Do Intermediaries Reverse the Impact of Monetary Policy in Low Interest Rate Environments?

Evidence from Geographical Variation in Market Concentration *

A. Setayesh †

Nov. 2021

Link to the Latest Version

Abstract

I study the internal workings of intermediaries by exploiting geographical variation in market concentration. I show that- in stark contrast to the textbook view but consistent with my mechanism- in low market rates more concentrated banks respond to market rate falls by reducing their deposit supply as well as their loan supply by more than those of less concentrated banks. As the market rate falls, household deposit and loan demand become less elastic to market rate changes as households allocate a larger fraction of their portfolio to deposits and deposit rates are only partially responsive to market rate changes. The reduction in elasticity increases the effective market power of banks. The downward pressure of the increased market power and the upward pressure of the traditional transmission channels, cause the non-monotonic response of bank to market rate changes and help explain the puzzling slow recovery of the economy as well as stable inflation after the global financial crisis. I also show that these results are consistent with banks active interest rate risk management. On the county-level, I show the impact of county exposure to bank market power on total mortgage lending, FinTech-based mortgage lending, and house prices becomes less in low market rates compared to high market rates. I argue these seemingly counter-intuitive results are a direct consequence of bank's non-monotone response to market rate changes.

*I am deeply indebted to my advisor, James Peck for his guidance and support throughout my PhD studies. I am grateful to Kyle Dempsey, Sanjay Chugh, Farzad Saidi, Isil Erel, Amin Shams, Jack Liebersohn, Micheal Irwin, and Mohsen Mohaghegh as well as participants in workshops series at the Ohio State University for their insightful comments and suggestions. All remaining errors are mine.

†Ohio State University, setayesh.1@osu.edu

Keywords— Banking, Market Power, Concentration, Shadow Bank, Slow Recovery, Reversal Interest Rate, Zero Lower Bound, ZLB, ELB, Regulation, Global Financial Crisis, COVID

JEL codes— E22, E44, E52, G18, G21, L13

1 Introduction

The great moderation era and its corresponding small and stable inflation rates have been the working framework to shape economic agents' expectations and behavior. This framework, however, came into question and concern after the financial crisis and large-scale financial packages that the U.S. government enacted to revitalize the U.S. economy. The Fed funds rate almost stuck to the zero lower bound for about seven years and the shadow market rate reached to levels as low as %-3 when considering impacts of unconventional monetary policies pursued by the Fed (Wu and Xia (2016)). Nonetheless, the history proved that the inflation rate remained stable and well-anchored even after those revitalizing packages were injected to the economy. Furthermore, the recovery period was sluggish compared to those in previous recessions. I study the characteristics of the intermediation structure in the U.S. economy and the role it played in economy's recovery path after the global financial crisis. Post-crisis macroeconomic conditions followed by unprecedented policy interventions set a new working framework in intermediation that differed in significant ways from what was traditionally assumed. I look at bank operation in low interest rate environments and find the banks do not pass-through expansionary monetary policy in low interest rates and thus exhibit anomalies consistent to those observed in the macroeconomy. I argue the micro-behavior of banks actually is the natural results of banks' responding to inelastic deposit and loan demand[1] in low interest rates as well as their active interest rate risk management. My mechanism is not limited to banks and applies similarly to other financial intermediaries. Thus, it can explain aggregate slow economic recovery after the global financial crisis[2].

I argue that the elasticity of deposits and loans demand to the market rate decreases as the market rate falls. Households make their consumption-saving decisions according to the market rates they observe. They have multiple investment options and each yield a different return. They can invest in money market funds that pay the market rate, they can make deposits that pay deposits rate and they can hold cash that pay zero. Note that the return on money market funds falls one-for-one for market rate falls. However, the return on deposits only partially reflects market rate changes (Drechsler et al., 2017) and cash is totally unresponsive to market rate changes. Therefore, as the market rate falls, deposits and cash become more and more desirable investment options wherein households invest a larger fraction of their assets. As a result, the portfolio interest rate they observe (which

[1] Throughout this paper, I refer to deposits and loans as services that banks supply and households demand.

[2] The COVID crisis starting in 2020 has important similarities with what happened then and therefore, the lessons from that period apply to the questions about the COVID crisis as well.

is the weighted average of the rates they receive from their different assets) comprises a larger fraction of deposits and cash and thus, becomes less and less responsive to market rate changes. Therefore, the pass-through of monetary policy to households dampens in low interest rates and causes a wedge between the intended and the actual impact of monetary policy. In other words, households do not increase their consumption and do not decrease their savings as much as intended in response to a market rate reduction in low interest rate environments which respectively results in a fall in the elasticity of loans demand and deposits demand to market rate in low interest rate environments.

A fall in elasticity of deposits and loans demand to market rate as the market rate falls translates into a rise in effective bank market power. As any other entity experiencing a rise in market power, banks reduce total supply - total supply of deposits and loans in this case. Yet this is not the only impact of a fall in the market rate; it also increases supply of deposits and loans through traditional channels[3]. Whether the net impact of a reduction in the market rate on total deposits and loans is positive or negative is an empirical question. I investigate this question separately for the deposits and loans. My empirical strategy builds on that of Drechsler et al. (2017).

For the deposits, I use the Federal Deposit Insurance Corporation (FDIC) summary of deposits that covers branch-level total deposits of all U.S. bank branches. I compare deposits growth rates at branches of the same bank located in areas with differing levels of local market concentration after a change in the market rate to assess the impact of market power. The identifying assumption is that local loans supply does not affect local deposits supply; that is, banks internally allocate available funds in different areas according to local marginal returns on lending and do not necessarily maintain an asset-liability balance at the branch level. rather, they do so only at the bank level. Under the identifying assumption[4], the changes in deposits growth of bank branches in different areas are due to changes in deposits supply which itself is due to local branch's market power. There results are reported in table 1. I show that the net impact of a rise in the market rate[5] is a decrease in deposits supply for market rates above one percent, hereafter high market rates. That is branches located in more concentrated areas decrease their deposits supply by more than those located in less concentrated areas. The result implies the increasing effect of traditional channels dominate the decreasing effect of bank market power in high market rates. Bank behavior in high interest rates is consistent with that implied by the textbook view through traditional channels. On the other hand, I show that the behavior of bank deposits supply completely reverses in low interest rates as the bank market power becomes the dominant factor. The net impact of a rise in the market rate is an increase in deposits supply by banks for market rates

[3]Bank lending channel, bank balance-sheet channel, bank deposits channel, etc.

[4]Which is consistent with what literature finds. See Gilje et al. (2016)

[5]My measure of market rate is the shadow rate introduced by Wu and Xia (2016) which practically equals the Fed funds rate when it is positive. But when Fed funds rate is stuck to the ZLB and is no more responsive to monetary policy, shadow rate summarizes the stance of monetary policy by going into the negative territory.

below one percent, hereafter low market rates. That is, branches located in more concentrated areas increase their deposits supply by more than those located in less concentrated areas. I also show that the responsiveness of deposits growth to bank market power steadily falls from positive values to negative values as the market rate rises further confirming my argument on a declining effective market power.

For the loans, I use small business lending data from the Community Reinvestment Act. This data covers small new loans issued by banks in different areas with which I assess the changes in bank loan supply. I exploit cross-sectional variation in bank lending behavior. I study the differential behavior of two banks with different levels of market power in their lending in one area and investigate whether their responses to market rate changes are different in low and high market rates. Since they lend in the same area, local loan demand would not distort the results and any changes will be entirely driven by banks' loan supply. The results are reported in table 2. I find that high-market-power banks significantly decrease their lending in high market rates compared to low-market-power banks for a rise in the market rate. The results are consistent with those of Drechsler et al. (2017) as well as Scharfstein and Sunderam (2016) for high market rates. However, the behavior changes in low market rates. The results show a positive but insignificant rise in total lending for high-market-power banks compared to that in low-market-power banks for a rise in market rate in low market rates. Thus, the impact of a further reduction in market rate is muted in low market rates and does not create expansionary pressure, rather it creates contractionary pressure if anything. Additionally, I study the same question for the number of small loans issued by banks and find a similar reversal in behavior in response to market rate changes in that setting as well. Note that this dataset is particularly useful as it targets small borrowers who most likely don't have access to financial markets and banks can still charge high loan rates for the loans issued for these types of borrowers even when the long-term rate in the economy has fallen to unprecedentedly low levels . Therefore, the shrinkage of the interest margin between short-term and long-term rates- as it is argued to be the reason behind bank loan supply reduction after the global financial crisis- cannot explain the shrinkage of bank loans supply in this dataset. Nonetheless, the mechanism outlined in the paper can predict this behavior and is actually larger for small borrowers with less access to financial markets.

I use quarterly bank data from Consolidated Reports of Condition and Income- generally referred to as Call reports to construct a measure of bank market power alas Drechsler et al. (2021) so to cross-validate the changes in bank effective market power as market rate changes. This measure shows the responsiveness of bank interest expenses to the market rate[6]. Market power enables banks to keep the interest rate on their liabilities low and insensitive to changes in the market rate. Thus, a high-market-power bank would have a lower interest expense beta. I compute the beta for all the banks for which data is available separately for periods with high market rates and periods with low market rates. As shown in figure 3, bank

[6] Hereafter bank expense beta

beta almost uniformly falls in low market rates over the entire distribution of bank betas. Equivalently, bank market power increases in low market rates. Note that this measure is not obtained from the average local market concentration a bank faces but from the outcomes of its actual behavior. It also takes into account the demographics, location-specific and industry-specific characteristics of its clients, etc and thus measures the market power that bank's management team perceives. Since other characteristics of bank do not change in different market rates, I argue the characteristic that drives this change in bank expense beta is the decreasing elasticity of deposits demand to market rate as the market rate falls[7]. The results are consistent with those on deposits as the increasing effective market power when the market rate falls is driving both results.

Banks generally issue short-term liabilities and long-term assets which generates a significant maturity mismatch between assets and liabilities and should expose them to interest rate risk if they earn the market rate from the assets and pay the market rate for the liabilities. In such a scenario, a one percent rise in the market rate should increase banks' yearly interest expenses by almost exactly one percent while not changing the interest income until the assets are due which exposes them to significant interest rate risk. Nonetheless, as discussed in Drechsler et al. (2021) despite the textbook view on bank's exposure to interest rate risk, they hedge interest rate risk by changing the composition and maturity of assets such that a change in the market rate would change interest expense and interest income exactly the same so that net interest margin of a bank is unaffected by market rate changes. I provide new evidence for their result by showing that banks keep this close matching even when their expense beta changes. In fact, the result of a declining interest expense beta as market rate falls will be a declining interest income beta so to keep banks unexposed to interest rate risk. I confirm this result by constructing banks' interest income sensitivity to market rate[8], in low and high market rates and show that not only interest income beta and interest expense beta match quite well in high interest rates, they also fall almost exactly the same when the market rate falls(figure 4 the middle graph). Therefore, I confirm Drechsler et al. (2021) results on the close matching in a new dimension.

I argue the reduction in loan and deposit supply in low market rates is also consistent with bank active interest rate risk management through matching expense beta and income beta. In fact, as the market rate falls, bank effective market power rises and bank expense beta falls. Since banks keep the close matching between bank expense beta and bank income beta, they adjust their assets portfolio such that bank income beta falls as well. That is, they shift funds away from the assets with relatively shorter duration towards those with relatively longer duration. Since securities generally have longer duration than loans, banks shift funds from loans towards securities. This channel also explains the ineffectiveness of monetary policy expansions on stimulating bank lending in low interest rates. That is, as the market rate falls, the reallocation of assets from loans to securities intensifies and below a

[7]Which itself is obtained from the consumption-saving equation of households.

