

Supply of Private Safe Assets: Interplay of Shadow and Traditional Banks *

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Abstract

We show that the creation of private safe assets by shadow banks can crowd out traditional banks' supply of safe assets. The 2014-2016 money fund reform created a large demand shock for safe assets, to which Federal Home Loan Banks (FHLBs) responded, expanding their balance sheets and increasing their issuance of short-term debt. To reduce the resulting interest rate risk, FHLBs shortened the repricing of their loans to banks. Focusing on small banks for which the reform was exogenous, we use a novel instrumental variable strategy to show that shadow banks create safe assets at the expense of banks' deposits.

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1 Introduction

Do shadow banks increase the total supply of private safe assets? Non-bank financial institutions have become important providers of money-like claims (Gorton, Lewellen & Metrick 2012). Shadow banks can satisfy the demand for such claims left unmet by the public sector (Sunderam 2014). Unlike the public sector, private suppliers cannot issue more safe debt without holding more assets to back their liabilities. An expansion of shadow banks' balance sheets may affect the issuance of safe debt by other financial institutions, for example traditional banks. While the interaction between private and public providers of safe assets is well documented (Krishnamurthy & Vissing-Jorgensen (2012); Greenwood, Hanson & Stein (2015)), the interaction of different private providers of safe assets is much less understood.

In this paper we focus on the creation of safe assets by the shadow banking system and its effects on the creation of safe assets by the traditional banking system. We study how a specific producer of safe debt, the Federal Home Loan Banks (FHLBs), reacted to a large demand shock for safe assets created by the 2016 money fund reform. Using data on money funds, FHLBs, commercial banks, and thrifts, we study how the creation of safe debt by private non-depository institutions directly influenced banks' supply of deposits as well as their assets structure.¹

The interaction between shadow banks and traditional banks has important implications for the transmission of monetary policy. The traditional banking system is still thought to be a cornerstone in how monetary policy affects the economy, for example via the credit channel (Bernanke & Gertler 1995) or the deposit channel (Drechsler, Savov & Schnabl 2017). Yet the shadow banking system or reforms of it have the potential to amplify or dampen monetary policy via the interlinkages to the traditional banking sector.

Any study of banks' reaction to changes in their funding conditions offered by shadow banks faces the classical identification challenge—banks' balance sheets are endogenous. Simultaneous changes in wholesale and deposit funding may simply reflect new growth prospects. To make a causal statement how shadow banks' choices influence banks' decisions, we need to disentangle these channels.

To address this identification problem, we make use of a regulatory reform that was a

¹The importance of traditional banks is the subject of a large theoretical literature, for example Diamond & Dybvig (1983); Gorton & Pennacchi (1990); Stein (2012); DeAngelo & Stulz (2015); Dang, Gorton, Holmström & Ordóñez (2017)

clear demand shock for shadow bank debt. In October 2016, the SEC money fund reform went into effect. The reform meant drastic changes to the money fund industry—funds were now not allowed anymore to post a stable net asset values and funds could limit withdrawals in certain circumstances. One type for money fund, government funds, were exempt from most changes. This exemption led to a massive rebalancing of the money fund industry in the months prior to the implementation of the reform: More than \$ 1 trillion went from mostly prime funds into government money funds. This sudden inflow shifted the demand for debt that these funds can invest in.

With their fixed issuance schedules, public providers of safe assets could not respond in the short term. The shadow banking system could, and in particular the FHLB system reacted to money funds' heightened demand. This system of wholesale banks usually finances itself through debt and invests the proceeds into loans to members, mostly commercial banks. As FHLBs issued more short-term debt or debt with frequent interest rate resets, frequent repricing, their interest rate risk grew. To mitigate this risk, they increased the frequency of repricing of their new loans to commercial banks, known as advances. These changes on FHLBs' assets side establish the link between the shadow banking system and the traditional banking system (Figure 1).

How did the increased issuance of safe shadow bank debt affect commercial banks' supply of deposits? To answer this question, we first show that banks' uptake of new FHLB advances depended on their medium- to long-term business model. Carefully matching assets and liabilities (Drechsler et al. 2017), not all banks could take advantage of cheap funding that bears higher interest rate risk through frequent repricing. As FHLBs changed the terms of their loans, only banks with historically more frequent repricing of liabilities increased their use of FHLB loans.

In an instrumental variable strategy, we focus on banks which are otherwise unaffected by the money fund reform. We use the pre-determined differential uptake of FHLB funding and the demand shock from government funds for FHLB debt as exogenous variation to these banks' use of FHLB loans. In the first stage we explain banks' FHLB funding by the interaction of government money funds' relative assets under management (AUM) and a bank's historical liabilities repricing. This interaction is exogenous to banks' investment opportunities and other unobserved variables. It affects banks' supply of deposits and other outcome variables only through the effect on FHLB funding.

Our main result is that as FHLBs' issue more safe debt, banks decrease deposit supply. To accommodate money funds' demand, FHLBs need to increase their balance sheet. Banks taking up the newly issued loans, FHLBs new assets, use these loans as almost perfect substitutes for deposits. Commercial banks mainly decrease retail deposits, while increasing longer-term time deposits. This counteracts the risk taken on by shorter FHLB advances. On the assets side, banks do not change their lending. They do, however, decrease their cash holding since fewer deposits require less reserves. Using price data, banks with more FHLB loans decrease their deposit rates. This leads to lower interest expenses on deposits, but higher interest expenses for other sources of funding. Non-interest expenses decrease and overall, net income increases.

Our analysis is based on several key assumptions. First, the money fund reform was exogenous to banks and had no direct influence on their funding conditions. This assumption clearly does not hold for large banks. Money leaving prime money funds means less demand for banks' commercial paper. We therefore exclude all banks with assets larger than \$10 billion and concentrate on small banks; banks that did not use wholesale funding from money funds and receive one-third of advances.

A second concern is that the period we investigate saw the Federal Reserve lifting interest rates after a long period of very low rates. A bank's business model and liabilities repricing may interact with these changes and have an effect on deposit supply and use of FHLB advances. Yet all our results are robust to including the interaction of repricing and the fed funds rate in our IV setting.

The results are further unaffected by controlling for local economic conditions via county-time fixed effects. Looking at different bank size buckets does not change the results and neither does the use of weighted least squares, where observations are weighted by banks' asset size.

These results add to the active field of research on the demand and supply of safe assets summarized by Gorton (2017). While most early papers mainly focus on public supply of safe assets, the financial crisis of 2007-2009 has sparked interest in the private creation of safe assets.² Gorton et al. (2012) relate the growth of the shadow banking system to the ongoing decrease in bank deposits since the 1980s. They argue that the shadow banking system stepped in to make up for the decrease in safe asset supply. Sunderam (2014)

²On the interaction between public and private safe debt see, for example Holmström & Tirole (1998), Krishnamurthy & Vissing-Jorgensen (2015), Gorton et al. (2012)

focuses on the run-up to the last financial crisis and argues that the demand for money-like assets contributed to the growth of the shadow banking system. While Gorton et al. (2012) focus on long-run developments, our paper adds to this interaction between the shadow banking system and the traditional banking system by focusing on the short-to-medium term. We also document how regulatory changes in the shadow banking system directly affect the creation of deposits in the banking sector.

Nagel (2016) examines the elasticity of substitution between deposits and public debt as an explanatory factor for the liquidity premium. While not directly estimating a liquidity premium, we add to this literature a specific case of substitution between different kinds of safe assets.³

Kacperczyk, Perignon & Vuillemeys (2017) find that short-term private securities trade at a premium for their non-pecuniary benefits. They find that banks react to increased safe-asset demand by issuing debt with shorter maturity. We provide further evidence that this behavior is not bound to the period around the financial crisis. FHLBs reacted similarly to increased demand from money funds.

We also add to the banking literature that examines how banks match the risks of their assets and liabilities. Drechsler, Savov & Schnabl (2018) document that banks match their interest rate risk on both sides of their balance sheet. We show that this matching can limit the use of certain types of funding in the short- to medium-run.

Our findings have implications for the transmission of monetary policy. Drechsler et al. (2017) document the deposit channel of monetary policy. We document how reforms outside the central banks' control can affect banks' deposit supply and reserve holdings.

The next section describes the FHLB system and the money fund reform. Section 3 lays out our empirical strategy. We describe our data in Section 4. Section 5 presents the main results. We address several identification concerns in Section 6. Section 7 concludes.

2 Institutional background

This section provides institutional background. Subsection 2.1 gives an overview of the FHLB system, and subsection 2.2 summarizes the money funds and the money fund

³Several papers connect the time-variation in the liquidity premium to the overall supply of safe assets. See, for example, Krishnamurthy & Vissing-Jorgensen (2012) Greenwood et al. (2015)

reform in the second part. Subsections 2.3 and 2.4 document the effects of the money reform on FHLB debt and FHLBs' assets structure.

2.1 The Federal Home Loan Banks

The Federal Home Loan Bank (FHLB) system was created by the FHLB Act of 1932 to help the liquidity of the mortgage market. Today, the system comprises 11 independent, regional wholesale banks and the national Office of Finance, the system's centralized debt issuance facility. Each FHLB is owned by its member institutions, which have equity stakes in the FHLB and must reside in the FHLB's district. Membership is available to commercial banks, thrifts, credit unions, and insurance companies.

