholesale financing. Hence, I show that the funding composition of banks changes substantially in response to monetary policy, and banks' market power is a good predictor of this compositional change.

My second main contribution is documenting that the change in bank funding dynamics affects monetary policy transmission to bank *lending* spreads and thus to bank lending.[3] Specifically, I show that banks with higher market power increase their loan spreads less following a monetary contraction. Two forces drive this result. First, market power enables banks to increase their deposit spreads more following a contractionary monetary policy. Second, banks with higher market power are able to access wholesale funding at a lower cost. The ability to keep deposit rates relatively low while leaning more on wholesale funding (where they get more favorable terms than other banks) enables banks with the higher market power to raise their interest on loans less as the federal funds rate rises. Thus, these banks' lending decreases significantly less than banks with lower market

[2] Deposit spread is the difference between federal funds and deposit rates. Similarly, wholesale funding spread is defined as the difference between federal funds and wholesale funding rates. Widening of these spreads implies a partial pass-through of the policy rate to deposit and wholesale funding rates.

[3] Lending spread is defined as the difference between the loan rate and the Treasury yield with a similar maturity.

power.[4] Taken together, my results show that market power dampens the impact of monetary policy on lending by altering the funding dynamics of the banks.

The third contribution of this paper is to provide a unified framework to analyze the effect of bank market power on the transmission of monetary policy to banks' deposit, wholesale funding, and credit decisions which is essential to achieve a complete understanding of monetary policy transmission mechanism to bank lending due to interdependence of these markets. Prior to my work, little was known about the simultaneous effect of market power on funding and lending markets in the face of a change in the policy rate. I bridge the deposit and credit market power channels that study the impact of market power on either deposit or loan spreads separately. Additionally, I reveal the importance of the wholesale funding channel for the monetary policy transmission mechanism by documenting the heterogeneous response of banks' wholesale funding spreads to monetary policy, which has not been established previously. In particular, I show that bank market power lowers the pass-through of monetary policy into wholesale funding, deposit, and loan rates. Moreover, I find that the lending and net interest margins of banks with higher market power decrease less following a contractionary monetary policy, leading to a relative increase in the profitability of banks with higher market power.

The fourth contribution of this paper is to show that bank market power affects the monetary policy transmission mechanism to the macroeconomy. Previous literature argues that after an increase in the policy rate, deposits flow out of the banking system, and banks with deposit market power shrink their lending. This amplifies the impact of contractionary monetary policy on real economic outcomes (Drechsler et al., 2017). However, they overlooked the effect of market power on banks' wholesale funding and lending spreads. I complete their story by comprehensively analyzing the impact of bank market power on U.S. banking markets and substantially expanding their sample. I show that lending of banks with higher market power decreases significantly less following a contractionary monetary policy as these banks substitute wholesale funding for deposit outflows, and pass-through to loan spreads are substantially lower for these banks. As a result, aggregate lending decreases less in areas served by banks with higher market power, and unemployment increases less in these regions following a contractionary monetary policy.

[4]Figure 1.2 illustrates this mechanism in detail where Figure 1.2a plots the average effect of monetary policy on bank funding dynamics and lending and Figure 1.2b shows the impact of monetary policy on the banks with higher market power.

Lastly, I contribute to the literature by building a theoretical model of monopolistic competition both in deposit and credit markets consistent with the micro-foundations presented in Ulate (2021). I use the model to rationalize my empirical findings and explain the underlying mechanism. In the model, banks with higher market power access wholesale funding markets at a lower cost, which generates imperfect pass-through of monetary policy to their deposit, loan rates, and lending, confirming my empirical findings. I cross-validate the model's predictions using data from U.S. Call Reports and show that the model performs well in matching the data.

There are a set of empirical challenges in identifying the impact of market power on the transmission of monetary policy to bank-level and macroeconomic outcomes. One significant identification challenge I face is the potential endogeneity of monetary policy. To address this concern, I use high-frequency monetary shocks from Bauer and Swanson (2022) as an instrument for the one-year Treasury rate in my analysis. These monetary policy shocks satisfy both instrument validity and exogeneity conditions as they are correlated with movements in the one-year Treasury rate yet uncorrelated with all other shocks.

Secondly, banks may have different lending opportunities, and banks' funding decisions might be responding to contemporaneous changes in bank-specific lending opportunities rather than directly to monetary policy. For example, if banks' lending opportunities reduce following the tightening of the monetary policy, banks issue fewer loans, and thus, their reliance on deposits decrease independent of banks' market power (Drechsler et al., 2017). As a result, banks' retail rates might be affected by the change in the bank-specific loan demand rather than the banks' market power. I tackle this issue by exploiting the geographic variation in the concentration of local banking markets and show that my results go through even I compare the funding and lending spreads of the same bank located in areas with different levels of concentration. I implement this branch-level analysis using branch-level deposit and loan rate information on U.S. banks from Ratewatch. I construct my branch-level market power measure by relying on the Herfindahl index (HHI), calculated by summing up the squared asset-market shares of all depository institutions that operate branches in a given county in a given year. As decisions related to wholesale funding are made at the bank rather than the branch level, I conduct my analysis on wholesale financing at the bank level and provide a complete picture of the mechanism using bank-level data from Call Reports.

Another critical identification challenge I face is the different local lending opportunities that banks may face, irrespective of their market power. That is, monetary policy may distinctly affect local lending opportunities in different regions where banks operate. To address this issue, I use Small Business Lending data from the Federal Financial Institutions Examination Council (FFIEC), which reports a bank's lending in a given county for a particular year. To separate the effects of higher rates from the underlying macro environment, I add county-time fixed effects to my analysis which absorbs the average impact of macroeconomic variables on demand for loans. That is, I ensure that my results are not driven by the differences in local lending opportunities. I then aggregate my lending data to the county level and establish a link between bank lending and county-level real economic outcomes. The county-level analysis reveals that bank market power substantially impacts monetary policy transmission through bank balance sheets.

The rest of this paper is organized as follows: Section 1.2 discusses the related literature, and Section 1.3 documents the relationship between the federal funds rate and aggregate deposit and wholesale funding flows, providing motivating evidence for my analysis. Section 1.4 describes the data and provides summary statistics. Section 1.5 explains the identification strategy and provides the empirical results. Section 1.6 presents the model. Section 1.7 provides robustness checks, and Section 1.8 concludes.

1.2. Literature Review

This paper contributes four strands of literature. First, it contributes to the literature on the bank lending channel of monetary policy (Bernanke, 1983; Bernanke and Blinder, 1988; Kashyap and Stein, 1995, 2000) which explores how bank lending responds to change in the monetary policy. In these papers, the underlying channel for the transmission of monetary policy to bank lending operates through bank reserves. On the other hand, the primary mechanism that drives the bank lending results in my paper is the variation in the response of bank funding dynamics to monetary policy based on banks' market power. Specifically, the monetary policy creates a dispersion in the wholesale funding and deposit spreads of banks with different degrees of market power, which in turn changes the funding composition of the banks and influences the monetary policy pass-through to bank loan rates and bank lending outcomes.

Second, my paper bridges the literature that examines the role of bank market power on the transmission of monetary policy to the bank deposit and lending spreads. These papers have emphasized the importance of bank competition for the monetary policy pass-through to household deposits and mortgage rates (Balloch and Koby, 2019; Drechsler et al., 2017; Scharfstein and Sunderam, 2016; Wang et al., 2022). Yet, they examine the impact of market power either on deposit or loan spreads and overlook its effect on the cost of accessing wholesale funding and banks' funding composition. Specifically, Drechsler et al. (2017) only focus on the impact of market power on deposit spreads centering on the pre-ZLB period. On the other hand, Scharfstein and Sunderam (2016) solely investigate the role of market power on mortgage rates concentrating on the low-interest rate environment. Building on these studies, my paper explores the impact of market power on monetary policy pass-through to bank funding and lending spreads jointly. It also proposes a new channel of monetary policy transmission through wholesale funding.

Third, my paper connects to literature that studies the impact of monetary policy on wholesale funding markets. Particularly, Xiao (2020) and Choi and Choi (2021) show that monetary tightening reduces the supply of retail deposits and expands funding creation in the money markets. I contribute to this literature by studying the impact of bank market power on banks' cost of accessing wholesale funding and banks' funding composition. I document that banks with higher market power change their funding dynamics to increase their funding profits which in turn allows them to charge lower loan markups and smooth the negative effect of contractionary monetary policy on their lending. This is a new dimension that these studies have not addressed, and my results provide significant insights into the impact of bank market power for the monetary policy transmission mechanism.

Finally, my paper connects to the literature that examines the effect of monetary policy on credit costs and real economic outcomes. Gertler and Karadi (2015) document that credit costs increase after a contractionary monetary policy shock due to the rise in the risk premia leading to a contraction in output. Eggertsson et al. (2019), Ulate (2021), Brunnermeier and Koby (2018) and Heider et al. (2019) explore the impact of low and negative interest rate environments on loan spreads and bank profitability. They show that the negative rate environment leads to a decline in banks' net worth, which can deteriorate output growth. I contribute to this literature by showing that bank market power alleviates the adverse effects of monetary policy both on bank funding and credit costs. Hence, the lending of banks with higher market power decreases relatively less after an increase in the policy rate. This, in turn, mitigates the negative impact of interest rate hikes on regional macroeconomic outcomes.

1.3. Motivating Evidence

In this section, I use aggregate bank-level data and document that monetary policy creates a wedge between the banks' funding spreads and the policy rate, leading to a change in the funding composition of the banking sector. Moreover, I illustrate the relationship between the policy rate and the bank profitability.

Figure 1.3a plots the average deposit and wholesale funding rate for the U.S. commercial banks against the federal funds rate over time using Call Reports data.[5] The figure reveals that both the deposit and wholesale funding rates rise less than one-for-one with the fed funds rate, generating a spread between the banks' funding rates and the policy rate.[6] As seen from the figure, both the deposit spread ($i^{FFR} - i^{D}$) and the wholesale funding spread ($i^{FFR} - i^{WF}$) are cyclical, increasing as the federal funds rate rises. Mainly, the tightening of the monetary policy increases the demand for interest-bearing deposits and wholesale funding products with respect to the money, enabling banks to restrict the pass-through of the higher policy rate to the cost of their funding.[7]

Figure 1.3c plots the average deposit rate by different deposit products using branch-level deposit data from Ratewatch. On average, time deposits offer higher rates than saving deposits as these products are less liquid than saving deposits.[8] Similarly, the pass-through to the wholesale funding rate is higher compared to the pass-through to the average deposit rate due to the illiquidity risk it bears.[9]

As the federal funds rate rises during monetary policy tightening cycles, the opportunity cost of holding deposits also rises. Consequently, depositors switch to relatively less liquid products that offer higher yields, such as bonds and money market products. This result can be seen by the negative relationship between the banks' core deposits and the federal funds rate presented in

[5] I calculate the deposit rate as interest income on domestic deposits divided by domestic deposits and then annualized.
[6] Drechsler et al. (2017) also reported the spread between the federal funds rate and deposits.
[7] Xiao (2020) also reported the spread between the federal funds rate and money market products.
[8] Particularly, time deposits are locked in for a term, whereas checking and saving deposits can be withdrawn immediately, generating a liquidity premium between these products (Drechsler et al., 2017).
[9] Wholesale funding is generally an uninsured form of borrowing, whereas retail deposits are fully insured. For instance, foreign deposits, which are a sizeable part of wholesale financing, are not guaranteed by FDIC.

Figure 1.4a. Specifically, the core deposits of the commercial banking system shrink substantially when the federal funds rate increases.[10] In return, banks seek to compensate for the decrease in their deposits by turning to wholesale funding markets, both of which contribute to the expansion of the shares of money market mutual funds, as shown in Figure 1.4a. Figure 1.4b plots the time series of wholesale funding to deposit ratio against the federal funds rate. Importantly, there is a positive relationship between the federal funds rate and banks' wholesale funding reliance, indicating that banks substitute wholesale funding for deposit outflows during periods of high-interest rates. Overall, the aggregate level analysis suggests that monetary policy changes the funding composition of the banking sector by generating a dispersion between the policy rate and bank funding rates.

Finally, Figure 1.3d plots the banks' net interest margins (NIM) and return on assets (ROA) against the federal funds rate and the 10-year Treasury yield. As seen from the figure, the term premium, in other words, the difference between the 10-year Treasury yield and federal funds rate, decreases when the federal funds rate increases. During the same time, NIMs and ROA also slightly decrease. As banks borrow short and lend long, an unexpected increase in the short rate increases banks' interest expense relative to their interest income, reducing their net interest margins. Taken together, the analysis suggests that the banks' profitability is significantly affected by the change in the policy rate.

1.4. Data and The Summary Statistics

This section describes the data and provides summary statistics relevant to my analysis.

1.4.1 Retail Rates: I use weekly data on loan and deposit rates collected across U.S. bank branches by Ratewatch. Ratewatch provides high-quality information on weekly deposit and loan rates of various deposit and loan products at the branch level. The data spans from January 2000 to December 2019 and can be merged with other data sets using an FDIC branch identifier.[11] Using Ratewatch data for my analysis is advantageous for a couple of reasons. First, it has the most extensive product coverage among the available datasets. Specifically, it covers rates on adjustable and fixed-rate mortgages with different maturities, home equity lines of credit (HELOCs), and home equity loans with different LTVs, automobile loans, and personal loans for a specific constant

[10] Banks' core retail deposits are calculated as the sum of the transaction and saving deposits.

[11] Drechsler et al. (2017) report that deposit data is available starting from 1997. However, Ratewatch provided me data beginning in 2000.

loan volume. On the deposit side, it provides data on savings, time, and checking deposits with various account sizes, such as money market deposit accounts with an account size of $10,000, $25,000, $75,000, and 6-month, 12-month, 24-month certificates of deposit with an account size of $10,000, $25,000, etc.

1.4.2 Small Business Lending: I collect county-level data on bank lending to small businesses from the Federal Financial Institutions Examination Council (FFIEC). The data covers small business lending by bank and county annually from 1997 to 2019.[12] In particular, it provides information about loan origination to U.S. small businesses (loans smaller than $1 million in size) at the county level by banks with assets roughly exceeding $1.25 billion.[13] I include all bank-county observations with at least $100,000 of new lending.[14] Small business lending data is particularly convenient for my analysis as small businesses have a strong dependency on local banks (Bord et al., 2015) and an illiquid form of lending. Moreover, it is well suited to investigate the impact of lending on real economic outcomes as small businesses represent more than 90% of all business establishments and around 50% of U.S. GDP. [15]

1.4.3 Monetary Policy Shocks: I use the Bauer and Swanson (2022) monetary policy shock series, graciously shared by the authors. These shocks are obtained by taking the first principal component of the changes in the first four quarterly Eurodollar futures contracts, ED1–ED4, around the FOMC announcements. Hence, these shocks also capture a forward guidance component, as argued in Gurkaynak et al. (2004).[16] These series are summed to a quarterly or an annual frequency, and they span from 1988 to 2019.[17] I instrument the changes in the one-year Treasury rate, my policy measure, with the Bauer and Swanson (2022) shocks. I re-scale it so that its effect on the one-year nominal Treasury yield equals one. I further checked the robustness of my results using the alternative monetary policy shocks obtained by orthogonalizing the Bauer and Swanson (2022)

[12] I exclude 2008 from my analysis to ensure that the financial crises do not drive my results, small business lending dropped significantly during the financial crises, as shown in Figure 1.5b.

[13] It excludes very small banks.

[14] My results are robust to using all bank-county observations in the sample.

[15] Small Business Administration January 2012. "Small Firms, Employment and Federal Policy," Congressional Budget Office, March 2012.

[16] Gürkaynak et al. (2007) show that Eurodollar futures are the best predictor of future values of the federal funds rate at horizons beyond six months and are virtually as good as federal funds futures at horizons less than six months.

[17] County-level data is available only at an annual frequency whereas bank-level data is mostly available at quarterly frequency.

shocks with respect to macroeconomic and financial data that pre-date the announcement.[18] There are many alternative approaches to identifying monetary policy shocks in the monetary policy literature. One of the many novel approaches is using residuals from a regression of the federal funds rate on lagged values and the Federal Reserve's information set using Greenbook forecasts as in Romer et al. (1990). Another approach is to identify the shocks in an SVAR and SVAR-IV as in Gertler and Karadi (2015), Miranda-Agrippino and Ricco (2021). However, many of these measures are not fully available for my period of study.

1.4.4 Federal funds Rate and Treasury Yields: In my analysis, I choose to use the one-year Treasury yield as the policy indicator since the average maturity of loans is higher than one year, whereas the average maturity of deposits is close to one year in the data. I instrument the one-year Treasury yield with Bauer and Swanson (2022) shocks to eliminate any concerns about the exogeneity of the policy instrument.[19] I collect the quarterly and yearly government Treasury bills and Federal fund rates from the FED H.15 series. In addition, I obtain data on U.S. commercial paper and 30-year mortgage rates from FRED.

1.4.5 Macroeconomic Data: The data on national level GDP, inflation and unemployment are from FRED. Similarly, data on U.S. commercial paper spread and 30-year mortgage rates also obtained from FRED. [20]

1.4.6 County Data: County-level data on GDP is collected from the U.S. Bureau of Economic Analysis at an annual frequency; it covers January 2001 to December 2019. County-level data on unemployment and wages are obtained from the Bureau of Labor Statistics. It covers 1997 January to 2019 December at an annual frequency.

1.4.7 Deposit Holdings: The data on branch-level deposits is from the Federal Deposit Insurance Corporation (FDIC). The data covers the universe of U.S. bank branches annually from January 1994 to December 2019. The data set also has branch characteristics such as the parent bank, address, and geographic coordinates. I use the unique FDIC branch identifier to match it with other data sets.

[18]Bauer and Swanson (2022) show that shocks obtained through both methods yield similar results on financial variables, whereas the orthogonalized shocks improve the results on macroeconomic variables.

[19]High-frequency monetary policy shocks are exogenous with respect to all macroeconomic variables that are publicly known prior to the FOMC announcement itself, making them a valid instrument.

[20]Commercial paper spread refers to difference between the 3-month commercial paper and the federal funds rate.

1.4.8 Bank Data: Quarterly aggregate bank-level data is obtained from the U.S. Call Reports provided by the Wharton Research data services (WRDS). I use data from January 1997 to December 2019.[21] The data contains novel information on income statements and balance sheets of all U.S. commercial banks. I match the bank-level Call Reports to the branch-level Ratewatch data using the FDIC bank identifier.

I focus on the period between 2000 to 2019 in my analysis as branch-level retail rate data is available starting from 2000. I exclude the period of financial crises from my analysis as banks' funding and lending decisions may change for other reasons unrelated to monetary policy during the extreme time of financial distress.

1.4.9 Summary Statistics: In my empirical approach, I use the Herfindahl-Hirschman Index (HHI) as a proxy for the local banking market concentration. The HHI is calculated by summing up the squared asset shares of all banks that operate branches in a given county in a given year and then averaged over time.[22]

$$HHI_{ct} = \sum_{j \in c} \left(\frac{assets_{jct}}{\sum_{j \in c} assets_{jct}} \right)^2 \tag{1.1}$$

I then assign to each bank branch in my data the HHI of the county in which it is located and refer to it as the HHI of the branch. For instance, I calculate the HHI of Miami as 0.11. Then I assign both Bank of America's Miami branch and Citibank's Miami branch an HHI of 0.11.[23]

Figure 1.6a maps the average HHI across the U.S. A lower number indicates a lower concentration level, hence a higher level of competition. There is a significant cross-sectional variation across counties, from a minimum HHI of 0.06 to a maximum of 1. Similarly, Figure 1.6b maps the same measure using the deposit share of the branches. Notably, both measures are highly correlated and indicate a similar dispersion in concentration among counties. On average, highly concentrated counties are smaller with a lower GDP and income. Moreover, the unemployment rate is slightly higher in these counties.

[21] I completed the missing series from data provided by Federal Financial Institutions Examination Council (FFIEC) 's website.

[22] As branch-level asset information is unavailable, I use banks' deposit-to-assets ratio from the Call Reports. I combine it with the branch-level deposit data from the Federal Deposit Insurance Corporation (FDIC) and compute the branch-level assets for each year.

[23] I use the asset market share of the branches as the main focus of the paper is capturing the market power on all markets.

The loan spread, $(i^L - i^{UST})$, is computed quarterly as the difference between the loan rate paid on a given type of loan and the interest rate on Treasury yield with the respective maturity. [24] Section 1.11 provide details on the construction of bank-level variables. Table 1.2 Panel B to D report the change in the loan spread by various loan products using branch-level loan data. There is a substantial variation among the bank branches, indicated by high standard deviations.

Table 1.3 Panel A provides summary statistics at the bank level. For my bank-level analysis, I compute a bank-level measure of concentration, Bank-HHI, defined as the weighted average of Branch-HHI (HHI_c) across all branches, using branch-level assets as weights.[25] The Table indicates greater variation in the wholesale funding spread, $(i^{FFR} - i^{WF})$, computed as the difference between the fed funds rate and the average rate paid on wholesale funding, is greater than in the deposit and loan spreads across the banks. Figure 1.5a plots the composition of wholesale funding for the U.S. commercial banks. Foreign Deposits, other borrowed money, brokered deposits, and repos have the highest share in banks' wholesale funding, respectively. In particular, they constitute more than 75% percent of banks' aggregate wholesale financing. Other components of wholesale funding include trading liabilities and subordinated debt, where subordinated debt comprises only a small portion of wholesale funding.

Table 1.3 Panel B provides summary statistics on small business lending, reported at the bank-county level at an annual frequency. Figure 1.5b plots the time-series of bank lending to small businesses both for the total volume and the number of loans. Notably, both series have declined substantially during the financial crises and have barely picked up to pre-crisis levels as of 2010. Table 1.3 Panel C provides information on annual county-level lending, GDP, unemployment, and wages. The average county-level GDP is around \$5 million, whereas average county-level wages are around \$2 million. The unemployment rate is around %6 with a standard deviation around %2.

The following section provides the empirical framework that explores the role of bank market power on the transmission of monetary policy to bank funding and lending rates, profitability, and lending. Moreover, it shows that monetary policy pass to real economic outcomes through banks' balance sheets.

[24] The loan rate is calculated by dividing total interest income on loans by the volume of loans and annualized.

[25] $BankHHI_{jt} = \sum_{i \in j} \left(\frac{assets_{it-1}}{\sum_{i \in j} assets_{it-1}} \times HHI_{ct} \right)$ as in Equation (1.3).

1.5. Empirical Analysis

My theory suggests that banks that operate in highly concentrated local banking markets, namely banks with higher market power, increase their interest rates on deposits and loan rates less after a monetary contraction. Moreover, they compensate for the decrease in deposits by increasing their reliance on wholesale funding as they pay relatively less for such funds. Consequently, lending and profitability of banks with higher market power decrease less. Moreover, real economic outcomes are less adversely affected by monetary policy in regions served by banks with higher market power.

Testing my hypothesis is particularly challenging as one cannot establish a direct causal effect of monetary policy on bank retail rates due to the potential for omitted variables. One of the most prominent omitted variables is the change in bank lending opportunities. If banks' lending opportunities changes as the Fed raises rates, this may affect banks' funding and lending decisions independent of banks' market power. In particular, banks' lending may shrink due to the adverse impact of monetary policy on their bank-specific loan demand, leading to a decrease in their funding needs (Drechsler et al., 2017). Thus, the change in lending opportunities may affect the funding and lending rates of the banks, irrespective of their market power. To obtain variation in concentration independent of bank-specific lending opportunities, I compare the deposit and lending rates across branches of the same bank located in areas with different concentration levels.[26] Comparing across branches of the same bank enables me to control the bank-specific lending opportunities and assess the effect of concentration on the responsiveness of bank retail rates to monetary policy.

As banks conduct decisions related to wholesale financing at the bank level and allocate their funds internally across their branches if needed, I turn into the bank-level Call Reports data. That is, I test the mechanism that generates an imperfect monetary pass-through to banks' lending rates and dampens the impact of contractionary monetary policy on banks' lending outcomes at the bank level. This bank-level estimation strategy is especially significant to emphasize the importance of the wholesale funding channel and give a complete view of the effect of market power on the transmission of monetary policy to bank balance sheets.

To establish a causal relationship between bank lending outcomes and the real economy, I further use bank-county level small business lending data that reports small business lending by bank

[26] This with-in bank estimation strategy comes from Drechsler et al. (2017).

and county for a given year. Small business lending is a significant form of borrowing for local businesses, allowing me to show a connection between bank-level lending and regional macroeconomic outcomes. First, I examine the effect of bank market power on banks' small business lending through my bank-county estimation, which enables me to link bank-level lending outcomes to county-level lending outcomes. Then, I assess the implications of the change in county-level lending on real economic outcomes using county-level unemployment data. This county-level analysis reveals that monetary policy transmits to macroeconomic outcomes through the bank lending channel.

The next section presents these estimation strategies and report the results.

1.5.1 Branch-level Estimation: In order to assess the impact of market power on the transmission of monetary policy to bank funding and lending spreads, I exploit the geographic variation in market power induced by the differences in the concentration of the local banking markets by using branch-level deposit and loan data from *Ratewatch*. As discussed earlier, the main challenge to identification is isolating the effect of bank market power independent of bank-specific lending opportunities. For instance, banks' lending might decrease because of the negative impact of monetary policy on their bank-specific loan demand, generating a decline in banks' need for deposits and wholesale funding. Thus, the funding and lending rates of the banks might be affected by the change in lending opportunities rather than bank market power. I tackle this issue by comparing the funding and lending spreads of the same bank located in counties with different degrees of concentration. Furthermore, I add state-time fixed effects to my analysis to ensure that these banks are subject to similar local banking market conditions, e.g., similar local loan demand. Finally, to eliminate the concerns regarding the endogeneity of the policy indicator, I instrument the change in the one-year Treasury yield with the plausibly exogenous monetary shocks of Bauer and Swanson (2022).

Equation (1.2) presents the baseline regression, allowing me to capture the average effect of monetary policy on bank lending and funding spreads in addition to the impact of banking market concentration.

$$\Delta y_{it} = \delta_i + \gamma_c + \lambda_s + \beta_1 \Delta R_t + \beta_2 \Delta R_t \times HHI_c + \Omega'(L) Z_t + \epsilon_{it} \tag{1.2}$$

Δy_{it} is either the quarterly change in the deposit spread or the change in the loan spread of branch i of bank j operating in county c from *t-1* to t. ΔR_t is the quarterly change in the one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. HHI_c is the concentration of the county where branch i of bank j is located. It is calculated by summing up the squared asset-market shares of all banks that operate in a given county in a given year and then averaged across years, as shown in Equation (1.2). δ_i, γ_c, and λ_s are branch, county, and state fixed effects, respectively. [27]

Branch fixed effects control for branch-specific characteristics. County fixed effects control for county-specific factors such as county-wide economic trends.[28] Similarly, state-fixed effects control state-specific factors such as time-in-varying banking market conditions. I also add a county fixed effects interacted with a dummy variable for the zero-lower bound period to control for differences that may stem from the zero lower bound period. Z_t includes additional control variables, which include GDP growth, unemployment rate and inflation. [29] The macroeconomic control variables were added to isolate the role of interest rates from cyclical conditions. Finally, I cluster the standard errors at the county level to control for correlation within counties. I compute the interaction terms and control variables relative to their means in this and all my upcoming specifications. The reason is that, by demeaning the variables in this way, the intercept term β_1 has the natural and desirable interpretation as the average conditional path when all controls are at their mean levels.

I further add bank-time fixed effects, which absorb all time-varying differences between banks and allow me to compare the branches of the same bank located in areas with different concentration levels following Drechsler et al. (2017). That is, I control for changes in bank-specific lending opportunities that the change in the monetary policy might cause. I also add state-time fixed effects to control state-level changes in local deposit and lending markets. Finally, I run several specifications with different combinations of fixed effects to gauge their impact and check the robustness of my results.[30]

[27] The interaction term is also instrumented by the Bauer and Swanson (2022) shocks in this and all the upcoming specifications.

[28] County and branch fixed effects are highly collinear as only a really small fraction of branches change counties.

[29] Results are robust, adding the change in the commercial paper spread and 30-year mortgage spread.

[30] Adding time fixed effects absorbs the β_1 as the change in the interest rate is the same for all branches at a particular point in time. On the other hand, it allows me to control for underlying observable and unobservable systematic differences between observed time units.

Table 1.4 shows that, on average, banks increase their deposit spreads, $(i^{FFR} - i^{D})$ after an increase in the policy rate, and deposit spreads widen more for branches in more concentrated areas. That is, the pass-through of monetary policy to deposit rates decreases with bank concentration. Column (1) focuses on all bank branches in my sample and examines the spread dispersion across the branches of the different banks, whereas columns (2) to (5) focus on the banks that operate in at least two counties to make sure that the county-specific community banks do not drive my results. In particular, Columns (3), (4), and (5) add state-time fixed effects, bank-time fixed effects, and both state-time and bank-time fixed effects, respectively.

Table 1.4 Panel A reports the results for 12 months of certificates of deposits, a common type of small-time deposit. Column (1) documents that deposit spreads increase around 34 bps after a 100 bps raise in the one-year Treasury yield. That is, the average deposit rate on 12-months CDs increases by 66 bps after a 100 bps increase in the policy rate. The interaction term on the change in the policy rate and the concentration index indicates that deposit spreads increase 13 bps more for branches that operate in more concentrated counties. In other words, deposit rates increases around 3.9 bps (13*0.30=3.9) less in bank branches that serve in counties with a 0.30 higher Herfindahl-Hirschman Index. Where 0.30 refers approximately the 75th percentile of the HHI distribution. Column (5) of Table 1.4 shows that deposit spreads of bank branches located in counties with higher concentrations increase more compared to branches located in areas with lower concentrations, even comparing the branches of the same bank located in the same state. Specifically, the deposit rate increase is around 3 bps (10*0.30=3) less for the bank branch that operates in a county with a 0.30 higher HHI than the county where the other branch is located.

Table 1.4 Panel B reports the results for $25K Money Market accounts, a common saving deposit type. It shows that spreads increase around 85 bps after a 100 bps increase in the one-year Treasury yield, which is 25 bps higher for branches located in concentrated counties.[31] In other words, the average deposit rate on $25K Money Market accounts increases only 15 bps after a 100 bps increase in the one-year Treasury yield. Moreover, it increases around 7.5 bps (25*0.30=7.5) less for bank branches that operate in counties with a 0.30 higher HHI. Column (5) of Table 1.4 shows that deposit spreads of bank branches located in counties with higher concentrations increase more

[31]The magnitude of the rise in the deposit spread is slightly higher than the one reported in Drechsler et al. (2017) due to the instrumental variable approach used in my paper. Usage of the Bauer and Swanson (2022) shock slightly amplifies the response of the deposit spread.

compared to branches located in areas with lower concentrations, even comparing the branches of the same bank located in the same state. As seen from the results, the interest rate pass-through is much lower for savings deposits than time deposits, which can be explained by the relative liquidity of saving deposits over time deposits.[32]

Tables 1.5 to 1.6 present the results for various loan products. The results indicate that loan spreads, $(i^L - i^{UST})$ increase after monetary policy tightening.[33] However, monetary policy pass-through to loan spreads is lower in more concentrated areas. One explanation for this result is that branches located in more concentrated areas reduce their loan markups to mitigate the effects of the fall in loan demand without losing profits, as they can increase their deposit spreads from the funding side. Specifically, Table 1.5 Panel A Column (1) show that personal loan spreads increase around 18 bps after a 100 bps increase in the one-year Treasury yield.[34] Yet, this increase is around 29 bps less for banks in areas with higher market concentration. That is, loan rates increase around 8.7 bps (29*0.30=8.7) less in bank branches that serve in counties with a 0.30 higher Herfindahl-Hirschman Index. Columns (2) to (5) report the results for the banks that operate at least in two counties for different fixed effect specifications, and the results are robust. Table 1.5 Panel B reports the results on 72-month automobile loans. The spread on automobile loans increases by 25 bps on average, but it rises 19 bps less for banks in more concentrated areas. If a bank branch is located in a county with a 0.30 higher Herfindahl-Hirschman Index, the rate on automobile loans increases by 5.7 bps (19*0.30=5.7) less on average.[35] Column (5) shows the result remains significant even when we compare the branches of the same bank operating in the same state yet located in counties with different degrees of concentration.

Table 1.6 reports similar results for HELOCs and 30-year fixed mortgage spreads.[36] Specifically, Panel A documents that spread on Home Equity Line of Credits (HELOCs) with less than 80% loan-to-value ratio (LTV) increases by 97 bps on average, yet it increases approximately 25 bps less for branches located in more concentrated markets.[37] Columns (2) to (5) present the results for the banks that operate at least in two counties for various fixed effect specifications, and the

[32] Time deposits are locked in for a term, whereas checking and saving deposits can be withdrawn immediately.

[33] Results are robust using the loan rates instead of spreads.

[34] I use the personal loan rates for Tier 1 customers, which has the best credit score among all other customers.

[35] I calculate the automobile loan spread by subtracting the average of 5 and 7-year Treasury yields from the automobile loan rates.

[36] I report the results on the most responsive loan products for each category.

[37] HELOCs are loans that allow you to borrow against your home's equity.

results remain robust. Mainly, Column (5) shows that among the branches of the same bank that operates in the same county, the one located in a more concentrated county increases its loan spread less for both products. Panel B reports similar results on 30-year fixed mortgage spreads. In particular, Column (5) shows that the loan spread increases around 33 bps less for branches located in more concentrated markets. That is, if a bank branch is located in a county with a 0.30 higher Herfindahl-Hirschman Index, the loan rate on mortgages increases by 9.9 bps less (33*0.30=9.9) on average.

Taken together, the results indicate that monetary policy pass-through to deposit and loan spreads are lower for bank branches located in more concentrated areas. In particular, these branches widen their deposit spreads more and offer lower deposit rates to their customers. At the same time, they also increase their markups on loans less to alleviate the effect of contractionary monetary policy on loan demand.

The previous results document that banks operating in concentrated areas increase their deposit spreads more, allowing them to keep their loan demand more stable by reducing the pass-through of higher policy rates to loan rates. Therefore, if banks that operate in concentrated markets compensate for the decrease in deposit inflows by relying on wholesale funding, as the aggregate data in Section 1.3 suggest, I expect these banks' lending to decrease relatively less following a contractionary monetary policy. Thus, banks' reliance on wholesale funding can mitigate the impact of deposit outflows and result in less loan contraction for banks with higher market power that operate in highly concentrated local banking markets. Since banks make their decisions on wholesale funding at the bank level and channel their funds across branches when needed, I test this hypothesis using aggregate balance sheet data from Call Reports in the next section. That is, I explore the impact of bank market power on the transmission of monetary policy on banks' wholesale funding spreads and funding composition. I also provide a complete picture of the underlying mechanism that leads to a lower monetary policy pass-through to loan spreads and lending for banks with higher market power.

1.5.2 Bank-level Estimation: In this section, I examine the effect of the bank market power on the aggregate bank-level variables to provide a comprehensive picture of the mechanism that diminishes the impact of monetary policy on bank lending. My theory suggests that banks that operate in highly concentrated markets adjust their deposit rates less and compensate for the decrease in their deposit by relying on wholesale funding as they access wholesale funding at a comparatively lower cost. Moreover, they increase the interest rates on their loans relatively less as funding costs increase less for them. Consequently, they dampen the effect of contractionary monetary policy on their lending.

