Running Out of Time (Deposits):

Falling Interest Rates and the Decline of Business Lending, Investment and Firm Creation

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Abstract

I show that the long-term decrease in the nominal short rate since the 1980s contributed to a decline in banks' supply of business loans, firm investment and new firm creation, and an increase in banks' real estate lending. The driving force behind these relationships was the shift in banks' funding mix from time deposits (CDs) to savings deposits, which was caused by the decrease in the nominal rate. I show that banks finance business lending with time deposits because of their matching interest-rate sensitivity and liquidity. A lower nominal rate reduces the spread on liquid deposits (e.g., savings deposits), leading households to substitute towards them and away from illiquid time deposits. In response to an outflow of time deposits, banks cut the supply of business loans and increase their price. The decrease in business lending leads to reduced investment at bank-dependent firms and a lower entry rate of firms in industries that are highly reliant on external funding. I document these relationships both in the aggregate, and in the cross-section of banks, firms and geographic areas. For identification, I exploit cross-sectional variation in banks' market power and business credit data. I develop a general equilibrium model which captures these relationships and shows that the transmission mechanism I document is quantitatively important.

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The recent decades have been marked by falling interest rates hitting historical lows across advanced economies. The potential consequences and challenges of this shifting environment have been at the forefront of academic and policy debates (e.g., CGFS, 2018; Powell, 2017; Rajan, 2015; Summers, 2014). According to the conventional view, lower interest rates are stimulating for the economy. Nevertheless, there are growing concerns that declining rates could also have negative repercussions (e.g., Asriyan *et al.*, 2021; Liu *et al.*, forthcoming; Martinez-Miera and Repullo, 2017).

Understanding the channels through which lower interest rates affect the economy is especially important in light of other secular trends observed over the last decades. In particular, falling interest rates have been accompanied by a decline in investment (e.g., Crouzet and Eberly, forthcoming; Gutiérrez and Philippon, 2016) and a slowdown in new firm creation (e.g., Decker *et al.*, 2016). In addition, as the rates have been falling, banks have been moving away from business lending towards real estate lending and security holdings (Figure 1). These empirical patterns leave open questions. Are the long-run trends in interest rates, bank lending to firms, investment and firm creation related? If so, what is the underlying mechanism linking them?

In this paper, I show that the long-term decrease in the nominal short rate contributed to a decline in business lending, firm investment and new firm creation observed over the last four decades. I establish a causal link between the falling Fed funds rate, the outflow of time deposits and the decline in the supply of business loans. Specifically, I show that banks use time deposits to fund business loans due to their matching interest-rate sensitivity and liquidity. A lower Fed funds rate induces banks to charge lower spreads on liquid deposits (e.g., savings deposits), and households to substitute towards them and away from illiquid time deposits. In response to the loss of time deposits, banks decrease business lending. Consistent with the supply effects, the quantity of business loans falls while the loan spreads increase. I show that a fall in the supply of bank business lending disproportionately affects credit and investment outcomes for bank-dependent firms that are unable to substitute to other sources of financing. Falling rates also contribute to a lower firm entry rate, especially in industries that are highly reliant on external financing. Finally, I present a general equilibrium model that captures these relationships and show that the transmission mechanism of falling interest rates to business lending through time deposits is quantitatively important.

My results are important for two reasons. First, I provide new insights into the propagation of monetary policy to business lending and emphasize the critical role of time deposits in the

transmission mechanism. By showing that in response to lower interest rates banks lose time deposits which triggers the contraction in lending to firms, I highlight the unintended consequences of expansionary monetary policy. Second, I show that the fact that banks have been running out of time deposits has important long-run macroeconomic implications. Specifically, I document the mechanism through which falling interest rates contributed to the secular decline of investment and firm creation observed in the U.S. over the last four decades.

I start the analysis by providing three pieces of evidence to document that banks finance business loans with time deposits. First, I show a striking and strong positive relationship between aggregate time series of business loans and time deposits as a share of banking sector total assets (Figure 1). Both series have been closely following a similar long-run trend and they have been decreasing since the beginning of 1980s.[1] The fall in time deposits and business loans lines up closely with the decrease in the Fed funds rate. The strong relationship between time deposits and business loans is also present in the cross-section of banks. Banks with larger increase in time deposits on their balance sheets also extend more business loans.[2]

Second, I use a removal of interest rates ceilings for small time deposits in 1978 as an exogenous shock to the supply of time deposits. As banks started paying competitive rates on time deposits, depositors substituted to time deposits from savings and checking deposits, whose rates were still capped. I find that the rise of time deposits was associated with an increase of business loans both in the aggregate time series and the cross-section of banks. I show that banks with larger inflow of time deposits increased business lending by more. Importantly, I do not observe similar behavior for other assets classes such as mortgages or security holdings.