[8]Hereafter, bank income beta

threshold level banks start shrinking their total loans outstanding. Interestingly, even within bank securities, those with longer duration experience a larger inflow of funds as the market rate falls. That is, Mortgage-Backed Securities[9] which have even longer duration experience a larger inflow compared to treasuries.

I use bank Call reports to investigate whether such reversals are present at the bank level and to test my predictions on bank securities holding. The results are shown in figures 1 and 2. The top graph in figure 1 reflects the regression lines of the impact of market rate on the share of loans out of bank assets for both low and high market rate environments. It shows an apparent reversal in bank total lending below and above one percent threshold. Not surprisingly, a similar analysis for the share of securities shown in the top graph of 2 reflects a reversal in behavior as well. In fact, total securities holding of a bank reaches its minimum at around one percent market rate. Furthermore, I similarly analyze the share of treasuries and MBS out of bank assets in different market rates. The middle and bottom graphs of figure 2 respectively show the results. As can be seen, there is almost a monotone shift of assets from treasuries to MBS as the market rate falls and the behavior does not change in low and high market rates which is again consistent with the paper's predictions. Next, I analyze the impact of bank market power on its securities holding. The results are reported in table 3. Consistent with the aggregate results, a high-market-power bank initially lowers its total outstanding securities compared to a low-market-power bank in response to a market rate fall. But the impact reverses in low market rates. Moreover, A similar pattern holds for total outstanding treasuries but the exact opposite holds for total outstanding MBS, suggesting a substitution from treasuries towards MBS as the market rate falls at low market rates that is more pronounced for high-market-power banks again consistent with the predictions.

This paper provides an alternative explanation for the change in bank behavior in low market rates. Other explanations usually point to a binding equity constraint in banks balance-sheets and borrowing frictions in wholesale funding as being the underlying reasons. For instance, Brunnermeier and Koby (2018) and Wang et al. (2020) pinpoint the importance of a binding equity constraint in determining bank's lending. Wang et al. (2020) estimate a structural model in which banks should maintain a maximum leverage through an equity requirement and show that the equity constraint becomes binding in low market rates and subsequently limits lending as the market rate falls further. Alternatively, I argue that this fall is actually the result of bank's increased market power as well as its active interest rate risk management when in low market rates. My explanation does not rely on a binding equity constraint and thus applies to all financial intermediaries including those not subject to bank regulations. Despite bank lending[10]which has become a small portion of total lending in the economy, the breadth of my explanation which applies to all intermediaries sheds light on why the slow-down can be seen in the aggregate macroeconomic outcomes as

[9]Hereafter, MBS

[10]or more broadly regulated sector lending

well whereas explanations based on bank-specific characteristics may not be able to do so. Additionally, The models relying on a binding equity constraint are generally sensitive to the definition of the equity constraint. They generally require the use of next period's equity in the current equity constraint despite the fact that current equity is used in analogous practical applications. Besides, bank equity is endogenous and banks can raise equity from the shareholders if they find it optimal to do so. Repullo (2020) sets up a model in which bank equity is endogenously provided by shareholders and shows that there is no reversal of monetary policy impact in such a setting. Additionally, the equity requirement explanation implies that banks should have a binding equity constraint in low interest rates. A look at the bank-level data, however, does not support this argument. Figure 5 in the appendix shows the distribution of risk-weighted capital ratios for large and small banks at the height of the global financial crisis in 2008 and shows even then the vast majority of banks had capital ratios well above the regulatory minimum (%4 at the time)[11]. Furthermore, even if raising equity is not feasible, a bank can limit dividends in low market rates and overcome the binding equity constraint after a few periods. Thus, the equity constraint explanation is only effective when the market rate has just fallen to the low market rates territory and should vanish over time. My explanation, however, does not imply such weakening of impact as it stems from banks optimization problem and does not fade away over time. Thus, this paper also provides a better understanding of why "low for long" monetary policy has persistent impacts as described by Brunnermeier and Koby (2018).

The paper results provide a clear case for the slow-down of economic recovery after the global financial crisis in which the fed funds rate was stuck to the zero lower bound for about six years and the shadow rate reached record low levels of -%3 percent. It was actually banks' increased market power that muted- or reversed- the expansionary pressures of a reduction in the market rate and limited new investments, thereby elongating the recovery process. Simultaneously, it also sheds light on the apparent small and negligible response of inflation after the global financial crisis even though the Fed followed aggressive and unprecedented monetary actions to stimulate the economy. There was a debate at the time whether those policies would de-anchor inflation expectations and consequently result in high inflation rates. However, inflation remained steady during the entire period. The declining elasticity of loan demand as the market rate falls hampered the response in aggregate demand for a given drop in the market rate and limited the inflationary pressures therein. It also sheds light on the underlying reasons for the effectiveness of forward guidance. Forward guidance becomes effective as it promises low interest rates for an extended period of time. The knowledge that the interest rate risk is diminished for some time allows banks to deviate from their expense beta and income beta matching and issue more loans, thereby stimulating the economy. The longer the horizon of this "promise", the larger the impact of forward guidance.

To assess the economic importance of these results, I study local economic performance among areas that are differentially affected by bank market power in response to market rate

[11] For a more complete analysis of capital ratios among U.S. banks see Corbae et al. (2021)

changes. I construct a measure of exposure to bank market power and consider the response of total mortgage lending, FinTech-based mortgage lending, and house prices to market rate changes for different exposure levels in low and high market rates. The results are reported in tables 4 and 5. I show that total mortgage lending is more responsive to market rate changes in the areas exposed to high-market-power banks. In contrary, the response of this variable to a change in the market rate changes signs and almost vanishes in low market rates. In other words, expansionary monetary policy loses its power as the market rate falls below one percent. FinTech-base mortgage lending substitutes traditional bank lending in general, but I show the substitution is stronger in the areas that are more exposed to bank market power. Within these areas, once the market rate falls below one percent, the substitution becomes less powerful suggesting traditional lender have become less responsive to monetary policy. I also study the response of house prices to market rate changes in those areas and show that house prices are generally more responsive to market rate changes in the areas exposed to high-market-power banks but the effect becomes less pronounced in low market rates.

This paper contributes to multiple strands of literature. First, it contributes to the literature on the transmission of monetary policy in ultra-low interest rates. A growing body of literature has studied this phenomenon as negative interest rates have become a common feature of monetary policy specially after the global financial crisis. For instance, Heider et al. (2019) study the supply of bank credit in Europe after the European Central Bank introduced negative policy rates. Eggertsson et al. (2019) consider Swedish bank lending behavior after several consecutive policy rate reductions by the Riksbank and show that deposits rates do not follow the policy rate into negative territory. In fact, policy rate reductions are no more transmitted into the deposits rate as well as loans rate once the deposits rate reaches the zero lower bound. In Eggertsson et al. (2017) they also provide evidence for the apparent zero lower bound in deposits rate in multiple countries. Basten and Mariathasan (2018) study the impact of negative policy rates on banks in Switzerland. A more complete survey of the literature can be found in Heider et al. (2021). This paper provides evidence that another channel is also present wherein the change in behavior is due to a declining elasticity of deposit and loan demand as market rate falls which increases bank's effective market power, and mutes the impact of monetary policy . This paper also shows that the adverse impacts of negative market rates shown in the literature also apply to low but positive rates.

Second, it contributes to the literature on the internal workings of the banks. This literature studies how banks manage their assets and liabilities given that they are exposed to multiple sources of risk. Bank's optimal behavior in such circumstances sometimes yields unexpected results. For instance, banks' management of liquidity risk is studied in Peck and Shell (2010). They show in a model that requiring banks to hold only liquid assets (narrow banking) which was originally proposed to eliminate bank runs can actually cause them. Furthermore, Peck and Setayesh (2021) show that when households are able to directly invest in the market, the general equilibrium outcome entails improved total welfare but at the cost

of less financial stability.
Banks' management of interest rate risk has also been extensively studied in the literature. Drechsler et al. (2021) show that banks closely match their interest income sensitivity to the market rate to their interest expense sensitivity to the market rate so that a market rate change does not affect their net interest margins. Li et al. (2019) study the substitution between deposits and treasuries from the perspective of lenders when treasuries supply changes and study its impacts on bank deposits supply. Begenau et al. (2015) study bank exposure to interest rate risks from a different perspective and argue the risk exposure may not be fully hedged by banks. This paper shows that the interest expense sensitivity of deposits falls as the market rate falls and interest income sensitivity of deposits closely matches it at both high and low market rates.

Third, it contributes to the literature on the role of intermediaries in the transmission of monetary policy. In particular, Kashyap and Stein (2000) study the role bank balance-sheet strength plays in the transmission mechanism and Scharfstein and Sunderam (2016) and Drechsler et al. (2017) show substantial bank market power respectively in the mortgage lending market and in the deposits market and analyze their roles in the transmission of monetary policy. I show that banks adjust the composition of their assets and liabilities so to take into account their increasing effective market power as the market rate falls and it results in a reversal of monetary policy impacts in low interest rates. Other papers have discussed the presence of a reversal rate arguing that the frictions banks face imply that below this rate expansionary monetary policy becomes contractionary. Brunnermeier and Koby (2018) argue for such a behavior in a theoretical model and Wang et al. (2020) analyze a structural model that produces this behavior. Nonetheless, they rely on a binding capital constraint at low market rates. Repullo (2020) shows in such models there is no reversal rate when bank equity is endogenously provided by shareholders.

Fourth, it contributes to the literature on the role of banks in financial stability. Basel III bank capital adequacy framework was developed in response to the deficiencies in the financial regulation as became evident during the 2008 financial crisis. The U.S. Federal Reserve announced the gradual implementation of Basel III guidelines in 2011. Among other consequences, it imposed higher equity requirements on banks. Nonetheless, The impact of bank market power on its behavior as well as its implications on financial stability has been a topic of interest going back to at least Keeley (1990) in which he evaluates the role of bank market power on its risk taking and shows that higher market power actually corresponds to higher charter value and lower default risk. Müller and Noth (2018) reach a similar conclusion by studying HMDA mortgage application data. Consistent with these result, Allen and Gale (2004) develop a model to study the competition among banks and argue for an efficiency-stability trade off and Setayesh (2019) studies the strategic destabilising interactions between healthy and unhealthy banks. This paper provides evidence for active risk management of banks using its market power in the deposits and loans markets such that they are no more exposed to interest rate risk. Therefore, the design of financial regulation policies may need to take into account the actual behavior of banks which diminishes concerns regarding banks' risk exposure. Interestingly, as figure 6 in the appendix shows, average concentration level in the banking industry has been increasing in the last 30 years. Whether, this rise in concentration is due to bank's profit maximizing motive or other potentially exogenous factors is yet to be studied. Nonetheless, it reveals the growing necessity of incorporating bank market power in macroeconomic and macrofinancial analyses.

Fifth, it contributes to the literature on macroeconomic models that incorporate the financial sector. Financial intermediaries were used to be considered as neutral entities that could be ignored in aggregate economic analysis. But the financial crisis changed the common view and a generation of research on the role of intermediaries in the aggregate economy was produced. To name a few, Gertler and Karadi (2011) develop a DSGE model with financially constrained intermediaries. Gertler and Kiyotaki (2015) develop an infinite horizon macroeconomic model that allows for bank runs and study different possible equilibria in this economy. Sims and Wu (2019) develop a new Keynesian model that incorporates a financial sector. This paper discusses active risk management strategies that banks undertake and thus, provides the building block structure of the intermediation system in such aggregate models.