In order to test this mechanism, I construct a bank-level measure of market power, Bank-HHI, by averaging the local concentration of the counties where the bank's branches operate (H_{ct}), weighing each branch by its lagged share of assets, and use this measure as a proxy for the bank market power. This measure specifically allows me to capture the impact of market power on banks' cost of accessing wholesale funding and wholesale funding reliance as decisions related to wholesale financing are conducted at the bank level. In addition, it further allows me to capture the impact of bank market power on lending.

$$BankHHI_{jt} = \sum_{i \in j} \left(\frac{assets_{it-1}}{\sum_{i \in j} assets_{it-1}} \times HHI_{ct} \right) \tag{1.3}$$

Equation (1.3) presents the calculation for the bank market power measure, where HHI_{ct} is the concentration of a particular county where branch i of bank j is located and $assets_{it-1}$ is the total assets of branch i of bank j.

To capture the impact of bank market power for the pass-through of monetary policy to bank-level outcomes, I run the following regression at the bank-quarter level:

$$\begin{aligned} \Delta y_{jt} =& \alpha_j + \beta_1 \Delta R_t + \beta_2 \Delta R_t \times BankHHI_{jt-1} + \gamma BankHHI_{jt-1} + \\ & \Gamma'(L) X_{jt-1} + \Omega'(L) Z_t + \epsilon_{jt} \end{aligned} \tag{1.4}$$

Where Δy_{jt} is the log change in a given balance sheet component of bank j from date *t-1* to t. ΔR_t is the change in the one-year Treasury yield from *t-1* to t instrumented with Bauer and Swanson (2022) shocks. $BankHHI_{jt-1}$ is the bank-level concentration of bank j, lagged by one period. α_j is bank fixed effects, and X_{jt-1} is bank-level controls such as the lagged change in the banks' assets, equity, and liquidity. Specifically, these bank-level variables enable me to control for differences that may stem from the bank size, liquidity, and bank soundness. They are added in log difference form to capture the time-series trend.[38] I also add bank fixed effects interacted

[38] Results are robust using lagged values of total assets, equity and liquidity to asset ratios.

with a dummy for the ZLB period to ensure that my results are not driven by the zero lower bound period. In addition, I add the following control variables: GDP growth, unemployment rate, inflation. These variables are captured by the term Z_t. I cluster the standard errors at the bank level to control for correlation within banks.[39] I demeaned the Bank-HHI and all other control variables.[40]

Table 1.7 reports the results. Column (1) of Table 1.7 Panel A shows that after a 100 bps points increase in the one-year Treasury yield, deposit spreads of banks (measured as the fed funds rate minus domestic deposit interest expense divided by domestic deposits) increase by 88 bps on average. That is, the average deposit rate banks pay to their depositor's increases around 12 bps after a 100 bps increase in the policy rate. Notably, the increase in the average deposit rates is lower than the amount reported on time and saving deposits presented in the previous section, as it also includes the transaction deposits.[41] The interaction term on the change in the policy rate and bank-level concentration indicates that deposit spreads of banks with higher market power increase by 8 bps more, consistent with my branch-level results. That is, banks with higher market power partially pass the increase in interest rate to their depositors. As a result, they experience a slightly higher decrease in their growth of deposits, as reported in Table 1.7 Panel B Column (1). However, the change in the deposit growth does not significantly differ among banks at the bank level, indicating that these banks face a relatively inelastic supply of deposits due to their market power. [42]

Table 1.7 Panel A Column (2) shows that a 100 bps increase in the one-year Treasury yield leads to a 71 bps increase in the wholesale funding spreads (measured as the fed funds rate minus wholesale funding interest expense divided by total wholesale funding). However, banks with higher market power access wholesale funding with a lower cost as the wholesale funding spreads increase around 20 bps more for those banks. Table 1.7 Panel B Column (2) shows that banks partially compensate for the decrease in total deposit inflows by relying on wholesale funding. It also presents

[39] My results are robust, including time f.e and reported in Section 1.7. As suggested in Cameron and Miller (2015), adding time fixed and clustering at the other dimension eliminates concerns on error correlation in multi-dimensions, if any.

[40] I winsorize all variables at the 1% and 99% level by quarter to isolate the effect of outliers following Drechsler et al. (2017).

[41] Transaction deposits include interest and non-interest-bearing checking deposits, NOW accounts, ATS accounts, and telephone and preauthorized transfer accounts.

[42] My results suggest that the responsiveness of the deposits to change in the deposit spread decreased in my sample period compared to Drechsler et al. (2017) who center on the pre-ZLB period.

that wholesale funding reliance increases significantly more for banks with higher market power. Table 1.7 Column (3) indicates that the increase in wholesale funding reliance enables banks with higher market power to entirely offset their shortfalls in deposits, as liabilities do not significantly differ between banks with high versus lower market power. Specifically, the coefficient on the interaction term between the change in the interest rate and market power is positive. Taken together, the results indicate that monetary policy changes the funding composition of the banking sector by creating a dispersion among the funding spreads of the banks with different degrees of market power.

Table 1.7 Panel A Column (3) displays the results for bank funding spreads, which are calculated as the weighted average spread on deposits and wholesale funding. In particular, funding spreads increase more for banks with higher market power. This, in turn, allows these banks to increase their loan spreads less to keep their loan demand stable, as shown in Column (4). Specifically, the average loan spread increases by 28 bps after a 100 bps increase in the one-year Treasury yield. However, it increases around 8 bps less for a bank with higher market power. Overall, the results confirm that bank market power mitigates monetary policy transmission to bank funding and lending rates.

Focusing on the impact of bank market power on bank profitability, I find that, on average, the banks' net interest margins decrease following a monetary contraction, as reported in Table 1.7 Panel A Column (5). Although there is a decline in the bank's net interest margins, the magnitude is small. Specifically, a 100 bps increase in the Federal funds rate decreases net interest margins by around 3 bps for an average bank. This result is consistent with Drechsler et al. (2021), who show that banks closely match the interest rate sensitivities of their interest income and expense. On the other hand, I document that net interest margins decrease significantly less for banks with higher market power due to the higher increase in their funding spreads, although the magnitude of the difference is small. Column (6) reports the results on ROA. Notably, bank profits are insensitive to fluctuations in interest rates, and the profits of the banks with higher market power slightly increase more for banks with higher market power.

As banks with higher market power increase their lending spreads less on average and increase wholesale funding reliance substantially more, I expect the lending of banks with higher market power decreases less. Table 1.7 Panel B Columns (4) and (5) show that total assets and loans reduce after policy tightening. However, total assets and loans decrease less for banks with higher market power. Similarly, securities also fall significantly less for banks with higher market power. In Section 1.7, I replicate my results using the LP-IV approach of Jordà (2005) and show that the impact of monetary policy on bank-level lending amplifies in longer horizons.

1.5.3 Bank-County Estimation: In the previous section, I have shown that funding spreads increase significantly more for banks with higher market power following a contractionary monetary policy. Consequently, these banks adjust their loan spreads less to mitigate the impact of contractionary monetary policy on their lending. Moreover, I document that the lower cost of accessing wholesale funding allows banks with higher market power to replace their deposit outflows with wholesale financing. Hence, lending of banks with market power decreases relatively less.

Next, I use branch-level small lending data from FDIC to investigate the link between bank lending and macroeconomic outcomes.[43] Usage of small lending data is particularly advantageous to establish causality between bank lending and county-level lending, and further county-level lending and unemployment as local businesses are highly dependent on small business lending to fund themselves. Moreover, bank-county level small business lending data allows me to control for differences in local lending opportunities and rule out the possibility that my results are driven by the local loan demand. Specifically, the main threat to identification in this setting is that borrowers in different counties might be distinctly affected by the macroeconomic environment resulting from the change in the policy rate. Consequently, a bank lending in a particular county might be influenced by the change in local lending opportunities independent of the bank's market power.

To tackle this issue, I add county-time fixed effects to my analysis that controls for the time-varying changes in the local loan demand. In addition, as banks execute wholesale funding decisions at the bank level and can allocate funds internally across their branches to fund their lending if needed, I use my bank-level concentration measure in my analysis which is a good indicator of how much funding a bank will raise and increase its profits from the funding side. In particular, if banks with higher market power can compensate for their shortfalls in deposits through cheaper access to wholesale funding and partially pass the increase in the policy rate to their borrowers, these banks' lending should decrease less compared to other banks.

[43] I exclude 2008 from my analysis as small business lending decreased around 30 percent during this period due to the adverse effect of the financial crises.

To test this hypothesis, I estimate the following regression at the bank-county level:

$$\Delta y_{jct} = \alpha_{jc} + \beta_1 \Delta R_t + \beta_2 \Delta R_t \times BankHHI_{jt-1} + \gamma BankHHI_{jt-1} + \Omega'(L) Z_t + \epsilon_{jt} \tag{1.5}$$

Δy_{jct} is the percentage change in the small business lending by bank j in county c from year *t-1* to *t*.[44] $BankHHI_{jt-1}$ is the bank-level concentration of bank j in year *t-1*. ΔR_t is the change in the one-year Treasury yield from *t-1* to t instrumented with Bauer and Swanson (2022) shocks. α_{jc} are bank-county fixed effects that absorb time-invariant characteristics such as banks' brand effects.[45] This approach allows me to capture the average effect of an increase in the interest rate on bank lending and identify the impact of bank market power on the transmission of monetary policy to bank lending. I further add county-time fixed effects, which soaks up the changes in local lending opportunities into my regression. Although including county-time fixed effects is preferable because it isolates the effects that may stem from the change in local lending opportunities, it requires excluding the ΔR_t, which captures the average effect of monetary policy on bank lending outcomes. Hence, I report the results obtained through both approaches and show that my results are robust to different specifications. Z_t includes GDP growth, unemployment rate, inflation.[46] These controls are added into the regression to isolate the role of the level of interest rates from that of cyclical conditions whenever time or county-time fixed effects are excluded. Standard errors are double clustered at the bank and county levels.

Table 1.8 displays the results on bank-county level lending. Column (1) presents the results across banks and regions. Specifically, it shows that bank-level small business lending decreases approximately by 14 bps after a 100 bps increase in the one-year Treasury yield, yet lending of banks with higher market power falls around 29 bps less in line with my hypothesis. In particular, small business lending decreases by 8.7 bps (28*0.30=8.7) less for banks with a 0.30 higher Bank-HHI. Column (2) includes the local concentration of the counties to the regression, and the interaction term between the change in the policy indicator and Bank-HHI remains economically and statistically significant. This result confirms that the bank-level market power rather than the county-level

[44] I use percentage change in loans rather than the level of loans to be able to account for differences in bank size, which considerably impacts banks' loan volumes.

[45] County fixed effects interacted with a dummy variable for the zero-lower bound period is also added to control for differences that may stem from the ZLB period.

[46] Results are robust adding the change in the commercial paper spread, and 30-year mortgage spread.

market power drives the wholesale funding channel. Column (3) adds time-fixed effects, and the interaction term coefficient remains significant. Column (4) repeats the same analysis by controlling for the local concentration of the counties and reports similar results. Finally, Column (5) presents the results with county-time fixed effects that absorb the impact of loan demand. The magnitude of the coefficient on the interaction term remains similar to Columns (1) and (2); additionally, it is still significant.

The results confirm that market power enables banks to increase their funding spreads, and banks with higher market power offset the higher decrease in deposit outflows by increasing their wholesale financing. This also allows banks with higher to increase their loan rates less on average. Consequently, their lending decreases relatively less after Fed raises the policy rate. In the next section, I aggregate my data to the county level to show that my results on bank-level lending have implications for the transmission of monetary policy to county-level small business lending and real economic outcomes.

1.5.4 County-level Analysis: In the previous section, I've shown that small business lending of the banks with higher market power decreases less compared to other banks. This result suggests that total lending in counties where banks with higher market power operate should decrease less after an increase in the policy rate. Thus, real economic outcomes such as unemployment should be affected less negatively in these regions as small business lending constitutes a substantial amount of the funding of the local businesses.

To test this prediction, I aggregate my bank-level small business lending data at the county level and construct a county-level concentration measure, County-HHI, defined as the weighted average of Bank-HHI across all banks lending in a given county, using their lagged lending shares as weights to alleviate concerns regarding the endogeneity of the measure.

$$CountyHHI_{ct} = \sum_{j \in c} \left(\frac{lending_{jct-1}}{\sum_{j \in c} lending_{jct-1}} \times BankHHI_{jt} \right) \tag{1.6}$$

In particular, County-HHI measures the extent to which a county is served by banks with higher market power and allows me to test the impact of bank market power on county-level outcomes.

As county-level macroeconomic outcomes such as unemployment might respond to monetary policy with a lag, I use the local projection (LP-IV) method of Jordà (2005) which allows me to capture the impact of bank market power in longer horizons. Equation (1.7) presents the baseline LP-IV specification, which estimates the dynamic causal effects of monetary policy changes subject to the alternative banking concentration of the counties.

$$\begin{aligned}\Delta_h log(y_{ct+h}) =& \alpha_c^h + \beta^h \Delta R_t + \Gamma^h \Delta R_t \times CountyHHI_{ct-1} + \theta^h CountyHHI_{ct-1} \\ & + \Omega'(L) Z_t + \epsilon_{ct+h}\end{aligned} \tag{1.7}$$

Where the horizon is $h = 0, 1, ..4$ years, and c and t denote county and time, respectively. The left-hand side of Equation (1.7) is the cumulative change in the outcome variable y, $\Delta_h log(y_{c,t+h}) = log(y_{c,t+h}) - log(y_{c,t-1})$, where y is the total county-level small business lending or unemployment.[47] The specification regresses the dynamic cumulative change in variable y on monetary policy changes subject to the banking concentration of counties. α_c^h denotes county fixed effect, which absorbs permanent differences across counties.[48] ΔR_t refers to the change in the one-year Treasury yield from year t-1 to t instrumented with Bauer and Swanson (2022) shocks. β^h captures the impulse response of the left-hand side variable at time t+h to a monetary policy change at time t. Γ^h gives the marginal effect of concentration on the responsiveness to monetary policy. I instrument the interaction term with the interaction of Bauer and Swanson (2022) shocks and the County-HHI variable.[49]

Z_t includes the following control variables: change in the national level GDP, unemployment rate, inflation.[50] Standard errors are clustered by county level to control for correlation within counties. The estimation is calculated up to a horizon of four years, and the lag structure on all right-hand-side variables is one year.

Figure 1.7 plots the estimated coefficients as well as their 95% confidence intervals on the total county-level small business lending. Figure 1.7a shows that total lending decreases by around 10 bps percent after a 100 bps increase in the policy rate. Moreover, the peak effect reaches 40 bps four years after the contractionary monetary policy. In contrast, Figure 1.7b shows sizable heterogeneity

[47] Using the level of loans as a left-hand side variable is particularly problematic in this case as the marginal effects implied by the level specification are implausible for any cross-section of markets that vary substantially in size. A change in the federal funds rate will have a much greater effect on loan volume in a large market than in a small market, as argued by Adams and Amel (2011).

[48] I further include county fixed effects interacted with a dummy variable for the ZLB period to control the effect of the low interest rate environment.

[49] I further add the local concentration of the county interacted with the change in the policy instrument.

[50] Results are robust adding mortgage and commercial paper spread.

in monetary policy outcomes conditional on the County-HHI of the counties. Specifically, county-level lending decreases around 10 bps less in counties in which banks with higher credit market power operate. The peak effect is about 50 bps, occurring three years after the monetary policy shock. Figure 1.7c plots the results for counties with County-HHI 0, 0.15, 0.20 and 0.30, respectively.[51] As shown in the Figure, county-level small business lending decreases around 10 bps following a 100 bps increase in the one-year Treasury yield. However, it reduces by around 3 bps less in counties with a County-HHI of 0.30. These findings highlight that small business lending in counties where banks with higher market power operate is less negatively affected by contractionary monetary policy relative to other counties. As small businesses are highly dependent on local lending and have a sizeable effect on the county's real economy, unemployment should also increase less in counties served by banks with higher market power following an increase in the policy rate.

Figure 1.8 presents the results on unemployment. Specifically, Figure 1.8a shows that the increase in unemployment reaches up to 15 bps after a 100 bps increase in the one-year Treasury yield. Figure 1.8b suggests that the unemployment rate rises less in counties with higher County-HHI, and it is more sizeable starting from a year after the interest rate hike. Overall, the results provide evidence that market power alleviates the negative impact of interest rate hikes on county-level lending and unemployment. Hence, market power has a crucial effect on the transmission of monetary policy to real economic activity.

The following section presents a partial equilibrium model of monopolistic competition that rationalizes my findings on the partial pass-through of monetary policy to the bank deposit and lending rates for the banks with higher market power.

1.6. A Simple Model of Monopolistic Competition

To provide intuition for the underlying mechanism and rationalize my empirical findings, I build a simple model of monopolistic competition and take it to the data. The model allows me to look at the simultaneous exercise of market power on both the deposit and lending side-necessary to understand previous empirical results on the lending channel for monetary policy.

The model assumes that deposits and loans are baskets of differentiated products with constant elasticity of substitution, which leads to a constant markup on the retail rates. The building block

[51] These values correspond to the 25th, 50th, and 75th percentile of the County-HHI distribution.

of the model comes from Ulate (2021) where the deposit supply and loan demand for each bank rise from the fact that depositors and borrowers have CES preferences across banks. The model takes the aggregate amounts of deposits supplied, and loans demanded as given since this is a partial equilibrium exercise. It predicts that pass-through to loan and deposit rates decrease for banks with higher market power which access the wholesale funding markets at a cheaper cost. That is, the model suggests that pass-through to the retail rates is determined by the cost of accessing wholesale funding, which is a function of bank market power

1.6.1 The Model: Assume that banks' cost of accessing wholesale funding is exogenously determined, and banks with higher market power access wholesale funding markets at a lower cost, consistent with the data. Banks operate under monopolistic competition, where market power could arise from product differentiation. Table 1.1 shows a bank's balance sheet with loans, L_j, securities G_j, as assets; and deposits D_j and wholesale funding WF_j, as liabilities.

TABLE 1.1. Balance Sheet

Assets	Liabilities
Loans L_j	Deposits D_j
Securities G_j	Wholesale Funding WF_j

Each bank j maximize profits given by Equation (1.8):

$$\max_{i_j^L, i_j^D} \Pi_j = (1+i_j^L)L_j + (1+f)G_j - (1+i_j^D)D_j - \left(1+f-\phi_j^{WF}\right) WF_j \tag{1.8}$$

subject to the loan and deposit demand and the bank balance sheet constraint given by

$$L_j = \left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L \tag{1.9}$$

$$D_j = \left(\frac{1+i_j^D}{1+i^D}\right)^{-\theta^d} D \tag{1.10}$$

$$L_j + G_j = D_j + WF_j \tag{1.11}$$

Where ${\phi_j}^{WF}$ is the wholesale funding spread of the banks, assumed to be exogenously higher for banks with higher market power as wholesale funding is cheaper for them.[52] $1 < -\theta^{\ell}$ is the elasticity of substitution for loans between banks, and L is the aggregate loan in the economy. i^L is the aggregate loan rate index. $\theta^d < -1$ is the elasticity of substitution for deposits between banks, D is the aggregate deposit in the economy, and i^D is the aggregate deposit rate index. The loan and deposit demand functions are derived by solving the saver and the borrower problems, where both agents have CES demand functions. These demand functions are driven in Section 1.11.

The maximization problem of the bank can be solved by substituting Equations (1.9) to (1.11) into Equation (1.8) and taking first-order conditions with respect to deposit and loan rates. The solution of the problem yields the loan and deposit rates as markup and markdown over the federal funds rate and the bank's wholesale funding spread, ${\phi_j}^{WF}$.[53]

$$1 + i_j^L = \underbrace{\frac{\theta^{\ell}}{\theta^{\ell} - 1}}_{\text{markup}} \left(1 + f - \phi_j^{WF}\right) \tag{1.12}$$

$$1 + i_j^D = \underbrace{\frac{\theta^{d}}{\theta^{d} - 1}}_{\text{markdown}} \left(1 + f - \phi_j^{WF}\right) \tag{1.13}$$

As $1 < \theta^{\ell}$ and $\theta^d < -1$ which indicates that

$$\frac{\theta^{\ell}}{\theta^{\ell} - 1} > 1$$

$$0 < \frac{\theta^{d}}{\theta^{d} - 1} < 1$$

Equation (1.12) shows that the loan rate is a markup over the federal funds rate and the bank's wholesale-funding spread, ${\phi_j}^{WF}$. On the other hand, Equation (1.13) shows that the deposit rate is a markdown over the federal funds rate and the bank's wholesale-funding spread, ${\phi_j}^{WF}$. Since wholesale funding spreads, ${\phi_j}^{WF}$ are higher for banks with higher market power, both Equations

[52] Note that ${\phi_j}^{WF}$ is assumed to be a function of the federal funds rate and widens more for banks with higher market power after policy tightening in line with the data.

[53] Note that higher ${\phi_j}^{WF}$ indicates that the bank accesses wholesale funding with a lower cost.

(1.12) and (1.13) indicate that deposit and loan rates are lower for banks with higher market power. In order to capture the impact of market power on banks' wholesale funding, deposit and loan volumes, we can now turn to Equations (1.9), (1.10), and (1.11).

In particular, Equation (1.9) suggests that the loan demand of the banks with higher market power is higher as these banks offer lower loan rates. On the other hand, Equation (1.10) indicates that the deposit supply of banks with higher market power is lower due to the lower deposit rate they offer. Hence, banks with higher market power rely more on wholesale funding, which can be seen through Equation (1.11).[54] Overall, the results show that the model matches with the data in terms of the response of deposit and loan rates as well as the response of banks' funding and lending volumes.

The paper's main focus is the monetary policy pass-through to deposit and loan rates; thus, I differentiate the loan and deposit rate equations with respect to the policy rate, f. Equations (1.14) and (1.15) suggest that monetary policy transmission to deposit and loan rates depend on pass-through to banks' wholesale funding spreads. As $\frac{d\phi_j^{WF}}{df}$ is higher for banks with higher market power, in other words, wholesale funding spreads widen more for banks with higher market power after an increase in the policy rate, pass-through to retail rates is lower for these banks. That is, banks with higher market power increase both the loan and the deposit rates less after an increase in the policy rate, verifying the predictions of my empirical analysis.

$$\frac{di_j^L}{df} = \frac{\theta^\ell}{\theta^\ell - 1} - \frac{\theta^\ell}{\theta^\ell - 1}\frac{d\phi_j^{WF}}{df} \tag{1.14}$$

$$\frac{di_j^D}{df} = \frac{\theta^d}{\theta^d - 1} - \frac{\theta^d}{\theta^d - 1}\frac{d\phi_j^{WF}}{df} \tag{1.15}$$

The next section test model predictions by taking the model into data. That is it shows that:

(1) Monetary policy pass-through to loan rates decreases with market power.

(2) Monetary policy pass-through to deposit rates decreases with market power.

[54] Banks use any extra funding to issue securities as also suggested by Equation (1.11).

1.6.2 Model Assessment: In this section, I test whether the model performs well in matching the data by using data from the Call Reports.

First, I estimate the average markup and markdown of the U.S banking system by using the following equations. This equations simply assume that the loan and deposit rate is a constant markup and markdown over the federal funds rate.

$$1 + i^L = \underbrace{\frac{\theta^\ell}{\theta^\ell - 1}}_{\text{markup}} (1 + f) \tag{1.16}$$

$$1 + i^D = \underbrace{\frac{\theta^d}{\theta^d - 1}}_{\text{markdown}} (1 + f) \tag{1.17}$$

Where i^L is the average loan rate for all banks, i^D is the average loan rate for all banks from the Call Reports, and f is the federal funds rate. The average markup for loans is found as 2.47, whereas the average markup on deposits is found to be 1.17, which is slightly higher than 1 as the deposit rates exceed the federal funds rate from time to time, as shown in Figures 1.3a and 1.3c.[55]

Next, I cross-validate the model to find the model implied loan and deposit rates. To do so, I obtain the average change in the wholesale funding spread, $\Delta\phi^{WF}(WF)$ from the Call Reports using Equation (1.18). I then plug it into Equations (1.19) and (1.20). I perform this exercise both for the banks above and below the 75th percentile of Bank-HHI distribution.

$$\Delta(1 + i^{WF}) = \Delta(1 + f - \phi^{WF}) \rightarrow \Delta\phi^{WF}(WF) \tag{1.18}$$

$$\Delta\big[1 + i^L\big] = \Delta\left[\frac{\theta^\ell}{\theta^\ell - 1}\big(1 + f - \phi^{WF}(WF)\big)\right] \rightarrow \Delta i^L \tag{1.19}$$

$$\Delta\big[1 + i^D\big] = \Delta\left[\frac{\theta^d}{\theta^d - 1}\big(1 + f - \phi^{WF}(WF)\big)\right] \rightarrow \Delta i^D \tag{1.20}$$

55 Note that I averaged these markups/markdowns over time.

Figure 1.9a presents the results for the change in the loan rate, where the left-hand-side panel reports the model implied change in the loan rate and the right-hand side is the actual change in the loan rate from the Call Reports, where the average loan rate for the High-HHI group is calculated by averaging the loan rate of all banks that are above the 75th percentile of the Bank-HHI distribution for a given year. Again, both the replications using the model and the actual data suggest that the loan rate changes less for the banks with higher market power. Similarly, Figure 1.9b reports the results for the deposit rate. It shows that both the actual data and the model indicate that the deposit rate changes less for the banks with higher market power. These exercises show that the simple model performs well in matching the data as monetary policy pass-through to deposit and loan rates decreasing with market power.

1.7. Robustness

This section conducts a large number of checks that confirm the baseline results are robust to alternative estimation strategies, usage of different market power measures, monetary policy shocks, and samples.

1.7.1 Usage of Alternative Loan and Deposit Products: I confirm the robustness of my results using the alternative loan and deposit products. In particular, I add 6-month certificates of deposits, 10K money market funds and 15-year fixed-rate mortgages to my analysis. Table 1.10 and 1.11 in Section 1.11 report the results and indicates that banks that operate in more concentrated areas increase their deposit spreads more, whereas their lending spreads less, verifying my main findings.

1.7.2 Usage of an Alternative Concentration Measure: Figure 1.6a and Figure 1.6b show that the loan and deposit market powers are highly correlated. Hence, both measures provide a good proxy for bank concentration. I re-estimate Equation (1.2) using the deposit market power measure to confirm that my results are robust using both concentration measures. Table 1.12 shows that deposit spreads widen more whereas loan spreads less in more concentrated banking regions, consistent with my main results.

1.7.3 Estimation of Bank-level Results using LP-IV Strategy: In general, funding and lending rates respond to monetary policy more rapidly. On the other hand, the transmission of monetary policy to bank-level assets and liabilities may take time. To address this issue, I repeat my analysis on bank-level balance sheet variables using the LP-IV approach of Jordà (2005). The LP-IV strategy enables me to capture the impact of monetary policy on bank-level variables over more extended periods. Equation (1.21) presents my estimation strategy:

$$\begin{aligned}\Delta_h log(y_{jt+h}) = &\alpha_j^h + \beta^h \Delta R_t + \Gamma^h \Delta R_t \times BankHHI_{jt-1} + \theta^h BankHHI_{jt-1} \\ &+ \Gamma'(L) X_{jt-1} + \Omega'(L) Z_t + \epsilon_{jt+h}\end{aligned} \tag{1.21}$$

Where the horizon is h = *0, 1, ..8* quarters, and j and t denote bank and time, respectively. The left-hand side of Equation (1.21) is the cumulative change in the bank-balance sheet variable y calculated as: $\Delta_h log(y_{ct+h}) = log(y_{ct+h}) - log(y_{ct-1})$. ΔR_t refers to the instrumented change in the one-year Treasury yield. $BankHHI_{jt-1}$ is the lagged bank-level concentration of bank j given by Equation (1.3). X_{jt-1} includes the lagged change in the bank-level assets, liquidity, and equity. Z_t includes the following control variables: change in the national level GDP, unemployment rate, inflation.[56] The lag structure on the control variable is set to be two quarters, and standard errors are clustered at the bank level.[57] Figures 1.11 to 1.20 in Section 1.11 plot the response of bank-level variables to monetary policy conditional on bank market power. Figures 1.11 to 1.13 show that my results hold using funding and lending rates rather than spreads. The Figures reveal that interest pass-through to bank retail and wholesale funding rates decreases even more for the banks with higher market power over time. Figure 1.19 present that wholesale funding reliance is much higher for the banks with higher market power after two quarters of the monetary policy contraction. Figures 1.15 and 1.16 suggest that both bank-level assets and loans decrease less for banks with higher market power, where the effect becomes notable two years after the monetary policy shock, at the time the impact on wholesale-funding starts to amplify, verifying my baseline findings. For other bank-balance sheet variables, I also obtain results similar to the ones reported in Table 1.7 and confirm that my results are robust to alternative specifications.

1.7.4 Usage of Additional of Bank-level Controls: I also test whether heterogeneity in other observable bank characteristics, such as bank size, can drive my main results. To do so, I re-estimate the main results using the specification in Equation (1.4), where monetary shocks are interacted with various bank characteristics. Specifically, I interact with the monetary policy with

[56] Results are robust including the change in the commercial paper spread, and change in the mortgage spread.
[57] I also include a dummy for the ZLB period to control for the changes this may stem from this period.

bank size, equity, and liquidity measures to ensure that my results are not driven by the differences in bank characteristics, especially the differences in bank size. Table 1.15 in Section 1.11 report the results. In each case, the coefficient on monetary policy and bank concentration interaction remains similar to the reported in the base line specification, suggesting that the main results are not driven by bank size, leverage, or liquidity differences across the banks.

1.7.5 Usage of the Time Fixed Effect Specification: I test the robustness of my results by adding time fixed effects to my analysis on bank balance sheet variables as in Drechsler et al. (2017). Table 1.16 in Section 1.11 presents that results are robust using either approaches.

1.7.6 Usage of Alternative Monetary Policy Shocks: I checked the robustness of my results by using the pure change in the one-year Treasury yield and orthogonalized monetary policy shocks from Bauer and Swanson (2022) and obtained similar results. In particular, usage of orthogonalized Bauer and Swanson (2022) shocks addresses the concerns on the potential correlation between monetary policy surprises and macroeconomic or financial data that becomes publicly available before the FOMC announcements. These shocks are obtained through regressing the standard Bauer and Swanson (2022) shocks, constructed by the first principal component analysis to ED1-ED4, on the economic and financial variables that predate the announcements and then taking the residuals. Tables 1.13 and 1.14 in Section 1.11 re-estimate results on deposit and loan spreads with both the pure change in the one-year Treasury yield and orthogonalized Bauer and Swanson (2022) shocks. The findings confirm the baseline findings, although the magnitude of the coefficients slightly increases for the specification with orthogonalized shocks. In particular, usage of orthogonalized Bauer and Swanson (2022) shocks addresses the concerns on the potential correlation between monetary policy surprises and macroeconomic or financial data that becomes publicly available before the FOMC announcements. These shocks are obtained through regressing the standard Bauer and Swanson (2022) shocks, constructed by the first principal component analysis to ED1-ED4, on the economic and financial variables that predate the announcements and then taking the residuals. Tables 1.13 and 1.14 in Section 1.11 re-estimate results on deposit and loan spreads with both the pure change in the one-year Treasury yield and orthogonalized Bauer and Swanson (2022) shocks. The findings confirm the baseline findings, although the magnitude of the coefficients slightly increases for the specification with orthogonalized shocks.

1.7.7 Usage of Full Small Lending Sample: I verify the robustness of my result by using the full sample on bank-county level small business lending. That is, I include the loan originations less than $100,000 in value in my sample. Table 1.17 in Section 1.11 reports the results. As seen from the Table, lending of banks with higher market power decreases less compared to other banks, consistent with my main findings in Table 1.8.

1.8. Conclusion

In this paper, I study the importance of bank market power for the monetary policy pass-through to bank funding dynamics, lending, and profitability. First, I document that monetary policy creates a considerable variation in banks' funding spreads depending on banks' market power. I find that both the wholesale funding and deposit spreads increase more for banks with higher market power after a policy tightening, and the funding composition of these banks changes substantially. In particular, I show that deposit inflows of banks with higher market power decrease slightly more due to a lower pass-through of the increase in the policy rate to their deposit rates, and these banks compensate for their funding shortfalls through wholesale funding as they access wholesale financing at a lower cost. Moreover, I document that the rise in funding spreads enables banks with higher market power to alter their loan rates less and smooth their lending and profitability. I further report that bank market power affects monetary policy transmission to the macroeconomy by showing that county-level lending and employment are less adversely affected by the monetary contraction in regions where banks with higher market power operate. Lastly, I build a theoretical model featuring monopolistic competition and rationalize my empirical findings.

The findings of this paper are crucial for the following reasons. Firstly, this study is the first paper evaluating the impact of bank market power on the transmission of monetary policy to banks' interest spreads, lending, and profitability, considering the interdependence among the deposit, wholesale funding, and credit markets which is crucial to achieving clear understanding on monetary policy transmission mechanism. Importantly, this paper provides a complete picture of the role of bank market power on the monetary policy transmission to bank-level outcomes by revealing the importance of the wholesale funding channel. Finally, the results of this paper have significant implications for policy-making as it presents new insights into the effect of market power on the pass-through of monetary policy to real economic outcomes.

1.9. Figures

Figure 1.1. The U.S Financial Markets

Figure (a) plots the asset share of the top 5 banks, whereas Figure (b) plots the total assets of Money Market Funds over time. The data are from the U.S. Call Reports and FRED, covering 1994 to 2019.

(a) Asset share of the Top 5 Banks

(b) Total Assets of MMFs

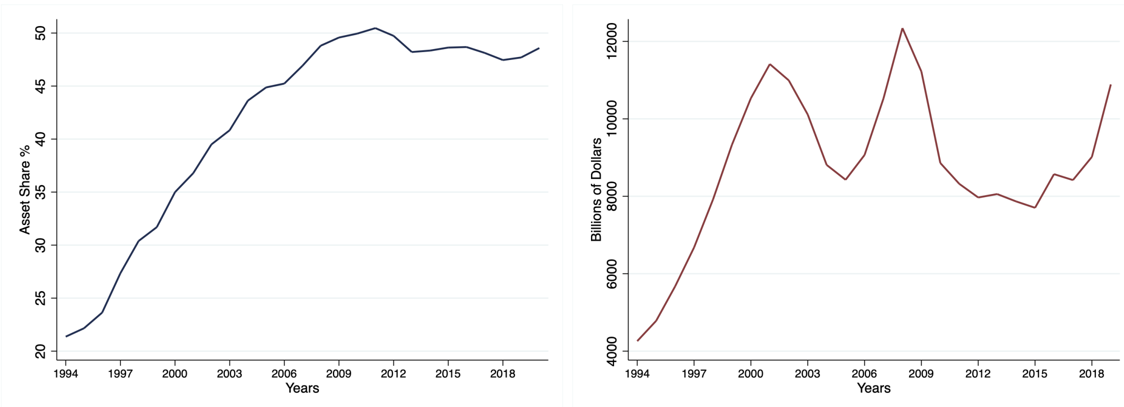


Figure 1.2. Outline of the Monetary Policy Transmission Mechanism

Figure (a) illustrates the average effect of the monetary policy, whereas Figure (b) illustrates the effect of market power on monetary policy transmission mechanism.