FHLBs provide wholesale funding to their members by extending over-collateralized loans, known as advances. Advances are available in various maturities with either fixed or variable interest rates.⁴ Each FHLB independently chooses the interest rates of its advances and the haircuts on its members' collateral.⁵ Figure 2 shows the evolution of advances and FHLB's borrowers. During recent years, the FHLB system expanded. Most of the growth was due to loans to large commercial banks. At the end of 2016, commercial banks with assets over \$50bn accounted for about half of FHLBs' outstanding loans.⁶ In this paper we will not use the growth in advances to large banks and limit ourselves to depository institutions with total assets below \$10bn in 2010, which receive more than one-third of advances to thrifts and commercial banks (Figure 3).⁷

⁴Other than loans to their members, FHLBs invest in mostly mortgage-related securities and hold a fraction of their assets in federal funds, repo, and interest bearing deposits as their contingent liquidity buffer.

⁵All FHLB advances are subject to the statutory super-lien, which means that in the case of the borrower's insolvency, any security interest granted to an FHLB has priority over the claims and rights of any other party. The super-lien on collateral has facilitated FHLBs' ability to lend to a variety of institutions, from subsidiaries of large insurance and bank holding companies to small saving banks and credit unions that might otherwise not have access to funding from investors who cannot secure such protection.

⁶This is a marked shift from the past: Whereas commercial banks with assets over \$50 billion accounted for less than 2 percent of overall advances in 2000, their share climbed to around 50 percent by the end of last year. The main motivation for the more recent rise in FHLB borrowing by large banks seems to be their incentive to engage in a "collateral upgrade" to help satisfy the requirements of the Liquidity Coverage Ratio (LCR) that banks are now subject to as part of the Basel III. Banks can post less-liquid assets such as whole mortgage loans to FHLBs as collateral against advances and use the proceeds to buy high quality liquid assets (HQLA). As long as FHLB advances have a remaining maturity of longer than 30 days, this strategy will improve the borrowing banks' LCRs. Also, the favorable treatment of FHLB advances in the LCR helps borrowing banks even with advances due within 30 days. Anecdotal evidence suggests that large banks are indeed motivated to borrow from the FHLBs for this reason.

⁷Because of the LCR rule, large banks had an incentive to increase their FHLB borrowing. We will

To fund their assets, FHLBs issue debt. Investors consider this debt as safe for two main reasons. First, the debt is jointly issued by the Office of Finance. All FHLBs have joint and several liability for the outstanding debt—if one bank is in trouble, the rest of the system has to help. Further, investors do not know which FHLB receives the debt proceeds, making FHLB debt information-insensitive (Gorton (2017)).

Second, investors perceive FHLB debt to have an implicit government guarantee due to the FHLBs’ government-sponsored entity (GSE) status. Yet FHLBs are privately owned and the federal government has no obligation to honor FHLB debt payments apart from a \$4bn credit line from the Department of Treasury. FHLBs stress this fact on the first page of their financial statements: “Federal Home Loan Bank obligations are not obligations of the United States and are not guaranteed by either the United States or any government agency”.⁸ This fact is also stressed by their investors, as for example the prospectus of a government money fund shows: “ U.S. government-sponsored entities (“GSEs”) ... may be chartered by Acts of Congress, but their securities are neither issued or guaranteed by the U.S. government.”⁹ This lack of an explicit guarantee distinguishes FHLB debt from public debt and makes it “private safe debt”. Together with FHLBs’ lack of deposit taking, FHLBs form part of the “government-sponsored shadow banking system”, issuing private safe debt (Poszar, Adrian, Ashcraft & Boesky (2013)).

2.2 The 2014-2016 SEC money fund reform

The largest investors in FHLB debt, money market funds, experienced a major reform in 2016. Money market funds are a type of mutual fund which are redeemable on demand and seek to maintain a stable net asset value (NAV) of typically \$1. Their dividends reflect prevailing short-term interest rates, making money funds an attractive cash management vehicle for investors. To provide a stable NAV for their investors, money funds in turn need to invest in safe and liquid assets. These assets differ across funds and money funds can be categorized by the type of their primary investment securities—government funds invest mainly in government- and government-like securities, prime funds in safe corporate debt securities, and tax-exempt money funds in tax-exempt municipal securities.

make later clear how this incentive may lead to problems in our estimation strategy if we would include these banks in our sample.

⁸Federal Home Loan Banks Combined Financial Report 2018 Q1

⁹Franklin U.S. Government Money Fund prospectus

With total assets of about \$3 trillion, money funds are an important source of demand for safe assets. This demand changed significantly because of the Security and Exchange Commission (SEC) 2014-2016 reform of the money fund industry. The SEC reform intended to increase the resilience of money funds and reduce the risk of runs.¹⁰ The reform changed the regulation of money funds in two substantial ways. First, the SEC required prime and tax-exempt money funds who cater to institutional investors to transact at a floating NAV, instead of a \$1 stable share price. This change intends to reduce the first-mover advantage of early redemption under a stable NAV, because daily share prices of these money market funds fluctuate along with changes in the market-based value of their portfolio securities. Second, the SEC allowed money market funds' boards to impose liquidity fees and temporarily suspend redemptions, known as redemption gates, if their funds' liquid assets fall below the regulatory minimum. The reformed regulation made one crucial exemption: Government money funds are not subject to the new liquidity fees and redemption gates regulation.¹¹

The reform triggered massive flows into government funds. Upon enactment of the new regulation in October 2016, investors with a preference for \$1 stable NAV who did not want to be subject to any liquidity or redemption gate can only invest in government money funds.¹² During the months prior to October 2016, over \$1 trillion in assets moved from prime and tax-exempt funds into government funds (Figure 4). While the total size of the money fund industry remained stable at around \$3 trillion, non-government funds' assets declined by over \$1.2 trillion, about two-third of their assets, and the size of government funds rose by about the same amount. This large compositional shift in the money fund industry was mainly the result of money fund investors withdrawing from non-government money funds and investing in government funds, and fund sponsors' converting their prime funds into government funds in accordance to their investors' preferences.

¹⁰The run on prime money funds during the 2007-2009 financial crisis culminated in the inability of the Reserve Primary Fund, a large prime fund, to maintain its \$1 NAV and thus "breaking the buck" in September 2008. The SEC implemented two rounds of reforms. In the first round, announced and implemented in 2010, the SEC tightened the maturity and credit quality standards, imposed new liquidity requirements, and enhanced disclosure of money funds' investment portfolio. In this paper, we focus on the second round of reforms.

¹¹Government money funds can voluntarily opt into the liquidity fees and redemption gates regulation, if they have previously disclosed it to their investors.

¹²Upon enactment of the reform, government money market funds had to invest at least 99.5 percent, instead of formerly 80 percent, of their assets in cash, government securities and/or repurchase agreements that are collateralized solely by government securities or cash.

This sudden inflow of money into government funds had consequences for government funds' demand for safe debt in the short as well as medium term. In the short run, it was not possible for government funds to maintain their portfolio composition. For example, there was not enough debt issued by Fannie Mae or Freddie Mac to invest about 25 cents of every dollar inflow to government funds, as was the case before the reform. The schedule of Treasury auctions could also not be changed and accommodate the increased demand.

2.3 The money fund reform: A supply shock to FHLB debt

Yet one provider of safe debt was flexible enough to respond to the demand shock by government money funds: FHLBs. Historically, government funds held about 20-25 percent of their assets in FHLB debt, with the total money industry having about 8 percent of AUM invested in FHLB debt. The debt was mostly short term, with a weighted average maturity of about 70 days and a weighted average life of about 120 days in at the end of 2012.

Once government funds faced an inflow of over \$1 trillion and could not turn to Fannie or Freddie (or Treasury in the short run), they turned to FHLBs as a more responsive issuer of safe debt. At the beginning of 2015, money funds held about 30 percent of outstanding FHLB debt; at the end of 2016, this share had risen to 40 percent. The percentage of FHLB debt in the total money industry's portfolio increased from below 10 percent to 20 percent (see Figure 5).

As money funds became FHLBs' largest investor, FHLBs needed to adjust the structure of their newly issued debt. Money funds need to keep their weighted average maturity below the regulatory limit of 60 days. Large holdings of FHLB debt were only feasible with either a very short maturity or at least frequent interest rate resets; it is an asset's repricing that matters for the calculation of WAM, not the final maturity.

FHLBs were willing to cater to these preferences. They increased their issuance of discount notes, very short term bonds, and most importantly started to make heavy use of floating rate bonds. Figure 6 depicts this sudden increase in variable rate bonds. In the first quarter of 2016, new bond issuances spiked, with most of them being variable rate bonds (not shown is the large increase in Discount Notes in 2015Q4). Figure 7 shows the effects of this change in debt structure. The WAM of FHLB debt held by money

funds fell dramatically from 80 days in 2015 to 30 days in 2018. Most of this change stems from the issuance of floating rate bonds. In contrast to the WAM, the weighted average life, calculated using the final maturity, stayed relatively constant.

2.4 FHLBs' assets side: The structure of newly issued FHLB advances

As the liability structure of FHLBs changed and the repricing of their debt shortened, FHLBs' exposure to interest rate risk rose. Unlike public issuers of safe debt, private issuers have to take into account their assets side as they issue new debt. An increase in T-bill supply will not immediately raise the question about what to do with the proceeds or how the new debt structure interacts with the existing assets structure. A private issuer, however, immediately faces these problems. In the case of FHLBs, a shorter maturity structure and more frequent interest rate resets increased their maturity mismatch and interest rate risk. These heightened risks occurred during a period when market participants expected rising interest rates. To mitigate these risks, FHLBs changed the structure of their largest asset class, loans to members. In 2011, almost two-thirds of advances had a fixed interest rate. At the end of 2016, over 50 percent of outstanding advances had a variable interest rate, resetting as frequently as every month. From the perspective of commercial banks, this meant that while an average loan either matured or reset its interest rate every 2.3 years in 2012, in mid-2017, the average loan reset its interest rate almost every year. Thus, while FHLBs passed their favorable funding conditions on to their members, they only did so for advances with a short maturity or repricing.