The rest of the paper is organized as follows; Section 2 describes the datasets used in this paper. Section 3 analyzes the aggregate behavior of bank balance-sheet items in low and high market rates. It provides suggestive evidence of the reversal of bank behavior as the market rate is reduced. Section 4 studies branch-level local deposits supply. It establishes the reversal in bank deposits supply by exploiting variation in local market concentration in the deposits market. Section 5 studies the lending side of banks' business and investigates the role of bank market power in its lending behavior in low and high market rates. The results confirm that a kink in lending behavior arises around the reversal rate. Section 6 studies bank's active interest rate risk management regarding their sensitivity of interest expense and income to market rate and analyze how that changes in different market rates. It establishes that how bank deposits supply and loans supply are connected. Section 7 assesses the impact of the Bank behavior on alternative lending competitors' behavior and their economic impact on house prices. Section 8 concludes and discusses future directions.

2 Data

Multiple data sources have been used in this paper. I use branch-level data on total deposits of the universe of branches of insured U.S. banks between 1994 and 2020 from the Federal Deposit Insurance Corporation (FDIC) Summary of Deposits. This dataset is available in yearly frequency.

I use small business lending data from the Community Reinvestment Act (CRA). The act is intended to encourage depository institutions to help meet the credit needs of the communities in which they operate. It reports county-level new small loan origination issued by banks in annual frequency and is available from 1996 to 2019. All banks that hold at least one billion dollars in assets are required to report their new lending. It reports total loan value and total number of small loans (less than $ 100,000), medium loans (between $ 100,000 and $ 250,000), and large loans (between $ 250,000 and $1,000,000). The amounts are reported in thousands of dollars. I define total new small business lending as the summation of all three loan categories' values and total number of new loans as the summation of all three loan categories' number of new loans. The dataset uses four different institution identifiers including FDIC certificate number, OTS docket number, OCC charter number, and Federal Reserve ID number commonly known as RSSDID. I use the identifier crossroad that I constructed from FDIC active institutions list to transform all identifiers to RSSDID.

I use the Consolidated Reports of Condition and Income commonly known as Call reports for bank-specific characteristics . This dataset covers detailed balance-sheet and income statement information of U.S. commercial banks on a quarterly basis. I use the compiled dataset accompanying Drechsler et al. (2017) that covers years 1976 to 2020.

I use FRED time series for the fed fund rates and the target rate. After the introduction of the target rate corridor, the Fed only announce the upper limit and the lower limit of the target rate. For those years I use the average of the two rates. I use Wu and Xia (2016) time series for the shadow rate that reflects the emerging shadow market rate if fed funds rate wasn't bound by the ZLB constraint. In other words, it considers the market rate that would have similar economic impact with that of excercised quantitative easing and unconventional policies. I also construct a market rate measure that is equal to the shadow rate when it is available and equal to the fed funds rate when the shadow rate is not available before 1990. Since a binding zero lower bound and unconventional monetary policies that can cause significant deviations between the market rate and the shadow rate have been predominantly exercised after the global financial crisis, I expect that to be a good measure of the shadow rate before 1990.

I use the data on county-level mortgage lending available through the appendix of Fuster et al. (2019). The numbers are reported in billions of dollars. The authors separate FinTech-based lenders from traditional ones. They report total value of mortgage originations for residential properties located in a given county and as well as total value of that issued by FinTech-based lenders.

The data on house prices is obtained from Zillow. The dataset reports a smoothed, seasonally adjusted typical home price on a monthly basis. It reflects the typical home value for the houses between 35th and 65th price percentiles. I also use their data on top-tier houses (average price for houses between 65th ans 95th price percentiles) and bottom-tier houses (average price for house between 5th and 35th price percentiles).

3 Aggregate Bank Results

I first study how bank's aggregates behave in different market rates and whether my predictions hold in the aggregate. Due to the nature of aggregate variables, I will not make causal arguments in this section. Rather, this section provides a foundation for what will be discussed in the future sections. The main source of data in this section is the dataset on balance-sheet and income statements of all commercial U.S. banks also known as Call reports. Since the variables that banks are required to report have changed over time, a mere use of raw data may bias the outcomes. To avoid this problem, I use the dataset available as the online companion of Drechsler et al. (2017). This dataset has processed the raw reports to form consistent time-series of bank balance-sheet and income statement items. I use the period from 1985 to 2020 to isolate from the impact of high-inflation years before the great moderation. I winsorize real-dollar value of bank data at the bottom 5 percent. For interest rates, I use the shadow rate computed by Wu and Xia (2016) which computes the fed funds rate had there not been a zero lower bound on interest rates. Since this study is based on the interest rate changes, the shadow rate is crucial for my study as it enables me to capture the magnitude of easing and tightening of monetary policy in low market rates when fed funds rate and the target rates are bound by the ZLB constraint and thus do not reflect the accurate stance of monetary policy.

Figure 1 shows the share of bank loans out of all assets in different shadow rates. Each graph contains twenty bins represented by dots. Each dot reflects the average of all observations in that bin. The regression lines are computed based on the observations that belong to below or above the shadow rate threshold (one percent). The results suggest a clear pattern that the share of bank loans does not increase anymore for a fall in the market rate once the market rate is below the threshold . The top graph in figure 1 shows the behavior of the share of total loans out of bank assets. The textbook view asserts that as the shadow rate falls, loan demand increases through the traditional interest rate channel and loan supply increases through bank lending and bank balance-sheet channels, among others. Thus, a reduction in the shadow rate should be accompanied by an increase in total lending. It is precisely what this graph shows but only for the market rates above the one percent threshold. As the market rate is reduced below the one percent threshold, the behavior reverses. There is in fact a reduction of total loans in response to that monetary expansion.

The middle graph in figure 1 is the analogous to the top graph for commercial and industrial loans. Surprisingly, this important part of bank lending falls in relative importance as the market rate is reduced and this notion continues to hold even when shadow rate is below one percent. The bottom graph is the analogous to the top graph for real estate loans. In stark contrast to C&I loans, real estate loans become relatively more important as the market rate is reduced. Thus, the behavior of total lending as well as its composition changes in low market rates. These graphs suggest that banks shift funds towards real estate loans rather than other types of loans as the shadow rate is reduced possibly because these loans are easier to securitize, so they won't sit in their balance-sheets for a long time and do not expose them to interest rate risk.

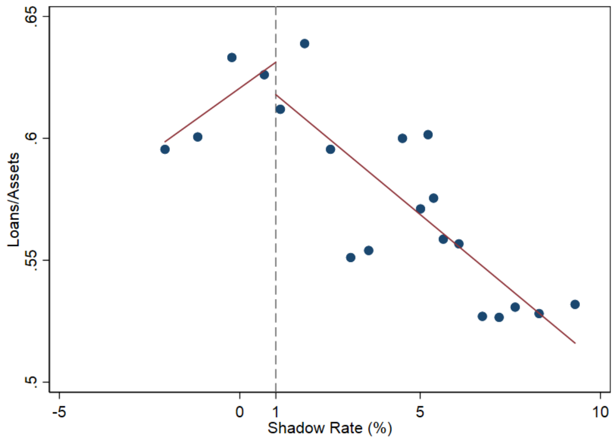
Figure 2 shows the share of bank total securities holdings out of all assets in different shadow rates. The number of bins and the regression lines are derived similarly to those in figure 1. The top graph draws total securities share of a bank in different market rates and suggests that- not surprisingly- the share of total securities reaches its minimum in about one percent shadow rate. As securities and loans are two major components of bank assets, this shape is consistent with the hump-shaped behavior of total loans share shown in the top graph of figure 1. One may think the hump-shaped lending behavior is due to banks holding excessive reserves in low market rates. But the behavior of securities holdings suggests otherwise. The middle graph and the bottom graph draw the share of treasuries and MBS held by a bank out of its total assets. The stark difference between the two suggests a shift of funds toward MBS holdings and out of treasuries holdings as the market rate falls. As I'll provide evidence in section 6 ,this shift is consistent with the banks motives generated by increased market power of banks in low market rates to lower their interest income beta by substituting longer maturity duration assets for shorter maturity duration ones, i.e. substituting MBS for treasuries[12].

4 Bank Deposits

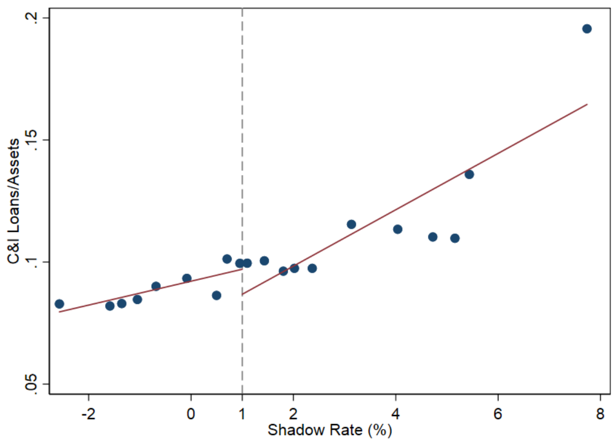
Even though the results expressed in section 3 provide a clear distinction between how a bank behaves in high versus low market rates, they do not identify a relationship from bank decisions to the observed behavior. As market rate changes are due to changes in the economic environment as well as responses of the Fed to those changes, the study of a bank over time faces important endogeneity challenges as to whether the observed relationships are actually bank's response to market rate changes or merely driven by other contemporaneous changes in the economic environment. To resolve this issue, I turn to the cross-section and exploit branch-level variation in bank deposits. My empirical strategy builds on that of Drechsler et al. (2017).

I study differential changes in deposit growth rates of bank branches located in counties with different levels of market concentration. Branch-level deposits are obtained from the FDIC summary of deposits. The impact of interest in this section is the sensitivity of deposits supply to market rate changes for different local market concentration levels. There are multiple other factors influencing branch-level total deposits observed in the FDIC data. The most important identification challenge is disentangling deposits supply response to changes in the market rate from the changes in bank lending opportunities. I tackle this

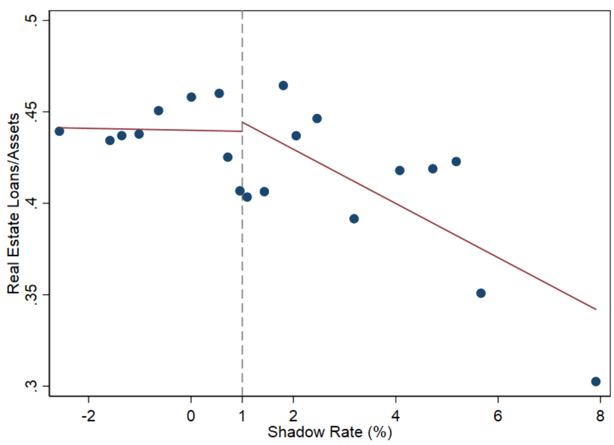
[12] It is also consistent with the securitization motive of banks. Banks issue more mortgages in lower market rates, and it takes time for a bank to sell off these securities. So it is natural that the MBS share in bank assets increases as the market rate is reduced. But this explanation doesn't answer why the share of treasuries should fall as market rate falls. Rather, it points to a substitution of MBS for loans.