(a) Average Effect of the Monetary Policy

(b) Effect for High Market Power Banks

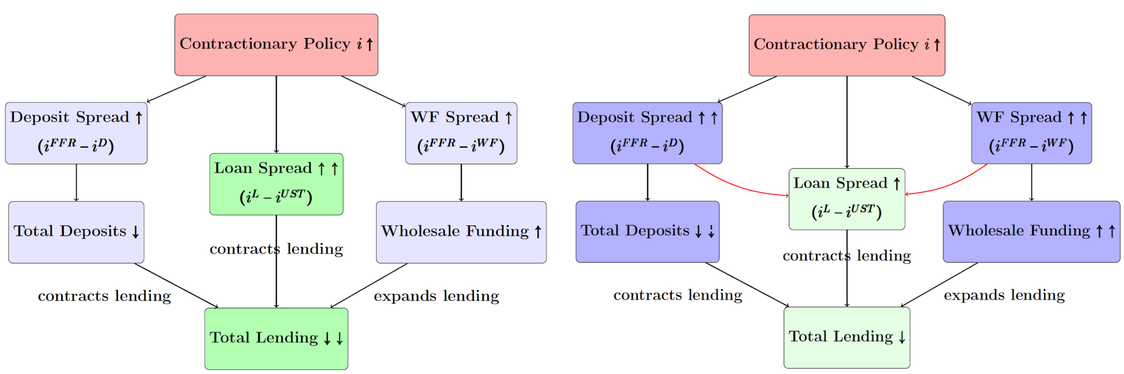
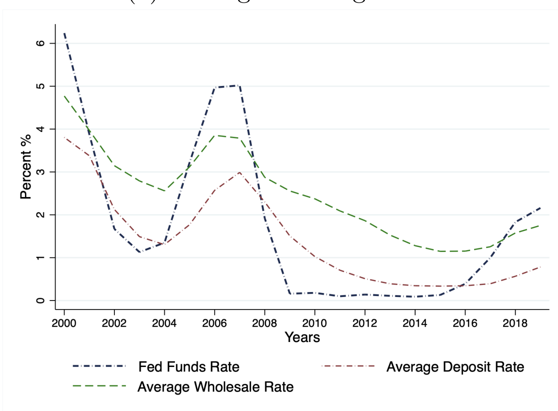


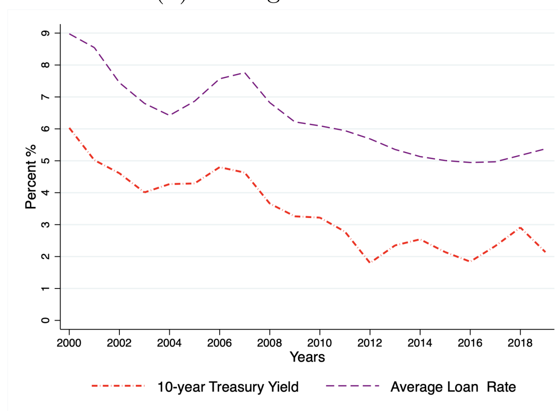
Figure 1.3. Bank Retail Rates, Profitability and Monetary Policy

Figures (a) and (b) plot the commercial banking sector's average deposit, wholesale funding, and loan rates. The data are from the U.S. Call Reports covering 2000 to 2019. Figure (c) plots the deposit rate on the most widely-offered deposit products using RateWatch data from 2000 to 2019. Lastly, Figure (d) plots the profitability of the U.S. banking system over time.

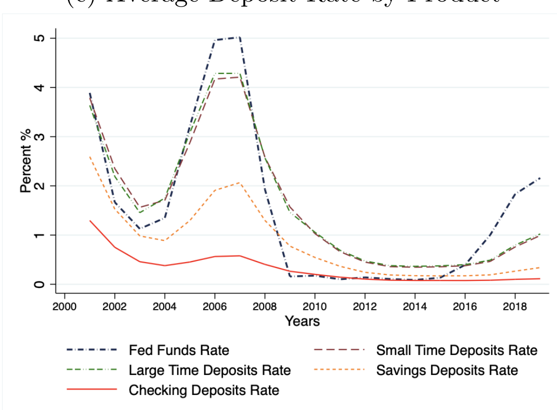
(a) Average Funding Rates



(b) Average Loan Rate



(c) Average Deposit Rate by Product



(d) Bank Profitability

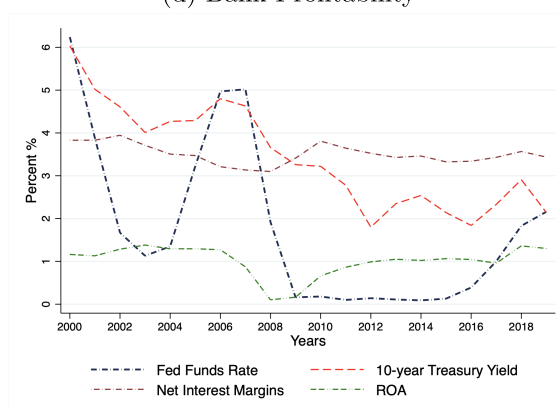
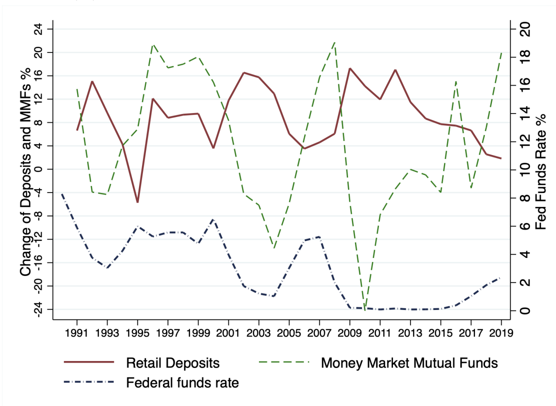


Figure 1.4. Retail Deposits, Wholesale Funding, MMFs and Federal Funds Rate

Figure (a) plots the time series of the federal funds rate against the change in the aggregate amount of retail deposits and the aggregate amount of money market funds. Similarly, Figure (b) plots the wholesale funding to retail deposits ratio for the U.S. commercial banks.

(a) Deposits and Federal Funds Rate



(b) Wholesale Funding to Deposits

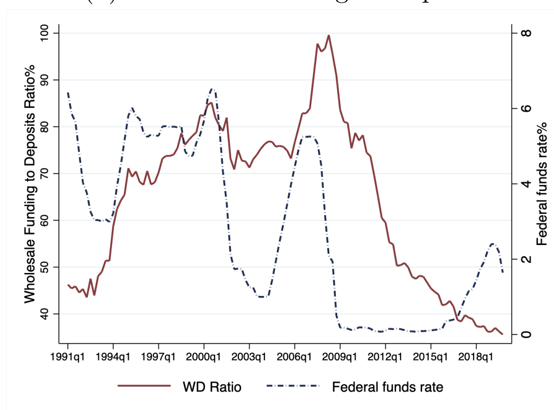
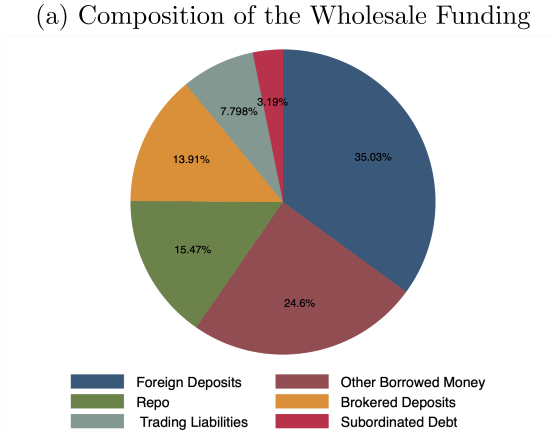


Figure 1.5. Composition of Wholesale Funding and U.S. Small Business Lending

Figure (a) plots the components of the wholesale funding for U.S. commercial banks. The data source is U.S. Call Reports, covering the period between 1997 to 2019. Figure (b) plots the time series of bank lending to small businesses: The red line plots the total volume of loans in billions of dollars, and the blue line plots the number of new loans in billions. Data is from FDIC and covers between 1997 to 2019.

(a) Composition of the Wholesale Funding



(b) U.S Small Business Lending

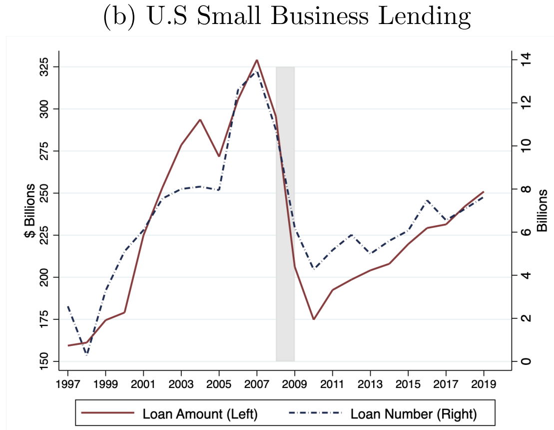
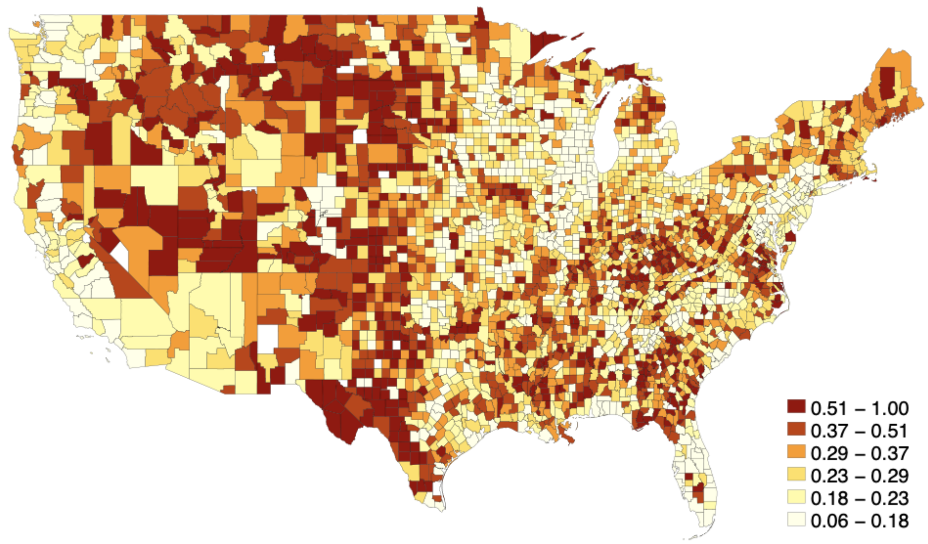


FIGURE 1.6. U.S. Banking Market Concentration

This map shows the average Herfindahl index for each U.S. county. The Herfindahl Hirschman Index is calculated each year using the asset market shares of all banks with branches in a given county and then averaged over the period from 1994 to 2019 for local credit market concentration. On the other hand, Figure (b) reports the Herfindahl Hirschman Index calculated using the deposit market shares of all banks with branches in a given county and then averaged over time. The data source is FDIC.

(a) Local Market Concentration Using Asset Shares



(b) Local Market Concentration Using Deposit Shares

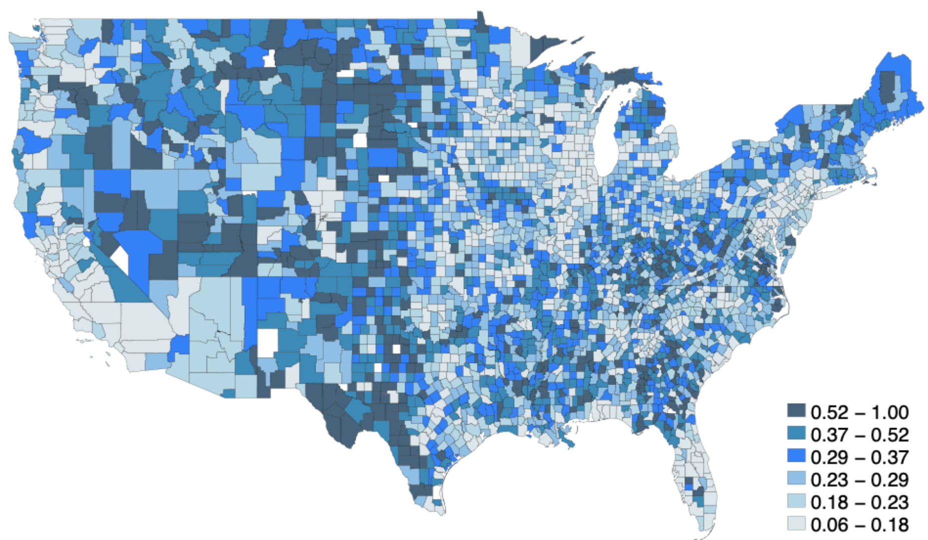
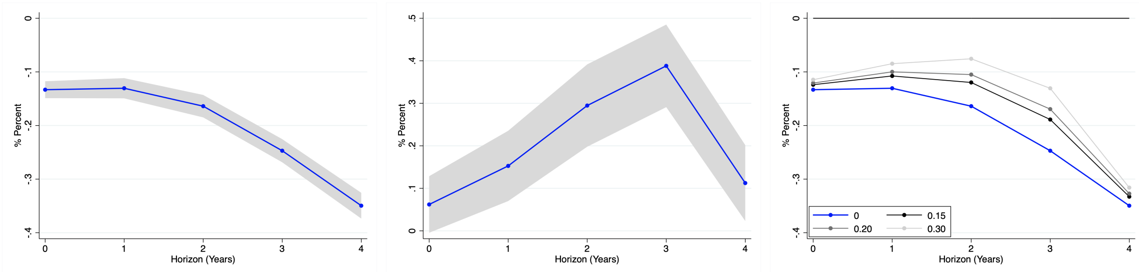


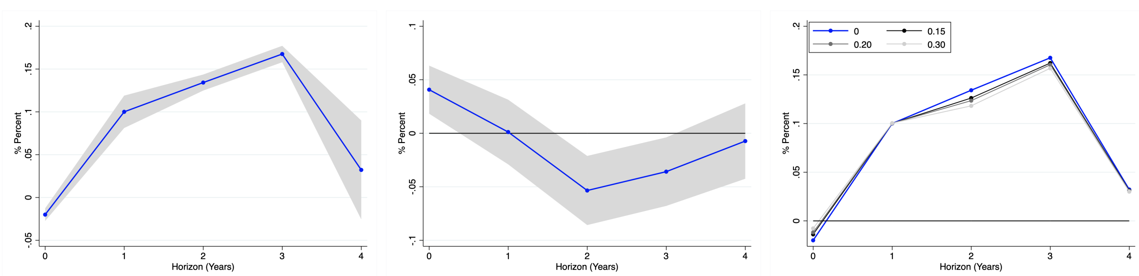
FIGURE 1.7. Impulse Responses of County-level Small Business Lending



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of total county-level small business lending using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is four years. The period is 1997-2019. The control variables are changes in the national level of GDP, unemployment rate, inflation, and HHI_c. Standard errors are clustered by bank and county. HHI-0.15, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.15, 0.20, and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

FIGURE 1.8. Impulse Responses of County-level Unemployment



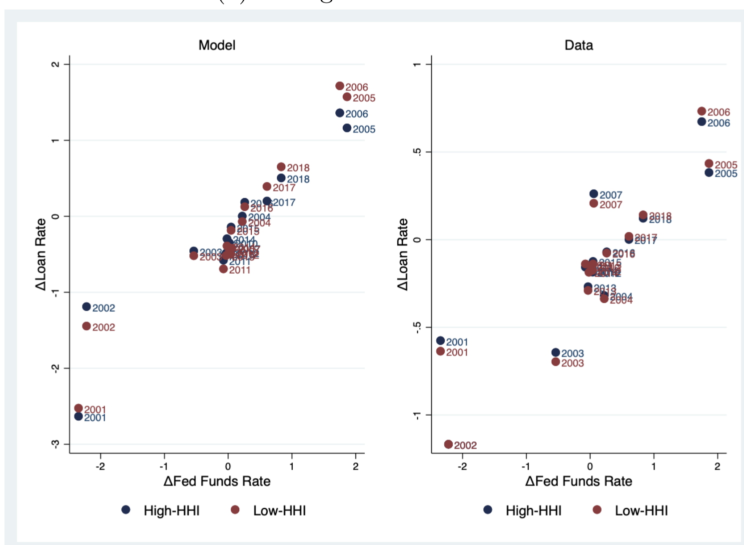
(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of total county-level unemployment using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is four years. The period is 1997-2019. The control variables are changes in the national level of GDP, unemployment rate, inflation, and HHI_c. Standard errors are clustered by bank and county. HHI-0.15, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.15, 0.20, and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

FIGURE 1.9. Comparison of Model with Data-Change in the Loan Rate

This figure compares the model's prediction for the change in the loan and deposit rates with the ones obtained from the data. The model predictions are obtained by plugging the wholesale funding spread obtained from actual data into the model implied loan and deposit rate equations (See Equations (1.19) and (1.20)). High-HHI refers to banks above the 75th percentile of the Bank-HHI distribution, whereas Low-HHI refers to banks below the 75th percentile of the Bank-HHI distribution.

(a) Change in the Loan Rate



(b) Change in the Deposit Rate

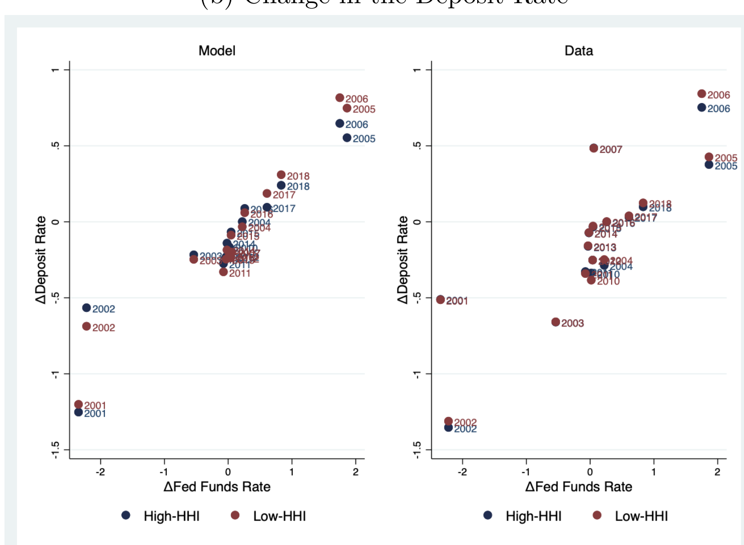


Table 1.2. Summary Statistics for Deposit and Loan Spreads-*Ratewatch*

Panel A: Deposit Spreads

	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
Δ12MCDspread	0.02	0.25	0.02	0.25	0.01	0.25
Δ06MCDspread	0.01	0.26	0.01	0.25	0.00	0.26
ΔMM25Kspread	-0.01	0.36	-0.02	0.35	-0.03	0.37
ΔMM10Kspread	-0.01	0.37	0.00	0.36	-0.01	0.37
HHI_c	0.18	0.12	0.10	0.03	0.25	0.12
Obs.(branch×quarter)	513,437		256,245		257,192	

Panel B: Personal Loan Spread

	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
ΔPersonal Loan Sprd	0.04	1.17	0.04	1.16	0.03	1.18
HHI_c	0.24	0.11	0.16	0.03	0.32	0.12
Obs.(branch×quarter)	162,173		81,050		81,123	

Panel C: Auto Loan Spread

	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
ΔAuto Loan Sprd	0.01	0.49	0.01	0.50	0.01	0.48
HHI_c	0.24	0.11	0.16	0.03	0.32	0.12
Obs.(branch×quarter)	76,695		38,289		38,406	

Panel D: Mortgage Spreads

	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
Δ15Yr Mtg Sprd	-0.00	0.35	-0.01	0.34	-0.01	0.36
Δ30Yr Mtg Sprd	-0.02	0.31	-0.03	0.30	-0.02	0.31
HHI_c	0.24	0.10	0.16	0.03	0.31	0.10
Obs.(branch×quarter)	39,554		19,766		19,788	

Panel E: HELOC Spreads

	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
Δ%80 LTV HELOC Sprd	-0.06	0.66	-0.06	0.68	-0.06	0.64
HHI_c	0.23	0.11	0.16	0.03	0.30	0.10
Obs.(branch×quarter)	143,330		71,597		71,733	

Table 1.3. Summary Statistics for Bank and County Level Variables

Panel A: Bank Level Interest Spreads	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
ΔDeposit sprd	0.02	0.40	0.02	0.39	0.02	0.41
ΔLoan sprd	-0.00	0.77	-0.00	0.77	-0.00	0.77
ΔWholesale-funding sprd	0.00	1.46	0.01	1.41	0.00	1.50
Bank-HHI	0.24	0.13	0.16	0.03	0.33	0.13
Observations	455,487		211,492		211,501	

Panel B: Small Business Lending	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
$\Delta Log(Lending)$	0.07	1.16	0.06	1.18	0.08	1.14
Bank-HHI	0.27	0.17	0.18	0.03	0.37	0.21
Observations	921,233		460,612		460,621	

Panel C: County Level Characteristics	All		Low HHI		High HHI	
	Mean	Std	Mean	Std	Mean	Std
Population	90,109	293,227	148,798	392,3864	31,457	105,871
Gdp (in mill $)	4,959	22,257	6,722	27,204	3,387	15,656
Wages (in mill $)	2,067	9,343	2,695	11,082	1,440	7,140
Unemp. rate	5.75	1.75	5.71	1.74	5.78	1.77
County-HHI	0.240	0.05	0.201	0.02	0.280	0.05
Obs. (counties)	3,219		1,510		1,709	

This table provides summary statistics on bank-level interest spreads, bank-county level small business lending, county-level lending, GDP, unemployment and wages.

TABLE 1.4. Time and Saving Deposit Spreads

Panel A: 12-Month CD

	ΔDeposit Spread				
	All	≥ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.342***	0.320***			
	(0.00432)	(0.00524)			
$\Delta R_t \times HHI_c$	0.135***	0.230***	0.244***	0.0892**	0.103***
	(0.0295)	(0.0409)	(0.0353)	(0.0382)	(0.0378)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	475,942	205,920	205,920	205,920	205,920
R-squared	0.346	0.315	0.002	0.000	0.000

Panel B: 25K Money Market Funds

	ΔDeposit Spread				
	All	≥ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.855***	0.831***			
	(0.00421)	(0.00565)			
$\Delta R_t \times HHI_c$	0.246***	0.215***	0.302***	0.226***	0.250***
	(0.0306)	(0.0447)	(0.0443)	(0.0506)	(0.0498)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	513,437	226,722	226,722	226,722	226,722
R-squared	0.477	0.446	0.000	0.000	0.000

This table estimates the effect of the change in one-year Treasury rate on most common types of time and saving deposits using Bauer and Swanson (2022) shocks as an instrument. The sample covers between 2000-2019.

TABLE 1.5. Personal Loan and Automobile Loan Spreads

Panel A: Personal Loans

	ΔLoan Spread				
	All	≥ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.179***	0.183***			
	(0.0222)	(0.0283)			
$\Delta R_t \times HHI_c$	-0.291*	-0.683***	-0.550**	-0.673**	-0.779**
	(0.154)	(0.251)	(0.271)	(0.302)	(0.317)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	162,173	66,253	66,253	66,253	66,253
R-squared	0.062	0.063	0.000	0.000	0.000

Panel B: Automobile Loans

	ΔLoan Spread				
	All	≥ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.245***	0.420***			
	(0.0222)	(0.0325)			
$\Delta R_t \times HHI_c$	-0.189**	-0.341**	-0.385**	-0.165	-0.277*
	(0.0832)	(0.141)	(0.164)	(0.151)	(0.153)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	76,695	34,030	34,030	34,030	34,030
R-squared	0.059	0.077	0.001	0.000	0.000

This table estimates the effect of the change in one-year Treasury rate on Personal and Automobile Loan spreads using Bauer and Swanson (2022) shocks as an instrument. The sample covers between 2000-2019.

TABLE 1.6. HELOC and Fixed Rate Mortgage Spreads

Panel A: Home Equity Line of Credits (HELOC)

	ΔLoan Spread				
	All	≥ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.969***	0.990***			
	(0.0131)	(0.0179)			
$\Delta R_t \times HHI_c$	-0.250**	-0.359**	-0.357**	-0.433**	-0.513**
	(0.0981)	(0.149)	(0.168)	(0.191)	(0.208)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	143,330	64,526	64,526	64,526	64,526
R-squared	0.208	0.175	0.000	0.000	0.000

Panel B: 30-Year Fixed Rate Mortgages

	ΔLoan Spread				
	All	≥ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.0249**	0.00325			
	(0.0102)	(0.0120)			
$\Delta R_t \times HHI_c$	0.00855	-0.101	-0.210*	-0.205*	-0.327***
	(0.0823)	(0.109)	(0.113)	(0.111)	(0.116)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	39,554	23,195	23,195	23,195	23,195
R-squared	0.080	0.082	0.000	0.001	0.000

This table estimates the effect of the change in one-year Treasury rate on HELOCs and Fixed Rate Mortgage spreads using Bauer and Swanson (2022) shocks as an instrument. The sample covers between 2000-2019.

Table 1.7. Bank-level Results

Panel A: Bank Interest Spreads

	ΔDeposit Spread	ΔWF Spread	ΔFunding Spread	ΔLoan Spread	ΔNIM	ΔROA
	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_t	.880***	.707***	.867***	.278***	-.0297***	.00108
	(.00247)	(.0168)	(.00248)	(.00506)	(.00313)	(.00813)
$\Delta R_t \times BankHHI_{jt-1}$	.0790***	.199*	.0996***	-.0767**	.0384**	.00961**
	(.0150)	(.104)	(.0150)	(.0327)	(.0196)	(.00489)
Bank f.e.	Y	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y	Y
Observations	455,505	455,505	455,505	455,505	455,505	455,505
R-squared	.501	.027	.493	.007	.018	.018

Panel B: Bank Assets and Liabilities

	ΔRetail Deposits	ΔW.sale Funding	ΔTotal Liabilities	ΔTotal Assets	ΔTotal Loans	ΔTotal Securities
	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_t	-.267***	.743*	-.408***	-.325***	-.188***	-.135
	(.0438)	(.0430)	(.0437)	(.0387)	(.0432)	(.128)
$\Delta R_t \times BankHHI_{jt-1}$	-.0267	8.721***	.297	.109	.0325	2.719***
	(.284)	(2.458)	(.282)	(.251)	(.304)	(.749)
Bank f.e.	Y	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y	Y
Observations	455,505	455,505	455,505	455,505	455,505	455,505
R-squared	0.042	0.002	0.041	0.037	0.066	0.020

This table estimates the effect of the bank market power on bank-level outcomes. Panel A reports the results for the interest spreads and profitability. Panel B reports the results for assets and liabilities. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. The sample covers between 2000-2019.

Table 1.8. Change in Bank-County Level Small Business Lending

	(1) ΔLending	(2) ΔLending	(3) ΔLending	(4) ΔLending	(5) ΔLending
ΔR_t	-0.138***	-0.140***			
	(0.0134)	(0.0133)			
$\Delta R_t \times BankHHI_{jt-1}$	0.290**	0.295**	0.273**	0.280**	0.292**
	(0.118)	(0.120)	(0.125)	(0.128)	(0.128)
$\Delta R_t \times HHI_{ct-1}$		-0.0278		-0.0321	
		(0.0314)		(0.0315)	
Bank f.e	Y	Y	Y	Y	Y
County f.e	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
County-bank f.e.	Y	Y	Y	Y	Y
County-time f.e.	N	N	N	N	Y
Macro-level controls	Y	Y	N	N	N
Observations	550,840	550,840	550,840	550,840	550,840
R-squared	0.031	0.031	0.003	0.003	0.003

This table estimates the effect of the bank market power on small business lending. ΔLending is the percentage change in the total amount of small business lending originated by a given bank in a given county compared to the previous year. Bank-HHI is the bank's market power, and HHI is the concentration of the county where the bank branch operates. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. The sample covers between 2000-2019.

1.11. Appendix

1.11.1 Data Appendix: This section describes my data construction procedure from the quarterly Call Reports. When constructing my sample. I control for bank mergers in my analysis by excluding banks with an asset growth rate of more than %100 between quarters.

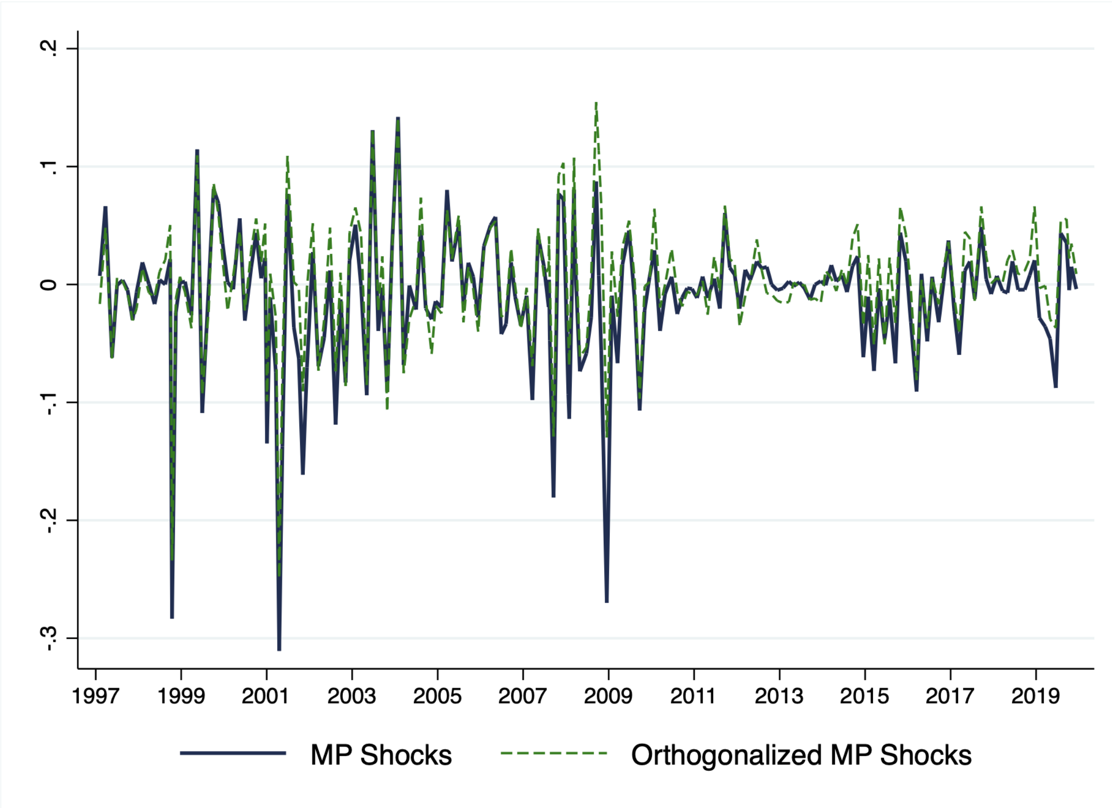
I use high-frequency monetary policy shocks from Bauer and Swanson (2022) obtained through the first principal component analysis of Eurodollar futures contracts, ED1–ED4. I confirm the robustness of my results by using the orthogonalized version of these shocks with respect to economic news before the announcement. Figure 1.10 plots these shocks over time.

Table 1.9. Description of Banking Variables

Variable Name	**Definition**
Domestic Deposits	Saving Deposits+Time Deposits+Transaction Deposits
Wholesale Funding	Liabilities-Domestic Deposits
Deposit Rate	Interest Expense on Domestic Deposits/Domestic Deposits
Wholesale F. Rate	Interest Expense on Wholesale Funding/Wholesale Funding
Loan Rate	Interest Income on Total Loans/Total Loans
Deposit Spread	Federal Funds Rate-Deposit Rate
Loan Spread	Loan Rate-Treasury Yield with the Respective Maturity
Wholesale F. Spread	Federal Funds Rate-Wholesale Funding Rate
Liquidity	Cash+Securities+Federal Funds Repos
ROA	Net Income/Assets
NIM	Interest Rate on Assets-Interest Rate on Liabilities

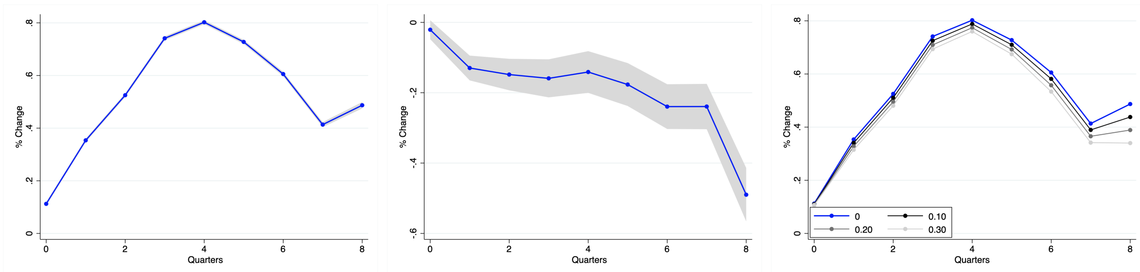
1.11.2 Additional Figures:

Figure 1.10. Bauer and Swanson (2022) Shocks



This figure plots the Bauer and Swanson (2022) shocks over time.