These changes on both sides of FHLBs' balance sheets complete the intermediation chain from money funds to commercial banks. As part of the shadow banking system, FHLBs' response to money funds' demand for safe assets interacted with the traditional banking system by a partial transfer of the interest rate risk.

The next section describes how this change in loans to members affected banks differentially and how we can use these differences to identify the effect of increased supply of FHLB debt on banks' supply of deposits.

3 The effects of the money market reform on FHLBs and banks

This section introduces our main empirical strategy to suggest a causal relationship between banks' deposit supply and FHLB funding. We first present the empirical strategy and then discuss the assumptions needed to suggest causality.

The goal is to study how changes in the structure of FHLB advances driven by FHLBs' increased supply of safe debt affected commercial banks and especially their supply of deposits. To identify this mechanism, we employ an instrumental variable strategy based on three main steps: First, the money fund reform was a supply shock for FHLBs' safe debt. We can measure the strength of this shock by how much AUM government funds have in each period relative to the total money fund industry. Second, when FHLBs increased the issuance of private safe debt, they changed their assets side as well. Newly issued advances had a shorter maturity or a more frequent repricing. Third, banks differed in their ability to utilize these new funding conditions.

At the center of our identification strategy is banks' differential uptake of advances, together with the large inflows into government funds. Commercial banks carefully match both sides of their books according to their medium-to long term business plan. Once advances became either short term or had a short repricing, banks could not equally take advantage of the newly available cheap funding from FHLBs. Only banks whose liabilities have historically been either short-term or with frequent rate resets could, and did, take advantage of the new funding opportunity from FHLBs.

This reasoning leads to our first stage regression. To explain a bank's use of FHLB advances we use the interaction of inflows into government funds and a bank's historical liability repricing as follows.

$$fhlb_{bt} = \beta_1 \cdot (gov_t * reprice_b) + \alpha_b + \delta_t + X_{bt}\gamma_{bt} + \epsilon_{bt},$$

where $fhlb_{bt}$ is bank b 's level of advances at time t , normalized by its lagged assets, gov_t is the ratio of AUM by government funds over total AUM in the money industry at time t , and $Reprice_b$ is a banks average repricing of liabilities (excluding equity) between 2010

and 2011.¹³

In the second stage, we use the predicted FHLB use from the first stage to see how banks' assets and liabilities change.

$$y_{bt} = \beta_2 \cdot \widehat{fhlb}_{bt} + \alpha_b + \delta_t + X_{bt}\gamma_{bt} + v_{bt},$$

where y_{bt} is a bank outcome in time t . Most of the balance sheet variables are scaled by lagged assets. \widehat{fhlb}_{bt} is bank b 's use of advances explained in the first stage by the interaction of repricing and money reform.

For our identification strategy we need the instrument to (i) have a strong predictive power, and (ii) be uncorrelated with unobservable factors. We first discuss the validity of our instrument and then turn to the exclusion restriction.

Instrument validity. For our instrument to be valid, we need two assumptions to hold. First, the money fund reform did lead to increased issuance of FHLB debt. Second, banks' historical repricing is a major determinant of banks' uptake of advances. We documented the increase in FHLB debt in the previous section. The left panel of Figure 8 provides evidence for the second assumption. We estimate a cross-sectional regression of advances growth between 2014 and 2017 on a bank's liability repricing and an extensive list of other bank characteristics. All else equal, a bank with a repricing of 4 months had a 40 percent higher growth rate of advances than a bank with a repricing of 8 month (equivalent to moving from the 75th to the 25th percentile).

This strong negative relationship is in stark contrast with the relationship between repricing and the use of advances before the money fund reform. The right panel of Figure 8 shows the binscatter plot of the same regression, except the dependent variable is the growth of advances between 2011 and 2014. During this period, advances were mostly medium- to longer term with a fixed interest rates. This made them very attractive to back medium- to long-term assets and banks with a longer repricing were the main borrowers from FHLBs, leading to a positive relation between repricing and advances growth.

Exclusion restriction. To satisfy the exclusion restriction, the main empirical hurdle to overcome is the endogeneity of banks' balance sheets. Our instrument needs to be uncorrelated with unobservable factors that may influence banks' balance sheet policy.

¹³The results are robust to use either only 2010, 2011, or other years following 2011.

There are three possible concerns.

First, the money fund reform needs to be exogenous to banks' decisions. For large banks, this assumption may not hold. Prime money funds were main holders of banks' commercial paper. Large outflows out of prime funds is potentially a funding shock for issuers of such notes that directly influences deposit taking and wholesale funding. Further, very large banks may potentially influence financial market reforms via lobbying or other channels, introducing reverse causality problems into the analysis. Therefore, we focus on banks below \$10 billion in assets, where a single bank does not have the lobbying power. Although very uncommon for small banks, We further make sure that we do not include banks that have issued commercial paper in the past. For small banks that never relied on commercial paper, the SEC reform was exogenous.

Second, repricing should be predetermined and independent of the money reform as well as FHLBs' response to it. We use historical repricing to capture banks' predetermined medium- to long-term business strategy. When deciding on their liability structure in 2010 or 2011, neither the 2016 money reform nor its consequences were expected.

Third, one possible concern is that changes in banking regulation influenced repricing as well as banks' use of advances. Although small banks were less affected by regulation after the 2007-2009 financial crisis than large banks, we cannot rule out that during our whole sample period some regulatory changes occurred. However, our setup is almost equivalent to a difference-in-differences specification with the time of the treatment being 2015Q3 to 2016Q3. The ratio of government funds' AUM over total money industry assets is very stable before 2015Q3 and after 2016. The run-up to the money reform amounts to an almost discrete change in the ratio. In the period right before and after the "jump" in our time-varying variable, banking regulations for small banks did not change.

4 Data

The main source for our bank-level data are commercial banks' quarterly filings with the FDIC, their Call Reports. Call Reports provide information on a bank's balance sheet at each quarter end as well as the bank's income statement. From the balance sheet we obtain information on a bank's main assets and liabilities, as well as detailed deposit

categories. Banks' income statements provide information on interest and non-interest income and expenses.

Table 1 provides descriptive statistics of the variables used in our study. The sample are all commercial banks with average assets below \$10bn in 2010 and the period under observation is 2012Q1 until 2018Q2. Most variables used in the analysis are scaled by last quarter's total assets. Our main explanatory variable, FHLB advances, is on average about 4 percent of banks' assets, with some banks having a ratio upwards of 6 percent. Deposits are by far the most important source of funding, with a mean deposit to assets ratio of over 80 percent. On the assets side, loans and leases are the largest category.

Banks' liabilities are on average repriced every 8 months. For liabilities other than deposits and equity, banks have to report either the final maturity or the next repricing, whichever is shorter. Repricing is not provided as a continuous variable but as discrete ranges, for example "FHLB advances from 3 to 5 years". To calculate weighted average repricing, we use the mid-point of each range and weight each discrete step by the ratio of assets or liabilities in a given range over the total assets or liabilities of a certain type. In the calculation of total liabilities repricing, deposits enter with a repricing of zero.

Money fund industry information is taken from money funds' N-MFP filings. Each month, money funds have to report their portfolio with detailed asset-level information. We take the information at each quarter end to coincide with banks' Call Report filings. We aggregate the fund-level data to the fund-type-level, government funds and prime funds. Over the whole sample period, the share of government funds' AUM in the total money industry is 34 percent. But as shown before, this is an average of the low share before 2015 and the very high share after 2016.

5 Main results

In this section, we provide our main results. First, we report the effect of FHLB funding on banks' deposits. We then go over the effect of FHLB funding on banks' assets.

5.1 The effect of FHLB funding on banks' liabilities

Deposits. Our main result is that as FHLBs issue more safe debt and adjust their balance sheet, banks decrease their supply of deposits. Table 2 shows the results for regressions

of different types of deposits on FHLB funding. All variables are normalized by last quarter's assets. Each additional dollar in FHLB funding is associated with a 61-85 cent decrease in total deposits (columns 1 and 2). The deposit reduction is spread across several types of deposits. Only about 25 percent of the decrease come from transaction accounts and an even lower fraction from time deposits (columns 3 and 4).

Panel B takes a closer look at different types of deposits. Demand deposits, the largest category of transaction accounts, decrease significantly, as do savings and money market accounts (columns 1 to 3). Time deposits with a maturity below 1 year as well as above 1 year decrease in about the same proportions.

A simple OLS regression does not allow us to make inference about the interaction of private suppliers of safe debt. It was mainly after 2015 when FHLBs were seen as important suppliers of safe debt, yet the results in Table 2 reflect correlations over the whole sample period. As we will discuss later, banks use FHLB funding in periods of growth. Banks' general growth will therefore bias our results, mixing together banks' reaction to an increased supply of safe assets by FHLBs with banks' general use of wholesale funding.

Tables 3 and 4 address this bias and turn to our instrumental variable strategy. Table 3 shows the estimates of the first stage. Without any fixed effects, column 1 shows that in the run-up to the money fund reform, banks used on average more advances. Repricing is positively correlated with the use of advances. As we have shown in the previous section, this positive correlation was particularly strong before 2015. Once money flows from prime into government funds, this relationship changes—the coefficient on the interaction term is negative. Columns 2 to 4 allow for common time trends and heterogeneity across banks. The coefficient on the interaction term is very stable across specifications, and its high significance alleviates problems of a weak instrument.