(a) Total Loans Share Vs. Shadow rate

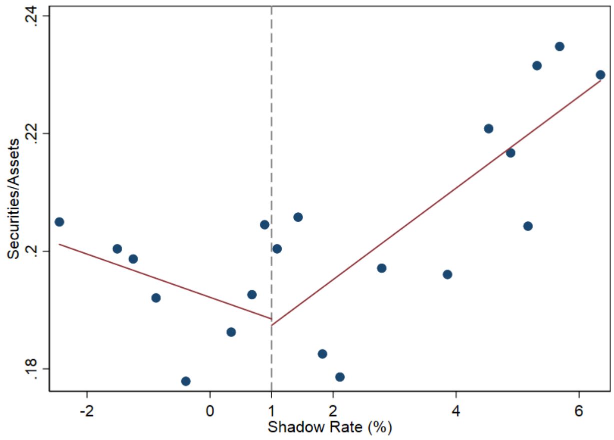


(b) Total Commercial and Industrial Loans Share Vs. Shadow rate

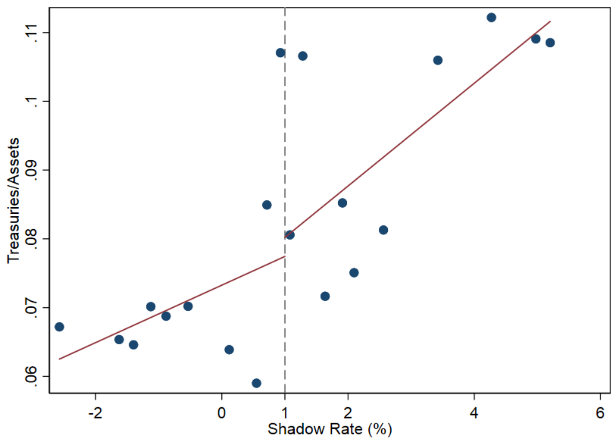


(c) Total Real Estate Loans Share Vs. Shadow rate

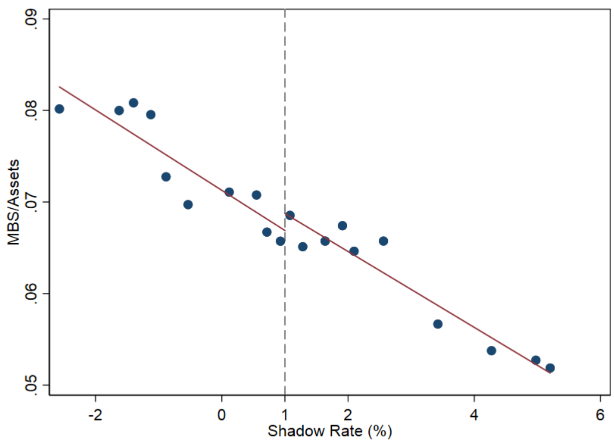
Figure 1: Bank Loans Composition in Different Market Rates
Shadow rate is the market rate that summarizes the stance of monetary policy and is obtained from Wu and Xia (2016) and loan information is obtained from Call reports. Each graph shows a binned scatter plot of the data with twenty bins. The lines are the corresponding regression lines for below and above one percent threshold.



(a) Total Securities Share Vs. Shadow rate



(b) Total Treasuries Share Vs. Shadow rate



(c) Total MBS Share Vs. Shadow rate

Figure 2: Bank Securities Composition in Different Market Rates
Shadow rate is the market rate that summarizes the stance of monetary policy and is obtained from Wu and Xia (2016) and securities holding information is obtained from Call reports. Each graph shows a binned scatter plot of the data with twenty bins. The lines are the corresponding regression lines for below and above one percent threshold.

issue by using extensive sets of fixed effects which absorb time-varying lending opportunities that a bank faces. The identification assumption is that banks accept deposits locally but issue loans nationally[13]. In other words, banks do not balance their assets and liabilities at the branch level. It's only balanced at the bank level. This assumption is consistent with empirical evidence on how banks manage liquidity obtained from exogenous liquidity windfalls as shown in Gilje et al. (2016). They study how banks allocate funds among their branches when some of them are experiencing an exogenous liquidity windfall. They show that such an event results in an increase in new mortgages not only in the area that is experiencing the windfall, but also in other areas wherein branches of the bank operate. Their results suggest savings in one area help fund investments in another and that banks internally allocate funds among their branches[14].

Similar to Drechsler et al. (2017) approach, I use FDIC branch-level data to construct a county-level deposits market concentration index. FDIC data provides total deposits in all bank branches in an area with which I construct deposits market share of local branches. I compute Herfindahl-Hirschman Index (HHI) of deposits market using deposits market shares[15]. HHI essentially is the summation of squared market shares of local branches. Since the market shares are in yearly frequency, HHI will be specific to each county-year. I then use the average of yearly HHIs to construct average HHI for each county[16]. Areas with only one branch have the highest HHI of one and areas with many branches generally have HHIs of less than 0.1. Hereafter, I refer to this variable as County HHI or local market concentration.

The regression I'll analyze is shown in equation 1 wherein i is bank identifier, b is branch identifier, c is county identifier, and t is year identifier. $CountyHHI$ shows average local market concentration in the county and Δr is the change in the shadow rate. $Above1$ is a dummy variable that is one when the market rate is above %1 with which I allow the sensitivity of deposits supply to the market rate to be different below and above %1 threshold. X is the vector of control variables which includes a combination of $bank \times state \times year$ fixed effects, $bank \times year$ fixed effects, $state \times year$ fixed effects, county fixed effects, and branch fixed effects.

$$\begin{aligned} \Delta.ln(Dep_{i,b,c,t}) = \alpha CountyHHI_c \times \Delta r_t + \beta CountyHHI_c \times \Delta r_t \times Above1 \\ + \Gamma \times X_{i,b,c,t} + \epsilon_{i,b,c,t} \end{aligned} \tag{1}$$

The main variable of interest is β which shows the differential response of bank deposit supply to local concentration in low and high market rates.

[13] In some sets of the fixed effects, the assumption become even weaker and it would be enough if banks issue loans at the state-level.

[14] They also show this surge is only seen for hard-to-securitize mortgages.

[15] I compute HHI for cases when different branches of the same bank in a county are considered independent- and set the branch's deposit rate independently- and when they are under central management- and thus form one local participant with the summation of total branch deposits.

[16] As figure 8 in the appendix shows, HHI is almost constant over time.

The regression results are reported in table 1. I only include the branches that have been active for at least ten years. All the regressions cluster observations at the county level. In each column of table 1, the first coefficient returns the general impact of local market concentration on the deposits inflow for a change in the shadow rate (α). The second coefficient returns the differential impact when the market rate is above %1 (β).

Column one uses *bank* $\times$ *year* fixed effects to control for time-varying bank lending opportunities. According to the identifying assumption, the regression effectively compares two branches of the same bank when including *bank* $\times$ *year* fixed effects. It also controls for time-varying state-level legislation and shocks using *state* $\times$ *year* fixed effects. The results show that branches located in more concentrated areas observe a larger deposit inflow compared to those in less concentrated areas for a fall in the shadow rate in high interest rates. However, the behavior reverses in low market rate. In fact, branches located in more concentrated areas observe a larger deposit outflow compared to those in less concentrated areas for a fall in the shadow rate.

Column two adds county fixed effects to the set of control variables to take out any area-specific characteristics that may bias the results including but not limited to demographics, income, education, financial sophistication, etc. Column three add branch fixed effects which in addition to controlling for county characteristics, controls for any special trust or mistrust local residents retain for a specific branch, the quality of its management, it's accessibility, etc. Column four includes *bank* $\times$ *state* $\times$ *year* fixed effects which not only controls for *bank* $\times$ *year* and *state* $\times$ *year* fixed effects, but also controls for time-varying state-level bank loan demand and uses a weaker identifying assumption that bank lending opportunities are managed at the state-level and not nationally. It also includes county fixed effects.

The main result is shown in column five. The specification includes *bank* $\times$ *state* $\times$ *year* fixed effects as well as branch fixed effects which practically cover all the fixed effects mentioned in previous specifications. The results are robust to a variety of specifications, are quite similar in all the columns, and all point to a change in behavior int low versus high shadow rates.

The mechanism underlying the deposits channel of monetary policy predicts that following a market rate fall, a bank branch in a more concentrated area increases its deposit supply by more than that in a less concentrated area. Nonetheless, my specification allows me to establish the exact opposite in low market rates. In fact, a bank branch in a more concentrated area decreases its deposit supply by more than that in a less concentrated area when the market rate falls in low market rates and increases its deposit supply for a similar change in high market rates. The results are surprising in that in almost every model of banking and every channel of monetary policy banks reduce their deposit supply as the market rate increases. Nonetheless, they are consistent with my mechanism predictions and are a direct result of banks experiencing higher effective market power in lower market rates.

It's also worth noting that changes in deposits supply are unlikely to be driven by other contemporaneous factors as the literature has established that deposit rates change within a week of the Fed announcements changing the target rate(Drechsler et al., 2017).

Table 1: Differences in Deposit Growth of a Bank's Branches in Different Counties with Different Levels of Concentration in response to shadow rate changes
Only branches that have been active for at least ten years are included . All the regressions cluster observations at the county level. $CountyHHI$ shows local market concentration in the county and Δr is the change in the shadow rate. $Above1$ is a dummy variable that is one when the market rate is above %1 threshold.

	(1)	(2)	(3)	(4)	(5)
	$\Delta Ln(Dep)$	$\Delta Ln(Dep)$	$\Delta Ln(Dep)$	$\Delta Ln(Dep)$	$\Delta Ln(Dep)$
County HHI $\times \Delta r$	2.189***	0.674***	0.706***	0.761***	0.796***
	(7.82)	(2.91)	(2.88)	(3.30)	(3.28)
County HHI $\times \Delta r \times Above\%1$	-5.063***	-1.140**	-1.336**	-1.171**	-1.393***
	(-7.98)	(-2.35)	(-2.55)	(-2.42)	(-2.69)
Observations	1426447	1426447	1426324	1421397	1421272
r2	0.150	0.156	0.240	0.173	0.255
Bank$\times State \times YearFE$	N	N	N	Y	Y
Bank$\times YearFE$	Y	Y	Y	Y	Y
State$\times YearFE$	Y	Y	Y	Y	Y
Branch FE	N	N	Y	N	Y
County FE	N	Y	Y	Y	Y

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 in the appendix is analogous to table 1 when the target interest rate is used instead of the shadow rate. It also shows a significant outflow of deposits in response to market rate falls in low market rates. The coefficient of impact is, however, much larger. It's not surprising though as large fluctuations in the shadow rate translate to small fluctuations in the target rate in low shadow rates due to the target rate being subject to the zero lower bound.
One may argue that the reversal of bank behavior may happen in the negative market rates and the results shown in table 1 are dominated by those in the negative shadow rate territory. To rule out this possibility, I show that the result holds even when I limit my observations to those between zero and one percent shadow rates. In fact, I compute the sensitivity of bank deposits supply at different shadow rate intervals. The results are shown in table 8 in the appendix. Interestingly, the sensitivity of deposits supply to the shadow rate changes shows an almost uniform increase as the shadow rate falls. It suggests a gradual deterioration of monetary policy effectiveness rather than a regime-switching type behavior. My explanation is based on the gradual increase in bank effective market power and thus supports the results of table 8.

Regression results imply that one standard deviation increase in county HHI, reduces banks deposits supply by about %0.18 more for a one percentage point fall in the market rate in low market rates. The effect almost exactly reverses in high market rates. Equivalently, according to table 7 a one percentage point fall in the target rate results in a much larger outflow of deposits in low market rates.

Deposits are generally a stable source of funding. About %70 of banks liabilities are in the form of deposits. Since total deposits is a stock variable, a change in that will have a much greater impact on bank lending. Because banks cannot change the terms of their outstanding loans until they are due, this change in the stock of deposits will have to appear in new lending or in other words in the flow of loans, consequently magnifying its impact.

The results obtained in this section may seem contradictory to the fact that total deposits significantly increased after the global financial crisis due to massive expansions in credit by the U.S. government. Nonetheless, I analyze the relative behavior of bank branches in supplying deposits which allows me to isolate from time-varying deposits demand by households. Therefore, the net rise in equilibrium total deposits after the global financial crisis was due to the size of increases in deposits demand compared to the decreases in deposits supply.