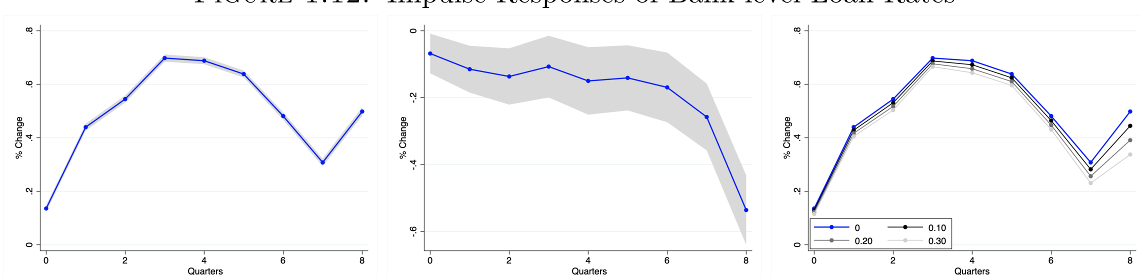
FIGURE 1.11. Impulse Responses of Bank-level Deposit Rates



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level deposit rates using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are the change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20, and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

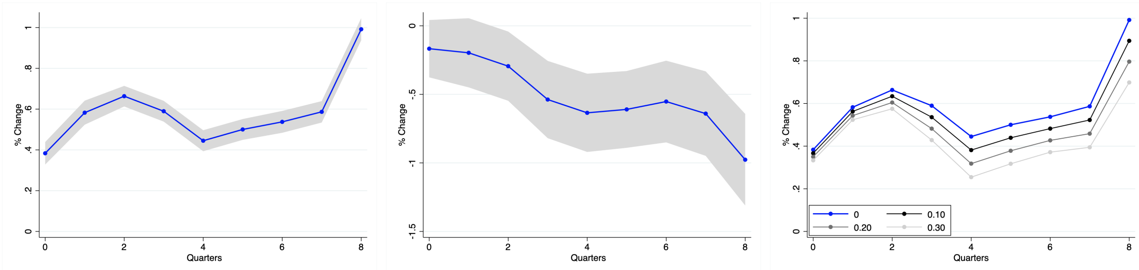
FIGURE 1.12. Impulse Responses of Bank-level Loan Rates



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level loan rates using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are the change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20, and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

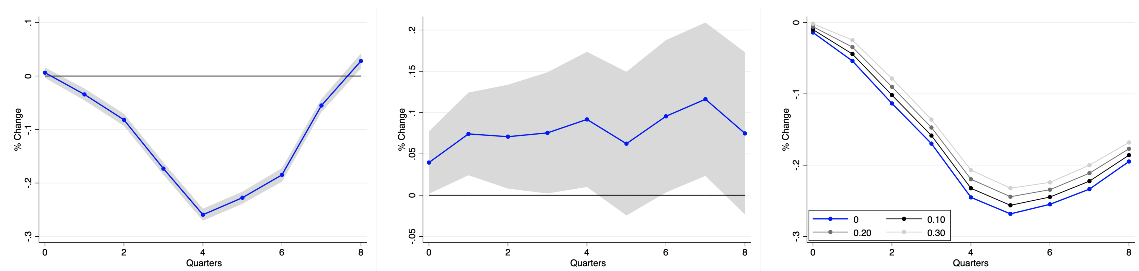
FIGURE 1.13. Impulse Responses of Bank-level Wholesale Funding Rates



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level wholesale funding rates using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are the change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20, and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

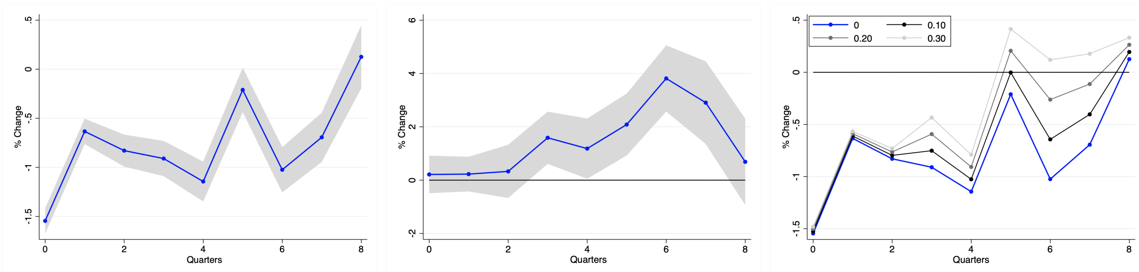
FIGURE 1.14. Impulse Responses of Bank-level NIMs



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level net interest margins using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are the change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20 and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

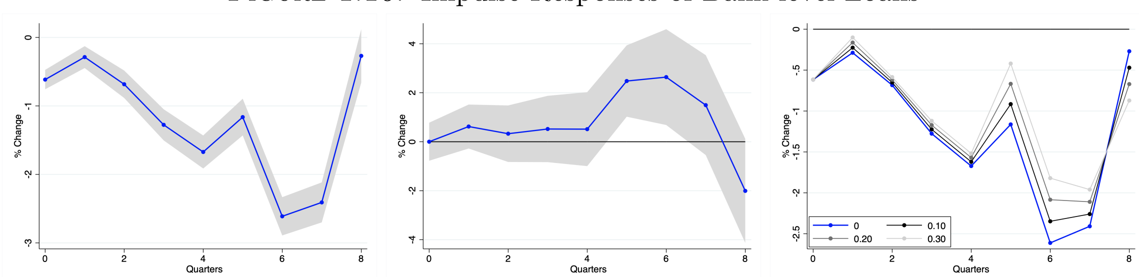
FIGURE 1.15. Impulse Responses of Bank-level Assets



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level assets using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20 and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

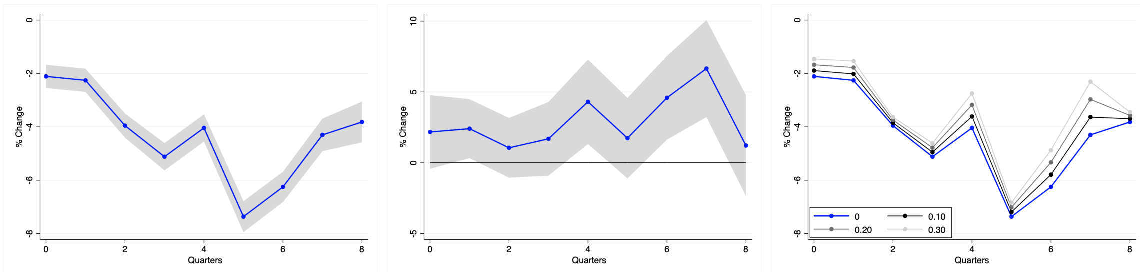
FIGURE 1.16. Impulse Responses of Bank-level Loans



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level loans using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20 and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

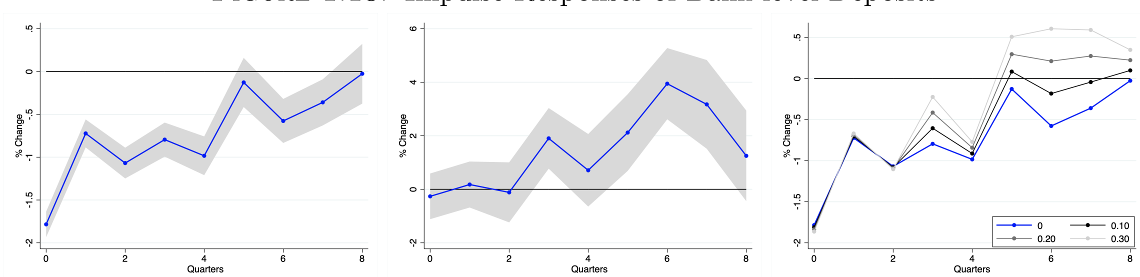
Figure 1.17. Impulse Responses of Bank-level Securities



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level securities using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20 and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

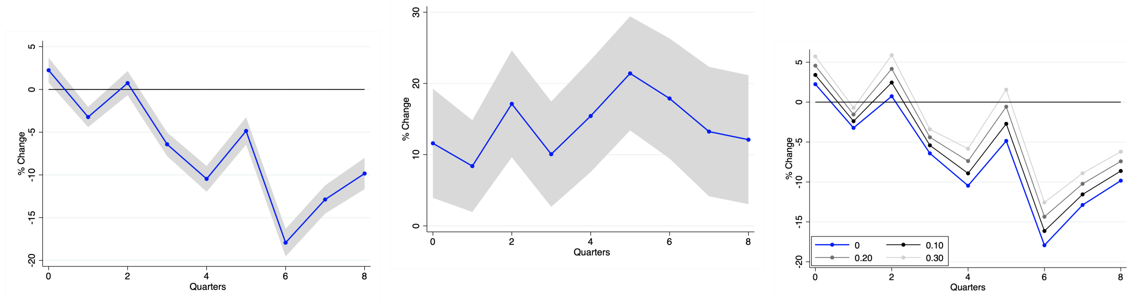
Figure 1.18. Impulse Responses of Bank-level Deposits



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level deposits using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20 and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

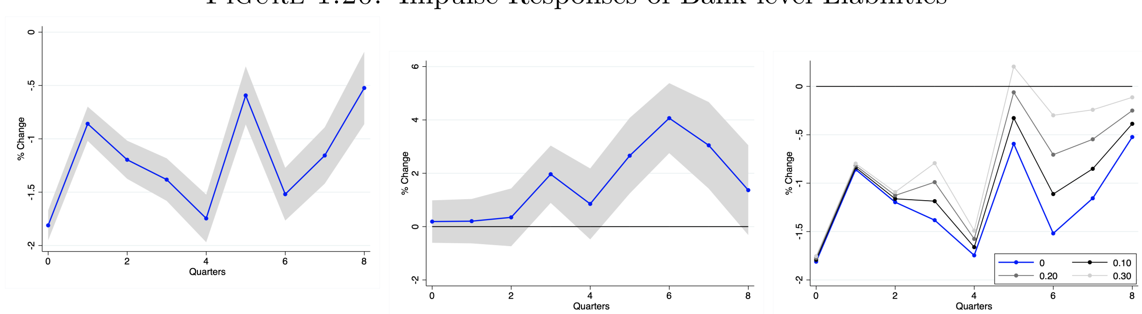
Figure 1.19. Impulse Responses of Bank-level Wholesale Funding



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level wholesale funding using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is eight quarters. The period is 2000-2019. The control variables are change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20 and 0.30, respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

Figure 1.20. Impulse Responses of Bank-level Liabilities



(a) $\hat{\beta^h}$ (b) $\hat{\Gamma^h}$ (c) $\hat{\beta^h} + \hat{\Gamma^h}$

The plots show the impulse responses of bank-level liabilities using local projection regressions with one-year Treasury yield instrumented by Bauer and Swanson (2022) shocks. The time horizon is 8 quarters. The period is 2000-2019. The control variables are change in the national level of GDP, unemployment rate, inflation, lagged change in assets, liquidity, and equity. Standard errors are clustered by bank and county. HHI-0.10, HHI-0.20, and HHI-0.30 refer to banks with HHI indexes of 0.10, 0.20 and 0.30 respectively. Shaded areas in panels (a) and (b) show 95% confidence intervals.

1.11.3 Additional Tables:

TABLE 1.10. Time and Saving Deposit Spreads

Panel A: 06-Month CD					
	ΔDeposit Spread				
	All	$\geq$ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.380***	0.368***			
	(0.00426)	(0.00521)			
$\Delta R_t \times HHI_c$	0.140***	0.216***	0.199***	0.131***	0.123***
	(0.0295)	(0.0399)	(0.0367)	(0.0403)	(0.0399)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	483,946	211,039	211,039	211,039	211,039
R-squared	0.386	0.356	0.001	0.001	0.001
Panel B: 10K Money Market Funds					
	ΔLoan Spread				
	All	$\geq$ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.890***	0.867***			
	(0.00399)	(0.00540)			
$\Delta R_t \times HHI_c$	0.214***	0.193***	0.260***	0.227***	0.229***
	(0.0289)	(0.0419)	(0.0430)	(0.0468)	(0.0463)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	512,650	226,212	226,212	226,212	226,212
R-squared	0.634	0.600	0.001	0.000	0.000

This Table estimates the effect of the change in one-year Treasury rate on alternative deposit and loan products using Bauer and Swanson (2022) shocks as an instrument. The sample covers between 2000-2019.

Table 1.11. Loan Spreads

15-Year Fixed Rate Mortgages					
	ΔLoan Spread				
	All	$\geq$ 2 Counties			
	(1)	(2)	(3)	(4)	(5)
ΔR_t	0.140***	0.122***			
	(0.0119)	(0.0146)			
$\Delta R_t \times HHI_c$	-0.0371	-0.139	-0.245*	-0.236**	-0.321**
	(0.0828)	(0.115)	(0.128)	(0.117)	(0.133)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
Bank-time f.e.	N	N	N	Y	Y
State-time f.e.	N	N	Y	N	Y
Macro controls	Y	Y	N	N	N
Observations	34,352	18,923	18,923	18,923	18,923
R-squared	0.093	0.071	0.001	0.001	0.001

This Table estimates the effect of the change in one-year Treasury rate on alternative deposit and loan products using Bauer and Swanson (2022) shocks as an instrument. The sample covers between 2000-2019.

TABLE 1.12. Loan and Deposit Spreads

Panel B:Deposit Spread

	ΔDeposit Spread			
	25K MMF	10K MMF	12-Month CD	6-Month CD
	(1)	(2)	(3)	(4)
$\Delta R_t \times HHI_c$	0.258***	0.232***	0.105***	0.126***
	(0.0507)	(0.0470)	(0.0383)	(0.0406)
Branch f.e.	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y
Bank-time f.e.	Y	Y	Y	Y
State-time f.e.	Y	Y	Y	Y
Observations	226,722	226,212	205,920	211,039
R-squared	0.000	0.000	0.000	0.001

Panel A:Loan Spreads

	ΔLoan Spread				
	Personal Loans	Auto Loans	15-Year Mortgages	30-Year Mortgages	80-LTV HELOCs
	(1)	(2)	(3)	(4)	(5)
$\Delta R_t \times HHI_c$	-0.840***	-0.248*	-0.305**	-0.307***	-0.486**
	(0.313)	(0.141)	(0.124)	(0.112)	(0.195)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y
Bank-time f.e.	Y	Y	Y	Y	Y
State-time f.e.	Y	Y	Y	Y	Y
Observations	66,253	34,030	18,923	23,195	64,526
R-squared	0.000	0.000	0.001	0.000	0.000

This table estimates the effect of the change in one-year Treasury rate on loan and deposit spreads using Bauer and Swanson (2022) shocks as an instrument. HHI_c measures the market concentration of the county where the branch is located using deposit shares of the branches as a robustness exercise. The sample covers between 2000-2019.

Table 1.13. Deposit Spreads

Panel A: 1-Year Treasury Yield

	ΔDeposit Spread			
	25K MMF	10K MMF	12-Month CD	6-Month CD
	(1)	(2)	(3)	(4)
$\Delta R_t \times HHI_c$	0.152***	0.141***	0.0892***	0.128***
	(0.0265)	(0.0250)	(0.0249)	(0.0264)
Branch f.e.	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y
Bank-time f.e.	Y	Y	Y	Y
State-time f.e.	Y	Y	Y	Y
Observations	226,722	226,212	205,920	211,039
R-squared	0.789	0.824	0.705	0.699

Panel B: IV with orthogonalized shocks

	ΔDeposit Spread			
	25K MMF	10K MMF	12-Month CD	6-Month CD
	(1)	(2)	(3)	(4)
$\Delta R_t \times HHI_c$	0.363***	0.348***	0.145*	0.120
	(0.0721)	(0.0965)	(0.0883)	(0.0855)
Branch f.e.	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y
Bank-time f.e.	Y	Y	Y	Y
State-time f.e.	Y	Y	Y	Y
Observations	226,722	226,212	205,920	211,039
R-squared	0.001	0.001	0.000	0.001

This table estimates the effect of the change in the one-year Treasury rate and orthogonalized Bauer and Swanson (2022) shocks on deposit rates as a robustness exercise. The sample covers between 2000-2019.

Table 1.14. Loan Spreads

Panel A: 1-Year Treasury Yield

	ΔLoan Spread				
	Personal Loans	Auto Loans	15-Year Mortgages	30-Year Mortgages	80-LTV HELOCs
	(1)	(2)	(3)	(4)	(5)
$\Delta R_t \times HHI_c$	-0.330**	-0.0539	-0.169**	-0.231***	-0.448***
	(0.159)	(0.0678)	(0.0706)	(0.0667)	(0.116)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y
Bank-time f.e.	Y	Y	Y	Y	Y
State-time f.e.	Y	Y	Y	Y	Y
Observations	66,253	34,030	18,923	23,195	64,526
R-squared	0.408	0.594	0.630	0.563	0.486

Panel B: IV with orthogonalized shocks

	ΔLoan Spread				
	Personal Loans	Auto Loans	15-Year Mortgages	30-Year Mortgages	80-LTV HELOCs
	(1)	(2)	(3)	(4)	(5)
$\Delta R_t \times HHI_c$	-1.692*	-0.277*	-0.466	0.437	-1.408*
	(1.003)	(0.153)	(0.323)	(0.458)	(0.818)
Branch f.e.	Y	Y	Y	Y	Y
County f.e.	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y
Bank-time f.e.	Y	Y	Y	Y	Y
State-time f.e.	Y	Y	Y	Y	Y
Observations	66,253	34,030	18,923	23,195	64,526
R-squared	0.002	0.000	0.001	0.000	0.001

This table estimates the effect of the change in the one-year Treasury rate and orthogonalized Bauer and Swanson (2022) shocks on loan rates as a robustness exercise. Δspread is the change in branch-level loan spread, which is equal to the change in loan rate minus the respective Treasury yield that matches the loan's maturity. HHI_c measures the market concentration of the county where the branch is located. The sample covers between 2000-2019.

Table 1.15. Bank-level Results Using Additional Bank-level Controls

Panel A: Bank Interest Spreads

	ΔDeposit Spread	ΔWF Spread	ΔFunding Spread	ΔLoan Spread	ΔNIM	ΔROA
	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_t	.838***	.676***	.825**	.206***	-.0273***	.00151*
	(.00247)	(.0162)	(.00248)	(.00495)	(.00309)	(.000795)
$\Delta R_t \times BankHHI_{jt-1}$	.0723***	.209*	.0775***	-.0658*	.0694***	.0138***
	(.0170)	(.108)	(.0157)	(.0336)	(.0199)	(.00504)
Bank f.e.	Y	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y	Y
Observations	455,505	455,505	455,505	455,505	455,505	455,505
R-squared	0.506	0.024	0.542	0.134	0.006	0.002

Panel B: Bank Assets and Liabilities

	ΔRetail Deposits	ΔW.sale Funding	ΔTotal Liabilities	ΔTotal Assets	ΔTotal Loans	ΔTotal Securities
	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_t	-.613***	.0432	-.614***	-.514***	-.370***	-.218*
	(.0453)	(.413)	(.0445)	(.0392)	(.0443)	(.127)
$\Delta R_t \times BankHHI_{jt-1}$	.476	6.410**	.584*	.375	.0645	3.308***
	(.307)	(2.745)	(.307)	(.272)	(.329)	(.791)
Bank f.e.	Y	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y	Y
Observations	455,505	455,505	455,505	455,505	455,505	455,505
R-squared	0.007	0.004	0.004	0.004	0.007	0.005

This table estimates the effect of the bank market power on bank-level outcomes. Panel A reports the results for the interest spreads and profitability. Panel B reports the results for assets and liabilities. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. The sample covers between 2000-2019.

Table 1.16. Bank-level Results Using Time Fixed Effect Specification

Panel A: Bank Interest Spreads

	ΔDeposit Spread	ΔWF Spread	ΔFunding Spread	ΔLoan Spread	ΔNIM	ΔROA
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta R_t \times BankHHI_{jt-1}$	.0570***	.149*	.0789***	-.104***	.0560***	.0132***
	(.0143)	(.0882)	(.0144)	(.0323)	(.0178)	(.00460)
Bank f.e.	Y	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y	Y
Observations	455,505	455,505	455,505	455,505	455,505	455,505
R-squared	.051	.006	.063	.037	.015	.019

Panel B: Bank Assets and Liabilities

	ΔRetail Deposits	ΔW.sale Funding	ΔTotal Liabilities	ΔTotal Assets	ΔTotal Loans	ΔTotal Securities
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta R_t \times BankHHI_{jt-1}$	-0.0127	8.436***	0.310	0.114	0.0756	1.869**
	(0.283)	(2.461)	(0.282)	(0.303)	(0.251)	(0.745)
Bank f.e.	Y	Y	Y	Y	Y	Y
Time f.e.	Y	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y	Y
Observations	455,505	455,505	455,505	455,505	455,505	455,505
R-squared	0.036	0.001	0.036	0.045	0.042	0.019

This table estimates the effect of the bank market power on bank-level outcomes. Panel A reports the results for the interest spreads and profitability. Panel B reports the results for assets and liabilities. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. The sample covers between 2000-2019.

TABLE 1.17. Change in the Bank-County Level Small Business Lending Full Sample

	(1) ΔLending	(2) ΔLending	(3) ΔLending	(4) ΔLending	(5) ΔLending
ΔR_t	-0.158***	-0.160***			
	(0.0438)	(0.0418)			
$\Delta R_t \times BankHHI_{jt-1}$	0.486**	0.490**	0.468**	0.472**	0.513**
	(0.197)	(0.198)	(0.195)	(0.195)	(0.202)
$\Delta R_t \times HHI_{ct-1}$		-0.0230		-0.0228	
		(0.0412)		(0.0374)	
Bank f.e	Y	Y	Y	Y	Y
County f.e	Y	Y	Y	Y	Y
Time f.e.	N	N	Y	Y	Y
County-bank f.e.	Y	Y	Y	Y	Y
County-time f.e.	N	N	N	N	Y
Macro-level controls	Y	Y	N	N	N
Observations	921,233	921,233	921,233	921,233	921,233
R-squared	0.022	0.022	0.002	0.002	0.002

This table estimates the effect of the bank market power on new small business lending using the full sample that includes loan originations less than $100,000 in value. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. Bank-HHI is the bank's market power, and HHI is the concentration of the county where the bank operates. The sample covers between 2000-2019.

1.11.4 Model Appendix: I derived the CES demand functions used in Section 1.6. The solution to loan and deposit demand comes from the Dixit-Stiglitz aggregator illustrated below:

Loan Market: Borrower seeks a total amount of loans equal to L; he borrows an amount L_j from each bank j and faces the following constraint:

$$L_j = \left(\frac{1}{N} \sum_{j=1}^{N} L_j^{\frac{\theta^\ell - 1}{\theta^\ell}} \right)^{\frac{\theta^\ell}{\theta^\ell - 1}} \tag{1.22}$$

Where $1 < \theta^\ell$ is the elasticity of substitution between banks.

Demand for the borrower can be derived from minimizing over L_j the total repayment (including principal) due to a continuum of banks j:

$$\min_{L_j} \frac{1}{N} \sum_{j=1}^{N} (1 + i_j^L) L_j$$

subject to

$$\left(\frac{1}{N} \sum_{j=1}^{N} L_j^{\frac{\theta^\ell - 1}{\theta^\ell}} \right)^{\frac{\theta^\ell}{\theta^\ell - 1}} \geq L$$

FOC with respect to L_j yields loan demand:

$$L_j = \left(\frac{1 + i_j^L}{1 + i^L} \right)^{-\theta^\ell} L$$

Where

$$1 + i^L = \left(\frac{1}{N} \sum_{j=1}^{N} {i_j^L}^{1-\theta^\ell} \right)^{\frac{1}{1-\theta^\ell}}$$

Deposit Market: Savers want to maximize total repayment from deposits subject to total deposits as aggregated through a CES aggregator:

$$D_j = \left(\frac{1}{N} \sum_{j=1}^{N} D_j^{\frac{\theta^d - 1}{\theta^d}} \right)^{\frac{\theta^d}{\theta^d - 1}} \tag{1.23}$$

Where $\theta^d < -1$ is the elasticity of deposit substitution across banks.

$$\max_{D_j} \quad \frac{1}{N}\sum_{j=1}^{N}(1+i_j^D)D_j$$

subject to

$$\left(\frac{1}{N}\sum_{j=1}^{N} D_j^{\frac{\theta^d-1}{\theta^d}}\right)^{\frac{\theta^d}{\theta^d-1}} \leq D$$

FOC with respect to D_j yields deposit supply:

$$D_j = \left(\frac{1+i_j^D}{1+i^D}\right)^{-\theta^d} D$$

Where

$$1+i^D = \left(\frac{1}{N}\sum_{j=1}^{N} {i_j^D}^{1-\theta^d}\right)^{\frac{1}{1-\theta^d}}$$

CHAPTER 2

Bank Liquidity and Monetary Policy Pass-Through

2.1. Introduction

Understanding the monetary policy transmission mechanism on bank lending and lending rates has been crucial. The current literature shows that banks alter their lending behavior in response to a change in monetary policy. Yet, do all banks in the market respond uniformly to monetary policy changes? In this paper, I ask whether there are crucial differences in the way that banks set their lending rates depending on the liquidity of their balance sheets, focusing on the U.S. commercial banks.

In particular, I examine whether the effect of monetary is more pronounced for banks with less liquid balance sheets, where I measure liquidity as the ratio of banks' liquid assets to total assets. I show that banks with less liquid balance sheets decrease their loan supply more following an increase in the policy rate, and their lending rates increase more than other banks. That is, I propose a new channel of monetary policy pass-through to bank lending rates, the *"bank-liquidity channel"*.

The fundamental motivation behind this paper is related to the long tradition of the "bank lending channel" of monetary policy that suggests that following a monetary policy contraction, banks cannot frictionlessly replace their insured deposits with external funding (Kashyap and Stein, 2000). As a result, lending of the banks decreases after an increase in the policy rate as the asset sides of their balance sheets must also shrink. However, if the banks have a more liquid balance sheet, they can easily preserve their loan portfolio by reducing their buffer stock of liquid assets. On the other hand, banks with less liquid balance sheets may need to cut their lending more to maintain their liquidity positions. My paper confirms this view and adds to it by showing that banks with less liquid balance sheets tend to increase their loan rates more following a monetary policy contraction. However, there is no significant heterogeneity in banks' deposit rate-setting decisions conditional on bank balance sheet liquidity.

There are several empirical challenges in identifying the impact of bank liquidity on bank lending rates and lending. First, eliminating the effect of monetary policy on bank loan demand is critical to identifying the impact of *"bank-liquidity channel"* on monetary policy pass-through to bank-level outcomes. To address this concern, I add various bank-specific and macroeconomic variables to my analysis enabling me to control bank-specific and aggregate-level loan demand conditions. Moreover, I show that my results are robust using Bank-MSA level mortgage lending and mortgage rate data and employing an MSA-time fixed effect estimation strategy, which enables me to isolate the impact of loan demand on the monetary policy transmission mechanism to bank-level outcomes. In particular, I compare the lending volumes and lending rates of the banks that operate in the same Metropolitan Statistical Area (MSA) yet have different levels of liquidity. That is, I show that my results are not driven by the impact of monetary policy on banks' loan demand. Another significant identification challenge I face is the potential endogeneity of monetary policy. I tackle this issue by employing an instrumental variable estimation strategy (IV), in which I instrument my policy measure with high-frequency monetary shocks that satisfy both instrument validity and exogeneity conditions.

I use the quarterly U.S. Call Reports for the period 2000-2019, which include rich income and balance sheet information for FDIC chartered U.S. banks. In addition, I use branch-level loan rate information from Ratewatch, which provides loan rate information on U.S commercial banks, and Bank-MSA level mortgage lending data from the Home Mortgage Disclosure Act (HDMA), which reports new mortgage lending of banks at the MSA level. I combine these datasets with high-frequency monetary shocks from Bauer and Swanson (2022). Finally, I construct a bank-level liquidity measure by summing up the cash, federal fund repo assets, and securities a bank has in a particular quarter and dividing it by its total assets. I lagged this measure by one period to eliminate endogeneity concerns. Finally, I test whether banks with less liquid balance sheets respond differently to monetary policy in this framework.

The key results can be summarized as follows: First, bank liquidity plays an important role in monetary policy pass-through to bank lending rates and bank-level outcomes. After an increase in the policy rate, the deposit inflows of the banking industry decrease significantly; although some banks are able to compensate for the decrease in their reservable deposits through external funding, the total liabilities of the banks decrease. Hence, banks start to shrink their balance sheets either by depleting their buffer stock of liquid assets or reducing their loan originations. Specifically, banks with less liquid balance sheets decrease their loan supply more than other banks due to the liquidity constraint they face. Moreover, they increase their loan rates more than other banks following a monetary contraction. On the other hand, bank liquidity does not play a significant role in monetary policy transmission to bank deposit rates.

Taken together, this paper contributes to the literature by presenting a new channel of monetary policy pass-through to bank lending rates: *"bank-liquidity channel"*. This is a previously unexplored dimension that differs from the earlier studies on the monetary-policy pass-through to bank retail rates.

2.2. Literature Review

This paper contributes three strands of literature. The first strand of literature this paper contributes to is the bank lending channel of monetary policy (Kashyap and Stein, 1995, 2000), which argues that smaller banks with less liquid balance sheets are affected more negatively by the contractionary monetary policy and decrease their lending more. The underlying mechanism behind this story is that banks with less liquid balance sheets don't have enough buffer stock securities to deplete when they face a contractionary monetary policy shock. However, these studies abstract from a strong identification strategy that allows them to eliminate the effect of monetary policy on loan demand. I extend the analysis of these papers substantially by using bank-level balance sheet data from U.S Call Reports. Additionally, I use a novel estimation strategy that enables me to isolate the impact of monetary policy on bank-loan demand. I further investigate the effect of bank liquidity on the transmission of monetary policy to banks' retail rates, which is missing in the literature.

Second, my paper contributes to the literature that investigates the role of different bank characteristics for monetary pass-through to bank retail rates. Altavilla et al. (2020) examine the effect of bank capitalization on monetary policy to bank lending rates focusing on the Euro area. In addition, Bellifemine et al. (2022) reveals the importance of bank size for monetary-policy transmission. Emeksiz (2022) show the importance of bank market power for monetary policy transmission to bank retail rates, where bank market power is the primary driver of monetary policy transmission mechanism through its heterogeneous impact on banks' deposit and wholesale funding rates. On the other hand, the main monetary policy transmission mechanism works through banks' liquidity position in this paper. Following a monetary contraction, banks with less liquid balance sheets cut their lending supply more due to the liquidity constraint they face. As a result, they increase their loan rates more than other banks. Hence, this paper contributes to this literature by proposing a new channel of monetary policy transmission to bank lending rates through bank liquidity.

Finally, my paper also connects to literature that focuses on different bank characteristics on bank risk-taking behavior (Acharya and Naqvi, 2012; Dell'Ariccia and Marquez, 2017; Jiménez et al., 2014; Khan et al., 2017). In particular, it adds to this literature by showing that banks with less-liquid balance sheets increase their loan rates more after monetary policy tightening.

The rest of this paper is organized as follows: Section 2.3 describes the data and provides summary statistics. Section 2.4 explains the empirical strategy and provides the empirical results. Section 2.5 discusses the details of the Basel III Liquidity Coverage Ratio. Section 2.6 presents the model. Section 2.7 provides robustness checks, and Section 2.8 concludes.

2.3. Data and Summary Statistics

In this section, I describe the data and provide summary statistics relevant to my analysis.

2.3.1 Bank Data: I use quarterly U.S. Call Reports data from the Wharton Research data services (WRDS). The data is available starting from 1976. The data provides information on all U.S. commercial banks' income statements and balance sheets. I merge the bank-level Call Reports to the branch-level Ratewatch data via the FDIC bank identifier.

2.3.2 Retail Rates: I use weekly data on loan and deposit rates collected across U.S. bank branches by Ratewatch. Ratewatch provides information on weekly deposit and monthly loan rates of various deposit and loan products at the branch-county level. To convert the data to the Bank-MSA level, I take the weighted average of the retail rates of the same bank branches operating in the same MSA, weighting them by the share of branch deposits. The data spans from January 2000 to December 2019 and can be merged with other data sets using an FDIC branch identifier. On the loan side, I use 1-year adjustable mortgage rate to eliminate the concerns regarding the term and liquidity premium. Similarly, on the deposit side, I use 12-month certificates of deposit with an account size of $10,000.

2.3.3 Deposit Holdings: I obtain branch-level deposits from the Federal Deposit Insurance Corporation (FDIC). The data is available at an annual frequency between 1994 to 2019. I use the branch-level FDIC identifier to match it with other data sets.

2.3.4 Bank-MSA Level Mortgage Lending: Home Mortgage Disclosure Act (HMDA) data reports every loan application made in the United States to lenders above a certain size threshold. The data includes information on whether the loan application was for a refinancing or a new home purchase, whether the loan application was granted, a lender identifier, and loan characteristics, including year, MSA, dollar amount, and borrower income. I construct an annual, Bank-MSA level sample of mortgage lending data using this data set from 2004-2017.[1] I use the sum of all loan categories, new home purchase, home improvement, and refinancing.[2]

2.3.5 Monetary Policy Shocks: I use the Bauer and Swanson (2022) monetary policy shock series, graciously shared by the authors. These shocks are obtained by taking the first principal component of the changes in the first four quarterly Eurodollar futures contracts, ED1–ED4, around the FOMC announcements.[3] Hence, these shocks also capture a forward guidance component. These series are summed to a quarterly or an annual frequency, depending on the analysis. They span from 1988 to 2019.

2.3.6 Federal funds rate and Treasury Yields: I use the one-year Treasury yield as the policy measure since the average maturity of loans is higher than one year. On the other hand, the average maturity of deposits is close to one year in the data. I instrument the one-year Treasury yield with Bauer and Swanson (2022) shocks to eliminate any concerns about the exogeneity of the policy instrument.[4] Data on quarterly and yearly government Treasury bills and Federal fund rates obtained from the FED H.15 series. In addition, data on U.S. commercial paper and 30-year mortgage rates are obtained from FRED.

[1]The data for the earlier period does not include the RSSD identifier, which is required to merge the dataset with the U.S. Call Reports.

[2]The data after 2017 does not have state and county numbers, preventing me from merging it with the FDIC data I use to calculate banking concentration.

[3]Figure 2.2 plots these shocks over time.

[4]High-frequency monetary policy shocks are exogenous to publicly known macroeconomic variables before the FOMC announcement, making them a valid instrument.

2.3.7 Macroeconomic Data: I collect data on national-level GDP, inflation, unemployment, and aggregate level loans from FRED. In addition, I obtain data on U.S. commercial paper spread and 30-year mortgage rates from FRED. [5]

My analysis focuses on the period between 2000 to 2019 since Ratewatch data is available starting from 2000.[6] I also eliminate the financial crisis period using NBER dates.

2.3.8 Summary Statistics: In my empirical approach, I use the liquidity-to-asset ratio of the banks as a bank-level liquidity measure. I compute the liquidity as the sum of cash, federal funds repo assets, and securities following Choi and Choi (2021). Figure 2.1 plots the evolution of the cross-sectional distribution of the liquidity to asset ratio over time. The solid line is the mean liquidity to asset ratio of banks in my sample, while the shaded band represents the corresponding interquartile range; the dotted line shows the median liquidity to asset ratio for the banks. As seen in the Figure, there is a considerable degree of variation in the liquidity to asset ratio of the banks.

Table 2.2 provides the summary statistics based on bank characteristics, where banks above the median liquidity-to-asset ratio are defined as High Liquidity Banks and below the median are defined as Low Liquidity Banks. The banks' average liquidity to asset ratio is 0.32, with a standard deviation of 0.16. As seen from the Table, Banks with higher liquidity-to-asset ratios are bigger, more capitalized, and have higher deposit market power. In particular, the average total assets of high-liquid banks are 1,798 million dollars, with a standard deviation of 42,957 million dollars. On the other hand, the average total assets of banks with lower liquidity are 1,713 million dollars, with a standard deviation of 21,636 million dollars. The average equity-to-asset ratio of high liquidity banks is 0.11 with a standard deviation of 0.04, whereas the average equity-to-asset ratio of low liquidity banks is 0.10 with a standard deviation of 0.04. There is no significant dispersion between high-liquid and low-liquid banks regarding wholesale funding to liabilities ratios. The average wholesale funding to liabilities ratio is 0.06 with a standard deviation of 0.17, whereas the average wholesale funding to liabilities ratio is 0.09 with a standard deviation of 0.16 for low liquidity banks.

2.4. Empirical Analysis

The theory behind my analysis suggests that banks with less liquid balance sheets increase their loan rates more after monetary policy contraction. In particular, following an increase in the

[5] Commercial paper spread refers to the difference between the 3-month commercial paper and the federal funds rate.

[6] I restricted the sample to 2019 to eliminate the impact of the COVID-19 crisis.

policy rate, banks can only partially replace their insured funding (e.g., deposits), which leads to a decrease in their total loan supply. While banks with high liquid balance sheets can reduce their buffer liquid assets such as securities to be able to keep their lending supply more stable, banks with low liquid balance sheets tend to increase their loan rates more as they are not able to supply loans as much as the banks with highly liquid balance sheets.