Third, I present an analysis using small business lending data. The focus on small business loans allows me to compare credit outcomes of banks facing similar lending opportunities within the same county. I exploit the variation in time deposits growth in the cross-section of banks and I find that banks with a stronger growth of time deposits increase new small business lending by more, even after controlling for county-time variation (including the county-level changes in credit demand).

Banks finance business loans with time deposits because of interest-rate sensitivity matching and liquidity matching. Different deposit products are associated with different levels of liquidity

[1] Normalized by the size of bank balance sheets, time deposits decreased from more than 50% at the beginning of the 1980s to less than 25% in the last decade. At the same time, business loans fell from around 30% in 1980s to less than 15% in the last decade.

[2] The relationship between business loans and other types of deposits, i.e. savings deposits, is negative both in the aggregate time series and in the cross-section of banks. I find that banks use savings deposits to fund real estate lending and security holdings. See Panel (b) of Figure 1.

and sensitivity to the short-rate (Fed funds rate) changes. While checking and savings deposits are demandable, time deposit are illiquid as they cannot be withdrawn until the end of the term without penalty. Due to their lower liquidity, time deposits offer the highest rates that are also the most sensitive to the changes in the Fed funds rate (Drechsler *et al.*, 2017). Business loans are floating-rate or short-term assets whose cash flows are highly sensitive to the Fed funds rate. Business loans are also considered illiquid regardless of their maturity because banks cannot easily dispose of them to meet liquidity needs (Berger and Bouwman, 2009; Hanson *et al.*, 2015).

Banks hedge interest-rate exposure by matching the Fed funds rate sensitivity of deposits and assets. I document this strategy both in the aggregate time series and in the cross-section of banks. In the cross-sectional analysis, I estimate the sensitivity of banks' business loan rates and time deposit rates to changes in the Fed funds rate and show that these two sensitivities are high and strongly correlated. Next, I show that the interest-rate sensitivity matching strategy allows banks to achieve a stable net interest margin which is less susceptible to interest-rate fluctuations.[3] By financing business lending with time deposits, bank also hedge liquidity risk. I show that on the margin, banks with more illiquid time deposits also make more illiquid loans. Using the cross-section of banks, I find a strong positive relationship between the maturity of time deposits and the maturity of floating-rate business loans.

My main result establishes a link between monetary policy, time deposits, business lending and firm-level outcomes. Using local projection approach, I show that when the Fed funds rate rises, banks experience an inflow of time deposits and an outflow of savings deposits. Consistent with the deposit channel of monetary policy in Drechsler *et al.* (2017), an increase in the Fed funds rate raises the effective market power of banks and allows banks to charge higher deposit spreads. As savings deposits become relatively more expensive, depositors substitute away from deposits in aggregate, and critically from (liquid) savings deposits to (illiquid) time deposits. The main focus of this paper is to examine the monetary transmission to business lending. As banks fund business loans with time deposits, and time deposits increase in response to the rising Fed funds rate, I establish a causal chain in which higher interest rates lead to an increase in the supply of business lending.

While aggregate and bank-level evidence present a useful big picture, it are also subject to a common identification challenge – time deposit supply can be responding to changes in

[3] At the same time, I also show that banks match low short-rate sensitivity by financing securities with savings deposits. Liquid savings deposits pay lower rates and exhibit only a modest sensitivity to the monetary policy rate. Securities (such as mortgage-backed securities and treasuries) are long-term fixed-rate assets whose cash flows have low sensitivity to the Fed funds rate.

bank business lending opportunities rather than directly to monetary policy. If banks' lending opportunities increase when the Federal Reserve raises the policy rate, banks would make more loans to firms and therefore also collect more time deposits.

I address this identification challenge in three steps. First, I exploit the variation in the bank market power in the time deposit market. I proxy for the bank market power with Time Deposits Spread Beta or Herfindahl–Hirschman Index (HHI) in local (county-level) deposit markets. Time Deposit Spread Beta captures the bank-level sensitivity of time deposit spread to the Fed funds rate changes.[4] I show that banks with more market power raise the spread on time deposits by more and attract fewer time deposits when the Fed funds rate rises. This provides me with a variation in the supply across banks, i.e. a cross-sectional supply shifter. By exploiting the heterogeneity in the market power in time deposits, I test the hypothesis that when the Federal Reserve increases the rates, banks with more market power in time deposit markets increase their business lending by less compared to banks with less market power.