5 Bank Lending

In this section, I study the non-monotonic response of banks regarding loan supply in low and high interest rates. Detailed bank loan data is often considered confidential and loan data is only available at the aggregate level. Fortunately, Community Reinvestment Act (CRA) requires all banks with at least one billion dollars in assets to report their total new small business lending[17] at the county level in yearly frequency. I use this dataset and investigate cross-sectional variation in lending patterns across different banks.

The question of how much bank market power affects its lending in low and high market rates requires an approach to control for loan demand differences. I do so by looking at total loans issued by two banks with different levels of market power in one county.

I construct a bank market power index which captures bank-level deposits market HHI. This index considers local market concentration in the areas that a bank has branches and takes deposits and is equal to the weighted average of local market concentration it faces in the deposits market with branch-level total deposits as weights. A branch's weight is its share of total deposits among all branches of the bank in the same year.

The regression I'll use is shown in equation 2 wherein i is bank identifier, c is county identifier, and t is year identifier. $BankHHI$ shows bank market power and Δr is the change in the shadow rate. Since loans are reported for each year, Δr captures the yearly change. $Above1$ is a dummy variable that is one when the market rate is above %1 with which I allow the sensitivity to be different below and above %1 threshold. X is the vector of control variables which includes a combination of $county \times year$, $bank \times county$, county, bank, and year fixed effects.

[17] Hereafter, I'll refer to this variable as SBL

$$
\begin{aligned}
ln(SBL_{i,c,t}) = & \alpha_1 BankHHI_{c,t-1} + \alpha_2 BankHHI_{c,t-1} \times \Delta r_t \\
& + \beta BankHHI_{c,t-1} \times \Delta r_t \times Above1 + \Gamma \times X_{i,c,t} + \epsilon_{i,c,t}
\end{aligned} \quad (2)
$$

The main identification challenge is to isolate from differences in loan demand when comparing total new SBL across different banks. I do so by adding *county* $\times$ *year* fixed effects which controls for time-varying county-level loan demand. Therefore, the regressions effectively compare total new SBL issued by banks with different levels of market power in one county. I use *bank* $\times$ *county* fixed effects to rule out the possibility that some banks have location preferences or operate mainly in their headquarter area, to control for any specific relationship that may exist between local residents in a county and an specific bank including but not limited to special trust or mistrust between bank and residents, bank's soft information on creditworthiness of residents, etc. I also use bank, county, and year fixed effects whenever I don't use the finer *county* $\times$ *year* or *bank* $\times$ *county* fixed effects.

The results are reported in table 2. In all the regressions, only observations in which SBL is at least $200,000 are considered. I cluster the regressions at the bank and county levels. In column one I use *county*$\times$*year* and *bank*$\times$*county* fixed effects. The coefficient in the first line returns the general impact of bank market power on total new SBL and suggests a positive but insignificant relationship exists. The second line, however, returns the differential impact of bank market power below and above %1 threshold and shows that a high-market power bank increases its lending significantly more when the market rate is above %1 compared to when its below %1 following a fall in the market rate. The controls have taken out time-varying local demand and bank-county relationships. Thus, this rise stems from increased bank loan supply and confirms that bank market power has a nonlinear impact on total new SBL in the area. Columns 2 to 5 are alternative specifications to assess robustness of the results. Column two includes *county* $\times$ *year* and bank fixed effects and column three includes *bank* $\times$ *county* and year fixed effects. Column four include county, bank, and year fixed effects and column five does not include any fixed effects. The results are consistent and pretty similar across all specifications.

The results show that the impact is sizable and economically significant. Column one reports that one standard deviation increase in bank market power increases its lending %2.99 more following a one percentage point fall in the market rate in high market rates. The result is positive, small and insignificant in low market rates.

I also do a similar analysis on the number of loans issued by banks with differing levels of market power. The results are reported in table 9 in the appendix. It shows that the number of new loans also follows a similar pattern to total new SBL. The number of new SBL is generally increasing in market power when the market rate falls but this relationship becomes insignificant in low market rates. Column one reports that one standard deviation increase in bank market power increases the number of new loans by 27 more following a one percentage point fall in the market rate in high market rates. The result is insignificant in low market rates.

Table 2: Differences in Total Small Business Lending issued by Different Banks in a County

	(1)	(2)	(3)	(4)	(5)
	Ln(SBL)	Ln(SBL)	Ln(SBL)	Ln(SBL)	Ln(SBL)
Bank HHI $\times \Delta r$	6.830	9.483	4.967	8.150	16.84***
	(0.47)	(0.81)	(0.34)	(0.76)	(3.01)
Bank HHI $\times \Delta r \times$ *Above*%1	-29.70***	-22.32**	-29.44***	-21.36**	-26.01**
	(-2.83)	(-2.04)	(-2.94)	(-2.11)	(-2.26)
Observations	572168	604972	583143	614674	614784
r2	0.849	0.360	0.827	0.334	0.0235
County$\times YearFE$	Y	Y	N	N	N
Bank$\times CountyFE$	Y	N	Y	N	N
County FE	N	N	N	Y	N
Bank FE	N	Y	N	Y	N
Year FE	N	N	Y	Y	N

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

One may argue that the declining margin between short-term and long-term rates limited bank incentives to issue new loans after the unconventional policies flattened the term structure of interest rates to fight the gloabl finnacial crisis. The CRA dataset provides a particularly good answer for this hypothesis as it targets small borrowers who do not have access to financial markets and rely on banks for their funding. The results show that the expansionary effect of monetary policy mutes in low market rates even for this group of borrowers. Since they rely on banks for their funding, bank can charge loans rates that are substantially higher than the long-term rates in the market. Thus, the declining margin cannot explain this change in bank loan supply for small borrowers. Nonetheless, the decreasing elasticity of loan demand from the borrowers in low market rates does not depend on the access to financial markets and works for both small and large borrowers.

6 Bank Beta Analysis

In this section, I turn to the study of bank interest income and expense based on Call reports data to shed light on bank interest rate risk management and establish a link between bank-level deposit supply and loan supply decisions due to that . I first construct bank income and expense betas consistent with those of Drechsler et al. (2021). I use data from 1985 to 2019. I only consider banks that have at least 80 observations (20 years worth of data). Bank Expense ratio equals the interest expenses bank has paid in a quarter divided by its average assets multiplied by four. Since the data is in quarterly frequency, I multiply the variable by four to estimate yearly bank expense ratio. Similarly, I construct bank interest income ratio.

I regress bank ratios on the quarterly changes in the shadow rate and its three lags separately for observations in which the current shadow rate is below and above one percent. Bank beta will be the summation of all these four coefficients. Therefore, I construct two bank income betas and two bank expense betas each for high and low market rates. I winsorize bank betas at the five percent level.
Figures 3 and 4 present binned scattered plots with 50 equally-sized bins. The red line is the regression line. Figure 3 compares bank expense betas in low and high market rates. The top graph shows that there is an almost uniform reduction in bank betas when the market rate falls from high interest rates to low interest rates. The middle and bottom graphs draw the histogram of bank expense beta in low and high market rates and to better observe the shift from high to low market rates. The uniform nature of this reduction makes bank-specific explanations implausible and suggests a cause outside the banking system. Nonetheless, the reduced elasticity of household deposit demand as the market rate falls predicts a uniform reduction in bank beta.

Figure 4 analyzes bank behavior in low market rates and establishes a link from increased bank market power in the deposits market to the composition of assets it chooses to hold. The top graph shows that higher Bank HHI- which is the branch-based market power- corresponds to lower expense betas- which reflects that bank managers perceive higher market power and respond to interest rate changes accordingly. Note that a similar graph for bank expense beta in high market rates would be similar in shape but only with a larger intercept. The middle graph shows the close matching between bank income and expense beta in low market rates which practically leaves the bank unexposed to market rate changes[18]. Note that the composition of bank assets determines its income beta. Such a close matching reflects active risk management by banks so to hedge against the interest rate risk. The bottom graph shows that as bank expense beta falls, banks increase the average repricing maturity of their securities, so to reduce their income beta which confirms the earlier predictions.

The uniform reduction in bank expense beta as the market rate falls and the close matching between bank expense beta and bank income beta reflect that bank income beta falls as the market rate falls. A fall in bank income beta is associated with longer average repricing maturity of assets. That is, banks shift funds from short-lived assets to long-lived ones. Since loans on average have shorter maturity than securities, banks assets comprise a higher fraction of securities and a lower fraction of loans in low market rates. This result explains why banks- more generally, all intermediaries that actively manage their interest rate risk- are reluctant to increase their lending in low market rates compared to high market rates for the same reduction in the market rate.

The securities that banks hold do not have similar maturity structures. In fact, MBS have usually longer maturity than treasuries. Thus, the mechanism predicts that bank assets comprise a higher fraction of MBS compared to treasuries in low market rates. That is exactly what is observed in the middle and bottom graphs of figure 2 as they exhibit a

[18]This close matching was first introduced in Drechsler et al. (2021).

monotone shift from treasuries to MBS in bank assets as the market rate falls.

I next turn to the analysis of bank securities holding. Securities are managed centrally by the banks and so can be only studied at the bank level. I investigate changes in different types of securities holding by banks with differing levels of market power in response to market rate changes in low and high market rates.

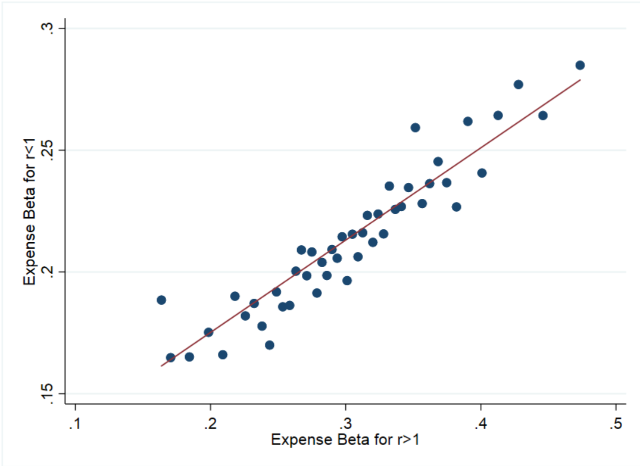
Equation 3 shows the econometric model I use for this section. Bank and quarter indicators are respectively b and t. The dependent variable is the percent change of various balance-sheet items. $BankHHI$ is a lagged indicator of bank market power. I detailed how it's constructed in section 5. r is the shadow rate and $Above1$ is a dummy variable that equals one when the shadow rate is above one percent. To limit the impact of outliers, I winsorize the variables at the five percent.

$$\Delta Ln(Y_{b,t}) = \alpha BankHHI_c \times \Delta r_t + \beta BankHHI_c \times \Delta r_t \times Above1 + \Gamma \times X_{b,t} + \epsilon_{b,t} \quad (3)$$

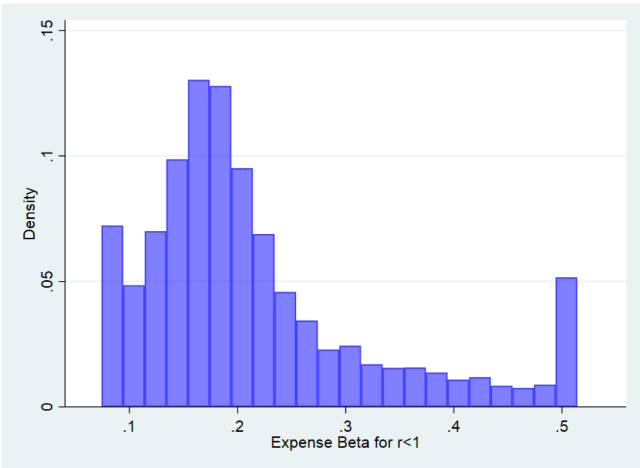
Table 3 shows the percentage change of bank securities holding for changes in the market rate at different levels of bank market power. I control for bank and quarter fixed effects in all the regressions. Columns one, two, and three respectively report results for total securities, total treasuries, and total MBS. All the columns show a change in behavior when the market rate falls below one percent. Column one shows that one standard deviation increase in bank market power, increases total securities holdings by about %0.60 for a one percentage point fall in the market rate in low market rates whereas it decreases by about %0.34 for a similar change in high market rates which suggests the impact observed in the top graph of figure 2 is due to the increased market power of bank in low market rates.
Furthermore, the results show a clear substitution between treasuries holdings and MBS holdings. A one standard deviation increase in bank market power decreases the share of MBS by %0.24 and increases the share of treasuries by %0.93 for a one percentage point fall in the market rate in low market rates. Interestingly, the opposite holds in high market rate as the traditional transmission channels become the dominant factors.