Testing my hypothesis is particularly challenging as one should separate the effect of monetary policy on loan supply from the loan demand. In order to tackle this issue, I first conduct my analysis at the bank level using aggregate bank-level data and control for bank-level and macroeconomic variables that may affect banks' loan demand. In the second stage, I turn to bank-MSA level loan rate and lending data and compare the loan rates and lending volume of the banks operating in the same Metropolitan Statistical Area (MSA) to ensure that these banks face similar lending opportunities.

Following sections describe these estimation strategies and provide the results.

2.4.1 Bank Level Estimation: In this section, I investigate the impact of bank-level liquidity on monetary policy-pass through to bank-level lending and lending rates.

To do so, I run the following regression at the bank-quarter level:

$$\begin{aligned}\Delta y_{jt} =& \alpha_j + \beta_1 \Delta R_t + \beta_2 \Delta R_t \times Liquidity_{jt-1} + \gamma_1 Liquidity_{jt-1} + \\ & \beta_3 \Delta R_t \times X_{jt-1} + \gamma_2 X_{jt-1} + \gamma_3 Z_t + \epsilon_{jt}\end{aligned} \tag{2.1}$$

Specifically, Δy_{jt} is the log change in a given balance sheet component of the bank j from date *t-1* to *t*. ΔR_t is the change in the one-year Treasury yield from *t-1* to *t* instrumented with Bauer and Swanson (2022) shocks. $Liquidity_{jt-1}$ is the lagged bank-level liquidity to asset ratio of the bank j, where liquidity is calculated as the sum of the cash, federal funds rate repos, and securities. α_j is bank fixed effects, and X_{jt-1} is bank-level controls such as the lagged equity to assets ratio, wholesale funding to liabilities ratio, and the market power measure of the bank. The bank-level control variables are also interacted with the change in the monetary policy to control their effect non-linearly. Specifically, these bank-level variables enable me to control for differences that may stem from the bank size, bank soundness, business model, and market power. I further include a dummy variable for the zero lower bound period to ensure that my results are not driven by this period. I add the following control variables: GDP growth, unemployment rate, inflation, change in the commercial paper spread, and mortgage spread. Moreover, I include the lagged aggregate loan growth to control for the aggregate demand across time.[7] All of these macroeconomic controls are captured by the term Z_t. I cluster the standard errors at the bank level to control for correlation within banks.

Table 2.3 reports the results. Panel B Columns (1) and (2) show that after monetary policy contraction, deposit inflow of the banking industry declines, and banks partially compensate for the decrease in their deposits through wholesale funding. Hence, the total liabilities of all banks decrease. However, the total liabilities of the banks with a more liquid balance sheet fall less than those with a less liquid balance sheet. Panel A Columns (2) and (3) show that banks with more liquid balance sheets are able to decrease their liquid assets, such as securities, and consume their additional liquid assets instead of reducing their lending. On top of that, the liabilities of these banks decrease less, as shown by Panel B Column (3). As a result, the total lending of banks with higher liquidity falls less following a monetary policy contraction. Specifically, banks with less liquid balance sheets have to cut their lending when their funding decreases, yet banks with more liquid assets are able to consume their buffer liquidity to be able to keep their lending more stable. Panel A Column (4) and (5) confirm these results and show that Commercial and Industrial Loans (C&I) and Residential Loans (RE) of banks with more liquid balance sheet decreases less after monetary policy contraction.

Taken together, these findings suggest that the fall in lending stems from the decrease in loan supply rather than the decrease in loan demand. As a result, banks with more liquid balance sheets increase their loan rates significantly less after monetary policy tightening since they can supply more loans thanks to their extra liquidity and funding advantage. Notably, the total lending of banks decreases by 28 bps after a 100 bps increase in the policy rate. On the other hand, the total lending of banks with liquid assets to asset ratio of 0.50 decreases around 43 ($86 \times 0.50 = 43$) bps less compared to banks with zero liquid assets. On the other hand, the average loan rate of banks increases around 54 bps after monetary policy contraction, yet the loan rate of a bank with a 0.50 liquidity ratio increases around 6 bps less compared to a bank with almost no liquid assets following a monetary contraction.[8] Panel B Column (5) shows that the deposit rate of banks

[7] I add the aggregate year-to-year growth of commercial and industrial lending. However, my results are robust, adding the sum of commercial and residential loans.

[8] Table 2.12 reports the response of key bank-level variables for different percentiles of the liquidity to asset ratio.

with more liquidity increases less.[9] In the following sections, I control more strictly for demand conditions, and I show that there is no deposit dispersion among banks, especially for time deposits.

2.4.2 Bank-MSA Level Estimation: In the previous sections, I have shown that banks with more liquid balance sheets can keep their loan supply more stable after monetary policy contraction as they are able to reduce their extra amount of liquidity following a decrease in their funding inflows. As a result, these banks with more liquid balance sheets increase their loan rates less after monetary policy contraction. As previously argued, the main challenge to identification in this setting is isolating the effect of loan demand from loan supply. To tackle this issue, I further compare the loan rates of different banks located in the same MSA by using an MSA-time fixed effect estimation strategy, as banks operating in the same MSA face similar demand conditions. This estimation strategy enables me to ensure that my results are not driven by the differences in the loan demand banks may face. This identification strategy differs from the bank-time and state-time fixed effect estimation strategy followed by Emeksiz (2022) as the idea is identifying the impact of bank-level liquidity for monetary policy pass-through in this setting rather than identifying the effect of banking concentration.

Equation (2.2) presents the baseline regression, allowing me to capture the average effect of monetary policy on mortgage volume and mortgage rates, in addition to the impact of bank liquidity on monetary transmission. On the other hand, Equation (2.3) presents the estimation with the MSA-time fixed effect estimation strategy.

$$\begin{aligned} \Delta y_{jt} =& \alpha_m + \beta_1 \Delta R_t + \beta_2 \Delta R_t \times Liquidity_{jt-1} + \gamma_1 Liquidity_{jt-1} + \\ & \beta_3 \Delta R_t \times X_{jt-1} + \gamma_2 X_{jt-1} + \gamma_3 Z_t + \epsilon_{jt} \end{aligned} \tag{2.2}$$

For the lending volume estimations Δy_{jt} is the new annual mortgage lending of the bank j operating in MSA m from *t-1* to *t*.[10] It includes loans generated for home purchases, home improvement, and refinancing. For the retail rate estimations, Δy_{jt} is the quarterly change in the 1-year adjustable mortgage rate (ARM) or 12-month of Certificates of deposit (CD) of the bank j

[9] As seen from the Table, neither the loan nor the deposit rate increases one to one with the policy rate consistent with the results presented in Emeksiz (2022).

[10] I also included the lag of the lending volume as a control variable in my regression.

operating in MSA m from *t-1* to *t*.[11] Usage of the short-term loan rate also allows me to eliminate the concerns about the impact of the term premium.

α_m is the MSA fixed effects that control for MSA-specific factors such as MSA-wide economic trends. $Liquidity_{jt-1}$ is the lagged bank-level liquidity to asset ratio of the bank j as in the previous specification. X_{jt-1} is bank-level controls such as the lagged equity to assets ratio and wholesale funding to liabilities ratio. These controls are added to isolate the effect of bank characteristics that may affect bank loan rates other than bank liquidity, such as bank size, capitalization, and the bank business model. Z_t includes additional control variables, which include GDP growth, unemployment rate, inflation, change in the commercial paper spread, and mortgage spread. It also includes MSA-level deposit market concentration.[12] The macroeconomic control variables were added to isolate the role of interest rates from cyclical conditions and control for loan demand. I also add a dummy variable for the zero lower bound period to control for differences that may stem from the zero-lower bound period. Finally, I cluster the standard errors at the MSA level to control for correlation within MSAs.

I further add time-fixed and MSA-time-fixed effects, allowing me to compare the loan rates of the banks operating in the same MSA by absorbing the impact of all time-varying MSA-level factors. That is, I control for changes in MSA-specific lending opportunities and isolate the impact of loan demand. Equation (2.3) presents MSA-time and time fixed effect added version of Equation (2.2) . As seen from Equation (2.3) , adding time and MSA-time fixed effects absorb the β_1 and Z_t as the change in the interest rate is the same for all branches at a particular point in time. α_{mt} is the MSA-time fixed effects that control for time-varying MSA-specific factors such as MSA-wide loan demand. δ_t is the time-fixed effects that control for time-varying aggregate economic conditions. All other variables are the same as those in Equation (2.2).

$$\Delta y_{jt} = \alpha_{mt} + \delta_t + \beta_1 \Delta R_t \times Liquidity_{jt-1} + \gamma_1 Liquidity_{jt-1} + \beta_2 \Delta R_t \times X_{jt-1} + \gamma_2 X_{jt-1} + \epsilon_{jt} \tag{2.3}$$

Table 2.4 reports the results of new mortgage lending. Column (1) shows that after a 100 bps increase in the policy rate, the total new loan creation, including loans generated for refinancing, decreases by around 93 bps. However, total new lending of banks with more liquid balance sheets

[11] Results are robust using annual frequency and reported in Section 2.11.

[12] MSA level deposit market concentration is calculated as the sum of the squared deposit share of all banks operating in that MSA at a given time.

falls less as the interaction term between the change in the interest rate and liquidity is positive and significant. Columns (1) and (2) add time and MSA-time fixed effects, respectively. In particular, Column (3) suggest that from the banks that operate in the same MSA, the lending of the ones with less liquid balance sheets decreases more as these banks need to reduce their loan supply more due to the liquidity constraint they face.

Table 2.5 reports the results on retail rates. Panel A reports the results on 1-year adjustable mortgage rates (ARM). Column (1) shows that after a 100 bps increase in the policy rate, 1-year ARM rates increase by 157 bps, yet it increases less for banks with more liquid balance sheets, shown by the interaction term between the change in monetary policy and bank liquidity. Specifically, a bank with a liquid asset ratio of 0.50 increases the loan rate by around 25 bps less than a bank with a non-liquid balance sheet. Column (2) adds time f.e. and Column (3) adds MSA-time f.e. into the analysis and confirms my findings. Remarkably, results in Column (3) isolate the effect of loan demand by comparing the banks that operate in the same MSA and indicate that the results are driven by the loan supply as suggested by *"bank liquidity channel"* of monetary policy. Panel B shows that after a monetary policy contraction deposit rate of the banks increases. However, there are no differences in the deposit rate banks set conditional on their liquidity as the interaction term between the change in the interest rate and bank liquidity is insignificant once time and MSA-time fixed effects are added to the regression. Taken together, bank-MSA level results confirm the findings of my bank-level estimation strategy by eliminating the impact of loan demand on retail rates. Moreover, it shows that banks with less liquid balance sheets increase their loan rates more due to the liquidity constraints they face, yet there is no significant variation among banks' deposit rates in terms of differences in balance sheet liquidity.

2.5. Basel III Liquidity Coverage Ratio (LCR) and Implications for the Theory

The liquidity coverage ratio is the requirement whereby banks must hold an amount of high-quality liquid assets that's enough to fund cash outflows for 30 days under Basel III. It is defined as:

$$LCR = \frac{\text{High Quality Liquid Assets}}{\text{Cash Outflow}} \geq \kappa$$

where

$$\text{High Quality Liquid Assets (HQLA)} = \sum_n \text{Liquidity weight}_n \times \text{Asset}_n$$

$$\text{Cash outflows} = \sum_n \text{Runoff rate}_n \times \frac{\text{Liability}_n}{\text{Maturity}_n}$$

Level 1 HQLAs include cash, central bank reserves, and government securities with a liquidity weight of 100%; level 2a HQLAs include GSE securities with a liquidity weight of 85%, and level 2b HQLAs include investment corporate and municipal bonds with a liquidity weight of 50%. Hence, this regulation requires banks to hold certain liquid assets in their balance sheets.[13]

In the model, I use this regulation as the motivation behind the liquidity constraint banks faces and show that when the liquidity constraint becomes more binding, the pass-through of monetary policy to loan rates increases.

2.6. A Model of Heterogeneous Pass-Through

I build a simple model of monopolistic competition with liquidity constraints to provide intuition for the underlying mechanism and rationalize my empirical findings. The model predicts a higher monetary policy pass-through to loan rate for banks where the liquidity constraint is more binding, and it suggests a *"bank liquidity channel"* of monetary policy. The underlying motivation for the model follows the liquidity coverage ratio (LCR) requirement of Basel III. In particular, under this regulation, banks should hold a certain degree of liquid assets in their balance sheets. Details of this regulation are discussed in Section 2.5.

The model assumes that deposits and loans are baskets of differentiated products with constant elasticity of substitution, leading to a constant markup/markdown over the bank's retail rates. The deposit supply and loan demand for each bank rises because depositors and borrowers have CES preferences across banks following Ulate (2021). In the model, the aggregate amounts of deposits supplied and loans demanded are taken as given, as it is a partial equilibrium exercise. The model shows that pass-through to loan rates decreases in bank liquidity. That is, the model suggests that banks' liquidity position determines monetary policy pass-through to loan rates.

2.6.1 The Model: In the model, banks are financial intermediaries and originate loans funded by deposits and wholesale funding. Financial regulations require banks to maintain specific bank

[13] Starting January 1, 2015, LCR was 60%, and it raised by 10% each year until it reached 100% by January 1, 2019.

liquidity ratios, and banks should hold a certain fraction of liquid assets such as securities due to the liquidity regulations, similar to the liquidity coverage ratio imposed by Basel III. Banks operate under monopolistic competition, where market power could arise from product differentiation.

Table 2.1 shows a bank's balance sheet with loans, L_j and securities G_j as assets; and deposits D_j and wholesale funding WF_j, as liabilities. Banks face a liquidity constraint and should keep a certain amount of liquid assets. The underlying structure for this liquidity constraint follows from the liquidity coverage ratio.

TABLE 2.1. Balance Sheet

Assets	Liabilities
Loans L_j	Deposits D_j
Securities G_j	Wholesale Funding WF_j

Each bank j maximize profits given by Equation (2.4) :

$$\max_{i_j^L, i_j^D} \Pi_j = (1 + i_j^L)L_j + (1 + f)G_j - (1 + i_j^D)D_j - (1 + f)WF_j \tag{2.4}$$

subject to the loan and deposit demand and the bank balance sheet and liquidity constraints given by

$$L_j = \left(\frac{1 + i_j^L}{1 + i^L}\right)^{-\theta^\ell} L \tag{2.5}$$

$$D_j = \left(\frac{1 + i_j^D}{1 + i^D}\right)^{-\theta^d} D \tag{2.6}$$

$$L_j + G_j = D_j + WF_j \tag{2.7}$$

$$G_j \geq (\psi + \epsilon_j)(L_j + G_j) \tag{2.8}$$

Where i_j^L is the loan rate, and i_j^D is the deposit rate bank j offers. For simplicity, banks earn the policy rate, f, on securities and similarly obtain the non-deposit funding by paying the policy rate. ψ is the regulatory securities to assets ratio each bank has to maintain. ϵ_j is the additional amount of liquidity banks prefer to sustain; hence it is bank specific.

Solving the maximization problem and arranging the first-order conditions yields the loan and deposit rate as a constant markup and markdown on the policy rate and the multiplier, γ_j, on the liquidity constraint.

$$1 + i_j^L = \underbrace{\frac{\theta^\ell}{\theta^\ell - 1}}_{\text{markup}} (1 + f + (\psi + \epsilon_j)\gamma_j) \tag{2.9}$$

$$1 + i_j^D = \underbrace{\frac{\theta^d}{\theta^d - 1}}_{\text{markdown}} (1 + f) \tag{2.10}$$

As $1 < \theta^\ell$ and $\theta^d < -1$ which indicates that

$$\frac{\theta^\ell}{\theta^\ell - 1} > 1$$

$$0 < \frac{\theta^d}{\theta^d - 1} < 1$$

As shown in Equation (2.9) , the lending rate is heterogeneous across banks due to differences in their liquidity level, $\psi + \epsilon_j$, interacting with γ_j; the multiplier on the liquidity constraint. Lending is relatively more costly for constrained banks, increasing their loan rates. However, the deposit rate is only a function of the policy rate, as Equation (2.10) indicates. Hence, there is no dispersion in deposit rates that banks offer consistent with my empirical findings.

The effect of bank liquidity on monetary policy pass-through can be obtained by taking the total derivatives of the loan and deposit rate with respect to the policy rate:

$$\frac{di_j^L}{df} = \frac{\theta^\ell}{\theta^\ell - 1} + \underbrace{\frac{\theta^\ell}{\theta^\ell + 1}(\psi + \epsilon_j)\frac{d\gamma_j}{df}}_{\text{liquidity channel}} \tag{2.11}$$

$$\frac{di_j^D}{df} = \frac{\theta^d}{\theta^d - 1} \tag{2.12}$$

Equation (2.11) indicates that the degree of monetary policy pass-through to loan rate is larger for banks with lower liquidity. Hence, a shift in the liquidity requirement affects loan rate pass-through significantly. In particular, lower liquidity leads to a higher pass-through (e.g., the liquidity channel). The reason is that the multiplier on the constraint, γ_j, declines in response to a monetary contraction as higher rates reduce loan demand. As a result, higher liquidity enables banks to benefit more from an easing constraint. That is, monetary policy pass-through to loan rates is lower for banks with more liquidity.

2.7. Robustness

This section performs a large number of robustness checks and shows that the baseline results are robust to adding additional bank-level controls, aggregating the data at the Bank Holding Company level, usage of different monetary policy shocks, estimation strategies, and alternative data sets.

2.7.1 Usage of Additional Bank level Controls: As an alternative bank-level control, I first change the definition of my bank capitalization measure to equity over liabilities from equity over assets. Then, I add the maturity mismatch measure of English et al. (2018), calculated as the weighted average of the repricing times between banks' assets and liabilities.[14] Table 2.6 presents the results and shows that the results are consistent with the baseline specification.

2.7.2 Usage of Time Fixed Effect Estimation: I checked the robustness of my results by adding time fixed effect to my bank-level estimation. As suggested in Cameron and Miller (2015), adding time fixed and clustering at the other dimension eliminates concerns on error correlation in multi-dimensions, if any. Equation (2.13) presents this estimation strategy. All variables are identical to the ones in Equation (2.1) . However, the average change in the monetary policy and macroeconomic controls are absorbed by time-fixed effects.

$$\Delta y_{jt} = \alpha_j + \delta_t + \beta_1 \Delta R_t \times Liquidity_{jt-1} + \gamma_1 Liquidity_{jt-1} + \beta_2 \Delta R_t \times X_{jt-1} + \gamma_2 X_{jt-1} + \epsilon_{jt} \quad (2.13)$$

Results are presented in Table 2.7 and consistent with the ones reported in Table 2.3.

[14] Section 3.3 describes the construction of this measure.

2.7.3 Usage of BHC-level Data: To check the robustness of my results, I aggregate my bank-level data to the Bank Holding Company (BHC) level and show that my results go through. Table 2.8 presents the results. As seen from the Table, deposit inflows of the BHCs decrease after monetary policy contractions, and BHCs are not fully compensated for the decrease in their reservable funding through external financing. Therefore, the total liabilities of BHCs decrease, leading to a decline in BHC's total assets. However, BHCs with more liquid balance sheets can keep their loan supply more stable as they are able to shrink their buffer liquidity. Therefore, securities of BHCs with more liquid balance sheets decrease more, whereas their lending decreases less compared to banks with liquidity constraints. Moreover, these BHCs increase their loan rates less following a monetary contraction. On the other hand, there is no significant difference in the deposit rates BHCs set.

2.7.4 Usage of Annual Retail Rate Data: As HDMA data is in annual frequency, I convert my mortgage rate data to annual frequency and show that my results go through. As seen from Table 2.9, banks with less liquid balance sheets increase their loan rates more after monetary policy tightening, whereas there is no significant difference among bank deposit rates conditional on bank liquidity.

2.7.5 Usage of Different Shocks: To check the robustness of my results on retail rates and lending, I replicate my analysis using Jarociński and Karadi (2020) shocks. These shocks are obtained following a similar approach with Bauer and Swanson (2022) available till 2016 [15]. Figure 2.2 plots these shocks over time. Tables 2.10 and 2.11 report the results obtained using Jarociński and Karadi (2020) shocks. As seen from the Tables, results are consistent with the ones in the baseline specification.

2.8. Conclusion

This paper examines how bank liquidity affects monetary policy pass-through bank lending and lending rates. First, I document the heterogeneous effect of monetary policy on bank lending and lending rates depending on banks' liquidity position. I show that following a monetary policy contraction, banks' total liabilities decrease, forcing banks to shrink the asset side of their balance

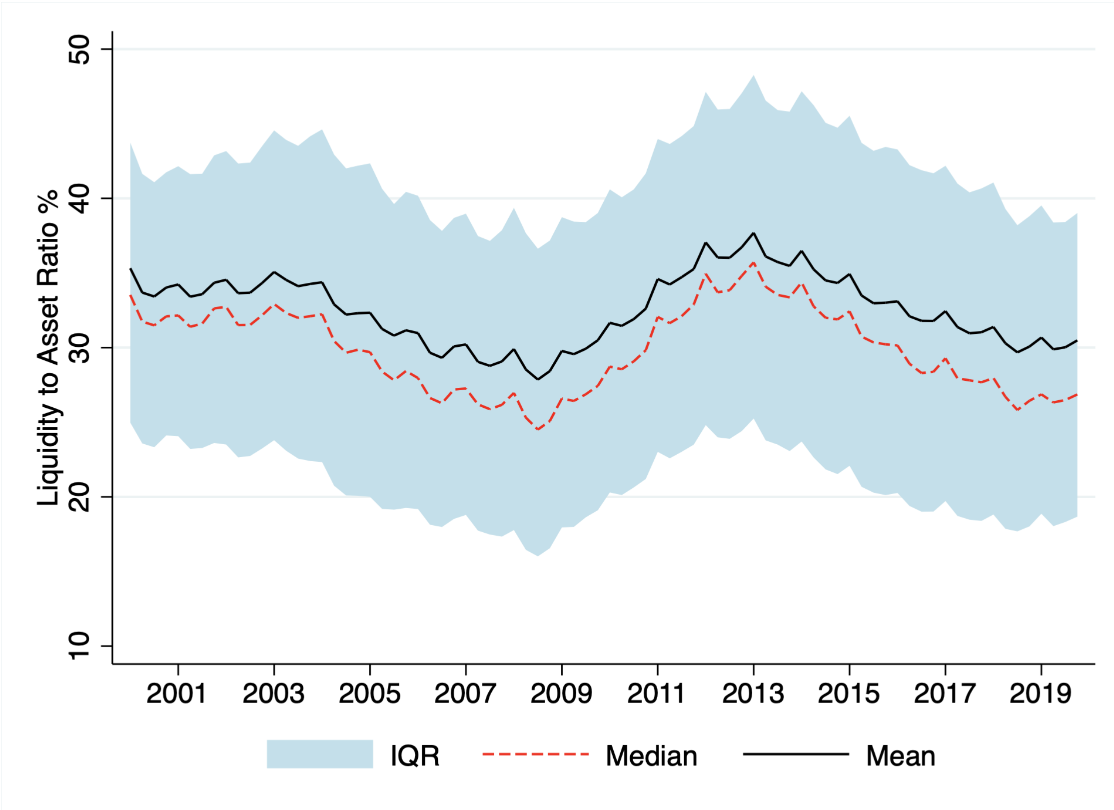
[15] Jarociński and Karadi (2020) shocks are obtained as the first principal component of surprises in the current month and three-month fed funds futures and two-, three-, and four-quarters ahead three- month Eurodollar futures. Hence, it includes additional interest rates compared to Bauer and Swanson (2022).

sheets. Yet, banks with more liquid balance sheets maintain their loan supply more easily as these banks can reduce their buffer stock of liquid assets such as securities. As a result, banks with less liquid balance sheets decrease their loan supply more and increase their lending rates more after an increase in the policy rate.

Second, I propose a new and stronger test of the bank liquidity channel of monetary policy by using micro-level lending and loan rate data and estimation techniques that allow me to control for the effect of monetary policy on loan demand. Finally, I construct a theoretical model of monopolistic competition where banks face a liquidity constraint and motivate my empirical findings.

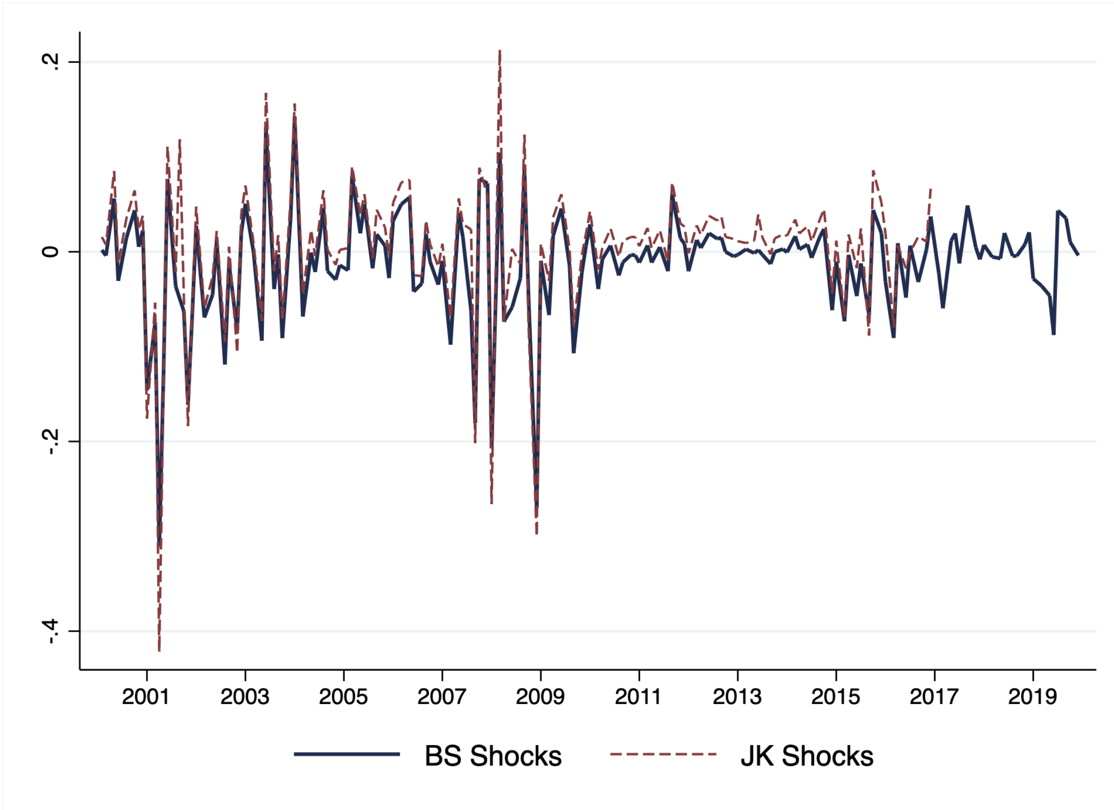
The findings of this paper are crucial for the following reasons. First, this study is the first paper investigating the effect of monetary policy on bank retail rates conditional on bank liquidity. Importantly, this paper provides a new channel of monetary policy transmission to bank lending rates: *"bank liquidity channel"*. Lastly, the results of this paper have important implications for macro-prudential regulations, such as bank liquidity requirements, as it presents new insights into the role of bank balance sheet liquidity on monetary policy transmission.

FIGURE 2.1. Bank Liquidity Measure



The sample period is 2000-2019. The solid line indicates the mean liquidity to asset ratio of banks in my sample, whereas the dotted line indicates the median liquidity to asset ratio. The shaded area corresponds to the interquartile range of the liquidity to asset ratio. Liquidity is defined as the sum of cash, federal funds rate repos, and securities.

FIGURE 2.2. Monetary Policy Shocks



This figure plots the Bauer and Swanson (2022) and Jarociński and Karadi (2020) shocks over time. Shocks are at a monthly frequency.

Table 2.2. Summary Statistics

	All		Low Liquidity		High Liquidity	
	Mean	Std	Mean	Std	Mean	Std
Assets (millions)	1,755	34,016	1,713	21,636	1,798	42,957
Liabilities (millions)	1,597	31,017	1,556	19,924	1,637	39,070
Equity/Assets	0.108	0.041	0.103	0.037	0.113	0.044
Wholesale F./Liabilities	0.079	0.162	0.090	0.156	0.068	0.168
Market Power (HHI)	0.241	0.133	0.228	0.122	0.254	0.142
Liquidity/Assets	0.327	0.160	0.202	0.064	0.453	0.124
Obs.(bank×quarter)	422,661		211,350		211,301	

This table presents the summary statistics on bank balance sheet variables.

TABLE 2.3. Bank Level Results

Panel A: Bank Assets

	ΔTotal Assets	ΔTotal Securities	ΔTotal Loans	ΔC&I Loans	ΔRE Loans
	(1)	(2)	(3)	(4)	(5)
ΔR_t	-0.352*	0.892	-0.284	-0.958	-0.280
	(0.193)	(0.614)	(0.233)	(0.632)	(0.309)
$\Delta R_t \times Liquidity_{jt-1}$	0.233	-4.792***	0.858**	1.097	1.553***
	(0.362)	(1.046)	(0.437)	(1.155)	(0.545)
Bank f.e.	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y
Observations	422,661	422,661	422,661	422,661	422,661
R-squared	0.030	0.006	0.023	0.004	0.008

Panel B: Bank Liabilities and Retail Rates

	ΔTotal Deposits	ΔTotal Wholesale	ΔTotal Liabilities	ΔLoan Rate	ΔDeposit Rate
	(1)	(2)	(3)	(4)	(5)
ΔR_t	-0.254	-0.943	-0.501**	0.535***	0.454***
	(0.223)	(1.983)	(0.233)	(0.0284)	(0.0152)
$\Delta R_t \times Liquidity_{jt-1}$	0.699*	3.829	0.681*	-0.0995**	-0.0524**
	(0.418)	(3.621)	(0.408)	(0.0493)	(0.0266)
Bank f.e.	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y
Observations	422,661	422,661	422,661	422,661	422,661
R-squared	0.034	0.003	0.036	0.014	0.081

This table estimates the effect of bank liquidity on bank-level outcomes. Panel A reports the results for assets. Panel B reports the results for the retail rates and liabilities. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks.

Table 2.4. Bank-MSA Level Results

	New Lending	New Lending	New Lending
	(1)	(2)	(3)
ΔR_t	-0.930***		
	(0.149)		
$\Delta R_t \times Liquidity_{jt-1}$	1.718***	0.534***	0.398**
	(0.234)	(0.153)	(0.161)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	49,121	49,121	49,087
R-squared	0.301	0.020	0.031

This table estimates the effect of bank liquidity on new HDMA lending. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. Lagged new lending is also added to the regression as a control variable.

Table 2.5. Bank-MSA Level Results

Panel A: 1-year Adjustable Mortgage Rate (ARM)

	ΔLoan Rate	ΔLoan Rate	ΔLoan Rate
	(1)	(2)	(3)
ΔR_t	1.568***		
	(0.127)		
$\Delta R_t \times Liquidity_{jt-1}$	-0.506**	-0.517**	-0.593***
	(0.252)	(0.216)	(0.214)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	10,909	10,909	10,909
R-squared	0.441	0.006	0.006

Panel B: 12-month Certificates of Deposit (CD)

	ΔDeposit Rate	ΔDeposit Rate	ΔDeposit Rate
	(1)	(2)	(3)
ΔR_t	1.692***		
	(0.0522)		
$\Delta R_t \times Liquidity_{jt-1}$	0.334***	-0.0626	-0.0548
	(0.0711)	(0.0465)	(0.0397)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	199,373	199,373	199,373
R-squared	0.913	0.008	0.007

This table estimates the effect of bank liquidity for monetary policy transmission on 1-year ARM and 12-month CD using Bauer and Swanson (2022) shocks as an instrument for the change in the one-year Treasury yield.

2.11. Appendix

2.11.1 Additional Tables:

Table 2.6. Bank Level Results with Additional Controls

Panel A: Bank Assets					
	ΔTotal Assets	ΔTotal Securities	ΔTotal Loans	ΔC&I Loans	ΔRE Loans
	(1)	(2)	(3)	(4)	(5)
ΔR_t	-0.151	1.578***	0.0591	-0.122	-0.112
	(0.144)	(0.591)	(0.167)	(0.436)	(0.228)
$\Delta R_t \times Liquidity_{jt-1}$	0.0606	-4.037***	1.288***	1.016	1.061*
	(0.335)	(1.102)	(0.432)	(1.123)	(0.550)
Bank f.e.	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y
Observations	422,661	422,661	422,661	422,661	422,661
R-squared	0.019	0.006	0.019	0.004	0.008
Panel B: Bank Liabilities and Retail Rates					
	ΔTotal Deposits	ΔTotal Wholesale	ΔTotal Liabilities	ΔLoan Rate	ΔDeposit Rate
	(1)	(2)	(3)	(4)	(5)
ΔR_t	-0.166	0.461	-0.260	0.428***	0.357***
	(0.172)	(1.460)	(0.162)	(0.0245)	(0.0134)
$\Delta R_t \times Liquidity_{jt-1}$	0.274	4.624	0.399	-0.111**	-0.0750***
	(0.403)	(3.323)	(0.385	(0.0548)	(0.0285))
Bank f.e.	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y
Observations	422,661	422,661	422,661	422,661	422,661
R-squared	0.022	0.004	0.019	0.015	0.085

This table estimates the effect of bank liquidity on bank-level outcomes with additional bank-level controls. Panel A reports the results for the retail rates and liabilities. Panel B reports the results for assets. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. The sample covers between 2000-2019.

TABLE 2.7. Bank Level Results with Time f.e.

Panel A: Bank Assets

	ΔTotal Assets	ΔTotal Securities	ΔTotal Loans	ΔC&I Loans	ΔRE Loans
	(1)	(2)	(3)	(4)	(5)
$\Delta R_t \times Liquidity_{jt-1}$	0.325	-6.763***	1.278***	1.090	1.546***
	(0.367)	(1.072)	(0.441)	(1.166)	(0.553)
Bank f.e.	Y	Y	Y	Y	Y
Time f.e	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Observations	422,661	422,661	422,661	422,661	422,661
R-squared	0.030	0.000	0.012	0.002	0.004

Panel B: Bank Liabilities and Retail Rates

	ΔTotal Deposits	ΔTotal Wholesale	ΔTotal Liabilities	ΔLoan Rate	ΔDeposit Rate
	(1)	(2)	(3)	(4)	(5)
$\Delta R_t \times Liquidity_{jt-1}$	0.914**	3.185	0.957**	-0.192***	-0.189***
	(0.422)	(3.675)	(0.413)	(0.0496)	(0.0261)
Bank f.e.	Y	Y	Y	Y	Y
Time f.e	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Observations	422,661	422,661	422,661	422,661	422,661
R-squared	0.031	0.000	0.036	0.007	0.001

This table estimates the effect of bank liquidity on bank-level outcomes. Panel A reports the results for assets. Panel B reports the results for the retail rates and liabilities. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. The sample covers between 2000-2019.