Second, I exploit more granular credit data, such as small business lending or syndicated lending, which allow me to control for time-varying demand for credit with fixed effects. In the small business lending analysis, I introduce county-time fixed effects to compare lending behavior by different banks facing similar lending opportunities within the same county at the same time. In the syndicated lending analysis, I saturate the regressions with sector-time or even firm-time fixed effects that absorb any sector-time or firm-time variation. These settings allow me to control for time-varying county-, sector- or firm- level demand for business credit and compare the lending behavior of banks with different time deposits market power when monetary policy tightens. The results exploiting the variation in time deposit market power and controlling for time-varying demand factors corroborate the finding from the aggregate time series. When the Fed funds rate rises, business lending increases. Furthermore, the increase in the supply of business lending is larger for banks with less market power (low Time Deposit Spread Beta or low HHI).

Third, I examine the response of business loan spreads (prices) to monetary policy. I show that when the Fed funds rate rises, the quantity of business loans increases while the loan spreads fall. I document a robust inverse relationship between spread and quantity of business loans in a range of exercises. I examine aggregate series over time and present local projections

[4]Time Deposit Spread Beta relates to Deposit Spread Beta presented by Drechsler *et al.* (2017) as a comprehensive measure of market power in the (overall) deposit market. I specifically focus on the market power in the *time* deposit market. As a result, I estimate Time Deposit Spread Beta of each bank by regressing the change in bank's time deposit spread on the changes in the Fed funds rate.

to monetary policy shocks. I also exploit bank cross-sectional variation in the syndicated loan market. These results are inconsistent with predictions from models with credit demand shifts. According to the demand effects, an increase in the Fed funds rate could shift the demand outward which would lead to both higher spreads and higher loan volumes. Instead, the empirical evidence illustrates that higher business loan volumes are associated with lower loan spreads which lends support to the shift in credit supply.

In addition, I present an evidence from a range of asset classes to demonstrate that other interest-rate sensitive assets (short-term securities, adjustable-rate mortgages or other floating-rate loans) also respond positively to Fed funds rate increases. On the contrary, interest-rate insensitive assets (long-term securities, fixed-rate mortgages or other fixed-rate loans) fall when the Federal Reserve raises rates. These findings highlight that business loans are not special when it comes to their response to monetary policy. Other assets, that share the same interest-rate sensitivity characteristics, behave similarly.

What are the effects of falling interest rates on business investment? The aggregate data shows a strong co-movement between business investment and business lending since 1960s both in trends and cycles. In contrast, there is only a weak, negative correlation between corporate bonds and business investment. Guided by the aggregate evidence, I examine the effects of monetary policy on investment in the cross-section of firms. Specifically, I split firms into two types: firms dependent only on banks (without bond market access) and firms with bond market access. To this end, I proxy for the access to bond market financing with the availability of firm ratings.[5]

I find that when the Fed funds rate falls, banks cut lending to both types of firms – with and without bond market access. Firms with bond market access are able to substitute towards bond financing. When firms do not have access to the bond market, this channel bears real consequences. A 1 pp decrease in the Fed funds rate is associated with a 1.9% cut in firm credit and a 1% drop in firm investment for bank-dependent firms (without access to bond market). This is important because only a small fraction of firms in the U.S. can issue bonds (20% within publicly traded Compustat firms).

While the banking sector sector has been running out of time deposits and reducing the supply of business loans, the firm creation in the U.S. has also declined over the past four decades. The contraction in business credit supply is particularly relevant for new firms as they

[5]I show that the results are robust to measuring bond market access with its previous borrowing through bonds.

are particularly dependent on bank loans. I examine the role of time deposits in the transmission mechanism of lower interest rates through bank balance sheets to firm creation. For this purpose, I exploit county level data on new firms and analyze the effects in both the short run and the long run. In the short run, I show that the counties exposed to banks with stronger decline in time deposits also have lower firm entry rates. A one standard deviation decrease in time deposits growth is associated with a 2% decline in firm creation. I exploit additional industry-level heterogeneity and show that the effects are driven by firms in industries with high external finance dependence, consistent with the decline in the supply of bank financing for firms. In the long run (1995 vs. 2015), I document that a decline in time deposits contributed to a downward trend in firm creation. Counties ex-ante more exposed to banks with a larger decline in time deposits and counties with a higher ex-ante dependence on time deposits in 1995, experienced the most pronounced drop in new firm creation.