7 Local Economic Performance

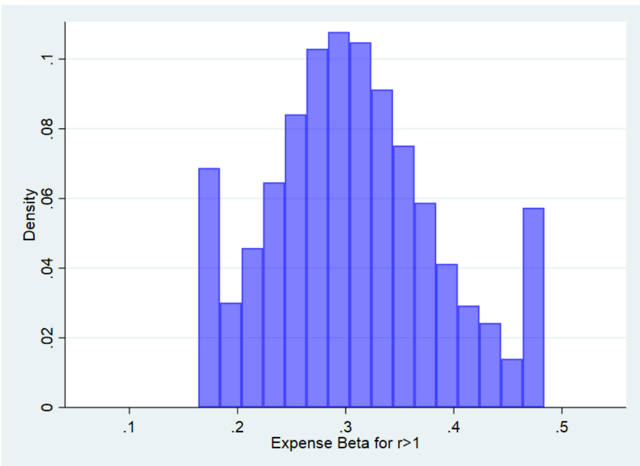
The impaired transmission of monetary policy brings its own disruptions in economic performance in areas affected by it. I study how bank loan supply affects local economic performance in this section. Counties are different in terms of their exposure to bank market power. The exposure is different from local market concentration as it does not reflect the competition level in the county (which is the case in local market concentration), instead it



(a) Binned Scattered Plot of Bank Expense Beta in Low versus High Market Rates

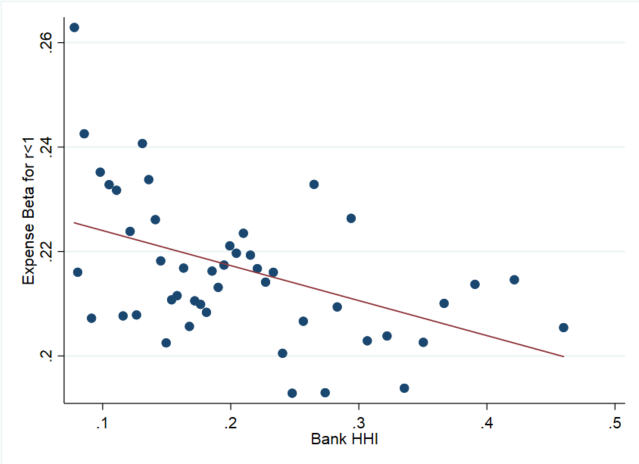


(b) Histogram of Bank Expense Beta in Low Market Rates

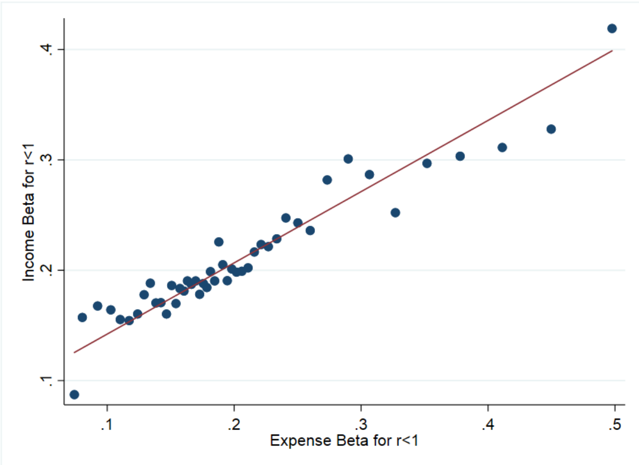


(c) Histogram of Bank Expense Beta in High Market Rates

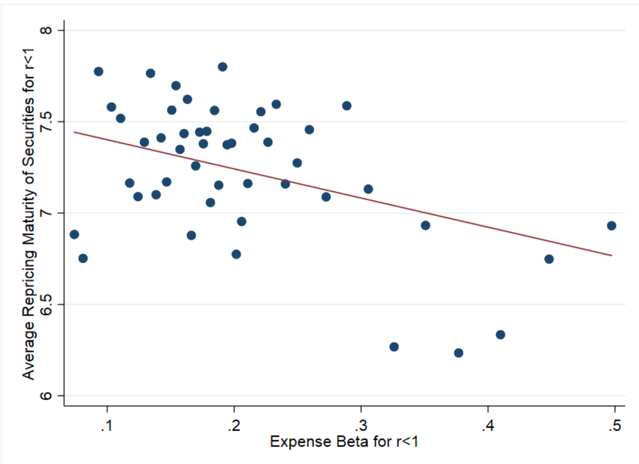
Figure 3: Bank Expense Beta in Low and High Market rates
There is an almost uniform reduction in bank betas across all banks in low market rates compared to high market rates. Computed bank betas are winsorized at %5 levels.



(a) Bank Expense Beta in Low Market Rates versus Bank HHI



(b) Binned Scattered Plot of Bank Income Beta versus Expense Beta in Low Market Rates



(c) Average Repricing Maturity in Low Market Rates versus Bank Expense Beta in Low Market Rates

Figure 4: The graphs are drawn using the corresponding data in low market rates. The top graph shows that a bank with higher Bank HHI level, has lower bank expense beta. The middle graph shows active risk management of a bank wherein expense beta and income beta are tightly matched. The bottom graph shows the matching is achieved by raising average repricing maturity of assets. Computed bank betas are winsorized at %5 levels.

Table 3: The Response of Bank Securities Holding to Market Rate changes in Different Levels of Bank Concentration

	(1) $\Delta Ln(Sec)$	(2) $\Delta Ln(SecTr)$	(3) $\Delta Ln(SecMBS)$
Bank HHI $\times \Delta r$	-6.078***	-9.305***	2.394**
	(-11.89)	(-11.77)	(2.16)
Bank HHI $\times \Delta r \times Above\%1$	9.480***	15.05***	-13.07***
	(15.59)	(16.29)	(-8.84)
Observations	664180	664180	498233
r2	0.0225	0.0176	0.0311
Bank FE	Y	Y	Y
Quarter FE	Y	Y	Y

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

reflects the average market power the banks active in the county maintain nationally. Thus, a county can have a low level of local market concentration but a high level of exposure to bank market power[19]. I construct a measure of exposure to capture this difference. County exposure equals the weighted average of bank market power using banks' local market shares as weights.

I use this measure to analyze how changes in the market rate differentially impact counties. The regression I'll use is shown in equation 4. The index c is county identifier and t is year identifier. $CountyExposure$ shows county exposure to bank market power and Δr is the change in the market rate. $Above1$ is a dummy variable that is one in high market rates with which I allow the sensitivity to be different below and above %1 threshold. X is the vector of control variables which includes year and county fixed effects. I'll study multiple dependent variables.

$$\begin{aligned} \Delta Y_{c,t} = &\alpha_1 CountyExposure_c + \alpha_2 CountyExposure_c \times \Delta r_t \\ &+ \beta CountyExposure_c \times \Delta r_t \times Above1 + \Gamma \times X_{c,t} + \epsilon_{c,t} \end{aligned} \tag{4}$$

The first row reflects the general impact of a rise in the county exposure on the variable and the second row reflect the additional impact at high market rates.

Table 4 explores the bank mortgage lending from the perspective of the competition between banks and FinTech-based lenders. If banks shrink their supply of mortgages in low market rates, total mortgage lending should become less sensitive to market rate changes in low market rates. Additionally, since FinTech-based lenders substitute traditional lenders in the market, a less responsive bank mortgage supply should yield a less responsive FinTech-based mortgage supply. The results in table 4 strongly confirm our expectations. Dependent

[19] Nonetheless, banks with higher county HHI usually have higher county exposure. See figure 9

variables are total mortgage lending and FinTech-based mortgage lending in a county in a year. The data is from the online appendix of Fuster et al. (2019) and cover 2010 to 2017. I winsorize total mortgage lending and total FinTech-based lending at the five percent. Column one shows that one standard deviation increase in the county exposure leads to a %1.1 increase in total mortgage lending in high market for a one percentage point fall in the market rate. Nonetheless, this impact almost entirely fades away in low market rates. Column two serves as the robustness check when I include county's own concentration in the specification. The results are almost unchanged after adding county HHI.

Column three shows that the impact is even bigger on FinTech-based lending. In fact, one standard deviation rise in county exposure results in a massive %2.95 fall in FinTech-based lending in high market rates which drops to a smaller %0.57 fall in low market rates. The fourth column serves as robustness check. The results confirm the role of FinTech-lenders as being substitutes to traditional lenders.

Table 4: New Mortgage Lending and Its Response to Market Rate changes at Different Levels of Local Market Exposure to Bank Concentration

	(1) Ln(TML)	(2) Ln(TML)	(3) Ln(FML)	(4) Ln(FML)
County Exposure $\times \Delta r$	0.659	1.140	9.620**	11.82**
	(0.24)	(0.40)	(1.97)	(2.21)
County Exposure $\times \Delta r \times Above\%1$	-18.18**	-18.08**	39.71**	40.18**
	(-2.47)	(-2.46)	(2.35)	(2.38)
County HHI $\times \Delta r$		-0.491		-2.246
		(-0.59)		(-1.09)
Observations	19350	19350	19350	19350
r2	0.993	0.993	0.963	0.963
Year FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Next, I use data on local house prices obtained from Zillow and study how county exposure affects local prices. I use three dependent variables that show bottom-tier, typical, and top-tier house prices in a county in a year. Zillow emphasises that the typical price is not the median price but a crafted measure that better captures house price level. Since in high market rates mortgage lending rises more in high-exposure counties following an interest rate fall, it is expected that house price also follows a similar pattern. Additionally, since this effect fades away in low interest rates, it is expected that the impact on house price to fade away in low interest rates as well.

The results in table 5 confirm our predictions. Column one studies the behavior of a top-tier house price and shows the impact of county exposure on house prices shrinks in low market rates. A one standard deviation rise in county exposure results in a %0.36 increase in house prices in high market rates for one percentage point fall in the market rate. The result is robust to adding county's own local market concentration as shown in column two. Columns three and four analyse the behavior of a typical house prices and columns five and six analyse the behavior of bottom-tier house prices. All the results are similar in magnitude and sign.