Table 4 turns to the second stage. The first column presents the results of the second stage without any fixed effects, instrumenting FHLB funding by the interaction of repricing and the share of government funds AUM. The period of the money fund reform has in general been a period of deposit growth and the coefficient on the variable MF is positive. A bank's historical repricing is on average not significantly related to deposit changes. Nevertheless, FHLB funding driven by these two factors together reduce total deposits significantly. Banks did almost perfectly substitute deposits for FHLB advances

(column 1).

Column 2 allows for heterogeneity across banks and common time trends, controlling for bank fixed effects and quarter fixed effects. This more general specification does not change the coefficient of interest significantly.

Columns 3 and 4 look at two prominent deposit categories, transaction accounts and time deposits. The coefficients in these two columns differ substantially from the OLS estimates. The OLS coefficient reflect the correlation between FHLB and deposit funding over the whole sample period, where a multitude of factors influence the growth of both forms of liabilities. Table 2 show the local average treatment effect around the money fund transition period. As mostly short-term and/or variable rate advances become cheaper, banks reduce their use of transaction accounts. The loss in transaction accounts is more than proportional. Time deposits, however, increase.

Panel B sheds more light on these results. The largest driver of the decrease in transaction accounts are demand deposits (column 1). Savings and money market deposits decrease as well (column 2 and 3). Columns 4 and 5 explain the positive effect on time deposits. As banks take on more interest rate risk through advances, they shed other short-term funding, time deposits with a maturity below 1 year (column 4). The still shorter repricing of liabilities is balanced by an increase in longer-term time deposits (column 5).

Deposit rates. Results on quantities do not completely rule out that some unobservable factors led to demand withdrawals at banks with frequent repricing. Our analysis would suffer from the problem of reverse causality. Banks facing deposit losses are likely to look for alternative sources of funding as a result of their inability to sustain high levels of deposits. Price data helps to disentangle demand and supply shifts. Banks facing deposit withdrawals are likely to raise deposit rates, banks reducing their supply will decrease rates.

Table 5 provides such evidence on prices. We use rates on certificates of deposits with different maturities and rates on checking accounts at the bank branch level, restricting our sample to rate-setting branches. Coefficients are negative throughout, although for some maturities not precisely estimated. These findings further suggest that the substitution between advances and deposits is not driven by consumers decreasing their demand for deposits. The results indicate that banks reduce their supply of safe assets

in response to FHLBs' increased supply.

5.2 The effect of FHLB funding on banks' assets

The focus in this paper is on the supply of safe debt. Nevertheless, in this subsection we look at banks' assets, as cheaper funding is usually related to higher credit supply. Policy implications will differ, if the decreased supply in deposits goes along with increased lending. So did banks increase their lending as advances became a cheap source of funding?

Table 6 reports the association of banks' FHLB funding with their total assets and disaggregated asset categories as well as income and expenses over the whole sample period in a simple OLS setup. Panel A clearly shows that increased use of advance often goes together with increased business activity in general. Assets increase, as do loans and net income. In contrast, cash holdings decrease as a result of lower reserve requirements when deposits decrease.

The increase in net income follows a decrease in interest expenses for deposits, as column 1 in Panel B suggests. However, Other interest expenses and total interest expenses increase on net (columns 2 and 3). These increased expenses are over-compensated by higher income, and total net income increases.

A joint increase in advances and loans is neither surprising nor the subject of this paper. As previously in the case of deposits, we are not controlling for banks' growth opportunities, which should influence total assets as well as advances in a positive way. This leads to a positive bias in our coefficients. So how did banks change their assets due to FHLBs' increased debt issuance?

Table 7 presents the results from the second stage of our IV design. In contrast to the OLS results, increased FHLB funding leads to an asset reduction. One dollar in additional FHLB advances is related with a 50 cent decrease of total assets (column 1). Most part of this decrease is driven by reduced cash holdings (column 2). Importantly, there is no significant lending response (column 3). As banks get leaner and more efficient, their net income increases (column 4).

In line with the OLS results in Table 6, Panel B of Table 7 looks at expenses. Qualitatively, the results are similar to the OLS specification—interest expenses on deposits decrease but increase overall. Non-interest expenses decrease. Quantitatively,

however, the effects are orders of magnitude larger when compared with Table 6.

6 Robustness

This section shows that our results are robust to various concerns. First, we address the concern of interest rate changes. Second, we address changes in the local economic conditions. Third, We show that our results are robust when looking at tighter margins for banks size or weight banks by asset size.

Interest rate environment. In December 2015, the Federal Reserve raised its interest rate target range for the first time in years. Several rate increases followed. The rate hike coincides with the timing of inflows into government money funds. One might worry that our time-variation does not only reflect changes in money markets, but also changes in the interest rate environment. And changes in the interest rate may affect banks with different liability repricing differently. A bank with more frequent interest rate resets will face higher costs of borrowing sooner than other banks. This could influence deposit supply and wholesale funding choices.

To allow for this possibility, we interact the fed funds rate with banks' historical repricing and include the interaction term in our main IV specification. Table 8 shows that our main conclusions do not change. Panel A shows that, overall, deposits decrease, with demand deposits contributing mostly to this decrease and (long-term) time deposits actually increasing. Panel B shows that allowing for separate effects of interest rate changes does neither change the sign nor the size of the coefficients on total assets and cash.

Banks' market power. The increase in interest rates may have affected banks differently depending on their market power. Drechsler et al. (2017) document that banks with more market power have a larger outflow of deposits and a deeper cut in deposit rates as monetary policy becomes tighter. If a bank's market power influences liabilities and repricing choice, our results may reflect the depository channel of monetary policy rather than a larger supply of advances.

To control for this possibility, Table 9 includes the interaction of the market structure a bank operates in and the fed funds rate. For each county, we calculate the Herfindahl Index (HHI) for deposits from branch level data from the 2010 FDIC Summary of

Deposits. Because most of small banks do not operate in multiple markets, we still use bank-level (instead of branch level) data and interact the 2010 HHI with the fed funds rate. The results remain unchanged compared to our baseline specification.

Local economic environment. Small banks operate mainly in local markets. A common time trends may not be sufficient to control for banks' growth prospect. Heterogeneity across different regions can influence banks' business models and financing decisions. If historically short repricing is correlated with the structure of the local economy, our results may reflect banks' response to different regional developments rather than the response to the money fund reform.

Comparing only banks in the same county and allowing for time-varying heterogeneity across counties is one possible remedy. Table 10 shows that the inclusion of county-time fixed effects does not have a significant impact on our main coefficients. And while county-time fixed effects together with the interaction of the fed funds rate render the coefficient on assets statistically insignificant, the point estimate is the same as before and the insignificance is only due to a noisier estimate.

Bank size. Our main analysis concentrates on banks with total assets below \$10 billions in 2010. To assure that our results are not overly influenced by very small banks, Table 11 provides results on deposits for banks of all sizes, certain size buckets, as well as weighted least squares results for our baseline sample. All results are in line with our baseline, except for the very large banks. For these banks our instrument is very weak. This finding is consistent with a common explanation for large banks' FHLB borrowing after 2012 which suggests that large banks used FHLB funding as a cheap method of collateral upgrade to comply with the liquidity coverage ratio (LCR) regulation (Gissler & Narajabad (2017)).

7 Conclusion

This paper provides an empirical analysis on how certain private suppliers of safe assets interact. The 2014-2016 SEC money fund reform created a large demand shock for short-term, government-like assets. While public provision of such assets did not change in the short- to medium-term, the FHLB system increased their debt issuances. Yet the total supply of private safe assets did increase by less. As FHLBs issued more debt, they

increased loans to commercial banks. Banks responded with a decrease in deposit supply.

These results add important lessons to the discussion on the private creation of safe assets. Several academics and policy makers see the rise of the shadow banking system as a response to banks' decreased or stagnating supply of deposits in a world with growing demand for safe assets. In contrast, we provide evidence that shadow bank debt and traditional bank debt may not only be complements, but also substitutes in certain instances. Understanding this interplay is important when analyzing the changes the financial system has undergone and how the shadow banking system and the traditional banking system are connected.

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Figures and Tables

Figure 1: Chain of intermediation: From government money funds to banks via FHLBs

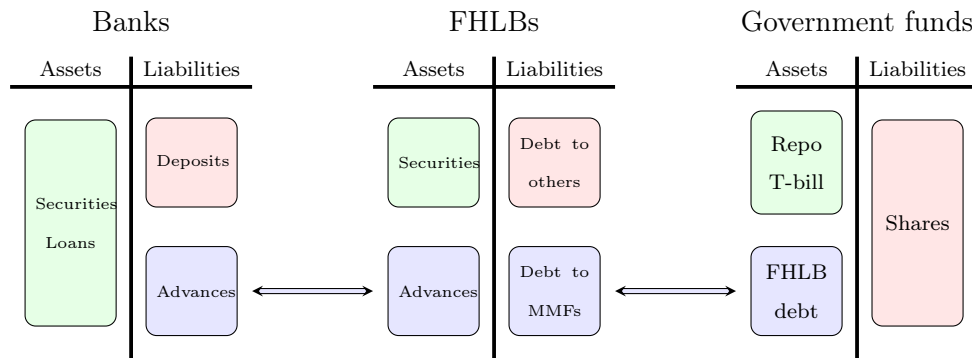


Figure 2: FHLB assets

The figure shows the evolution of FHLBs' assets (upper panel) and outstanding FHLB advances (lower panel) between 2002 and 2017. Assets are broken down by asset type and advances are broken down by member type. In each of the panels, the left figure shows the evolution of assets or advances in \$billions, and the right figure shows the evolution per asset type or member type in percent.