Table 2.8. BHC-level Results

Panel A: Bank Assets

	ΔTotal Assets	ΔTotal Securities	ΔTotal Loans	ΔC&I Loans	ΔRE Loans
	(1)	(2)	(3)	(4)	(4)
ΔR_t	-0.600***	0.231	0.0190	-1.159*	0.164
	(0.206)	(0.680)	(0.223)	(0.699)	(0.296)
$\Delta R_t \times Liquidity_{jt-1}$	-0.360	-3.096***	1.270***	4.236***	0.633
	(0.354)	(1.075)	(0.454)	(1.088)	(0.530)
Bank f.e.	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y
Observations	337,885	337,885	337,885	335,852	320,375
R-squared	0.029	0.004	0.020	0.005	0.007

Panel B: Bank Liabilities and Retail Rates

	ΔTotal Deposits	ΔTotal Wholesale	ΔTotal Liabilities	ΔLoan Rate	ΔDeposit Rate
	(1)	(2)	(3)	(4)	(5)
ΔR_t	-0.927***	0.0527	-0.743***	0.623***	0.500***
	(0.237)	(2.263)	(0.222)	(0.0336)	(0.0157)
$\Delta R_t \times Liquidity_{jt-1}$	0.181	3.880	0.170	-0.105**	0.0334
	(0.420)	(4.089)	(0.386)	(0.0489)	(0.0236)
Bank f.e.	Y	Y	Y	Y	Y
Bank-level controls	Y	Y	Y	Y	Y
Macro controls	Y	Y	Y	Y	Y
Observations	337,885	337,885	337,885	337,859	337,885
R-squared	0.030	0.004	0.031	0.054	0.206

This table estimates the effect of bank liquidity on BHC-level outcomes.Panel A reports the results for assets. Panel B reports the results for the retail rates and liabilities. ΔR_t is the change in the one-year Treasury Yield instrumented by Bauer and Swanson (2022) shocks. The sample covers between 2000-2019.

Table 2.9. Bank-MSA Level Results

Panel A: 1-year Adjustable Mortgage Rate (ARM)

	ΔLoan Rate	ΔLoan Rate	ΔLoan Rate
	(1)	(2)	(3)
ΔR_t	0.940***		
	(0.0682)		
$\Delta R_t \times Liquidity_{jt-1}$	-0.427**	-0.447***	-0.463**
	(0.169)	(0.169)	(0.188)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	2,528	2,528	2,527
R-squared	0.489	0.011	0.007

Panel B: 12-month Certificates of Deposit (CD)

	ΔDeposit Rate	ΔDeposit Rate	ΔDeposit Rate
	(1)	(2)	(3)
ΔR_t	1.136***		
	(0.0244)		
$\Delta R_t \times Liquidity_{jt-1}$	0.0142	-0.0434	-0.0500
	(0.0345)	(0.0338)	(0.0306)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	49,133	49,133	49,128
R-squared	0.763	0.004	0.003

This table estimates the effect of bank liquidity on retail rates using annualized rates. Panel A reports the results for the loan rates. Panel B reports the results for deposit rates.

Table 2.10. Bank-MSA Level Results with Alternative MP Shocks

	New Lending	New Lending	New Lending
	(1)	(2)	(3)
ΔR_t	-2.394***		
	(0.538)		
$\Delta R_t \times Liquidity_{jt-1}$	3.279***	0.966***	0.523***
	(0.610)	(0.265)	(0.191)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	43,211	43,211	43,171
R-squared	0.435	0.402	0.134

This table estimates the effect of bank liquidity for monetary policy transmission on HDMA lending using Jarociński and Karadi (2020) shocks as an instrument. Lagged new lending is also added to the regression as a control.

Table 2.11. Bank-MSA Level Results with Alternative MP Shocks

Panel A: 1-year Adjustable Mortgage Rate (ARM)

	ΔLoan Rate	ΔLoan Rate	ΔLoan Rate
	(1)	(2)	(3)
ΔR_t	1.993***		
	(0.205)		
$\Delta R_t \times Liquidity_{jt-1}$	-0.794**	-0.816***	-0.911**
	(0.343)	(0.302)	(0.357)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	10,132	10,132	10,132
R-squared	-0.750	-0.017	-0.008

Panel B: 12-month Certificates of Deposit (CD)

	ΔDeposit Rate	ΔDeposit Rate	ΔDeposit Rate
	(1)	(2)	(3)
ΔR_t	2.060***		
	(0.107)		
$\Delta R_t \times Liquidity_{jt-1}$	0.564***	0.0970	0.0346
	(0.168)	(0.0963)	(0.0916)
MSA f.e.	Y	Y	Y
Time f.e.	N	Y	Y
MSA-time f.e.	N	N	Y
Bank-level controls	Y	Y	Y
Macro controls	Y	N	N
Observations	158,626	158,626	158,564
R-squared	-1.699	-0.002	-0.001

This table estimates the effect of bank liquidity on retail rates. Panel A reports the results for the loan rates. Panel B reports the results for retail deposits. ΔR_t is the change in the one-year Treasury Yield instrumented by Jarociński and Karadi (2020) shocks.

Table 2.12. Response of Key Variables for Different Levels of Liquidity

	ΔTotal Assets	ΔTotal Liabilities	ΔTotal Securities	ΔC&I Loans	ΔLoan Rate
	(1)	(2)	(3)	(4)	(5)
$10th$	-0.317	-0.399	0.175	-0.794	0.521
$25th$	-0.302	-0.355	-0.137	-0.723	0.514
$50th$	-0.280	-0.292	-0.585	-0.620	0.505
$75th$	-0.252	-0.211	-1.154	-0.490	0.493
$90th$	-0.223	-0.127	-1.747	-0.354	0.481

This Table reports the response of key bank-level variables to monetary policy shock for different levels of *Liquidity to Asset Ratio*. 10th, 25th, 50th, 75th and 90th corresponds to the 10th to 90th percentile of the *Liquidity* measure, respectively. The Table is constructed based on the results obtained from Equation (2.1).

2.11.2 Model Appendix: In this section, I provide the full solution of the model.

We can re-arrange the bank problem as:

$$\max_{i_j^L, i_j^D} \Pi_j = (1+i_j^L)L_j + (1+f)G_j - (1+i_j^D)D_j - (1+f)\, WF_j$$

$$\max_{i_j^L, i_j^D} \Pi_j = (1+i_j^L)L_j + (1+f)G_j - (1+i_j^D)D_j - (1+f)\,(L_j + G_j - D_j)$$

$$= L_j + i_j^L L_j + G_j + fG_j - D_j - i_j^D D_j - L_j - fL_j - G_j - fG_j + D_j + fD_j$$

$$\max_{i_j^L, i_j^D} \Pi_j = L_j \left(i_j^L - f\right) + (f - i_j^D)D_j$$

$$\max_{i_j^L, i_j^D} \Pi_j = \left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L\left(i_j^L - f\right) + (f - i_j^D)D_j + \gamma_j\left(G_j - (\psi + \epsilon_j)(L_j + G_j)\right)$$

$$\max_{i_j^L, i_j^D} \Pi_j = \left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L\left(i_j^L - f\right) + (f - i_j^D)D_j + \gamma_j(G_j - (\psi + \epsilon_j)\left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L - (\psi + \epsilon_j)G_j)$$

Differentiate with respect to i_j^L:

$$\left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L - \frac{\theta^\ell i_j^L}{1+i_j^L}\left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L + \frac{\theta^\ell f}{1+i_j^L}\left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L + \frac{\theta^\ell(\psi+\epsilon_j)\gamma_j}{1+i_j^L}\left(\frac{1+i_j^L}{1+i^L}\right)^{-\theta^\ell} L$$

$$\frac{\partial \Pi_j}{\partial i_j^L} = 1 - \frac{\theta^\ell i_j^L}{1+i_j^L} + \frac{\theta^\ell f}{1+i_j^L} + \frac{\theta^\ell(\psi+\epsilon_j)\gamma_j}{1+i_j^L} = 0$$

$$0 = \frac{\partial \Pi_j}{\partial i_j^L} = 1 + i_j^L - \theta^\ell i_j^L + \theta^\ell f + \theta^\ell(\psi+\epsilon_j)\gamma_j$$

$$0 = \frac{\partial \Pi_j}{\partial i_j^L} = 1 + i_j^L - \theta^\ell i_j^L + \theta^\ell f + \theta^\ell(\psi+\epsilon_j)\gamma_j + \theta^\ell - \theta^\ell$$

$$0 = \frac{\partial \Pi_j}{\partial i_j^L} = (1-\theta^\ell)(1+i_j^L) + \theta^\ell + \theta^\ell f + \theta^\ell(\psi+\epsilon_j)\gamma_j$$

$$1 + i_j^L = \frac{\theta^\ell}{\theta^\ell - 1}\left(1 + f + (\psi+\epsilon_j)\gamma_j\right)$$

Similarly we can solve for i_j^D :

$$\max_{i_j^L, i_j^D} \Pi_j = (1+i_j^L)L_j + (1+f)G_j - (1+i_j^D)D_j - (1+f)\, WF_j$$

$$\max_{i_j^L, i_j^D} \Pi_j = D_j\left(f - i_j^D\right) + L_j\left(i_j^L - f\right)$$

$$\max_{i_j^L, i_j^D} \Pi_j = \left(\frac{1+i_j^D}{1+i^D}\right)^{-\theta^d} D\left(f - i_j^D\right) + L_i\left(i_j^L - f\right) + \gamma_j\left(G_j - (\psi+\epsilon_j)(L_j+G_j)\right)$$

$$\frac{d\Pi_j}{di_j^D} = \frac{-\theta^d f}{1+i_j^D}\left(\frac{1+i_j^D}{1+i^D}\right)^{-\theta^d} D + \frac{\theta^d i_j^D}{1+i_j^D}\left(\frac{1+i_j^D}{1+i^D}\right)^{-\theta^d} D - \left(\frac{1+i_j^D}{1+i^D}\right)^{-\theta^d} D = 0$$

$$\frac{d\Pi_j}{di_j^D} = \frac{-\theta^d f}{1+i_j^D} + \frac{\theta^d i_j^D}{1+i_j^D} - 1 = 0$$

$$\frac{d\Pi_j}{di_j^D} = -\theta^d f + \theta^d i_j^D - 1 - i_j^D = 0$$

$$1 + i_j^D = \frac{\theta^d}{\theta^d - 1}(1+f)$$

To summarize:

$$1 + i_j^L = \underbrace{\frac{\theta^\ell}{\theta^\ell - 1}}_{\text{markup}}(1 + f + (\psi+\epsilon_j)\gamma_j)$$

$$1 + i_j^D = \underbrace{\frac{\theta^d}{\theta^d - 1}}_{\text{markdown}}(1+f)$$

$$\frac{di_j^L}{df} = \frac{\theta^\ell}{\theta^\ell - 1} + \frac{\theta^\ell}{\theta^\ell - 1}(\psi+\epsilon_j)\frac{d\gamma_j}{df}$$

$$\frac{di_j^D}{df} = \frac{\theta^d}{\theta^d - 1}$$

CHAPTER 3

The Effect of Monetary Policy on Bank Equity Valuations: How Has the Transmission Mechanism Evolved During the ZLB?

3.1. Introduction

The effect of the low-interest rate environment on bank performance has gained prominence aftermath of the global financial crises. Although lower policy rates have helped sustain economic growth during the recent global financial crisis and have provided some support for banks, the final impact of these policies on bank-profitably is still ambiguous IMF (2020). The main reason for this ambiguity is the existence of direct and indirect channels that determine the effect of monetary policy on bank profitability. In particular, low-interest rates can stimulate credit growth and enhance banks' balance sheet performance by leading to capital gains, supporting asset prices, and reducing non-performing loans. Hence, low rates may increase bank profitability through its indirect positive effects on the overall economic conditions and banks' balance sheet performance Demertzis and Wolff (2016); Lopez et al. (2020*a*); Turk (2016). On the other hand, through its adverse direct effect on net interest margins, low rates can erode profitability, leading banks to seek higher yields and induce risk-taking Borio and Gambacorta (2017); Claessens et al. (2018*a*), Dell'Ariccia and Marquez (2017); Rajan (2013). Moreover, the direct effect of monetary policy on banks' net interest margins depends on the repricing maturity gap (maturity mismatch) between banks' assets and liabilities and whether banks hedge themselves toward the interest rate risk. Suppose the repricing maturity time of banks' assets is longer than its liabilities. In that case, expected net interest income should increase as the yield curve steepens, increasing banks' expected profitability.

In this paper, I ask how the maturity mismatch channel amplifies/dampens the effect of monetary policy on bank stock prices and whether its impact has changed during the zero lower bound (ZLB) environment. In particular, I study the importance of the maturity mismatch channel for the transmission of monetary policy to bank profitability paying specific attention to the role of this channel during the ZLB environment. Moreover, I separate the impact of conventional and unconventional monetary policy on bank stock prices using high-frequency monetary policy surprises from Swanson (2021) and ask whether the effect of maturity mismatch channel varies depending on the policy tool used. The literature has not investigated whether the role of the repricing gap channel has changed during the ZLB environment. Moreover, I am the first to distinguish the impact of conventional and unconventional monetary policy on banks' equity valuations.

I first show that contractionary federal funds rate and forward guidance surprises decrease bank stock prices. However, banks with larger repricing gaps (maturity mismatch) are less negatively affected by these contractionary shocks due to the crucial increase in their expected net interest margins. However, banks with a larger repricing gap benefit only partially from the rise in the slope of the yield curve, as the overall effect of contractionary monetary surprises on bank stock prices is still negative. This result suggests that the direct impact of monetary policy through the maturity mismatch channel only partially dominates the indirect effects of monetary policy (signaling effect of a weaker economy, increase in delinquency rates, and potential capital losses) on bank stock prices.

As banks can hedge themselves towards interest rate risk, I further examine the impact of hedging on bank stock prices. By controlling for interest rate derivative usage, leverage, bank size, and core deposit dependence, I document that banks are not able to hedge their interest rate exposure and the repricing gap channel exists even if one controls for the effect of hedging and the other balance sheet related variables that may affect the transmission of monetary policy to bank stock prices. This result is consistent with Begenau et al. (2012), suggesting that interest rate derivative usage is concentrated among a few large U.S. banks, and net derivative positions tend to amplify rather than offset balance sheet exposure to the interest rate risk.

Turning to the effect of the low-interest rate environment on bank stock prices, I show that LSAP and forward guidance shocks that lead to an easing effect on the yield curve affect bank stock prices positively through the signaling impact of a stronger economy, lower default probabilities, and an enhanced bank balance sheet performance (indirect effects). Hence, the positive impact of the low-interest rates on bank stock prices outweighs the adverse effects that may stem from the lower expected net interest income (direct effect), and bank stock prices have benefited from lower rates during the ZLB period. I then examine whether the repricing maturity channel was intact during the ZLB environment in light of the literature which discusses the efficacy of the unconventional monetary policy. I find that there isn't any significant heterogeneous effect of the monetary policy depending on the maturity mismatch between banks' assets and liabilities during the ZLB period, and this result is not driven by the impact of hedging. Hence, my results indicate that the repricing maturity gap channel was muted during the ZLB period.

There are two explanations consistent with my results. First, the sensitivity of banks' borrowing/lending rates to the unconventional monetary policy is reduced due to the lower bound on these rates (Ippolito et al., 2018). As deposit rates did not go beyond zero, banks hesitated to pass the lower rates to loans to maintain profitability. Hence, the transmission of monetary policy to the rates faced by firms and consumers weakened during this period (Eggertsson et al., 2019). This helps banks to keep their net interest margins relatively stable. Additionally, the repricing maturity mismatch might lose its importance as the yield curve became relatively insensitive during the ZLB, especially from 2011 to mid-2013. (Swanson and Williams, 2014).

Focusing on the role of different policy tools, I document that federal funds rate surprises substantially affect bank stock prices compared to forward guidance shocks during normal times. However, the effect of forward guidance shocks was dominated by LSAP surprises during the ZLB period. Although this finding contradicts Swanson (2021) that shows that S&P500 stock prices respond more significantly to forward guidance shocks during the ZLB period, it is not surprising considering that LSAP surprises are associated with purchases of long-term U.S. bonds and mortgage-backed securities that have a significant influence on banks' balance sheet.

This paper is organized as follows: Section 3.2 discusses the related literature. Section 3.3 describes the data and provides relevant summary statistics. Section 3.4 presents the empirical framework, and Section 3.5 discusses the main results. Section 3.6 concludes.

3.2. Literature Review

My work combines methods and ideas from the stock and asset pricing literature, literature on bank profitability, and the effects of the low-interest environment on monetary policy transmission, giving particular importance to the role of the repricing maturity gap channel for monetary policy pass-through.

First, extensive literature studies how monetary policy affects firms' stock prices (Ehrmann and Fratzscher, 2004; Thorbecke, 1997). Using high-frequency monetary policy shocks Cochrane and Piazzesi (2002), Bernanke and Kuttner (2005), Gurkaynak et al. (2004), Rigobon and Sack (2004) show that an increase in interest rates leads to a decrease in firms' stock prices, arguing that it reduces the present value of stocks' future valuation through a discounting channel and signaling a weaker economy. Campbell et al. (2012), Nakamura and Steinsson (2018) and Swanson (2021) extended this literature by focusing on the effects of unconventional monetary policy on stock prices and documenting the effectiveness of the unconventional monetary policy on non-financial firms' stock prices. My work contributes to this literature by examining the impact of conventional and unconventional monetary policy on banks' stock prices, an important player in the transmission mechanism between monetary policy and the real economy.

Another strand of this literature focuses on the impact of monetary policy on banks' stock prices and profitability, focusing on cross-sectional differences among banks. For example, Akella and Greenbaum (1992); English et al. (2018); Flannery and James (1984); Gomez et al. (2021); Kane and Unal (1990); Lumpkin and O'Brien (1997); Paul (2023) show that an increase in the policy rate leads to a decrease in bank stock prices, especially for banks with a smaller repricing maturity gap. Relative to these studies, which mainly focus on the conventional monetary policy during the pre-ZLB period, my paper extends the sample period substantially and compares the effect of different conventional&unconventional monetary policies on banks' equity valuations. Moreover, it examines whether the role of the repricing maturity gap channel has changed during the ZLB environment.

As prolonged low-interest rates in advanced economies have increased concerns about declining bank profitability and the financial sector's soundness, unconventional monetary policy's impact on banks' profitability has gained prominence. Studies such as Borio et al. (2017); Busch and Memmel (2017); Claessens et al. (2018*b*); Rajan (2013) and Genay et al. (2014) argue that by compressing banks' net interest margins, low rates might lead to weaker balance sheets and lower bank profitability that may prevent lending. It may also lead banks to "search for yield", which, in turn, could undermine the stability of the financial sector over time Dell'Ariccia and Marquez (2017); Jiménez et al. (2014). On the other hand, Lopez et al. (2020*b*); Zimmermann (2019), and Demertzis and Wolff (2016) show that easing of the monetary policy increases the bank profitability as losses in the net interest income balanced mainly by the decrease in the impaired assets and non-performing loans. Recently, Ampudia and Van den Heuvel (2022) has investigated the impact of monetary policy on the equity values of European banks during low/negative interest rate periods. They report that unexpected decreases in longer-term interest rates positively affected bank equity values during the low/negative interest rate environment. Yet, these studies fail to take into account the role of the repricing gap channel on monetary-policy transmission. Compared to these studies, I study the role of maturity mismatch channel for monetary pass-through to bank profitability focusing on U.S banks. Moreover, I compare the effect of different conventional and unconventional monetary policy tools, which is missing in these studies.

My work also connects to the literature that studies the role of floating debt on firms' stock prices. Ippolito et al. (2018) show that bank loan leverage, which is mostly in floating rate, matters in the stock price response of non-financial firms to monetary policy surprises, but this relationship broke down during the ZLB episode. Recently, Gürkaynak et al. (2022) shows that firms with more cash flow exposure see their stock prices affected more. In contrast with Ippolito et al. (2018), they report the existence of the cash flow channel during the ZLB period. Building on this literature, my paper examines how the repricing gap affects bank equity valuations and whether the transmission mechanism has changed during the ZLB period. My results indicate that banks with a more significant repricing gap are less negatively affected by the contractionary target and forward guidance surprises. Moreover, my paper contributes to the literature by showing that the repricing gap channel ceased to exist during the ZLB period.

3.3. Data

This section describes the data and provides summary statistics relevant to my analysis.

3.3.1 Monetary Policy Data: As the equity market will already have responded to anticipated policy actions, my analysis focuses on the unexpected (surprise) component of the monetary policy actions during the FOMC announcements. Although previous literature mainly uses the Kuttner (2001) surprises or the actual change in the long-term Treasury yields, I use Swanson (2021) monetary policy surprises that the author graciously shared with me. This allows me to differentiate the effect of conventional and unconventional monetary policy and further the impact of forward guidance and LSAP on banks' stock prices, filling the gap in the literature. Swanson

(2021) shocks are obtained through principal component analysis of interest rates in a 30-minute window bracketing each FOMC announcement. The narrow window ensures that other aggregate shocks do not contaminate the response of the yield curve. In particular, 30-minute changes in the first and third federal funds futures contracts, the second, third, and fourth Eurodollar futures contracts, and the 2-, 5-, and 10-year Treasury yields are used in the principal component analysis. As principal components are only a statistical decomposition and do not have a structural interpretation, the federal funds' target factor, forward guidance factor, and LSAP factor are obtained through the following restrictions. First, the LSAP factor is assumed to be 0 during the pre-ZLB period. In addition, the forward guidance and LSAP factors are assumed not to affect the current federal funds rate. The federal funds' target factor is close to zero during the ZLB period, so it is excluded from the analysis for this period (see Figure 3.1).

Swanson (2021) normalizes all factors to have a unit standard deviation. For ease of interpretation, I normalize the scale of the federal funds rate target factor so that a change of 1 in the target factor corresponds to a surprise of 100 bps in the federal funds rate (this is equivalent to making the coefficient of the target factor 1). Similarly, I normalize their scale so that the effect of forward guidance and LSAP factors is the same as the effect of the normalized target factor on the 2-year Treasury yield, about 33 bps.

The sample period underlying my analysis covers all Federal Open Market Committee (FOMC) announcements between July 2, 1997, and December 19, 2018, excluding 2008. The sample's start is the earliest FOMC meeting for which the detailed Call Report data on the maturity or repricing times of assets and liabilities are available. For example, the ZLB sample starts in January 2009 and ends in October 2015. This leaves me with 170 announcements during the full sample, 55 for the ZLB, and 91 for the pre-ZLB period. Figure 3.1 plots the shocks, and Table 3.4 provides the relevant summary statistics. More detailed information can be found in Swanson (2021).

3.3.2 Bank-level Data: To examine the reaction of bank stock prices to monetary policy surprises, I use daily stock price data of the publicly traded Bank Holding Companies (BHCs) from the Center for Research in Security Prices (CRSP) database.[1] Particularly, I use the average of the closing bid and ask prices as my price measure and use a one-day window change of these stock

[1]CRSP data allows me to obtain stock prices in the BHC level rather than individual commercial bank level.

prices. That is, I use the percentage change between the stock prices on the day of the FOMC announcement with respect to the day before the announcement.

I obtained the balance sheet data of BHCs (FR-9&Call reports) from the Bank Regulatory Database of Wharton Research Data Services (WRDS).[2] In the U.S., Bank Holding Companies (BHCs) file quarterly FR-9, whereas their commercial bank subsidiaries file quarterly U.S. Call Reports. However, only Call Reports include the detailed repricing maturity period of the banks' assets and liabilities. Hence, I used a SAS code to match the BHCs with its commercial bank subsidiaries with the method described in Drechsler et al. (2017). [3]

I matched the bank stock returns around the FOMC announcement on the day t to bank-specific characteristics taken from the most recent Call Report (FR-9 form) dated strictly before day t. I combined the CRSP data and FR-9 reports using the Federal Reserve Bank of New York CRSP-FR-9 link table, which matches the PERMCO of the CRSP database with the RSSD ID of FR-9 reports.[4]

After trimming the data from the outliers, I ended up with an unbalanced panel of 294 BHCs for the full sample, 233 BHCs for the pre-ZLB, and 185 banks for the ZLB period. The sample selection criteria are described in Section 3.10.

3.3.3 Repricing Maturity Gap: To calculate the repricing maturity gap of bank assets and liabilities, I followed the methodology of English et al. (2018). Most of the previous literature, such as Flannery and James (1984) and Gomez et al. (2021), uses the difference between assets and liabilities with a repricing maturity of one year or less as a proxy for the repricing maturity gap. However, I compute the repricing maturity of assets as the time until the asset's interest rate resets.[5] This measure allows me to make a more comprehensive assessment of the degree to which a bank engages in maturity transformation. Although it measures the banks' exposure to interest rate risk imperfectly, as new lending/borrowing will also relate to the improving/worsening position of the bank on financial markets, it is still a good proxy. In particular, I constructed my repricing maturity gap as the following:

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[2] Most of the variables changed name after 2013 and missing in WRDS; I completed my data with the Call Reports I downloaded from Chicago Fed and extended it till 2018.

[3] For total assets, a variable available at both the holding company and bank subsidiary level, the sum of assets across all subsidiaries accounted, on average, for 97 percent of assets at the holding company level.

[4] The Table is downloadable from the Federal Reserve Bank of New York website.

[5] The closest repricing or maturity time for assets and liabilities.

The variable m_j^A represents the average repricing maturity period (in months) for asset category j. A_{it}^j is the dollar amount in asset category j reported by bank i in quarter t; and A_{it} denotes bank i 's total assets.

$$\text{(3.1)} \qquad RepricingGAP_{it} = \sum_j m_j^A \frac{A_{it}^j}{A_{it}} - \sum_j m_j^L \frac{L_{it}^j}{A_{it}}$$

Similarly, m_j^L is the average repricing period (in months) for the liabilities. L_{it}^j is the dollar amount of liability category j reported by bank i in quarter t.[6] I assigned zero repricing maturity to demandable deposits such as the transaction and savings deposits by the instructions provided by the Call Reports.[7] In line with the zero contractual maturity of such deposits, there is substantial empirical evidence that they are quite sticky and, in many cases, the rates paid on these deposits respond very sluggishly to changes in market interest rates Hannan and Berger (1991), Neumark and Sharpe (1992), Drechsler et al. (2017).

3.3.4 Descriptive Statistics: In this section, I establish the main characteristics of the banks in my sample. Table 3.1 presents the relevant statistics for my analysis. In particular, the average repricing maturity for assets is 4.2 years, with a standard deviation of approximately 2 years in my full sample, whereas the average repricing maturity for liabilities is 0.4 years, with a standard deviation of 0.2 years. Hence, the aggregate banking sector exhibits a repricing maturity gap of about 3.8 years. This indicates that a 100 bps level easing shock to the slope of the yield curve cause a cumulative 380 bps reduction in expected net interest margins (interest income minus interest expense, divided by assets) over the following years.[8]

Figure 3.2 reports the evolution of the cross-sectional distribution of the repricing maturity gap over time. The solid line is the mean repricing maturity gap for the 294 BHCs in my sample, while the shaded band represents the corresponding interquartile range; for comparison, the dotted line shows the median repricing maturity gap for the BHCs. As seen in Figure 3.2, there is a considerable degree of variation in the asset-liability mismatches across banks at each point in time.

[6] I assigned the midpoint of each bin for the items that report the repricing maturity time in intervals.

[7] By definition, demand&transaction deposits do not yield any interest at all.

[8] As liabilities are relatively closely tied to short-term rates, whereas returns on bank assets are more closely tied to longer-term rates, NIMs are expected to be higher when the yield curve is steeper. Once assets and liabilities have repriced, a steeper yield curve implies higher rates on assets relative to those on liabilities English et al. (2018).

In terms of size, as measured by total assets, the sample covers a broad spectrum of BHCs, with the range running from about 150 million to more than 1.5 trillion dollars. Note that with the median observation of about 1.37 billion dollars, the sample also includes smaller BHCs. The mean leverage calculated as the equity over total assets is 9% with a standard deviation of 1.90 percent.[9] There is considerable discrepancy between the banks for the usage of interest rate derivatives. The use of such derivatives is concentrated among a few large institutions. When I turn to the correlation among these variables, bank size is positively correlated with the repricing maturity gap, leverage, usage of interest rate derivatives, and amount of saving deposits held but negatively correlated with demand&transaction deposits held during the whole sample (see Table 3.3). The correlation between these variables indicates the importance of controlling for them to prevent the potential omitted variable bias.

3.4. Empirical Framework

Several "Fed information effect" studies such as Nakamura and Steinsson (2018), Campbell et al. (2012) question the exogeneity of the monetary policy surprises and argue that these surprises may occur due to other factors such as a revision in investor beliefs about the state of the economy. Recently, Bauer and Swanson (2020) show the existence of the "Fed response to news" channel in which both the Fed and private sector forecasters respond to publicly available economic news released in the run-up FOMC announcements instead of a Fed information effect channel. They argue that financial markets do not have full information about the Fed's monetary policy reaction function violating the Full Information Rational Expectations (FIRE) in financial markets. In particular, financial markets need to pay more attention to how responsive the Fed would be to the economy. This would lead to ex-post predictability of monetary policy surprises even if those surprises were unpredictable. They further provide a model to show that even though the high-frequency monetary policy surprises might be correlated with macroeconomic data ex-post, they still can be used, without adjustment, to estimate the effects of an exogenous change in monetary policy on asset prices in a narrow window of time around an FOMC announcement.[10]

[9]FDIC's threshold for adequate capitalization is 8%; most of the banks in my sample are adequately capitalized.

[10]Bauer and Swanson (2020) argue that for high-frequency identification of the effects of monetary policy in a VAR, correcting the high-frequency monetary policy surprises for the Fed response to news channels may be necessary in some cases, depending on the timing assumptions in the VAR.

I follow Bauer and Swanson (2020) and conduct my analysis via OLS as by the definition of the surprise, the federal funds rate, forward guidance, and LSAP factors are independent over time, and the usage of high-frequency data still allows me to prevent the endogeneity issues related to omitted variable bias and reverse causality in light of the discussion in Bauer and Swanson (2020).

To analyze how the reaction of bank stock returns to interest rate surprises varies with the repricing gap, I estimate the different versions of the baseline regression, in which the three policy-induced interest rate shocks have interacted with the repricing gap and other bank characteristics, which I include as controls, according to:

(3.2)

$$\Delta p_{it} = \beta'(L)Shocks_t + \Gamma'(L)GAP_{it-1} \times Shocks_t + \Gamma_0 GAP_{it-1} + \theta'(L)Z_{it-1} \times Shocks_t + \theta_0 Z_{it-1} + \epsilon_{it}$$

Where i is the subscript for the BHC, t is the time subscript for the date of the FOMC announcement.[11] Δp_{it} is the change in the stock price on the announcement day with respect to the day before the announcement.[12] $Shocks_t$ includes Federal Funds Rate, Forward Guidance, and LSAP surprises. Z_{it-1} is the set of bank characteristics measured based on the previous quarter's balance sheet information.[13] In particular, these controls are the most critical determinants of the monetary policy transmission mechanism to banks in the literature: size Kashyap and Stein (1995), leverage (Kishan and Opiela, 2000).[14] These are also the most commonly used controls in the literature that investigate the stock prices of firms and monetary policy shocks Gürkaynak et al. (2022), Ippolito et al. (2018). In addition to bank size and leverage, I also control banks' derivative usage, as banks may hedge their interest rate exposure by using derivatives.[15] I use log(total assets) to measure the bank size and computed leverage as the ratio of the book value of the equity to total assets. I control interest rate derivatives' usage by including the notional value of interest rate derivatives used for non-trading (hedging) purposes. More information on banks' derivative usage is given in Section 3.5. As additional controls, I added banks' usage of saving deposits and demand deposits normalized by total liabilities since they are excluded from the calculation of the repricing

[11] The Equation also includes a constant.

[12] $\Delta p_{it} = \frac{P_{it}}{P_{it-1}} - 1$

[13] To ensure investors have access to information before the announcements.

[14] Athanasoglou et al. (2008) argue that when one controls for an extensive set of bank characteristics, variables might overlap because some of them essentially proxy the same profitability determinant.

[15] I also control for the different specifications of leverage as a robustness check.

maturity gap due to their zero contractual maturity period. I also add firm fixed effects, which allows me to exploit within-firm variation. I clustered my standard errors at the Bank Holding Company level.[16]

3.5. Results

3.5.1 The Response of Stock Prices Across Firms: In this section, I examine whether the sensitivity of stock prices varies across banks based on their balance sheet composition, particularly the repricing maturity gap between their assets and liabilities. If the repricing maturity time of banks' assets is longer than its liabilities, expected net interest income should increase as the yield curve steepens, increasing banks' expected profitability measured by stock prices. Table 3.5 presents the results for the entire sample, whereas Table 3.6 shows the results for the pre-ZLB period; the interaction of the repricing gap with target and forward guidance surprise is positive and statistically significant in both samples. That is, the expected increase in net interest margins due to the contractionary level and slope surprises attenuates the overall negative impact of these shocks on banks' stock prices. However, banks only benefit partially as the overall effect of the feds funds rate and forward guidance surprises are still negative, reflecting a combination of potential capital losses on longer-term assets and the impact of a higher discount rate, as well as possible effects of higher interest rates on lending volumes and asset quality. Hence, the direct impact of higher rates on bank stock prices through net interest margins is surpassed by its indirect effects, yet the maturity mismatch channel dampens this mechanism.

Turning to the effect of other bank characteristics, the negative coefficients on the interaction between the bank size and the target and forward guidance surprises suggest that stock prices of larger banks are more negatively affected by tightening shocks, especially from the federal funds rate (target) surprises. Furthermore, the negative coefficient on the interaction between the leverage and federal funds rate (target) surprises indicates that banks with more leverage (more capitalized) are more negatively affected by the increase in the federal funds rate. Although high bank leverage

[16] There is no consistency in the literature on which level to cluster, I follow the literature that focuses on the impact of monetary policy on bank profitability Altavilla et al. (2019), Heider et al. (2019), Demiralp et al. (2021) which cluster standard errors at the bank level. This is equivalent to assuming that observations may be correlated within each bank but must be independent across banks. Moreover, assuming that the most crucial variation is coming across banks. The ZLB period consists of 55 monetary shocks. Thompson (2011) emphasize that one needs more than 50 clusters in the time dimension for clustering to yield the correct results. Additionally, Petersen (2009) there are only a few clusters in one dimension; clustering by the more frequent cluster should be preferred. Hence, I cluster my standard errors by the bank dimension.

(capital to asset ratio) may absorb unforeseen losses, a relatively high capital–assets ratio could signify that a bank is operating over-cautiously and ignoring potentially profitable diversification or other opportunities (Goddard et al., 2004). Considering that the median bank in my sample is more than adequately capitalized with respect to FDIC's classification, this might also be one of the underlying reasons that drive my results. This result is also consistent with Ottonello and Winberry (2020), which shows that firms with low debt-level are more responsive to monetary policy.[17] I further add saving and demand&transaction deposits to my control variables. Bank size and leverage play a more significant role in monetary pass-through to bank profitability than other bank characteristics. On the other hand, the interaction of these deposits with the target and forward guidance factor is mostly negative, as expected. However, these coefficients are not statistically significant as they either have a fixed interest rate or pay no interest, as indicated before. Moreover, adding saving and demand&transaction deposits does not significantly change the other coefficients.

The following section presents the results associated with the zero lower bound (ZLB) period to assess whether the role of the repricing maturity gap channel has changed during the ZLB environment.