Table 5: House Price and Its Response to Market Rate changes at Different Levels of Local Market Exposure to Bank Concentration

	(1) $\Delta Ln(Price)$	(2) $\Delta Ln(Price)$	(3) $\Delta Ln(Price)$	(4) $\Delta Ln(Price)$	(5) $\Delta Ln(Price)$	(6) $\Delta Ln(Price)$
County Exposure $\times \Delta r$	-0.889***	-1.059***	-1.001***	-0.905**	-1.259***	-1.132***
	(-2.68)	(-2.80)	(-3.01)	(-2.38)	(-3.60)	(-2.78)
County Exposure $\times \Delta r \times Above\%1$	-5.233***	-5.233***	-5.670***	-5.671***	-5.746***	-5.746***
	(-6.22)	(-6.21)	(-6.39)	(-6.40)	(-6.45)	(-6.45)
County HHI $\times \Delta r$		0.141		-0.0788		-0.105
		(0.81)		(-0.43)		(-0.57)
Observations	40606	40606	40549	40549	40461	40461
r2	0.523	0.523	0.510	0.510	0.511	0.511
House Tier	Top	Top	Typical	Typical	Bottom	Bottom
Year FE	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

8 Conclusions

This paper provides an alternative explanation for the declining impact of monetary policy in low market rates that does not depend on bank-specific capital regulations or agency frictions. Rather, it is due to increased market power of intermediaries in low market rates as well as their active risk management.

As the market rate falls, the households become less responsive to market rate changes since they increase the share of deposits and cash in their portfolio of assets and these two investment options are only partially responsive to market rate changes. Thus, bank's effective market power increases in low market rates which lowers its sensitivity of interest expenses to market rate. As an entity with increased market power, bank reduces the supply of deposits and loans. Furthermore, to hedge the interest rate risk, bank chooses a portfolio that is less responsive to the market rate. Since securities have longer maturity duration than loans, banks shift funds from loans towards securities. Thus, total lending falls as the market rate falls. I provide extensive empirical evidence supporting this mechanism in the deposits market and loans market. The outlined mechanism does not depend on bank-specific characteristics and applies to all intermediaries and thus, helps explain the slow recovery and stable inflation after the global financial crisis in the presence of other types of intermediaries that were not bound by capital regulations.

This paper focuses on the size and composition of bank lending. An interesting path forward is to look at the riskiness of bank lending and how it changes in different market rates. Since banks raise their originate-to-distribute share of total loans in low market rates, they effectively control their risk exposure to market rates as well. Whether the bank lending behavior is different when such an opportunity exists is also an interesting topic that can be explored further.

Even though this paper focuses on the economic recovery after the financial crisis, The mechanisms studied in this paper and the insights it provides are general and also apply to the economic issues after the COVID-19 shock and the monetary responses to that. It is actually of particular interest to study the net impact of the government policies in response to COVID shock on bank lending as it involves sizable cash injections through the Paycheck Protection Program (PPP) in additions to expansionary monetary policies.

References

Allen, F. and D. Gale (2004). Competition and financial stability. *Journal of money, credit and banking*, 453–480.

Basten, C. and M. Mariathasan (2018). How banks respond to negative interest rates: Evidence from the swiss exemption threshold.

Begenau, J., M. Piazzesi, and M. Schneider (2015). Banks' risk exposures. Technical report, National Bureau of Economic Research.

Brunnermeier, M. K. and Y. Koby (2018). The reversal interest rate. Technical report, National Bureau of Economic Research.

Corbae, D., P. D'Erasmo, et al. (2021). Capital buffers in a quantitative model of banking industry dynamics. *Econometrica 8*.

Drechsler, I., A. Savov, and P. Schnabl (2017). The deposits channel of monetary policy. *The Quarterly Journal of Economics 132*(4), 1819–1876.

Drechsler, I., A. Savov, and P. Schnabl (2021). Banking on deposits: Maturity transformation without interest rate risk. *The Journal of Finance 76*(3), 1091–1143.

Eggertsson, G. B., R. E. Juelsrud, L. H. Summers, and E. G. Wold (2019). Negative nominal interest rates and the bank lending channel. Technical report, National Bureau of Economic Research.

Eggertsson, G. B., R. E. Juelsrud, and E. G. Wold (2017). Are negative nominal interest rates expansionary? Technical report, National Bureau of Economic Research.

Fuster, A., M. Plosser, P. Schnabl, and J. Vickery (2019). The role of technology in mortgage lending. *The Review of Financial Studies 32*(5), 1854–1899.

Gertler, M. and P. Karadi (2011). A model of unconventional monetary policy. *Journal of monetary Economics 58*(1), 17–34.

Gertler, M. and N. Kiyotaki (2015). Banking, liquidity, and bank runs in an infinite horizon economy. *American Economic Review 105*(7), 2011–43.

Gilje, E. P., E. Loutskina, and P. E. Strahan (2016). Exporting liquidity: Branch banking and financial integration. *The Journal of Finance 71*(3), 1159–1184.

Heider, F., F. Saidi, and G. Schepens (2019). Life below zero: Bank lending under negative policy rates. *The Review of Financial Studies 32*(10), 3728–3761.

Heider, F., F. Saidi, and G. Schepens (2021). Banks and negative interest rates.

Kashyap, A. K. and J. C. Stein (2000). What do a million observations on banks say about the transmission of monetary policy? *American Economic Review 90*(3), 407–428.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American economic review*, 1183–1200.

Li, W., Y. Ma, and Y. Zhao (2019). The passthrough of treasury supply to bank deposit funding. *Columbia Business School Research Paper, USC Marshall School of Business Research Paper*.

Müller, C. and F. Noth (2018). Market power and risk: Evidence from the us mortgage market. *Economics Letters 169*, 72–75.

Peck, J. and A. Setayesh (2021). Bank runs and the optimality of limited banking. Technical report.

Peck, J. and K. Shell (2010). Could making banks hold only liquid assets induce bank runs? *Journal of Monetary Economics 57*(4), 420–427.

Repullo, R. (2020). The reversal interest rate: A critical review. *CEPR Discussion Papers* (15367).

Scharfstein, D. and A. Sunderam (2016). Market power in mortgage lending and the transmission of monetary policy. *Unpublished working paper. Harvard University 2.*

Setayesh, A. (2019). Heterogeneous intermediaries and stability in financial networks. *Working Paper*.

Sims, E. R. and J. C. Wu (2019). The four equation new keynesian model. Technical report, National Bureau of Economic Research.

Wang, Y., T. M. Whited, Y. Wu, and K. Xiao (2020). Bank market power and monetary policy transmission: Evidence from a structural estimation. Technical report, National Bureau of Economic Research.

Wu, J. C. and F. D. Xia (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking 48*(2-3), 253–291.

9 Appendix

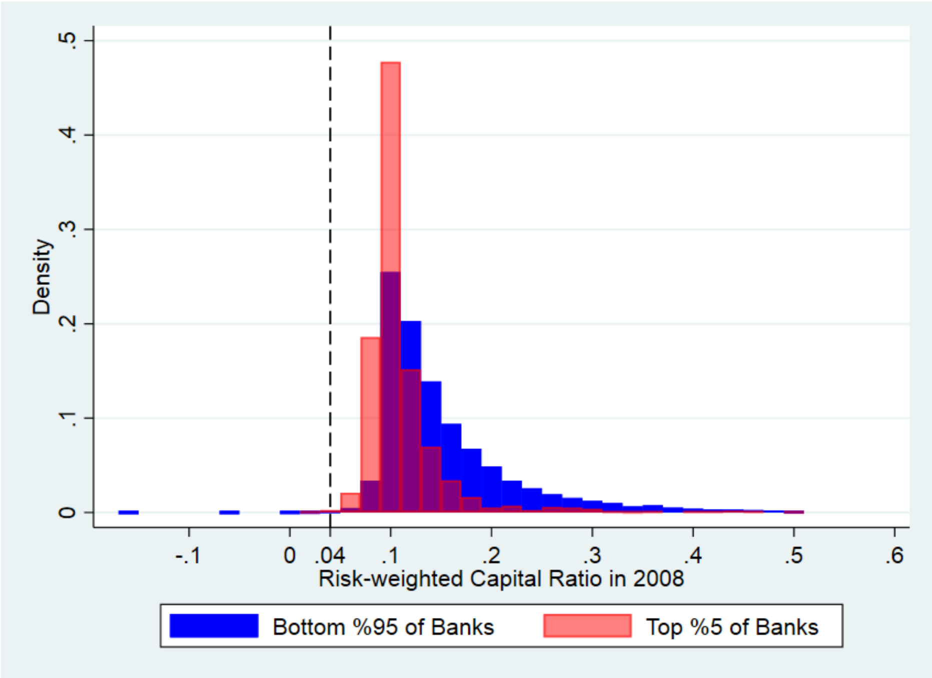


Figure 5: The distribution of risk-wighted capital ratio of U.S. banks at the height of the crisis in year 2008.
Bank information is obtained from Call reports.

Table 6: Summary Statistics of Important Variables

	Mean	s.d.	Observations
Branch			
Deposits (Million $)	80.93	1411.70	2,431,393
County			
# Branches	27.99	69.22	3,225
County HHI	0.25	0.23	3,225
County Exposure	0.13	0.06	2,962
Small Business Lending			
SBL (Million $)	2.55	13.48	1,962,744
# SBL	72.93	663.11	1,962,744
Bank			
Log(Assets)	11.99	1.38	7,254
Deposit Share	0.73	0.09	6,995
Bank HHI	0.20	0.10	15,468
Expense Beta	0.29	0.07	7,013
Expense Beta (r>1)	0.31	0.08	7,013
Expense Beta (r<1)	0.22	0.11	7,013
Income Beta	0.30	0.11	7,013
Income Beta (r>1)	0.31	0.13	7,013
Income Beta (r<1)	0.22	0.19	7,013
County-Level Mortgage Lending			
FML(Million $)	30.30	149.99	23,888
TML(Million $)	567.60	2573.29	23,888
County-Level House Price 2000			
Typical Home Value ($)	113,164	65,060	1,244
Top-tier Home Value ($)	198,155	132,390	1,251
Bottom-tier Home Value ($)	67,724	45,141	1,236
County-Level House Price 2010			
Typical Home Value ($)	134,043	84,367	2,543
Top-tier Home Value ($)	228,921	160,839	2,544
Bottom-tier Home Value ($)	81,948	58,318	2,542

Table 7: Differences in Deposit Growth of a Bank's Branches in Different Counties in response to target rate changes
Only branches that have been active for at least ten years are included . All the regressions cluster observations at the county level. $CountyHHI$ shows local market concentration in the county and Δr is the change in the target rate. $Above1$ is a dummy variable that is one when the market rate is above %1 threshold.

	(1) $\Delta Ln(Dep)$	(2) $\Delta Ln(Dep)$	(3) $\Delta Ln(Dep)$	(4) $\Delta Ln(Dep)$	(5) $\Delta Ln(Dep)$
County HHI $\times \Delta r$	9.872***	5.472***	5.185***	4.706***	4.410***
	(7.05)	(5.00)	(4.54)	(4.60)	(4.10)
County HHI $\times \Delta r \times Above\%1$	-9.957***	-5.519***	-5.241***	-4.555***	-4.298***
	(-6.69)	(-4.69)	(-4.34)	(-4.20)	(-3.83)
Observations	1426447	1426447	1426324	1421397	1421272
r2	0.150	0.156	0.240	0.173	0.255
Bank$\times State \times YearFE$	N	N	N	Y	Y
Bank$\times YearFE$	Y	Y	Y	Y	Y
State$\times YearFE$	Y	Y	Y	Y	Y
Branch FE	N	N	Y	N	Y
County FE	N	Y	Y	Y	Y

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Differences in Deposit Growth of a Bank's Branches in Different Counties in response to shadow rate changes at Different shadow Rate intervals
Only branches that have been active for at least ten years are included . All the regressions cluster observations at the county level. $CountyHHI$ shows local market concentration in the county and Δr is the change in the shadow rate.