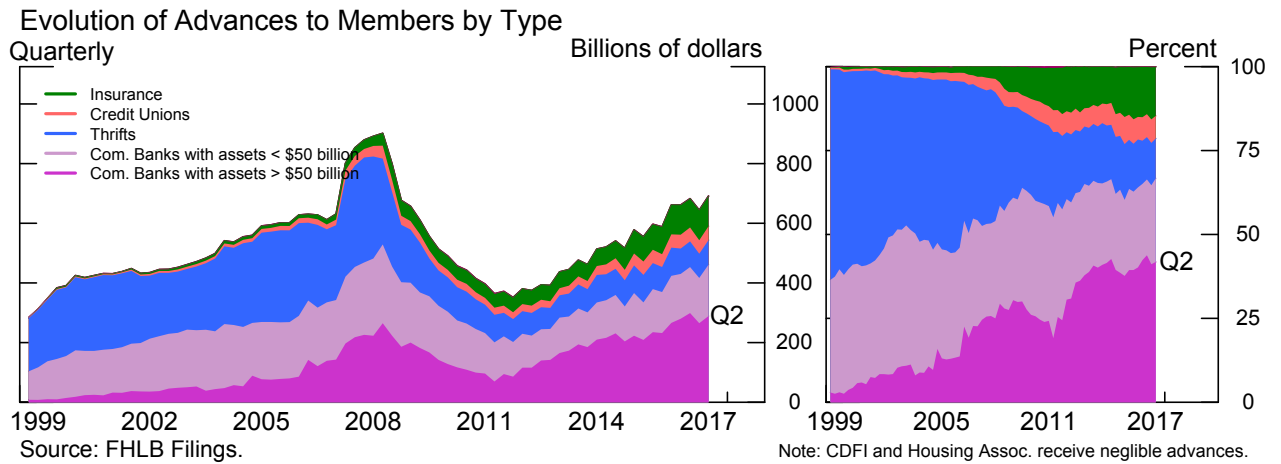
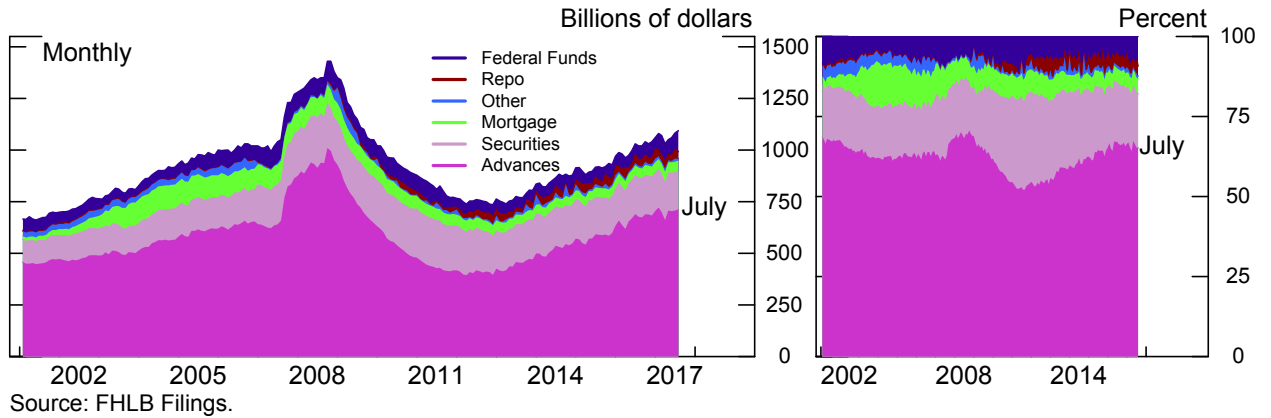


Figure 3: FHLB assets

The figure shows the evolution of FHLBs' advances to thrifts and commercial banks between 2012 and 2018, broken down by the size of these depository institutions.

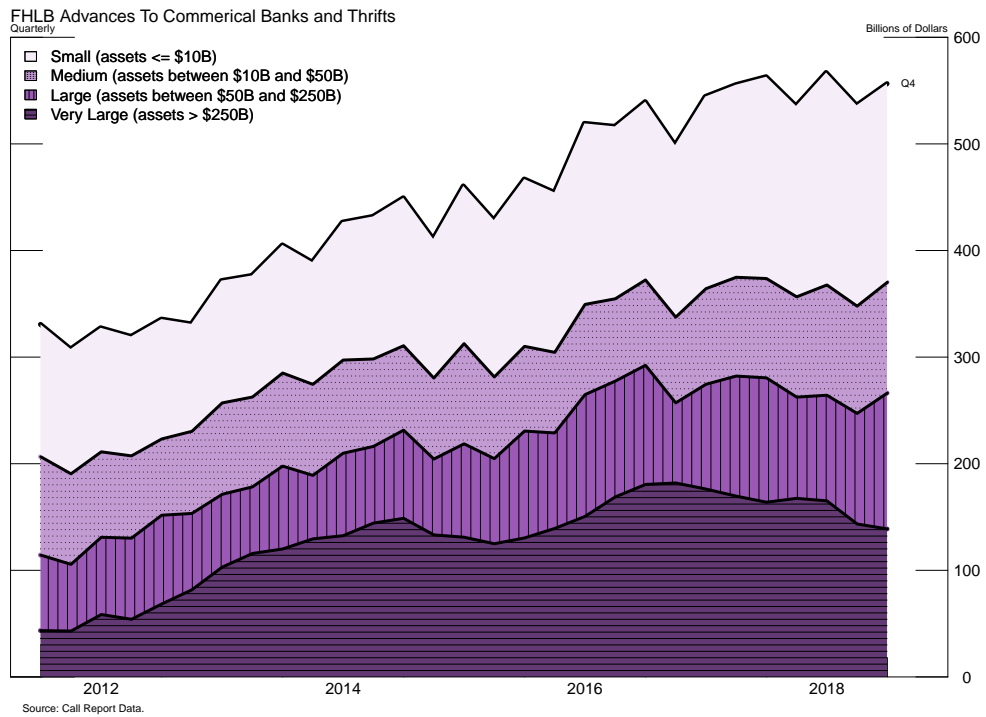


Figure 4: Money funds and FHLB debt.

This graph shows the evolution of the money fund industry and its holdings of FHLB debt by fund type.

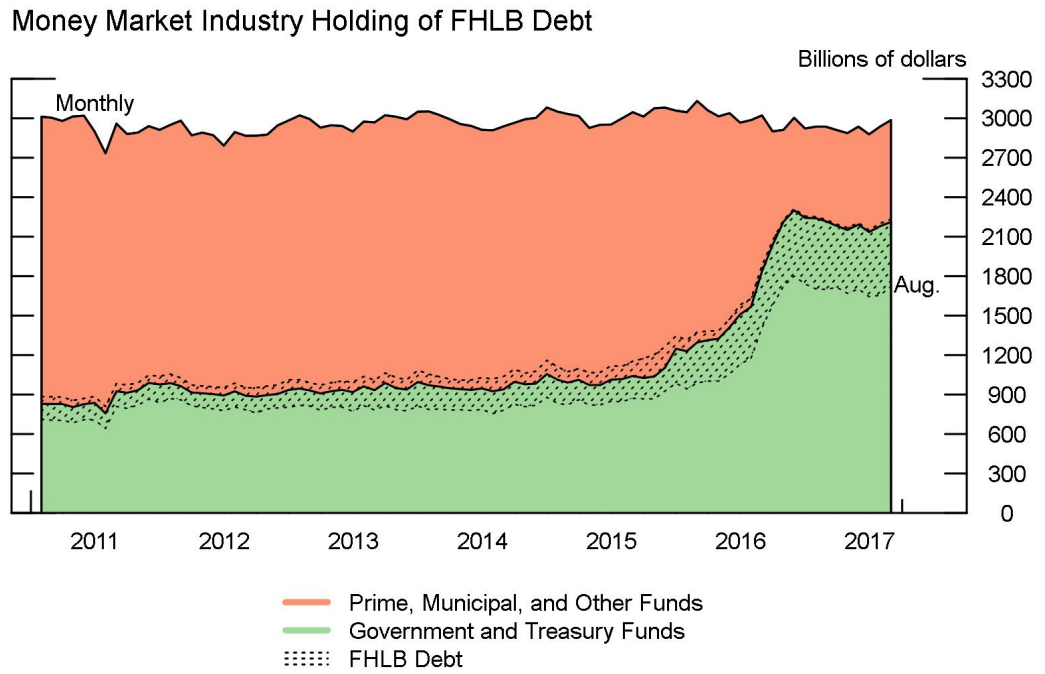


Figure 5: Money funds and FHLB debt.

This graph shows the evolution of FHLB debt held by money funds. The left panel shows the percentage of government money funds and the entire money fund industry assets invested in FHLB debt. The right panel shows the percentage of outstanding FHLB debt held by government money funds and the entire money fund industry.