3.5.2 Has the Monetary Policy Transmission Mechanism Changed?: The recent literature discusses the effectiveness of monetary policy and examines whether the effect of the monetary policy has changed during the ZLB period (Campbell et al., 2012; Debortoli et al., 2020; Gürkaynak et al., 2022; Ippolito et al., 2018; Krishnamurty and Vissing-Jorgensen, 2011). Building on this recent literature, I further investigate the effectiveness of the repricing maturity channel during the ZLB period. Table 3.7 shows the repricing maturity gap channel shut down during the ZLB episode. As shown in the first two columns, the interaction term of the forward guidance and repricing gap is still positive but loses its significance. On the other hand, the interaction of it with the LSAP surprises is negative, as expected, yet insignificant. Columns (3) and (4) repeat the exercise by adding saving and demand&transaction deposits as additional controls, and interaction terms with the repricing maturity gap remain insignificant. Hence, the repricing maturity gap channel weakened during the ZLB period. One possible explanation might be the zero lower bound on these rates argued by Ippolito et al. (2018) or the findings of Eggertsson et al. (2019), who show that monetary

[17] High leveraged banks in my setting refers to the banks that are highly capitalized, in other words, banks with high capital to asset ratio.

policy transmission to borrowing and lending rates are relatively slow when rates are low. Another explanation might be the relative unresponsiveness of the yield curve in line with the argument of Swanson and Williams (2014), who document that the yield curve was relatively insensitive to news from 2011 to mid-2013. As shown in the local projections of these surprises on the reference borrowing/lending rates in Figures 3.8a, 3.8b 3.9a and 3.9b, it seems like reference borrowing and lending rates became less responsive to monetary policy during this period. One possible explanation might be the zero lower bound on these rates argued by Ippolito et al. (2018) or the findings of Eggertsson et al. (2019), who show that monetary policy transmission to borrowing and lending rates are slow when rates are low. As deposit rates could not decrease any further due to the zero lower bound, banks may hesitate to reduce the interest rate on loans to preserve their profitability which slows down the transmission of monetary policy to both lending&borrowing rates. Another explanation might be the relative unresponsiveness of the yield curve in line with the argument of Swanson and Williams (2014), who document that the yield curve was relatively insensitive to news from 2011 to mid-2013. In Section 3.10, I show that monetary policy pass-through to reference deposit and lending rates have weakened during the ZLB period.

When we look at other variables important for the transmission of monetary policy to firm stock prices, large banks are affected positively by the low rates during the ZLB period. Moreover, less capitalized banks seem to benefit from LSAP surprises. One prominent result is the negative coefficient on the interaction term of saving deposits with LSAP surprises which may reflect the inability of banks to decrease interest rates further (Altavilla et al., 2019; Claessens et al., 2018*b*).[18]

3.5.3 Usage of Interest Rate Derivatives: As emphasized by Choi and Elyasiani (1997) and Purnanandam (2007), banks can actively use derivatives to alter their interest rate risk profile. For example, banks may hedge interest rate risk in their portfolios or take specific positions on future interest rate movements. However, according to the U.S. Call Report data, most derivatives contracts are used for trading rather than non-trading (hedging) purposes. Moreover, derivatives contract usage is concentrated among a few big banks. In contrast, the median bank has no derivative contract usage. More generally, 35% of banks report no derivative exposure during my full sample, and approximately 50% of them report no derivative usage during the pre-ZLB period.

[18] Note that demand deposits do not pay interest rate by definition, so saving deposits is more relevant in this context despite the sticky rates.

Table 3.2 reports the intensity of usage of interest rate derivatives across the size distribution of banks. To construct this Table, I sort my sample of banks into five quantiles based on their total assets at the beginning of the quarter. Then, I calculate the mean and median amounts of interest rate derivatives relative to total assets for every quarter. Moreover, I calculate the same for the banks in the 99th percentile of the bank size distribution. Table 3.2 indicates that interest rate derivatives are highly concentrated among a few very large banking institutions. As seen from the Table, the typical usage of interest rate derivatives is scant and concentrated among a few banks. When one looks at the 99th percentile of the bank size distribution, the notional value of interest rate derivative contracts outstanding increases significantly as these institutions play the key intermediary role in the transfer of interest rate risk in the derivatives markets. In addition, for interest rate derivatives used for trading purposes, contracts with positive fair (market) values almost offset those with negative values. This suggests that the banking sector avoids large net exposures and serves mainly as an intermediary in allocating interest rate risk (English et al., 2018).

To examine how the reaction of bank stock returns to interest rate shocks is influenced by banks' usage of interest rate derivatives, I expand my set of control variables. In particular, I include the notional amounts of total interest rate derivatives held for purposes other than trading (hedging). The notional amount of it is normalized by the bank's total assets. Because of the extreme skewness of these exposures, I use the transformation log [1 +(notional value/total assets)] when interacting interest rate derivative positions with the monetary policy surprises.

Before turning to the results, it is essential to emphasize the critical limitation of the Call Report data about interest rate derivatives. Particularly, Call Reports do not provide systematic information on whether the bank's derivatives positions are "long" or "short" on the future direction of interest rates. That is, I know the extent to which banks are using derivatives without the direction of their net positions. Moreover, it only provides me with the notional value of the exposures, yet it is unclear whether using their fair value is a better indicator in the literature.

Columns (2) and (4) of Tables 3.5, 3.6 and 3.7 report the results when one controls for the interest rate derivative usage for each sub-sample period. The coefficient on the derivatives is primarily negative and statistically insignificant, indicating that the usage of interest rate derivatives does not dampen the adverse reaction of stock returns to interest rate fluctuations. Most importantly, the estimated effects of all the other bank characteristics remain similar to those reported in the specification without derivatives usage. This finding should not be surprising in light of the negligible exposure of most banks to interest rate derivatives.

3.5.4 Average Effects of Monetary Policy on Bank Stock Prices: To examine how the bank stock prices are affected by monetary policy surprises during the zero lower bound (ZLB) period compared to normal times, I also estimate the average effect of monetary policy surprises in my BHC-level data. As I investigate the average impact of these surprises on banks' stock prices rather than looking at the cross-sectional variation across banks, there is no need to control for various banks' characteristics. Moreover, the high-frequency nature of policy surprises enables me to overcome the endogeneity issues that may stem from reverse causality. In particular, I drop the bank characteristics in Equation (3.2). Instead, I interpret β's as the average effect of monetary policy surprises on banks' stock prices. This approach also allows me to assess the relative importance of different monetary shocks on banks' stock prices.

The first Column of Table 3.8 presents the results for the full sample, covering the period between July 1997 and December 2018. A 100 bps increase in the federal funds factor—with no surprise change in the forward guidance and LSAP factors- is estimated to lower bank stock prices by around 5 percent. As forward guidance and LSAP surprises enter my regression as separate variables, a positive shock to federal funds rate (target) surprise can be interpreted as a parallel upward shift in the yield curve in my context.[19]

Swanson (2021) defines forward guidance as the components of the FOMC announcements that convey information about the future path of short-term interest rates above and beyond the federal funds rate changes. That is, what separates the forward guidance factor is that it moves market expectations of future values of the federal funds rate without changing its current value. Moreover, the forward guidance factor captures the effects of monetary policy on the longer-term interest rates above and beyond the usual effects of changes in the federal funds rate. In my context, forward guidance surprises steepen the yield curve as they are associated with larger movements in the long end of the yield curve as presented by Swanson (2021). The forward guidance factor normalized to have the same effect on the 2-year yield with the normalized federal funds rate (target) factor decreases stock prices by around 1.1 percent. Thus, FOMC communication that leads to higher expected future short-term interest rates—and therefore to a steeper yield curve—causes bank

[19] Swanson (2021) notes that a surprise change in the federal funds rate today has implications for future values of the federal funds rate, leading to an increase in the level of the yield curve.

equity values to fall. This result may seem surprising considering that banks should benefit from a steep yield curve as the expected net interest margins increase through its direct effect. However, as noted earlier, the negative reaction of bank stock returns to such a slope surprise likely reflects some combination of its indirect effect through a signaling effect of a weaker economy, capital losses on longer-term assets, and higher discount rates on future earnings; factors that seem to surpass the direct effect of an interest rate increase on the expected net interest income.[20]

LSAP surprises are defined as the component of FOMC announcements that conveys information about asset purchases above and beyond the changes in the federal funds rate itself and captures the effects of FOMC announcements on the yield curve that are above and beyond the usual effects of changes in the federal funds rate and forward guidance. In particular, the LSAP factor does not affect the federal funds rate; its effect is much larger at the long end of the yield curve (Swanson, 2021). In my context, an increase in the LSAP factor has an easing effect on the yield curve, hence flattening it. As seen from the first Column of Table 3.8, LSAP surprises with the same effect as the normalized federal funds rate on the 2-year Treasury yield increase bank stock prices around 0.3 percent in the full sample, but the effect is insignificant. Column (2) of Table 3.8 reports the results for the pre-ZLB period. Results are consistent with what is reported for the full sample. In particular, the federal funds rate and forward guidance surprises decrease bank stock prices where the effect of the federal funds rate factor is larger.[21]

Turning to the ZLB period, my results suggest that contractionary forward guidance surprises decrease stock prices by around 2.2 percent, whereas LSAP surprises that have an easing effect on the yield curve lead to an increase of about 7.4 percent (see Table 3.8 Column (3)). Hence, LSAP surprises have a more amplified effect on bank stock prices, in contrast with Swanson (2021), which reports that LSAP surprises do not significantly impact the stock prices of S&P500 firms even in the ZLB period. The positive coefficient on the LSAP factor indicates that lower interest rates positively affect bank stock prices through a signaling effect for a stronger economy, reduced delinquency rates,

[20]Negative effect of contractionary monetary policies on stock prices also contradicts with studies such as Jarociński and Karadi (2020), Cieslak and Schrimpf (2019), Lunsford (2019) arguing that higher interest rates cause stock prices to rise when a strong information effect is present and can be considered as evidence against to"Fed information effect" channel.

[21]Swanson (2021) assess the impact of a unit standard deviation increase, my results robust to using this normalization.

and stronger bank balance sheets.[22] Hence, it seems like the indirect effect of low rates on bank profitability outweighs its potential negative impact on net interest margins. This result is also consistent with the repricing gap channel losing its importance during the ZLB environment. My results suggest that low-interest rates benefited bank stock prices and counterbalanced any adverse effects on the expected net interest income.

3.5.5 The Effect of Monetary Surprises on Bank Lending/Borrowing Rates:

To examine the transmission of monetary shocks to lending rates, I use the 3-month London Interbank Offered Rate (LIBOR) and Bank Prime Loan Rate as a proxy for bank lending rate and the 3-month yield on Certificates of Deposits as a proxy for the borrowing rate.[23] I use local projection method of Jordà (2005) and estimate the following regression at horizons *h=0,1,2...12*.

$$y_{t+h} - y_{t-1} = a_h + \beta_{1h} Target_t + \beta_{2h} Forward_t + \beta_{3h} LSAP_t + \epsilon_{t+h} \tag{3.3}$$

The dependent variable is either the 3-month LIBOR, bank prime loan rate, or the 3-month yield on certificates of deposits. Monetary policy shocks are the Swanson (2021) shocks cumulated at the monthly level. The effect of the cumulated federal funds rate factor is normalized to be 100 bps on the federal funds rate. I normalize the scale of cumulative forward and LSAP factors such that the effect of cumulative forward guidance and cumulative LSAP factors is exactly the same as the effect of the cumulative target factor on 2-year Treasury yield.[24] I clustered the standard errors at the month level. Figures 3.7a to 3.9b show that unconventional monetary policy did not significantly affect the reference rates used in borrowing/lending. Figures 3.4a to 3.6b show that the federal fund's target rate was effective in moving 3-month LIBOR, the interest rate on 3-month CD and Bank Prime Loan Rate during the pre-ZLB period, whereas forward guidance shock is only effective on moving Bank Loan Prime Rate.[25] On the other hand, this effect disappears during the ZLB as neither the forward guidance shocks nor the LSAP shocks move any of the yields significantly, which can be seen from Figures 3.7a to 3.9b. As unconventional monetary policy did not significantly affect the borrowing and lending rates during the ZLB period, this might be considered one of

[22] As the contractionary forward guidance shocks are associated with a negative coefficient, this indicates that forward guidance shocks that flatten the yield curve also increased stock prices during the ZLB, yet in a smaller magnitude.
[23] This is the only available aggregate data on deposits rates for the full sample in FRED.
[24] I also used monthly data for the federal funds rate and 2-year Treasury yield.
[25] 90 percent confidence intervals are used in figures.

the underlying reasons for the ineffectiveness of the maturity pricing gap channel during the ZLB episode.

3.6. Robustness

This section shows that my results are robust to using alternative definitions of variables and different empirical specifications.

First, I show that my results are not sensitive to the monetary policy shock I use. To do so, I use policy news shock of Nakamura and Steinsson (2018) as an alternative measure of policy surprise. These shocks are obtained as the first principal component of the unanticipated change over the 30-minute windows in the following five interest rate futures: the current-month and three-month-ahead federal funds futures contracts, and the two-, three-, and four-quarter-ahead Eurodollar futures contracts. Usage of the Fed funds futures and Eurodollar futures to measure changes in market expectations about future interest rates at the time of FOMC announcements; in other words, the effect of forward guidance. The shocks are normalized such that their impact on the one-year nominal Treasury yield equals one. Table 3.9 presents the results for the full sample, whereas Table 3.10 presents the results for the pre-ZLB period. Consistent with the previous specification, the interaction of the repricing gap with the policy news surprise is positive and statistically significant in both samples. Similarly, the coefficient is not significant during the ZLB period, as reported in Table 3.11. When one focuses on the average effect of the policy news shock on banks' stock prices, the negative coefficient on all periods indicates that stock prices are negatively affected by the increase in interest rates. In other words, the indirect effect of higher rates on stock prices surpassed their direct impact consistent with the previous results.

As an additional robustness check, I non-parametrically estimate the dynamic effects across firms by interacting the monetary shock with bins of the bank size/repricing gap/interest rate derivative usage distribution. Hence, I revised my empirical specification as the following:

$$\Delta p_{it} = \sum_{g}^{G} \beta_g [Z_{it-1} \epsilon g] + \sum_{g}^{G} \Gamma'_g(L) [Z_{it-1} \epsilon g] \times Shocks_t \tag{3.4}$$

$Shocks_t$ is a vector of monetary policy shocks that includes Federal Funds Rate (Target), Forward Guidance, and LSAP surprises. Z_{it-1} is a set of firm characteristics, and the indicator function takes a value of 1 if the bank characteristic falls in a particular “bin” of the distribution, which I refer to as the firm’s group. Z can be multidimensional, yet there is a trade-off since conditioning on multiple firm characteristics significantly decreases each group’s sample size. I split the sample between large and small banks depending on their total assets. Banks with over 2000 billion dollars in total assets are classified as big banks.[26] I further condition based on maturity mismatch and interest rate derivatives usage. I use a cutoff value of 4 for the maturity mismatch.[27] I use a dummy variable for interest-rate derivative usage since there is a considerable dispersion among the banks. Column (1) and (2) of Table 3.13 shows that larger banks are more negatively affected by contractionary monetary policy shocks. However, large banks with larger repricing maturity mismatches attenuate this adverse effect. On the other hand, Column (3) indicates that mainly large banks benefited from LSAP surprises and the impact of the repricing gap channel muted during the ZLB period. As there is a substantial difference between large and small banks, I divide the sample into two in terms of bank size and investigate the role of maturity gap and hedging.

Table 3.14 presents the results for the Full sample, whereas Table 3.15 presents the results for the pre-ZLB period. The results indicate that large banks are more negatively affected by contractionary monetary policy surprises. Yet, a larger repricing gap helps them to mitigate the negative of these surprises.[28] Moreover, banks could not hedge their interest rate risk. The ZLB period results are consistent with the previous findings (see Table 3.16). Larger banks are positively affected by LSAP surprises and negatively affected by contractionary forward guidance surprises. Moreover, the repricing gap channel is not active during the ZLB period.

Finally, as there is no uniform definition of leverage in the banking literature, I first check the robustness of my results by using alternative specifications for leverage. In particular, I used $\frac{assets}{equity}$ instead of $\frac{equity}{assets}$ as in the main specification. Table 3.17 presents the results for the full sample, whereas Table 3.18 presents the results for the pre-ZLB period. Consistent with the previous specification, the interaction of the repricing gap with target and forward guidance surprise is positive and statistically significant in both samples. Yet, the interaction of the repricing gap

[26]This corresponds to the 75th percentile of the distribution of the assets in the entire sample.

[27]This is slightly higher than the mean value of the maturity mismatch. I also use a cutoff value of 5, and the results are robust.

[28]For the small banks repricing gap channel seems not powerful as the interaction of it with policy surprises is not significant

with forward guidance and LSAP surprises is insignificant during the ZLB period (Table 3.19). The magnitude of the coefficients is also close to the one in the main specification. However, the interaction of the leverage with the target surprise is not significant anymore. Yet, it is still negative. On the other hand, the interaction between the forward guidance and leverage is negative, indicating that contractionary forward guidance negatively affects the banks with high leverage. This result is still consistent with the main specification, suggesting that banks with higher leverage are adversely affected by contractionary monetary surprises. The main difference is the coefficient of the interaction between the leverage and the LSAP shock. The positive coefficient suggests that banks with higher leverage are more positively affected by the expansionary monetary policy.

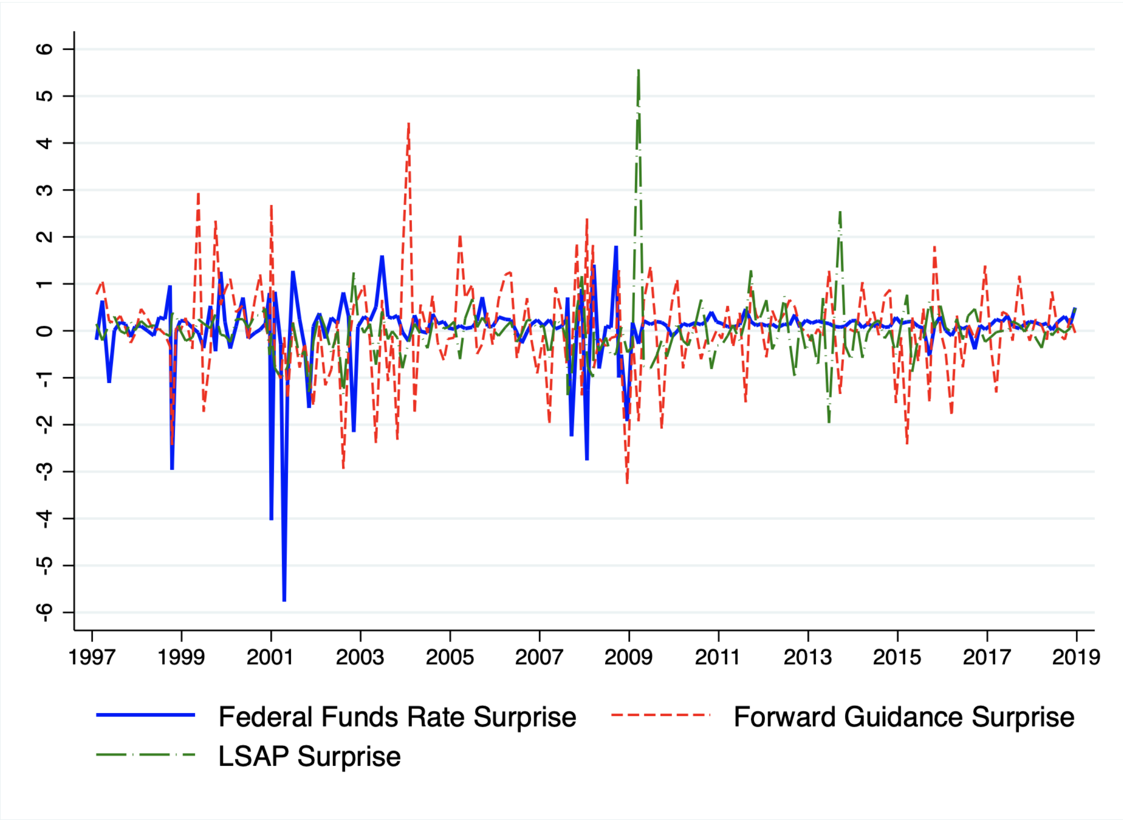
3.7. Conclusion

In this paper, I examine how the maturity mismatch channel impacts monetary policy transmission to bank stock prices and whether the effect of this channel has changed during the zero lower bound (ZLB) period. I show that higher maturity mismatch reduces the negative impact of the increase in the level and slope of the yield curve on banks' stock prices, partially confirming their role as maturity transformers. On the other hand, the maturity mismatch channel lost its importance during the ZLB period as the yield curve became more insensitive to monetary policy, and monetary policy transmission to reference rates weakened during this period.

Additionally, I distinguish the effect of conventional and unconventional monetary policy on bank equity valuations. I show that banks are negatively affected by contractionary federal funds rate and forward guidance surprises that increase the level and slope of the yield curve. Furthermore, higher interest rates increase the discount rate on future profits, raise default rates, and signal a weaker economy. These adverse indirect effects outweigh the positive direct impact of higher rates on the bank's net interest income. On the contrary, LSAP shocks that flatten the yield curve affect bank stock prices positively, signaling a stronger economy and stronger bank balance sheets during the ZLB period and counterbalancing its potential adverse effects on the expected net interest margins. My findings are particularly significant in shedding light on the debate concerning the negative impact of the low-interest rate environment on bank profitability and the financial sector's health. Moreover, my results encourage more research on the efficacy of monetary policy by indicating a potential limitation to unconventional monetary policy.

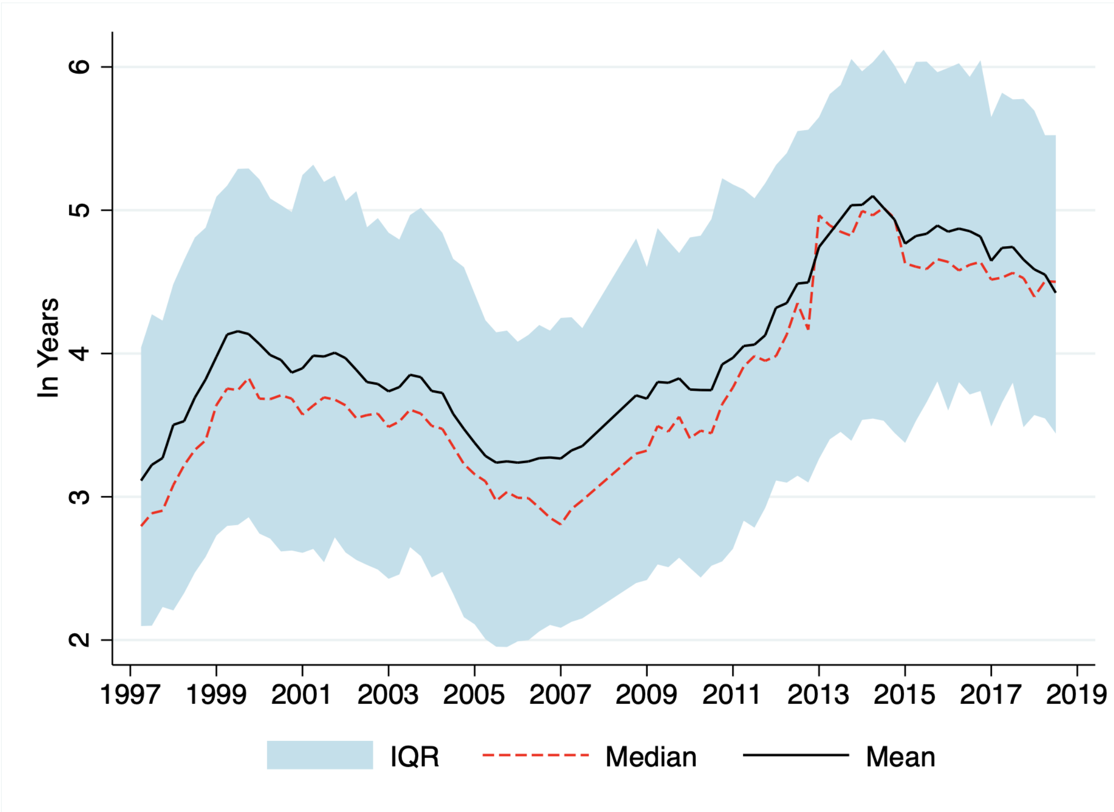
3.8. Figures

Figure 3.1. Monetary Policy Surprises



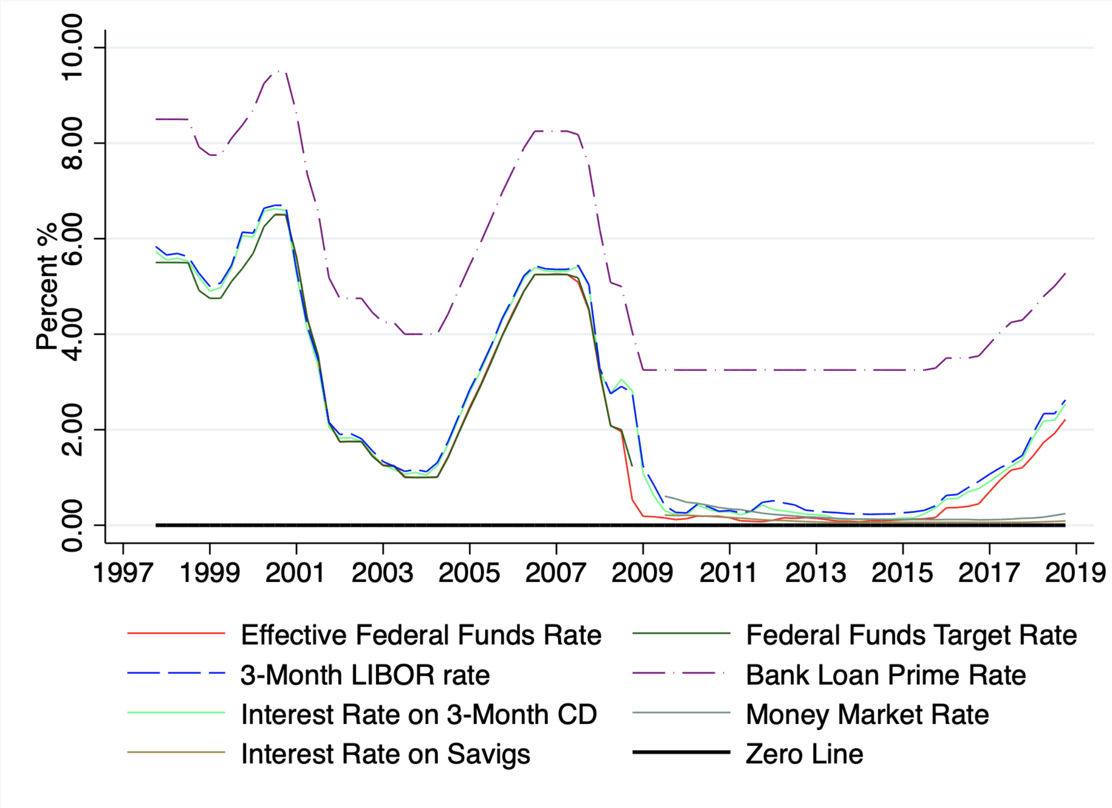
This figure plots Swanson (2021) shocks between July 1997 and Dec 2018. All shocks are normalized and have a unit standard deviation. Positive values of LSAP shocks indicate easing surprises, whereas positive values of Federal Funds Rate and Forward Guidance shocks indicate contractionary surprises.

Figure 3.2. Repricing Maturity Gap



The sample period is 1997-2018. The solid line indicates the mean repricing maturity gap of 294 BHCs in my sample, whereas the dotted line indicates the median repricing maturity gap. The shaded area corresponds to the interquartile range of the repricing maturity mismatch. The repricing maturity gap is defined as the weighted average of the repricing maturity time of assets less liabilities.

FIGURE 3.3. Federal Funds Rate and the Reference Rates



This figure shows the relationship between the two most common reference rates used in borrowing/lending, namely 3-Month London Interbank Offered Rate (LIBOR) and the Bank Prime Loan Rate, Money Market Rate, and National rate on saving deposits from July 1997-Dec 2018. Quarterly data are obtained from the Federal Reserve Bank of St. Louis FRED Economic Data.

3.9. Tables

Table 3.1. Summary Statistics for Balance Sheet Variables

Panel A: Full Sample	Mean	Std	Min	Median	Max
Repricing Maturity Gap	3.86	1.77	0.13	3.56	11.25
-Assets	4.23	1.75	0.20	3.91	11.89
-Liabilities	0.36	0.20	0.01	0.33	1.85
Leverage	9.37	1.93	0.24	9.08	18.45
Saving Deposits	0.43	0.15	0.06	0.41	0.87
Demand&Transaction Deposits	0.10	0.06	0.0001	0.09	0.57
Derivatives	63.21	349.09	0	0	14026.32
Total Assets	12518.84	89403.66	149.971	1370.65	1776873
Panel B: PRE-ZLB Sample	Mean	Std	Min	Median	Max
Repricing Maturity Gap	3.65	1.71	0.13	3.33	11.25
-Assets	4.03	1.70	0.20	3.69	11.89
-Liabilities	0.38	0.20	0.02	0.34	1.85
Leverage	8.85	1.61	0.24	8.64	18.45
Saving Deposits	0.38	0.12	0.07	0.37	0.81
Demand&Transaction Deposits	0.27	0.14	0.01	0.25	0.98
Derivatives	36.68	177.954	0	0	3459.604
Total Assets	7351.334	37064.35	149.971	1033.72	561849.7
Panel C: ZLB Sample	Mean	Std	Min	Median	Max
Repricing Maturity Gap	4.18	1.81	0.52	3.84	10.82
-Assets	4.54	1.78	0.60	4.16	11.14
-Liabilities	0.36	0.21	0.01	0.33	1.69
Leverage	10.11	2.00	1.80	9.99	17.36
Saving Deposits	0.50	0.15	0.06	0.51	0.86
Demand&Transaction Deposits	0.20	0.13	0.01	0.16	1.04
Derivatives	80.28	283.81	0	2660.5	7589.88
Total Assets	18096.43	119684.5	243.854	1978.165	1603110

This Table presents the Summary Statistics for Balance Sheet variables. The repricing maturity gap measure is denoted in years. Saving, demand, and transaction deposits are indicated as a share of total liabilities. Derivatives are the gross notional value of interest rate derivatives used for hedging. Assets and derivatives are donated in millions of U.S. dollars. The number of BHCs is 238 for the full sample, 233 for the pre-ZLB sample, and 185 for the ZLB sample.

Table 3.2. The Usage of Derivatives by Bank Size, Full Sample

Trading Purposes	1st Q.	2nd Q.	3rd Q.	4th Q.	5th Q.	99th
Notional Value						
-Mean	0.02	0.04	0.20	1.01	16.89	194.60
-Median	0.00	0.00	0.00	0.00	0.00	74.54
Net Fair Value						
-Mean	0.00	0.00	0.00	0.04	0.38	4.39
-Median	0.00	0.00	0.00	0.00	0.00	1.98
Non-trading Purposes	1st Q.	2nd Q.	3rd Q.	4th Q.	5th Q.	99th
Notional Value						
-Mean	0.55	1.38	1.23	2.10	7.41	49.14
-Median	0.00	0.00	0.00	0.13	1.62	32.59
Net Fair Value						
-Mean	0.00	0.01	0.02	0.05	0.16	0.81
-Median	0.00	0.00	0.00	0.00	0.02	0.55
Bank size[a]	0.58	1.00	1.83	3.62	69.96	720.22

This Table reports the usage of derivatives by bank size. The sample period is 1997:Q2-2018:Q4. The number of banks is 238. The number of observations is 24,051. The bank size quantiles (Q.1–5) are based on the period-specific quantiles of the distribution of total assets. Net fair value is equivalent to the market value of all interest rate derivative contracts with a positive value less the absolute market value of all contracts with a negative value.
a: Average total assets in the specified size quintile in billions of dollars.

Table 3.3. Cross-correlation Tables

Panel A: Full Sample	Banksize	Gap	LEV	SD	DTD	Derivative
Banksize[a]	1.00					
Gap[b]	.053*	1.00				
LEV[c]	.133*	-.048*	1.00			
SD[d]	.219*	.123*	.300*	1.00		
DTD[e]	-.082*	-.035*	.005	-.143*	1.00	
Derivative[f]	.102*	-.053*	.070*	.035*	-.060*	1.00
Panel B: PRE-ZLB Sample	Banksize	Gap	LEV	SD	DTD	Derivative
Banksize	1.00					
Gap	.056*	1.00				
LEV	-.079*	-.199*	1.00			
SD	.072*	-.006	.084*	1.00		
DTD	-.278*	-.090*	.051*	-.073*	1.00	
Derivative	.109*	-.079*	.002	-.061*	-.104*	1.00
Panel C: ZLB Sample	Banksize	Gap	LEV	SD	DTD	Derivative
Banksize	1.00					
Gap	-.951*	1.00				
LEV	.235*	-.011	1.00			
SD	.167*	.126*	.205*	1.00		
DTD	.049*	.067*	.074*	-.108*	1.00	
Derivative	.015	-.061*	-.005	-.023*	.013	1.00

a: Banksize=log(totalassets)
b: Gap=repricing maturity gap
c: LEV=book value of equity/ assets
d: SD=savings deposits/liabilities
e: DTD=demand&transactions deposits/liabilities
f: Derivative=log[1+(derivatives/assets)]

Table 3.4. Summary Statistics for Monetary Policy Shocks

Panel A: Full Sample	Target Shock	Forward G. Shock	LSAP Shock
Mean	0.0464	0.0009	-0.0008
Median	0.1365	-0.0007	0.1365
Std	0.7329	1.0008	0.6616
Min	-5.7674	-2.9402	-1.9618
Max	1.606	4.4319	5.6307
Number of positive shocks	137	84	98
Number of negative shocks	33	86	82
Panel B: PRE-ZLB Sample	Target Shock	Forward G. Shock	LSAP Shock
Mean	-0.0235	0.0187	-0.0501
Median	0.1106	-0.0481	0.0502
Std	0.9803	1.1512	0.4601
Min	-5.7674	-2.9402	-1.3685
Max	1.606	4.4319	1.2461
Number of positive shocks	64	42	50
Number of negative shocks	27	49	41
Panel C: ZLB Sample	Target Shock	Forward G. Shock	LSAP Shock
Mean	0.1301	-0.0252	0.0367
Median	0.1434	0.0421	-0.1424
Std	0.1403	0.8513	1.0000
Min	-0.5335	-2.4187	-1.9618
Max	0.4652	1.8037	5.6307
Number of positive shocks	51	30	31
Number of negative shocks	4	25	24

This Table presents the Summary Statistics for Swanson (2021) shocks.