To rationalize and quantify the empirical results, I develop a quantitative macro-finance general equilibrium model with banks exposed to liquidity and interest rate risk. In the model, households derive utility from liquidity. They can save in four types of assets providing different levels of liquidity services: money, savings deposits, time deposits and short-term bonds. While money is the most liquid asset, it pays no interest. Savings deposits are less liquid than money but more liquid than time deposits. Both types of deposits pay deposit rates set by banks. Short-term bonds provide no liquidity and pay nominal rate set by the central bank.

Banks engage in liquidity and maturity transformation. They are funded by equity, savings and time deposits. Banks have market power over their deposit markets and set the deposit rates internalizing the differences in their liquidity among households' assets. On the asset side, banks face a portfolio choice between long-term loans to financially constrained firms and long-term government bonds. Loans to firms are floating-rate and as a result their cash flows are highly sensitive to short-rate changes. Government bonds are fixed-rate and, hence, their cash flows exhibit low sensitivity to short-rate changes. Bank assets also differ in how difficult they are to liquidate on a short notice. Business loans are very illiquid and selling them rapidly is costly. Instead, the market for government bonds is deep and they can be sold promptly without a discount.

Differences in liquidity and interest-rate sensitivity of deposits and assets are important in light of two frictions the bank faces. First, liquid savings deposits are exposed to a funding shock which triggers a sudden withdrawal of savings deposits by households (e.g., Diamond and

Dybvig, 1983; Shleifer and Vishny, 1997; Drechsler *et al.*, 2018). Upon a withdrawal shock, bank needs to rapidly liquidate their assets to satisfy the outflow of savings deposits. While liquid government bonds can be sold at a market value, selling illiquid business loans results in a fire-sale discount. Second, it is costly for the bank to raise additional equity or change the dividend policy (e.g., Floyd *et al.*, 2015; Elenev *et al.*, 2021). As a result, banks have an incentive to smoothen their dividends and they are averse to variations in the net interest margin.

In equilibrium, differences in the liquidity of deposits give rise to differences in their sensitivity to policy rate changes. Specifically, as savings deposits are more liquid than time deposits, banks set higher prices (deposit spreads) for savings deposits. As a result, savings deposit rates are lower and less volatile compared to time deposit rates. On the contrary, time deposits protect banks against the funding shock but their rates are higher and more sensitive to the Fed funds rate changes. In the model, banks manage interest rate and liquidity risk by endogenously matching loans to firms with time deposits and long-term government bonds with savings deposits. Both time deposits and business loans are illiquid and have a high short-rate sensitivity. Savings deposits and long-term bonds are instead liquid and exhibit low interest rate sensitivity. Hence, financing business loans with time deposits and government bonds with savings deposits hedges bank interest-rate and liquidity risk.

The model is calibrated to match macro, banking and financial data for the U.S. economy. I use the calibrated model to examine the effects of a decline in nominal rates from 8% (the level of the Fed funds rate in 1985) to 0.5% (level in 2016) on equilibrium outcomes.[6] In response to lower nominal rates, the opportunity cost of holding money falls which decreases banks' effective market power. As a result, banks decrease the spreads on deposits. As savings deposits are the closest substitute for money, the savings deposit spread falls by more than the time deposit spread. In response to a fall in the relative price of savings deposits, households substitute away from illiquid time deposits towards liquid savings deposits. Consequently, the share of bank financing from time deposits falls significantly from 42% to 17% in line with the patterns observed in the data. As a reaction to the decline in time deposits, banks decrease their supply of business loans which falls from around 40% to around 22% of banks' total assets. The model implied decline in business loans is quantitatively significant and accounts for the entire decrease in business loans observed in the data. Consistent with the supply effects, the business loan spread increases by 2 pp in line with the empirical values. Finally, the fall in nominal rates

[6] When changing the steady-state level of nominal interest rates, inflation adjusts to keep the real rate constant.

induces a 16% drop in investment as a share of gross operating surplus. Taken together, the model suggests that falling nominal rates played a quantitatively important role in the decline of time deposits, business lending and investment.