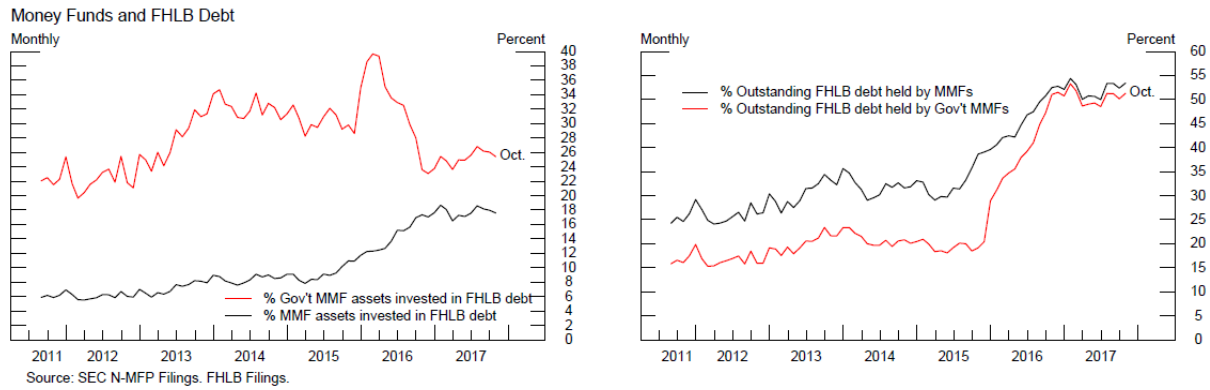


Figure 6: Coupon type of newly issued FHLB debt

This graph shows the amount of FHLB debt issued each quarter by coupon type, fixed rate debt or floating rate debt.

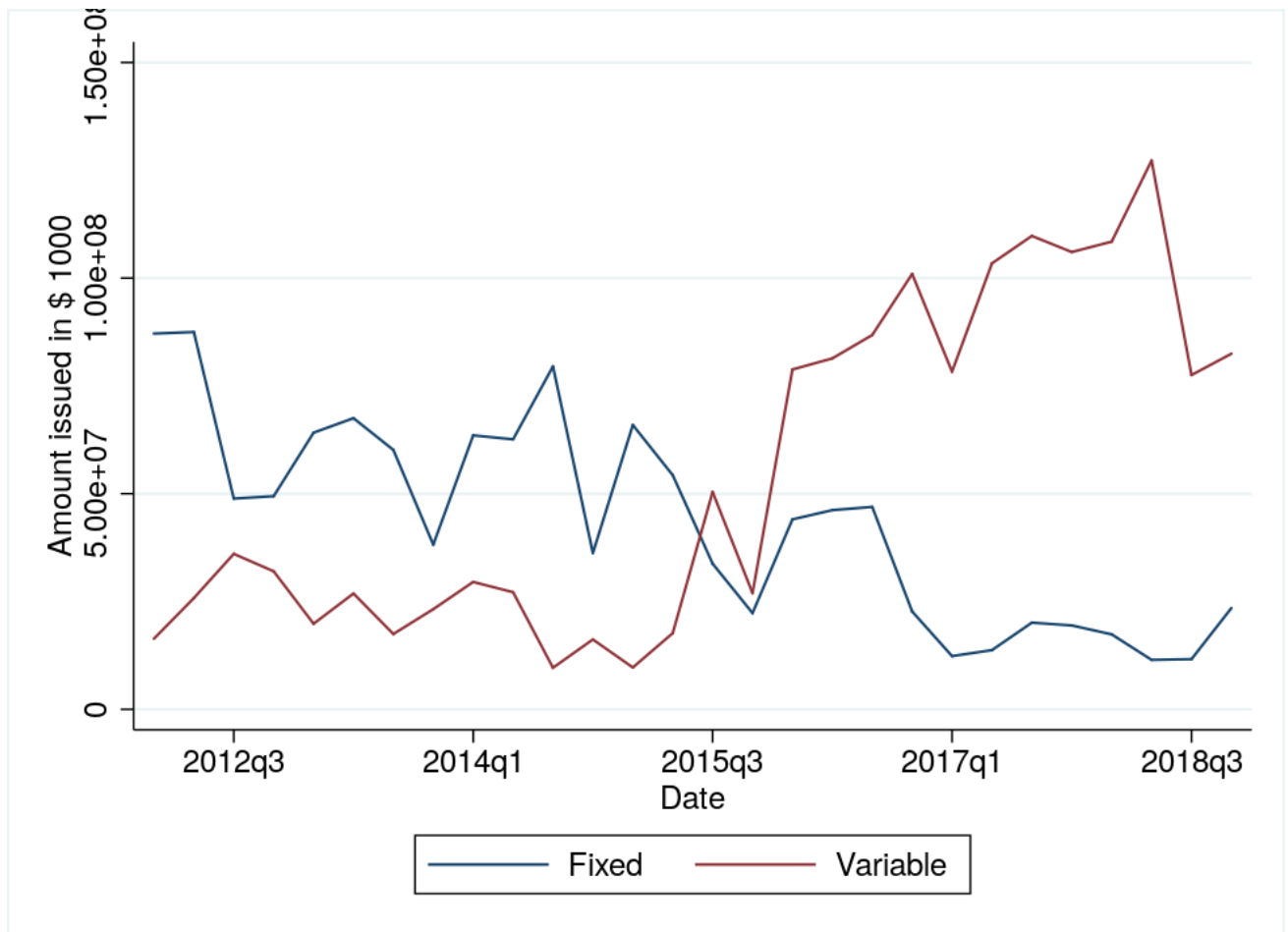


Figure 7: Money funds' weighted average maturity and weighted average life of FHLB debt.

This graph shows the evolution of the weighted average maturity and life of FHLB debt held by money funds and the overall weighted average maturity of all assets held by money funds.

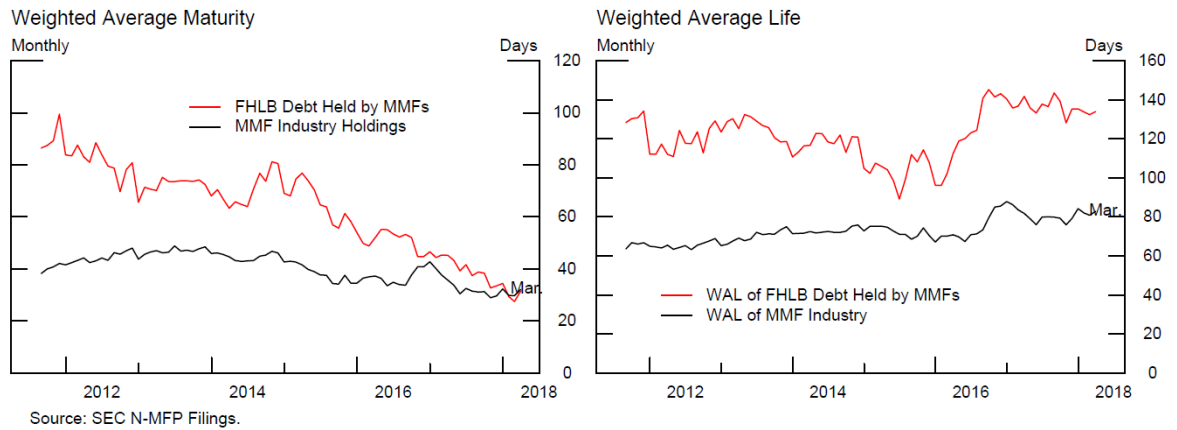


Figure 8: Advances growth and bank liability repricing

The left panel shows the binscatter plot of cross-sectional regression of advances growth between 2014 and 2017 on bank's liability repricing and an extensive list of other bank characteristics. The right panel use the growth of advances between 2011 and 2014.