Table 3.5. Full Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Target Surprise[a]	-5.807***	-5.807***	-5.909***	-5.849***
	(0.445)	(0.443)	(0.509)	(0.527)
Forward Guidance Surprise[b]	-1.154***	-1.167***	-1.138***	-1.170***
	(0.105)	(0.108)	(0.109)	(0.116)
LSAP Surprise[c]	0.522	0.661	0.347	0.034
	(0.758)	(0.770)	(0.783)	(0.822)
Repricing Gap×Target Surprise	0.469*	0.463*	0.477**	0.470**
	(0.226)	(0.227)	(0.230)	(0.231)
Repricing Gap×Forward Guidance Surprise	0.143**	0.146**	0.132**	0.134**
	(0.0543)	(0.0543)	(0.0541)	(0.0541)
Repricing Gap×LSAP Surprise	0.460	0.446	0.687	0.674
	(0.402)	(0.400)	(0.420)	(0.417)
Leverage×Target Surprise	-0.697**	-0.695**	-0.684***	-0.680**
	(0.260)	(0.261)	(0.263)	(0.264)
Leverage×Forward Guidance Surprise	0.0762	0.0754	0.0802	0.0791
	(0.0562)	(0.0559)	(0.0562)	(0.0560)
Leverage×LSAP Surprise	-1.666***	-1.661***	-1.394***	-1.387***
	(0.433)	(0.433)	(0.436)	(0.436)
Banksize×Target Surprise	-2.089***	-2.076***	-2.035***	-2.023***
	(0.303)	(0.303)	(0.302)	(0.303)
Banksize×Forward Guidance Surprise	-0.220***	-0.227***	-0.217***	-0.222***
	(0.0591)	(0.0596)	(0.0614)	(0.0617)
Banksize×LSAP Surprise	0.360	0.398	0.519	0.398
	(0.618)	(0.623)	(0.633)	(0.623)
Derivatives×Target Surprise		-5.790		-6.099
		(22.36)		(22.54)
Derivatives×Forward Guidance Surprise		2.969		2.658
		(3.869)		(3.851)
Derivatives×LSAP Surprise		-16.88		-18.64
		(22.81)		(24.08)
Saving Deposits×Target Surprise			-1.898	-2.055
			(3.754)	(3.778)
Saving Deposits×Forward Guidance Surprise			-0.586	-0.562
			(0.779)	(0.777)
Saving Deposits×LSAP Surprise			-19.07***	-19.14***
			(5.745)	(5.742)
Demand Deposits×Target Surprise			2.788	2.581
			(6.861)	(6.934)
Demand Deposits×Forward Guidance Surprise			-0.221	-0.182
			(1.524)	(1.509)
Demand Deposits×LSAP Surprise			-8.906	-9.206
			(12.53)	(12.38)
FE	Yes	Yes	Yes	Yes
Observations	24,051	24,051	24,051	24,051
Number of BHCs	238	238	238	238

Table 3.6. PRE-ZLB Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Target Surprise[a]	-5.069***	-5.071***	-5.006 ***	-5.130***
	(0.430)	(0.468)	(0.517)	(0.495)
Forward Guidance Surprise[b]	-1.007***	-1.025***	-1.010***	-1.027***
	(0.104)	(0.110)	(0.126)	(0.110)
Repricing Gap×Target Surprise	0.506*	0.499*	0.470**	0.463*
	(0.227)	(0.227)	(0.237)	(0.238)
Repricing Gap×Forward Guidance Surprise	0.132*	0.129*	0.134**	0.131**
	(0.0606)	(0.0606)	(0.0653)	(0.0652)
Leverage×Target Surprise	-0.777**	-0.775**	-0.771***	-0.769***
	(0.259)	(0.260)	(0.260)	(0.260)
Leverage×Forward Guidance Surprise	0.0219	0.00184	0.00112	0.000934
	(0.0489)	(0.0490)	(0.0480)	(0.0481)
Banksize×Target Surprise	-1.976***	-1.971***	-2.023***	-2.019***
	(0.291)	(0.290)	(0.346)	(0.345)
Banksize×Forward Guidance Surprise	-0.199*	-0.197***	-0.189**	-0.187**
	(0.0609)	(0.0609)	(0.0784)	(0.0784)
Derivatives×Target Surprise		-5.459		-5.295
		(21.43)		(21.41)
Derivatives×Forward Guidance Surprise		-1.639		-1.700
		(3.557)		(3.507)
Saving Deposits×Target Surprise			-7.178	-7.233
			(9.396)	(9.420)
Saving Deposits×Forward Guidance Surprise			-0.282	-0.349
			(3.113)	(3.112)
Demand Deposits×Target Surprise			-2.251	-2.291
			(7.536)	(7.558)
Demand Deposits×Forward Guidance Surprise			0.422	-0.182
			(2.398)	(1.509)
FE	Yes	Yes	Yes	Yes
Observations	16,170	16,170	16,170	16,170
Number of BHCs	233	233	233	233

a: The marginal effect of federal funds rate (target) surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
b: The marginal effect of forward guidance surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
The numbers in the parentheses are standard errors. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.7. ZLB Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Forward Guidance Surprise[a]	-1.115***	-1.130***	-0.837**	-1.089***
	(0.380)	(0.379)	(0.385)	(0.366)
LSAP Surprise[b]	2.536***	2.524***	2.811***	2.812***
	(1.047)	(1.050)	(1.099)	(1.096)
Repricing Gap×Forward Guidance Surprise	0.296	0.328	0.296	0.325
	(0.187)	(0.186)	(0.190)	(0.190)
Repricing Gap×LSAP Surprise	-0.220	-0.189	0.224	0.251
	(0.630)	(0.666)	(0.642)	(0.667)
Leverage×Forward Guidance Surprise	-0.101	-0.102	-0.0723	-0.0759
	(0.253)	(0.252)	(0.252)	(0.212)
Leverage×LSAP Surprise	-1.523*	-1.525*	-1.036	-1.043
	(0.662)	(0.660)	(0.658)	(0.656)
Banksize×Forward Guidance Surprise	0.339	0.330	0.357	0.346
	(0.227)	(0.226)	(0.219)	(0.218)
Banksize×LSAP Surprise	2.960**	2.940**	3.043**	3.018**
	(1.010)	(1.008)	(0.981)	(0.979)
Derivatives×Forward Guidance Surprise		20.52		19.30
		(12.77)		(12.78)
Derivatives×LSAP Surprise		20.78		24.20
		(36.96)		(37.99)
Saving Deposits×Forward Guidance Surprise			-2.270	-2.044
			(2.368)	(2.161)
Saving Deposits×LSAP Surprise			-24.52***	-24.18**
			(7.825)	(7.609)
Demand Deposits×Forward Guidance Surprise			-0.695	-0.777
			(2.153)	(2.122)
Saving Deposits×LSAP Surprise			-17.18	-17.20
			(9.131)	(9.126)
FE	Yes	Yes	Yes	Yes
Observations	6,492	6,492	6,492	6,492
Number of BHCs	185	185	185	185

a: The marginal effect of forward guidance surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
b: The marginal effect of LSAP surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
The numbers in the parentheses are standard errors. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.8. Average Effect of Policy Suprises on Bank Stock Prices

	Full Sample	PRE-ZLB	ZLB
	ΔStock Price		
	(1)	(2)	(3)
Target Surprise	-5.039***	-5.193***	
	(0.407)	(0.480)	
Forward Guidance Surprise	-1.065***	-1.093***	-2.164**
	(0.0975)	(0.215)	(0.791)
LSAP Surprise	0.283		7.364***
	(0.681)		(2.104)
Constant	0.219***	0.258***	0.268***
	(0.0155)	(0.0159)	(0.0350)
Observations	24,051	16,170	6,492
Number of BHCs	238	233	185

This Table presents the average effect of monetary policy on bank stock prices. The full sample covers July 1997 and December 2018, excluding 2008. The pre-ZLB sample covers the period between July 1997 and December 2007. Finally, the ZLB covers the period between January 2009 and October 2015.

3.10. Appendix

3.10.1 Data Appendix:

This section describes the sample selection criteria used in the paper.

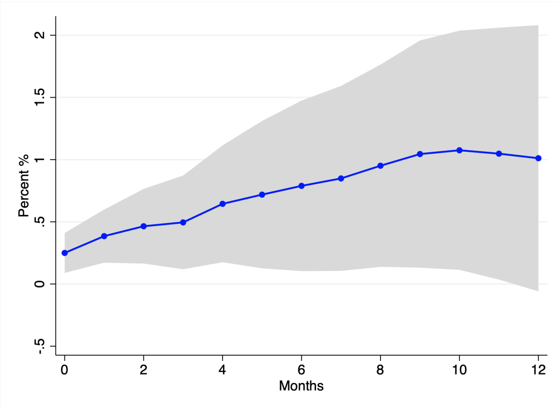
First, all BHC/quarter observations with zero total loans and leases were eliminated. Second, all BHC/quarter observations with a repricing maturity gap above the 99th percentile and below the 1st percentile of its distribution over the 1997:Q2–2018: Q4 was eliminated. Third, all bank/quarter observations with absolute asset growth in excess of 20 percent is eliminated. This filter ensured that banks in the sample did not frequently acquire assets outside the banking industry. All banks with total loans and leases accounted for less than 25 percent of their total assets, on average are eliminated. This filter eliminated institutions that do not engage primarily in traditional banking activity. To mitigate the effects of outliers on my regression results, I trimmed the following variables above the 99th percentile and below the 1st percentile of their respective distribution over the 1997:Q2–2018: Q4 period: net interest income as a percent of assets (NII), net non-interest income as a percent of assets (NNI); and return on assets (ROA). I eliminated all banks with less than 40 continuous quarters of data during my sample period. Finally, I eliminated all bank/quarter observations with negative leverage value.

3.10.2 Additional Figures:

FIGURE 3.4. 3-Month LIBOR, PRE-ZLB

These Figures present the impact of Federal Funds Rate and Forward Guidance Surprises on the 3-month LIBOR Rate for the pre-ZLB period.

(a) The Effect of Target Surprises



(b) The Effect of Forward G. Surprises

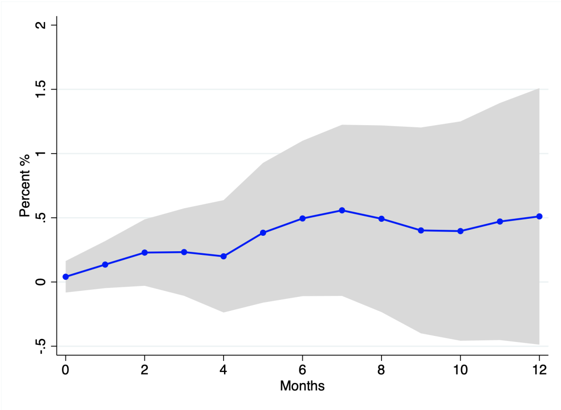
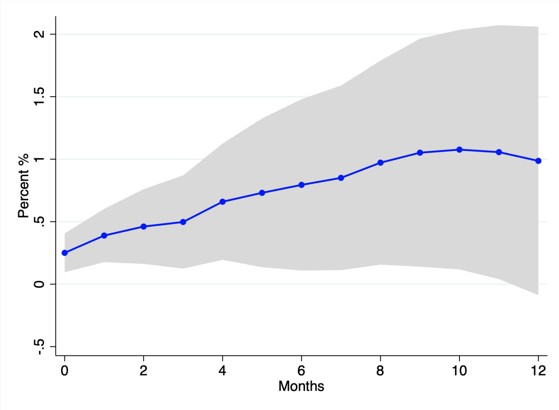


FIGURE 3.5. 3-Month CD, PRE-ZLB

These Figures present the impact of Federal Funds Rate and Forward Guidance Surprises on 3-Month Certificates of Deposits for the pre-ZLB period.

(a) The Effect of Target Surprises



(b) The Effect of Forward G. Surprises

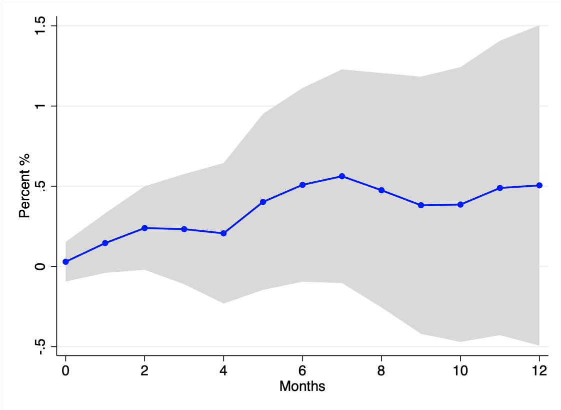
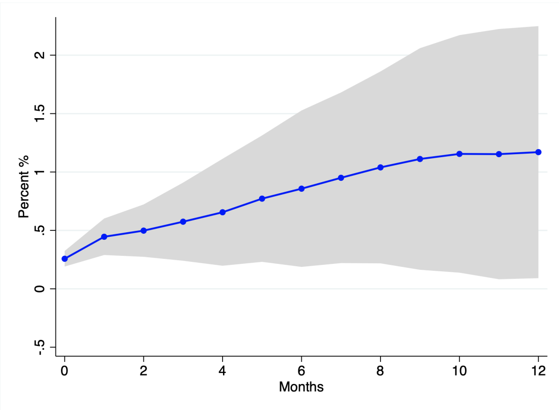


FIGURE 3.6. Bank Prime Loan Rate, PRE-ZLB

These Figures present the impact of Federal Funds Rate and Forward Guidance Surprises on Bank Prime Loan Rate for the pre-ZLB period.

(a) The Effect of Target Surprises



(b) The Effect of Forward G. Surprises

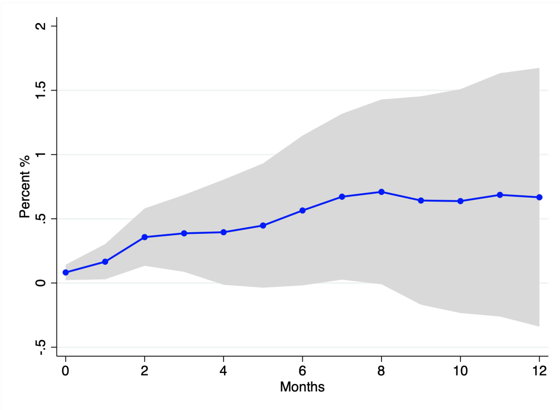
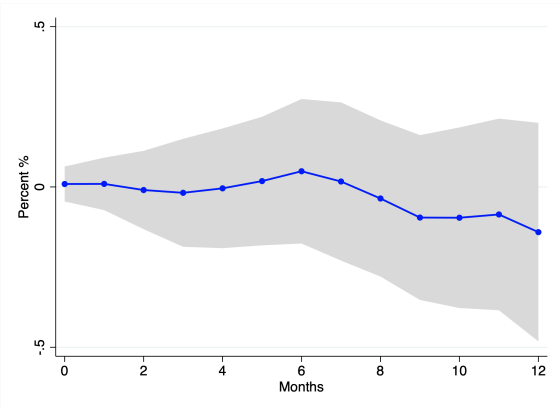


FIGURE 3.7. 3-Month LIBOR, ZLB

These Figures present the impact of Forward Guidance and LSAP Surprises on the 3-Month LIBOR Rate for the ZLB period.

(a) The Effect of Forward G. Surprises



(b) The Effect of LSAP Surprises

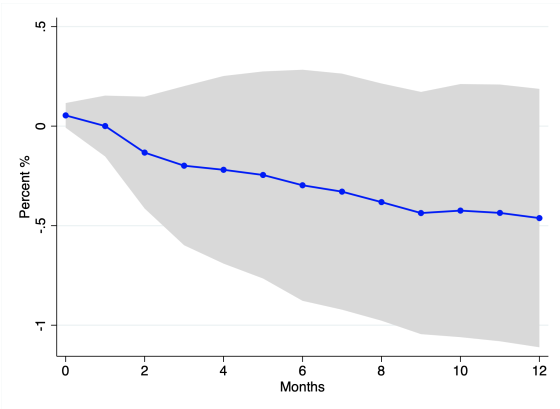
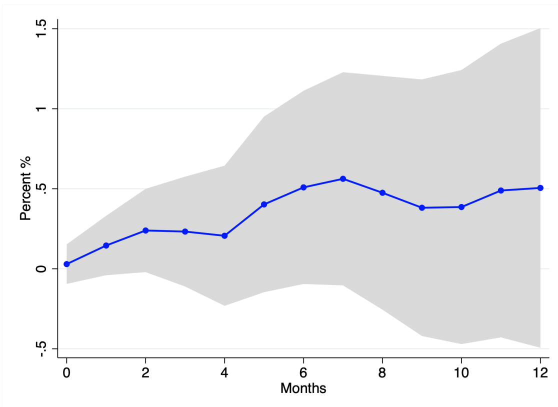


Figure 3.8. 3-Month CD, ZLB

These Figures present the impact of Forward Guidance and LSAP Surprises on 3-Month CD for the ZLB period.

(a) The Effect of Forward G. Surprises



(b) The Effect of LSAP Surprises

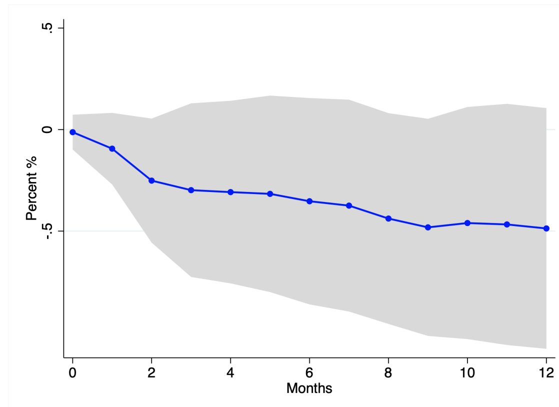
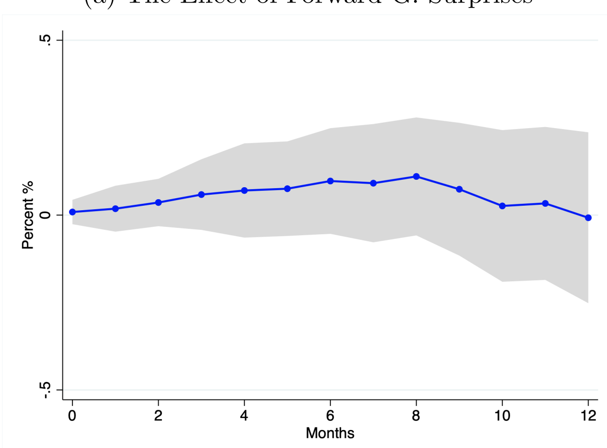


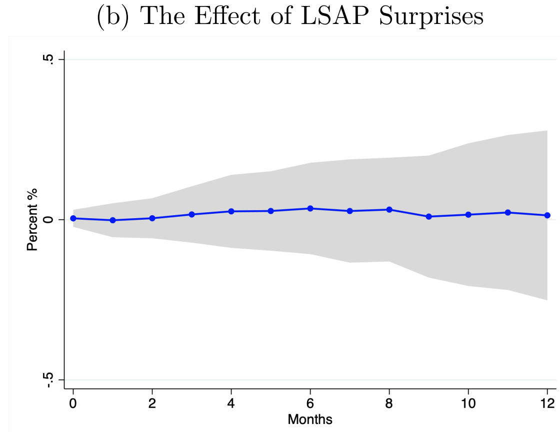
Figure 3.9. Bank Prime Loan Rate, ZLB

These Figures present the impact of Forward Guidance and LSAP Surprises on Bank Prime Loan Rate for the ZLB period.

(a) The Effect of Forward G. Surprises



(b) The Effect of LSAP Surprises



3.10.3 Additional Tables:

Table 3.9. Full Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Policy News Shock[a]	-6.288***	-6.260***	-6.370***	-6.509***
	(0.392)	(0.389)	(0.435)	(0.441)
Repricing Gap×Policy News Shock	0.504*	0.499*	0.506*	0.497*
	(0.200)	(0.200)	(0.205)	(0.206)
Leverage×Policy News Shock	-0.982***	-0.981***	-0.903***	-0.899***
	(0.263)	(0.264)	(0.256)	(0.257)
Banksize×Policy News Shock	-2.260***	-2.247***	-2.183***	-2.165***
	(0.282)	(0.280)	(0.294)	(0.291)
Derivatives×Policy News Shock		-5.521		-8.080
		(17.72)		(17.64)
Saving Deposits×Policy News Shock			-9.511**	-9.667**
			(3.473)	(3.505)
Demand Deposits×Policy News Shock			0.779	0.498
			(6.113)	(6.213)
FE	Yes	Yes	Yes	Yes
Observations	21,615	21,615	21,615	21,615
Number of BHCs	238	238	238	238

This Table presents the impact of the repricing gap for monetary pass-through using Nakamura and Steinsson (2018) shocks for the full sample.
a: The marginal effect of policy news shock evaluated at the median of all bank-specific variables, 75th percentile of interest rate derivative usage.
The numbers in the parentheses are standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.10. PRE-ZLB Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Policy News Shock[a]	-5.520***	-5.433***	-5.554***	-5.549***
	(0.380)	(0.388)	(0.402)	(0.414)
Repricing Gap×Policy News Shock	0.572**	0.562**	0.568**	0.553**
	(0.199)	(0.227)	(0.205)	(0.207)
Leverage×Policy News Shock	-0.801**	-0.801**	-0.773**	-0.770***
	(0.241)	(0.242)	(0.238)	(0.239)
Banksize×Policy News Shock	-2.127***	-2.103***	-2.087***	-2.062***
	(0.256)	(0.252)	(0.276)	(0.271)
Derivatives×Policy News Shock		-10.90		-13.49
		(17.93)		(17.81)
Saving Deposits×Policy News Shock			-7.027*	-7.322*
			(3.461)	(3.511)
Demand Deposits×Policy News Shock			0.774	0.537
			(2.739)	(2.781)
FE	Yes	Yes	Yes	Yes
Observations	16,170	16,170	16,170	16,170
Number of BHCs	233	233	233	233

This Table presents the impact of the repricing gap for monetary pass-through using Nakamura and Steinsson (2018) shocks for the pre-ZLB sample.
a: The marginal effect of federal funds rate (target) surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
The numbers in the parentheses are standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.11. ZLB Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Policy News Shock[a]	-13.098***	-13.115***	-11.308***	-12.162***
	(2.375)	(2.405)	(2.366)	(2.354)
Repricing Gap×Policy News Shock	-0.0482	0.342	0.274	0.343
	(1.193)	(1.191)	(1.217)	(1.214)
Leverage×Policy News Shock	-2.471	-2.430	-1.740	-1.719
	(1.606)	(1.603)	(1.575)	(1.575)
Banksize×Policy News Shock	-3.948*	-4.221*	-3.552	-3.809
	(1.979)	(2.023)	(1.981)	(2.020)
Derivatives×Policy News Shock		113.8		96.29
		(81.90)		(85.06)
Saving Deposits×Policy News Shock			-29.91	-27.84
			(16.44)	(16.82)
Demand Deposits×Policy News Shock			-34.99	-35.83
			(20.32)	(20.38)
FE	Yes	Yes	Yes	Yes
Observations	5,603	5,603	5,603	5,603
Number of BHCs	184	184	184	184

This Table presents the impact of the repricing gap for monetary pass-through using Nakamura and Steinsson (2018) shocks for the ZLB sample.
a: The marginal effect of forward guidance surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.

Table 3.12. Average Effect of Policy Suprises on Bank Stock Prices Full Sample

	Full Sample	**PRE-ZLB**	**ZLB**
	ΔStock Price		
	(1)	(2)	(3)
Policy News Shock	-5.938***	-5.655***	-15.29***
	(0.373)	(0.368)	(2.335)
Constant	0.259***	0.262***	0.400***
	(0.0005)	(0.0002)	(0.0156)
Number of BHCs	238	233	184

This Table presents the average impact of monetary policy on bank stock prices using Nakamura and Steinsson (2018) shocks.

Table 3.13. Effects of Monetary Policy, Non-Parametric Approach

	ΔStock Price		
	Full Sample	PRE-ZLB	ZLB
	(1)	(2)	(3)
Target Surprise	-3.248***	-3.064***	
	(0.493)	(0.487)	
Target Surprise×Banksize	-8.544***	-8.764***	
	(1.135)	(1.212)	
Target Surprise×Gap	1.396	0.596	
	(1.030)	(1.011)	
Target Surprise×Banksize×Gap	4.383**	4.815*	
	(1.707)	(1.984)	
Forward Guidance Surprise	-0.960***	-0.920***	-1.078*
	(0.143)	(0.138)	(0.440)
Forward Guidance Surprise×Banksize	-0.626**	-0.604*	1.200
	(0.252)	(0.255)	(0.956)
Forward Guidance Surprise×Gap	0.0519	0.235	1.125
	(0.281)	(0.251)	(0.811)
Forward Guidance Surprise×Banksize×Gap	1.139**	1.175*	2.862
	(0.506)	(0.511)	(2.291)
LSAP Surprise	-0.290		2.376
	(1.133)		(1.362)
LSAP Surprise×Banksize	-0.277		7.621*
	(1.756)		(3.229)
LSAP Surprise×Gap	1.577		-0.513
	(1.955)		(2.526)
LSAP Surprise×Banksize×Gap	1.910		-0.966
	(3.670)		(7.029)
Observations	24,051	16,170	6,492
Number of BHCs	238	233	185

This Table presents the effect of Monetary Policy using non-parametric approach.

Table 3.14. Large versus Small Banks Full Sample

	ΔStock Price	
	Large Banks	Small Banks
	(1)	(2)
Target Surprise	-12.75***	-3.467***
	(2.162)	(0.584)
Target Surprise×Gap	5.950*	1.179
	(2.618)	(0.928)
Target Surprise×Hedge	0.689	1.965
	(2.918)	(2.583)
Target Surprise×Hedge×Gap	-2.538	-2.380
	(3.581)	(3.683)
Forward Guidance Surprise	-2.022***	-1.014***
	(0.398)	(0.171)
Forward Guidance Surprise×Gap	1.447*	-0.0749
	(0.594)	(0.266)
Forward Surprise×Hedge	-0.0283	0.806
	(0.517)	(0.452)
Forward Guidance Surprise×Hedge×Gap	0.372	-0.799
	(0.815)	(0.624)
LSAP Surprise	-1.125	1.542
	(2.771)	(1.347)
LSAP Surprise×Gap	6.815	-0.814
	(4.621)	(2.111)
LSAP Surprise×Hedge	-1.530	-11.255
	(3.638)	(3.007)
LSAP Surprise×Hedge×Gap	-1.432	6.802
	(5.747)	(4.191)
Observations	9,599	14,452

This Table presents the effect of Monetary Policy for large versus small banks using the full sample.

Table 3.15. Large versus Small Banks PRE-ZLB Sample

	ΔStock Price	
	Large Banks	Small Banks
	(1)	(2)
Target Surprise	-12.92***	-3.281***
	(2.259)	(0.571)
Target Surprise×Gap	6.525*	0.958
	(2.742)	(0.928)
Target Surprise×Hedge	0.556	1.322
	(3.045)	(2.587)
Target Surprise×Hedge×Gap	-2.247	-2.274
	(3.737)	(3.671)
Forward Guidance Surprise	-1.648***	-0.919***
	(0.370)	(0.157)
Forward Guidance Surprise×Gap	1.653*	-0.189
	(0.594)	(0.250)
Forward Guidance Surprise×Hedge	-0.559	0.384
	(0.492)	(0.448)
Forward Guidance Surprise×Hedge×Gap	0.242	-0.788
	(0.939)	(0.569)
Observations	5,349	10,821

This Table presents the effect of Monetary Policy for large versus small banks using the pre-ZLB sample.

Table 3.16. Large versus Small Banks ZLB Sample

	ΔStock Price	
	Large Banks	Small Banks
	(1)	(2)
Forward Guidance Surprise	-2.556*	-0.913
	(1.248)	(0.171)
Forward Guidance Surprise×Gap	3.646	0.166
	(1.904)	(0.266)
Forward Guidance Surprise×Hedge	2.486	0.387
	(1.472)	(1.343)
Forward Guidance Surprise×Hedge×Gap	-3.271	-0.219
	(2.367)	(2.177)
LSAP Surprise	7.675*	3.101
	(2.951)	(2.135)
LSAP Surprise×Gap	0.0963	-2.532
	(6.076)	(3.428)
LSAP Surprise×Hedge	-2.267	-13.52
	(3.903)	(3.007)
LSAP Surprise×Hedge×Gap	3.839	10.04
	(7.609)	(4.191)
Observations	4,322	3,717

This Table presents the effect of Monetary Policy for large versus small banks using the ZLB sample.

Table 3.17. Alternative Leverage Measure, Full Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Target Surprise[a]	-5.416***	-5.416***	-5.600***	-5.660***
	(0.432)	(0.428)	(0.506)	(0.524)
Forward Guidance Surprise[b]	-1.088***	-1.102***	-1.084***	-1.109***
	(0.102)	(0.102)	(0.106)	(0.105)
LSAP Surprise[c]	0.063	0.069	0.188	0.597
	(0.725)	(0.737)	(0.757)	(0.822)
Repricing Gap×Target Surprise	0.610**	0.604**	0.600*	0.591*
	(0.228)	(0.228)	(0.234)	(0.234)
Repricing Gap×Forward Guidance Surprise	0.142**	0.144**	0.126*	0.128*
	(0.0541)	(0.0543)	(0.0536)	(0.0536)
Repricing Gap×LSAP Surprise	0.535	0.522	0.772	0.758
	(0.398)	(0.396)	(0.415)	(0.413)
Leverage×Target Surprise	-0.0754	-0.0743	-0.0311	-0.0299
	(0.0845)	(0.0846)	(0.0949)	(0.0949)
Leverage×Forward Guidance Surprise	-0.0711*	-0.0702*	-0.0672*	-0.0663*
	(0.0285)	(0.0284)	(0.0296)	(0.0294)
Leverage×LSAP Surprise	0.640**	0.633**	0.543*	0.535*
	(0.240)	(0.240)	(0.233)	(0.232)
Banksize×Target Surprise	-2.017***	-2.003***	-1.963***	-1.947***
	(0.299)	(0.298)	(0.299)	(0.298)
Banksize×Forward Guidance Surprise	-0.206***	-0.212***	-0.206***	-0.211***
	(0.0599)	(0.0603)	(0.0616)	(0.0618)
Banksize×LSAP Surprise	0.172	0.206	0.376	0.415
	(0.614)	(0.620)	(0.630)	(0.634)
Derivatives×Target Surprise		-6.914		-8.038
		(23.41)		(23.37)
Derivatives×Forward Guidance Surprise		2.699		2.415
		(3.880)		(3.855)
Derivatives×LSAP Surprise		-15.99		-18.11
		(22.73)		(24.05)
Saving Deposits×Target Surprise			-3.189	-3.370
			(3.699)	(3.721)
Saving Deposits×Forward Guidance Surprise			-0.558	-0.538
			(0.781)	(0.778)
Saving Deposits×LSAP Surprise			-20.92***	-20.99***
			(5.685)	(5.681)
Demand Deposits×Target Surprise			1.877	1.600
			(6.933)	(7.002)
Demand Deposits×Forward Guidance Surprise			0.0248	0.0556
			(1.534)	(1.522)
Demand Deposits×LSAP Surprise			-13.58	-13.85
			(12.11)	(11.98)
FE	Yes	Yes	Yes	Yes
Observations	24,051	24,051	24,051	24,051
Number of BHCs	238	238	238	238

Table 3.18. Alternative Leverage Measure, PRE-ZLB Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Target Surprise[a]	-5.168***	-5.172***	-4.991***	-4.963***
	(0.431)	(0.431)	(0.504)	(0.542)
Forward Guidance Surprise[b]	-0.983***	1.006***	-0.972***	-.0961***
	(0.104)	(0.108)	(0.123)	(0.127)
Repricing Gap×Target Surprise	0.722**	0.713**	0.643**	0.634**
	(0.233)	(0.231)	(0.240)	(0.239)
Repricing Gap×Forward Guidance Surprise	0.143*	0.141*	0.139**	0.137**
	(0.0619)	(0.0619)	(0.0671)	(0.0670)
Leverage×Target Surprise	-0.216	-0.214	-0.218	-0.216
	(0.187)	(0.186)	(0.189)	(0.189)
Leverage×Forward Guidance Surprise	-0.0874*	-0.0867*	-0.0887*	-0.0880*
	(0.0403)	(0.0406)	(0.0399)	(0.0402)
Banksize×Target Surprise	-1.867***	-1.861***	-1.979***	-1.974***
	(0.293)	(0.291)	(0.347)	(0.345)
Banksize×Forward Guidance Surprise	-0.191**	-0.190**	-0.190**	-0.189**
	(0.0603)	(0.0603)	(0.0781)	(0.0781)
Derivatives×Target Surprise		-6.683		-6.524
		(22.43)		(22.44)
Derivatives×Forward Guidance Surprise		-1.088		-1.186
		(3.567)		(3.521)
Saving Deposits×Target Surprise			-10.87	-10.92
			(9.090)	(9.113)
Saving Deposits×Forward Guidance Surprise			-0.853	-0.892
			(3.096)	(3.093)
Demand Deposits×Target Surprise			-5.193	-5.230
			(7.362)	(7.385)
Demand Deposits×Forward Guidance Surprise			-0.00860	-0.0287
			(2.405)	(2.411)
FE	Yes	Yes	Yes	Yes
Observations	16,170	16,170	16,170	16,170
Number of BHCs	233	233	233	233

a: The marginal effect of federal funds rate (target) surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
b: The marginal effect of forward guidance surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
The numbers in the parentheses are standard errors. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.19. Alternative Leverage Measure, ZLB Sample

	ΔStock Price			
	(1)	(2)	(3)	(4)
Forward Guidance Surprise[a]	-1.07***	-1.09***	-0.79***	-1.04***
	(0.368)	(0.363)	(0.367)	(0.357)
LSAP Surprise[b]	2.196***	2.178***	2.494***	2.488***
	(1.074)	(1.075)	(1.057)	(1.053)
Repricing Gap×Forward Guidance Surprise	0.284	0.316	0.306	0.335
	(0.187)	(0.186)	(0.191)	(0.192)
Repricing Gap×LSAP Surprise	-0.169	-0.136	0.281	0.309
	(0.627)	(0.625)	(0.663)	(0.664)
Leverage×Forward Guidance Surprise	-0.122	-0.116	-0.146	-0.138
	(0.214)	(0.214)	(0.215)	(0.216)
Leverage× LSAP Surprise	0.888	0.897	0.662	-1.043
	(0.508)	(0.508)	(0.530)	(0.656)
Banksize×Forward Guidance Surprise	0.258	0.252	0.317	0.346
	(0.212)	(0.226)	(0.210)	(0.218)
Banksize×LSAP Surprise	2.867**	2.849**	3.118**	3.094**
	(1.002)	(1.000)	(0.963)	(0.979)
Derivatives×Forward Guidance Surprise		20.52		19.30
		(12.58)		(12.73)
Derivatives×LSAP Surprise		20.78		24.53
		(36.96)		(37.87)
Saving Deposits×Forward Guidance Surprise			-3.226	-4.356
			(2.343)	(4.707)
Saving Deposits×LSAP Surprise			-25.90**	-25.54**
			(7.912)	(7.919)
Demand Deposits×Forward Guidance Surprise			-4.126	-4.356
			(4.829)	(4.707)
Demand Deposits×LSAP Surprise			-42.87	-42.96
			(20.01)	(19.93)
FE	Yes	Yes	Yes	Yes
Observations	6,492	6,492	6,492	6,492
Number of BHCs	185	185	185	185

a: The marginal effect of forward guidance surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
b: The marginal effect of LSAP surprises evaluated at the median of all bank-specific variables, 75th percentile of the interest rate derivative usage.
The numbers in the parentheses are standard errors. *** p<0.01, ** p<0.05, * p<0.1.

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