	(1) $\Delta Ln(Dep)$	(2) $\Delta Ln(Dep)$	(3) $\Delta Ln(Dep)$	(4) $\Delta Ln(Dep)$	(5) $\Delta Ln(Dep)$
County HHI $\times \Delta r$	11.41***	0.909***	-2.311***	-10.03**	-1.261*
	(5.01)	(2.94)	(-2.65)	(-2.07)	(-1.92)
Observations	431059	309571	150072	59174	372453
r2	0.356	0.441	0.500	0.587	0.422
Shadow Rate	r<%0	$\%0 \leq r < \%1$	$\%1 \leq r < \%2$	$\%2 \leq r < \%3$	$\%3 \leq r$
Bank$\times State \times YearFE$	Y	Y	Y	Y	Y
Bank$\times YearFE$	Y	Y	Y	Y	Y
State$\times YearFE$	Y	Y	Y	Y	Y
Branch FE	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

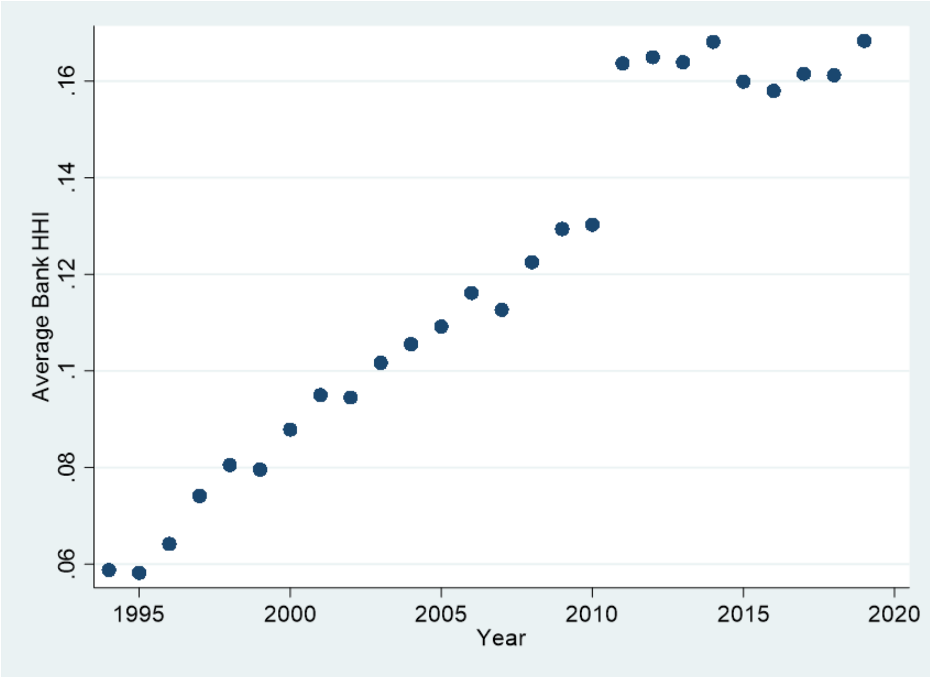
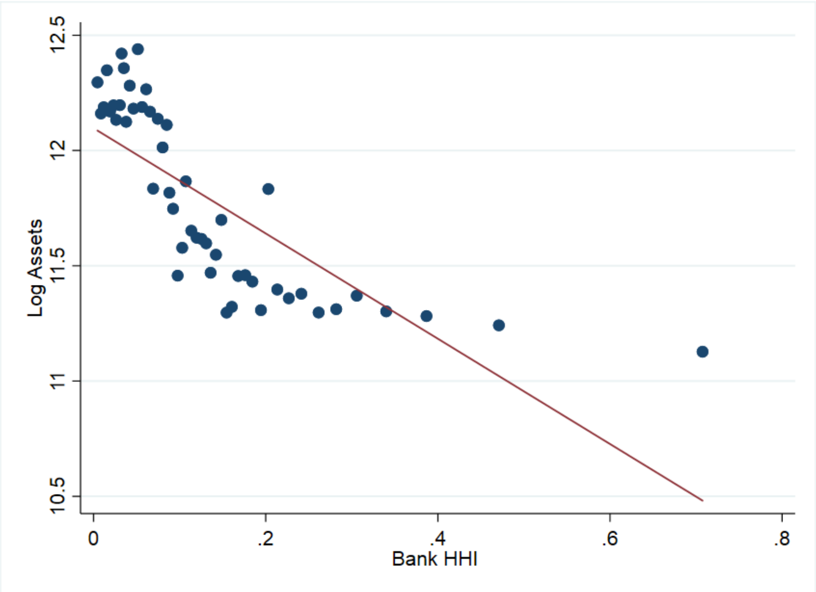


Figure 6: Secular Growth in Bank Concentration over the last 30 years.
Bank information is obtained from Call reports. For a detailed description on the construction of Bank market power index (Bank HHI) look at section 5

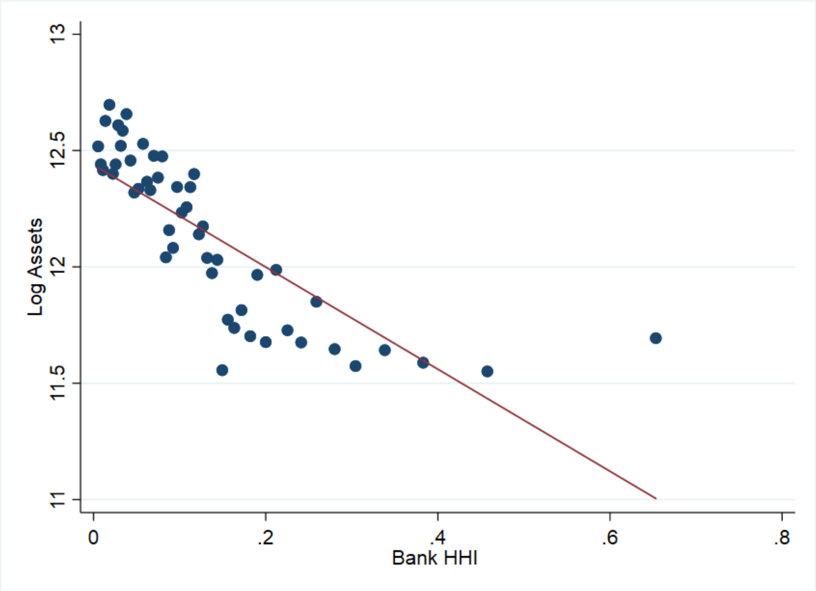
Table 9: Differences in the Number of Small Loans issued by Different Banks in a County

	(1) # SBL	(2) # SBL	(3) # SBL	(4) # SBL	(5) # SBL
Bank HHI $\times \Delta r$	-56.93	-45.50	-57.69	-32.94	-31.41
	(-0.70)	(-0.77)	(-0.78)	(-0.73)	(-0.98)
Bank HHI $\times \Delta r \times$ *Above*%1	-275.3***	-180.9**	-223.6***	-126.8***	-54.97
	(-3.40)	(-2.31)	(-3.53)	(-2.59)	(-0.66)
Observations	572168	604972	583143	614674	614784
r2	0.716	0.139	0.702	0.126	0.00526
County$\times YearFE$	Y	Y	N	N	N
Bank$\times CountyFE$	Y	N	Y	N	N
County FE	N	N	N	Y	N
Bank FE	N	Y	N	Y	N
Year FE	N	N	Y	Y	N

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



(a) Snapshot of Year 2000



(b) Snapshot of Year 2010

Figure 7: Bank market power versus bank asset size
For a detailed description on the construction of bank market power (Bank HHI) look at section 5

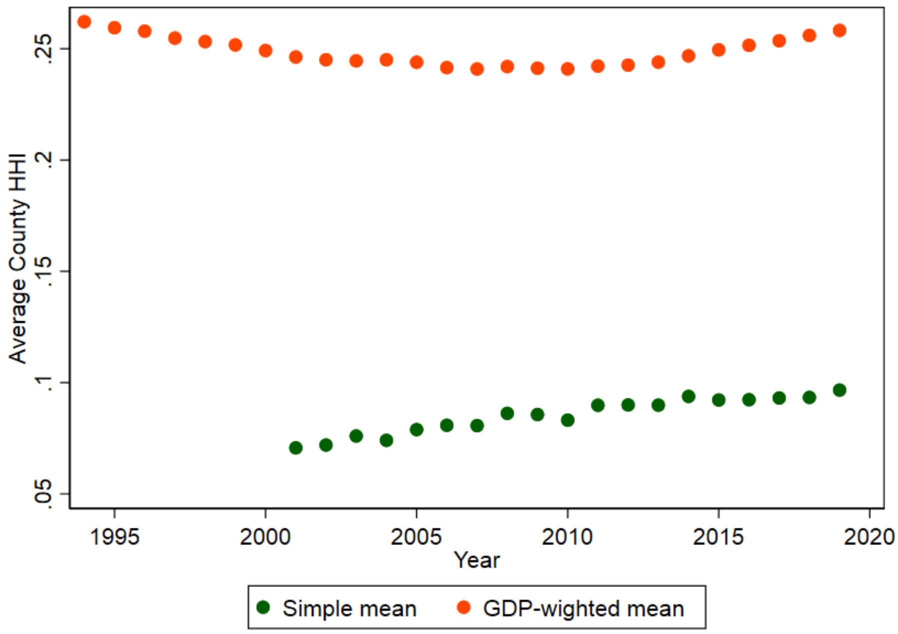


Figure 8: Average local market concentration over time
For a detailed description on the construction of local market concentration index (County HHI) look at section 4

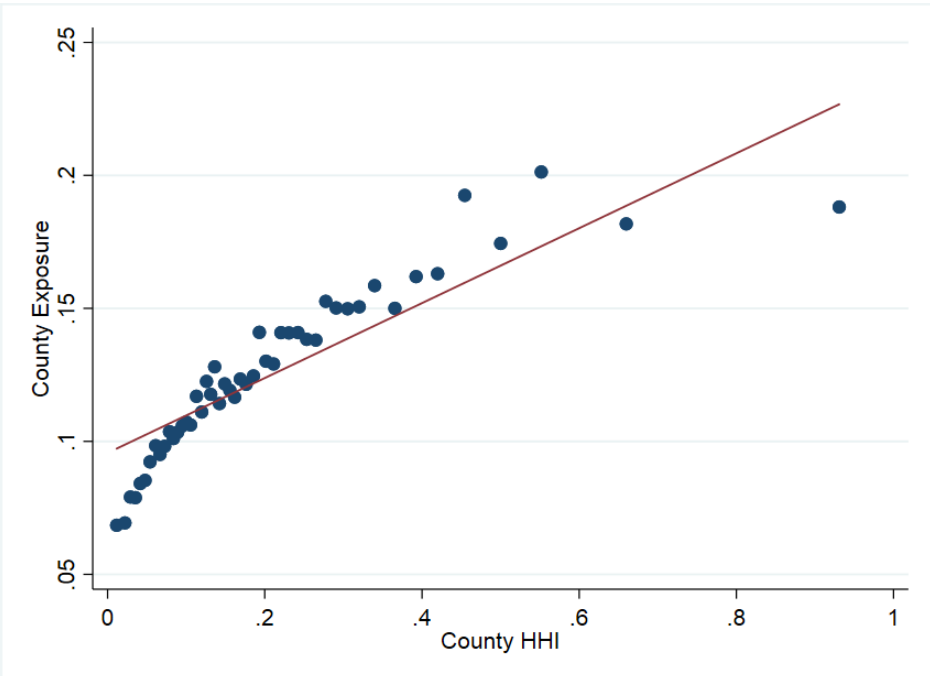


Figure 9: County exposure to bank market power and local market concentration
For a detailed description on the construction of county HHI and county exposure respectively look at sections 4 and 7.