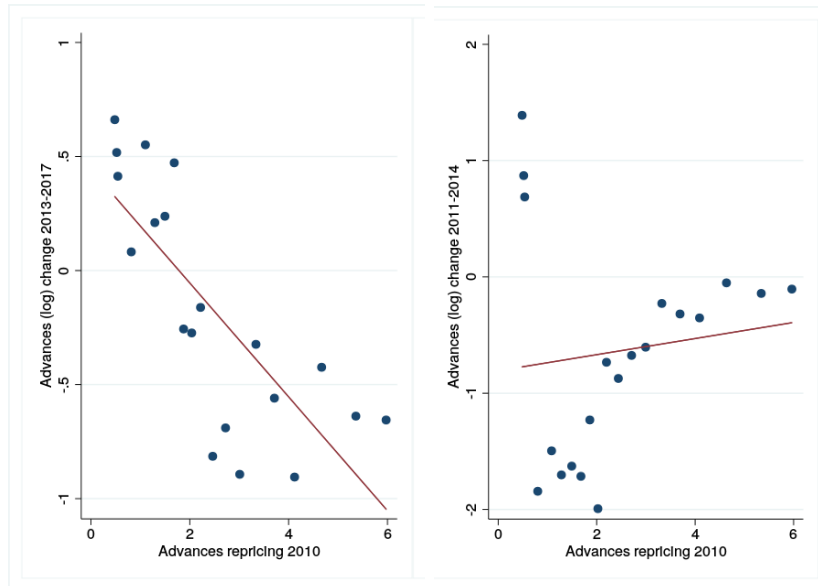


Table 1: Descriptive statistics

| | N | Mean | St.Dev. | Median | Min | Max |
|---------------------------------------|-------|----------|----------|-----------|------------|---------|
| <i>Bank variables, in % of assets</i> | | | | | | |
| FHLB | 75337 | 0.0426 | 0.0478 | 0.0291 | 0 | 0.639 |
| Deposits | 75337 | 0.840 | 0.0669 | 0.845 | 0.623 | 1.027 |
| Transaction accounts | 75337 | 0.235 | 0.127 | 0.238 | 0.0121 | 0.574 |
| Time deposits | 75337 | 0.287 | 0.119 | 0.276 | 0.0449 | 0.675 |
| Demand deposits | 75337 | 0.135 | 0.0829 | 0.127 | 0.00376 | 0.437 |
| Savings deposits | 75337 | 0.143 | 0.126 | 0.101 | 0 | 0.539 |
| Money market deposits | 75337 | 0.174 | 0.128 | 0.147 | 0 | 0.592 |
| Time dep. <1 year | 75337 | 0.184 | 0.0870 | 0.170 | 0.0300 | 0.529 |
| Time dep. >1 year | 75337 | 0.102 | 0.0656 | 0.0909 | 0.00111 | 0.332 |
| Cash | 75337 | 0.0757 | 0.0640 | 0.0553 | 0.00221 | 0.453 |
| Loans and leases | 75337 | 0.648 | 0.143 | 0.663 | 0.226 | 0.928 |
| Net income | 75337 | 0.00406 | 0.00299 | 0.00407 | -0.139 | 0.110 |
| Interest exp. savings dep. | 75337 | 0.000226 | 0.000181 | 0.000177 | 0.00000997 | 0.00137 |
| Other interest expenses | 75337 | 0.000223 | 0.000279 | 0.000130 | 0 | 0.00171 |
| Total interest expenses | 75337 | 0.000347 | 0.000721 | 0.0000126 | -0.000741 | 0.00406 |
| Non-interest expenses | 75337 | 0.00761 | 0.00263 | 0.00722 | 0.00307 | 0.0217 |
| <i>Other bank variables</i> | | | | | | |
| Assets, in \$Millions | 75337 | 655.9 | 1513.5 | 246.7 | 9.0 | 32066.9 |
| Liabilities repricing, in years | 75337 | 0.613 | 0.267 | 0.580 | 0.0479 | 1.670 |
| <i>Money industry variables</i> | | | | | | |
| Govt AUM/Total AUM | 75337 | 0.341 | 0.198 | 0.233 | 0.221 | 0.795 |

Note: This table shows the descriptive statistics of the variables used in the paper. The sample period is 2012Q1 until 2018Q4 and all variables are observed at the end of every quarter. The sample is restricted to banks with average assets below \$10bn in 2010. Bank-level variables are from their Call Report filings, money fund industry variables are calculated using money funds' N-MFP filings at the SEC.

Table 2: Substitution between deposits and FHLB advances

| Panel A: Deposits | | | | |
|--------------------------|-----------------------|-----------------------|-----------------------|------------------------|
| <i>Dep.var.:</i> | (1) Deposits | (2) Deposits | (3) Transact. dep. | (4) Time dep. |
| FHLB | -0.847*** (0.0137) | -0.617*** (0.0165) | -0.230*** (0.0181) | -0.0600*** (0.0198) |
| Observations | 92,570 | 92,536 | 92,536 | 92,536 |
| R-squared | 0.372 | 0.681 | 0.897 | 0.901 |
| Bank FE | N | Y | Y | Y |
| Time FE | N | Y | Y | Y |

| Panel B: Deposit types | | | | | |
|-------------------------------|-----------------------|-----------------------|-----------------------|-------------------------|-------------------------|
| <i>Dep.var.:</i> | (1) Demand | (2) Savings | (3) MM | (4) Time dep (short) | (5) Time dep. (long) |
| FHLB | -0.135*** (0.0140) | -0.105*** (0.0133) | -0.147*** (0.0167) | -0.0289* (0.0155) | -0.0206* (0.0117) |
| Observations | 92,536 | 92,536 | 92,536 | 92,536 | 92,536 |
| R-squared | 0.852 | 0.933 | 0.927 | 0.859 | 0.846 |
| Bank FE | Y | Y | Y | Y | Y |
| Time FE | Y | Y | Y | Y | Y |

Note: This table shows the estimates of OLS regressions of deposits on FHLB funding. The sample are all commercial banks and thrifts with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. Panel A shows the results for total deposits, transaction deposits, and total time deposits. Panel B shows the results for demand deposits, savings deposits, money market deposits, short-term time deposits with a maturity below 1 year, and long-term time deposits with a maturity longer than 1 year. Fixed effects are noted at the bottom of each table. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 3: First stage: FHLB funding, money fund reform, and repricing

| <i>Dep.var.:</i> FHLB | (1) | (2) | (3) | (4) |
|-----------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Reprice X MF | -0.0225*** (0.00501) | -0.0250*** (0.00434) | -0.0245*** (0.00458) | -0.0229*** (0.00468) |
| Reprice | 0.0837*** (0.00349) | | 0.0820*** (0.00324) | |
| MF | 0.0149*** (0.00291) | 0.0170*** (0.00254) | | |
| Observations | 86,888 | 86,786 | 86,819 | 86,854 |
| R-squared | 0.177 | 0.780 | 0.189 | 0.778 |
| Bank FE | N | Y | N | Y |
| Time FE | N | N | Y | Y |

Note: This table shows the estimates of the effect of the money fund reform interacted with historical repricing on banks' FHLB funding. The sample are all commercial banks and thrifts with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. The dependent variable in all columns is FHLB advances normalized by last quarters' assets. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. Fixed effects are noted at the bottom of each table. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 4: IV estimation of substitution between deposits and FHLB advances

| Panel A: Deposits | | | | |
|--------------------------|------------------------|----------------------|----------------------|---------------------|
| <i>Dep.var.:</i> | (1) Deposits | (2) Deposits | (3) Transact | (4) Time dep. |
| FHLB | -1.148*** (0.181) | -1.086*** (0.158) | -1.765*** (0.448) | 1.920*** (0.543) |
| Reprice | 0.0118 (0.0139) | | | |
| MF | 0.00223** (0.00101) | | | |
| Observations | 86,888 | 86,854 | 86,854 | 86,854 |
| R-squared | 0.327 | 0.656 | 0.830 | 0.764 |
| Bank FE | N | Y | Y | Y |
| Time FE | N | Y | Y | Y |
| Kl.-P. F | 20.09 | 23.86 | 23.86 | 23.86 |

| Panel B: Deposit types | | | | | |
|-------------------------------|----------------------|--------------------|----------------------|-------------------------|-------------------------|
| <i>Dep.var.:</i> | (1) Demand | (2) Savings | (3) MM | (4) Time dep (short) | (5) Time dep. (long) |
| FHLB | -1.049*** (0.322) | -0.434* (0.255) | -0.925*** (0.332) | -0.546** (0.270) | 2.379*** (0.558) |
| Observations | 86,854 | 86,854 | 86,854 | 86,854 | 86,854 |
| R-squared | 0.800 | 0.934 | 0.911 | 0.850 | 0.161 |
| Bank FE | Y | Y | Y | Y | Y |
| Time FE | Y | Y | Y | Y | Y |
| Kl.-P. F | 23.86 | 23.86 | 23.86 | 23.86 | 23.86 |

Note: This table shows the estimates of the second stage regressions of deposits on FHLB funding. The sample are all commercial banks and thrifts with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. *FHLB* is the predicted variable from a regression of FHLB funding on the interaction of *Reprice* and *MF*, as reported in Table 3. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. Panel A shows the results for total deposits, transaction deposits, and total time deposits. Panel B shows the results for demand deposits, savings deposits, money market deposits, short-term time deposits with a maturity below 1 year, and long-term time deposits with a maturity longer than 1 year. Fixed effects are noted at the bottom of each table. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 5: IV estimation of deposit rates on FHLB funding

| <i>Dep.var.:</i> | (1) 3 months CD | (2) 6 months CD | (3) 12 months CD | (4) 24 months CD | (5) Checking acct. |
|------------------|--------------------|--------------------|---------------------|---------------------|-----------------------|
| FHLB | -0.510 (1.911) | -1.009 (1.544) | -3.282* (1.904) | -4.815** (2.178) | -0.129 (0.391) |
| Observations | 80,157 | 89,828 | 90,569 | 88,510 | 85,340 |
| R-squared | 0.686 | 0.667 | 0.560 | 0.541 | 0.720 |

Note: This table shows the estimates of the second stage regressions of deposit rates on FHLB funding. The sample are all commercial bank branches that set deposit rates and the commercial bank had average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. *FHLB* is the predicted variable from a regression of FHLB funding on the interaction of *Reprice* and *MF*, as reported in Table 3. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. The table shows the results for certificates of deposits (CD) with maturities of 3,6,12, and 24 months and deposit rates for interest-paying checking accounts. All regressions include bank fixed effects and time fixed effects. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Banks' assets and FHLB funding, OLS results**Panel A: Total assets, cash, loans, and income**

| <i>Dep.var.:</i> | (1) Assets | (2) Cash | (3) Loans | (4) Net income |
|------------------|-----------------------|-----------------------|----------------------|--------------------------|
| FHLB | 0.258*** (0.00892) | -0.107*** (0.0106) | 0.355*** (0.0225) | 0.00305*** (0.000652) |
| Observations | 92,464 | 91,676 | 91,810 | 92,536 |
| R-squared | 0.156 | 0.741 | 0.885 | 0.494 |

Panel B: Interest and non-interest expenses

| <i>Dep.var.:</i> | (1) Interest exp.dep. | (2) Interest exp.other | (3) Interest exp. | (4) Non-int. exp. |
|------------------|----------------------------|---------------------------|--------------------------|-------------------------|
| FHLB | -0.000221*** (4.22e-05) | 0.00243*** (7.57e-05) | 0.00121*** (8.37e-05) | -0.000600 (0.000500) |
| Observations | 92,517 | 78,389 | 92,536 | 92,536 |
| R-squared | 0.773 | 0.873 | 0.806 | 0.779 |

Note: This table shows the estimates of OLS regressions of assets, income, or expenses on FHLB funding. The sample are all commercial banks with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. Panel A shows the results for total assets, cash holdings, total loans and leases, and net income. Panel B shows the results for interest expenses on deposits, other interest expenses, total interest expenses, and non-interest expenses. All regressions include bank fixed effects and time fixed effects. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Banks' assets and FHLB funding, IV results

Panel A: Total assets, cash, loans, and income

| <i>Dep.var.:</i> | (1) Assets | (2) Cash | (3) Loans | (4) Net income |
|------------------|----------------------|----------------------|-------------------|-----------------------|
| FHLB | -0.571*** (0.160) | -0.836*** (0.267) | 0.0178 (0.395) | 0.0194** (0.00990) |
| Observations | 86,786 | 86,043 | 86,166 | 86,854 |
| R-squared | -0.066 | 0.679 | 0.886 | 0.485 |
| Kl.-P. F | 23.76 | 22.64 | 22.94 | 23.86 |

Panel B: Income and expenses

| <i>Dep.var.:</i> | (1) Interest exp.dep. | (2) Interest exp.other | (3) Interest exp. | (4) Non-int. exp. |
|------------------|--------------------------|---------------------------|------------------------|-------------------------|
| FHLB | -0.00401*** (0.00105) | 0.0223*** (0.00613) | 0.0126*** (0.00246) | -0.0289*** (0.00900) |
| Observations | 86,842 | 76,244 | 86,854 | 86,854 |
| R-squared | 0.583 | -1.550 | 0.683 | 0.725 |
| Kl.-P. F | 23.80 | 8.984 | 23.86 | 23.86 |

Note: This table shows the estimates of the second stage regressions of assets, income, or expenses on FHLB funding. The sample are all commercial banks with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. *FHLB* is the predicted variable from a regression of FHLB funding on the interaction of *Reprice* and *MF*, as reported in Table 3. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. Panel A shows the results for total assets, cash holdings, total loans and leases, and net income. Panel B shows the results for interest expenses on deposits, other interest expenses, total interest expenses, and non-interest expenses. All regressions include bank fixed effects and time fixed effects. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Robustness: Interest rate movements

| Panel A: Deposits | | | | |
|--------------------------|----------------------|-----------------------|-----------------------|----------------------|
| <i>Dep.var.:</i> | (1) | (2) | (3) | (4) |
| | Deposits | Transact.acct. | Demand | TD |
| FHLB | -0.835*** (0.281) | -2.072*** (0.688) | -0.988** (0.438) | 2.245** (0.876) |
| Reprice X FF | 0.00295 (0.00260) | -0.00360 (0.00573) | 0.000713 (0.00367) | 0.00381 (0.00747) |
| Observations | 86,854 | 86,854 | 86,854 | 86,854 |
| R-squared | 0.677 | 0.798 | 0.807 | 0.713 |

| Panel B: Assets | | | | |
|------------------------|-----------------------|-----------------------|----------------------|----------------------------|
| <i>Dep.var.:</i> | (1) | (2) | (3) | (4) |
| | Assets | Cash | Loans | Net income |
| FHLB | -0.563* (0.292) | -1.043** (0.438) | 0.266 (0.583) | -0.0170 (0.0183) |
| Reprice X FF | 9.53e-05 (0.00284) | -0.00237 (0.00348) | 0.00287 (0.00417) | -0.000427*** (0.000162) |
| Observations | 86,786 | 86,043 | 86,166 | 86,854 |
| R-squared | -0.062 | 0.636 | 0.889 | 0.477 |

Note: This table shows the estimates of the second stage regressions of deposits, assets, or income on FHLB funding. The sample are all commercial banks with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. *FHLB* is the predicted variable from a regression of FHLB funding on the interaction of *Reprice* and *MF*, as reported in Table 3. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. The first and second stage include the interaction of *FF*, the Fed funds rate at the end of a quarter, and *MF*. All regressions include bank fixed effects and quarter fixed effects. Panel A shows the results for total deposits, transaction accounts, demand deposits, and time deposits. Panel B shows the results for total assets, cash holdings, total loans and leases, and net income. All regressions include bank fixed effects and time fixed effects. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Robustness: Banks' market power

| Panel A: Deposits | | | | |
|--------------------------|-------------------------|-----------------------|-----------------------|-----------------------|
| <i>Dep.var.:</i> | (1) | (2) | (3) | (4) |
| | Deposits | Transact.acct. | Demand | TD |
| FHLB | -0.835*** (0.282) | -2.071*** (0.688) | -0.988** (0.438) | 2.244** (0.875) |
| Reprice X FF | 0.00295 (0.00260) | -0.00360 (0.00573) | 0.000711 (0.00367) | 0.00382 (0.00747) |
| HHI x FF | -0.00563** (0.00256) | 0.00853 (0.00789) | 0.00400 (0.00536) | -0.00966 (0.00874) |
| Observations | 86,854 | 86,854 | 86,854 | 86,854 |
| R-squared | 0.677 | 0.798 | 0.807 | 0.713 |

| Panel B: Assets | | | | |
|------------------------|-----------------------|-----------------------|-----------------------|----------------------------|
| <i>Dep.var.:</i> | (1) | (2) | (3) | (4) |
| | Assets | Cash | Loans | Net income |
| FHLB | -0.563* (0.292) | -1.043** (0.438) | 0.265 (0.583) | -0.0170 (0.0183) |
| Reprice X FF | 9.68e-05 (0.00284) | -0.00237 (0.00348) | 0.00286 (0.00417) | -0.000427*** (0.000162) |
| HHI x FF | -0.00290 (0.00267) | 0.00168 (0.00455) | -0.00939 (0.00615) | -0.000272 (0.000186) |
| Observations | 86,786 | 86,043 | 86,166 | 86,854 |
| R-squared | -0.062 | 0.636 | 0.889 | 0.477 |

Note: This table shows the estimates of the second stage regressions of deposits, assets, or income on FHLB funding. The sample are all commercial banks with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. *FHLB* is the predicted variable from a regression of FHLB funding on the interaction of *Reprice* and *MF*, as reported in Table 3. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. The first and second stage include the interaction of *FF*, the Fed funds rate at the end of a quarter, and *MF*. *HHI* is the Herfindahl index of deposits calculated at the county level from the 2010 FDIC Summary of Deposits. Panel A shows the results for total deposits, transaction accounts, demand deposits, and time deposits. Panel B shows the results for total assets, cash holdings, total loans and leases, and net income. All regressions include bank fixed effects and time fixed effects. Standard errors are clustered at the bank level. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Robustness: Controlling for local economic conditions

| <i>Dep.var.:</i> | (1) Deposits | (2) Deposits | (3) Assets | (4) Assets |
|------------------|----------------------|----------------------|----------------------|------------------------|
| FHLB | -1.051*** (0.159) | -0.765** (0.327) | -0.558*** (0.162) | -0.560 (0.342) |
| Reprice X FF | | 0.00337 (0.00308) | | -1.93e-05 (0.00338) |
| Observations | 84,455 | 84,455 | 84,387 | 84,387 |
| R-squared | 0.657 | 0.676 | -0.042 | -0.043 |
| Kl.-P. F | 23.39 | 9.183 | 23.28 | 9.106 |

Note: This table shows the estimates of the second stage regressions of deposits or assets on FHLB funding. The sample are all commercial banks with average assets below \$10 billion in 2010. The sample is at a quarterly level from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. *FHLB* is the predicted variable from a regression of FHLB funding on the interaction of *Reprice* and *MF*, as reported in Table 3. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. The first and second stage include the interaction of *FF*, the Fed funds rate at the end of a quarter, and *MF*. All regressions include bank fixed effects and time fixed effects. Key: *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Robustness: The effect of FHLB funding on deposits by bank size

| <i>Sample:</i> | (1) All banks | (2) <2bn | (3) 2-10bn | (4) >10bn | (5) <2bn (WLS) |
|----------------|----------------------|----------------------|----------------------|------------------|----------------------|
| FHLB | -1.122*** (0.165) | -1.086*** (0.158) | -0.603*** (0.223) | 1.104 (2.110) | -1.131*** (0.291) |
| Observations | 89,482 | 86,854 | 3,593 | 2,520 | 86,854 |
| R-squared | 0.655 | 0.656 | 0.646 | 0.571 | 0.669 |
| Kl.-P. F | 23.93 | 23.86 | 10.89 | 1.145 | 11.47 |

Note: This table shows the estimates of the second stage regressions of deposits on FHLB funding. The sample are all commercial banks in column 1, banks with average assets below \$2 billion in 2010 in column 2, average assets between \$2 billion and \$ 10 billion in column 3, larger than \$ 10 billion in column 4, and below \$ 10 billion in column 5. The sample period is quarterly from 2012Q1 to 2018Q4. All variables are normalized by last quarters' assets. The dependent variable is total deposits in all columns. *FHLB* is the predicted variable from a regression of FHLB funding on the interaction of *Reprice* and *MF*, as reported in Table 3. *Reprice* measures a bank's 2010/2011 weighted average repricing of liabilities. *MF* is the ratio of assets under management by government money funds over the total money fund industries' assets, measured at the end of each quarter. All regressions include bank fixed effects and time fixed effects. Key: *** p<0.01, ** p<0.05, * p<0.1.