Related literature. My work contributes to several strands of the literature. First, I connect to a large body of work on the bank lending channel of monetary policy (e.g., Bernanke and Blinder, 1988; Bernanke and Gertler, 1989; Drechsler *et al.*, 2017; Kashyap and Stein, 2000; Jimenez *et al.*, 2012, 2014). Most closely, I relate to Drechsler *et al.* (2017) by emphasizing the role of deposits in the monetary transmission. I focus on the monetary transmission to business lending and firm-level outcomes through time deposits. I find that the fall in the Fed funds rate is associated with an outflow of time deposits and a subsequent decline in supply of business lending. This mechanism can help explain how falling interest rates contributed to a decline in investment and firm creation.

The transmission through time deposits also allows me to reconcile a puzzling result in the data that business lending rises following a contractionary monetary policy documented by several papers (Gertler and Gilchrist, 1993; Kashyap and Stein, 1995; Den Haan *et al.*, 2007; Greenwald *et al.*, 2021). I show that this effect can be directly linked to my finding that banks finance business loans with time deposits. My findings highlight that in response to a decline in the Fed funds rate, banks experience an outflow of time deposits which due to interest-rate sensitivity and liquidity matching of time deposits and C&I loans is associated with a decrease in bank business lending supply.

Second, I relate to the literature on risks in the banking system (e.g., Begenau *et al.*, 2015; Calomiris and Kahn, 1991; Di Tella and Kurlat, 2021; Diamond and Rajan, 2001; Drechsler *et al.*, 2018, 2021a; Goldstein and Pauzner, 2005; Gomez *et al.*, 2021; Hanson *et al.*, 2015; Jermann, 2019). Banks engage in maturity transformation which exposes them to interest rate risk (Drechsler *et al.*, 2021a) and liquidity risk (Diamond and Dybvig, 1983). I contribute to this literature by showing that banks manage liquidity and interest rate risk by matching interest-rate sensitive and illiquid business loans with interest-rate sensitive and illiquid time deposits. The quantitative general equilibrium model of banks and monetary policy I develop to rationalize and quantify my empirical findings contributes to the macro-banking literature (e.g., Begenau, 2020; Elenev *et al.*, 2021; Jermann, 2019; Jermann and Xiang, 2021; Mendicino *et al.*, 2019, 2020; Piazzesi *et al.*, 2019). While existing literature has primarily focused on the role of credit risk, I examine the role of interest-rate and liquidity risk for banks' asset allocation

and the transmission of monetary policy.

Third, my paper is at the intersection of the literature on the real effects of low interest rates (e.g., Asriyan *et al.*, 2021; Brunnermeier and Koby, 2018; Balloch and Koby, 2019; Eggertsson *et al.*, 2019; Kroen *et al.*, 2021; Liu *et al.*, forthcoming; Martinez-Miera and Repullo, 2017; Wang, 2018) and the literature examining the trends and driving factors of firm entry and investment (e.g., Crouzet and Eberly, forthcoming; Gomes, 2001; Gutiérrez and Philippon, 2016; Jermann and Quadrini, 2012; Decker *et al.*, 2016; Gourio *et al.*, 2016; Karahan *et al.*, 2017; Covarrubias *et al.*, 2020). I show that low interest rates lead to an outflow of time deposits and as banks fund business loans with time deposits, this causes a lower supply of business loans and higher cost of business lending. This mechanism helps explain a decline in investment (e.g., Crouzet and Eberly, forthcoming; Gutiérrez and Philippon, 2016; Philippon, 2019) and lower firm entry (e.g., Decker *et al.*, 2016) observed over the recent decades. I show that falling interest rates disproportionately harm firm without bond market access that cannot substitute a decline in bank credit supply.[7] My findings also relate to the evidence in Kroen *et al.* (2021) who show that industry leaders take advantage of low interest rates.

The remainder of this paper is organized as follows. Section 1 summarizes the data. Section 2 presents the evidence that banks fund business loans with time deposits. Section 3 discusses the reasons behind it. Section 4 analyzes the role of monetary policy on time deposits and business lending. Section 5 examines the role of supply and demand. Section 6 presents the evidence from other asset classes. Section 7 examines the effect on firm investment and Section 8 shows the results for new firm creation. Section 9 presents the model. Finally, Section 10 concludes.

1 Data

Bank-level data. I use financial data on banks from U.S. Call Reports provided by the Federal Reserve of Chicago. The data includes quarterly bank-level information on bank balance sheets and income statements for all commercial banks in the United States. I collect Call Reports data from 1976 to 2015.[8]

[7] A large body of literature studying the heterogeneous effects of monetary policy on firm investment has shown differential responses across firms of different risk (Ottonello and Winberry, 2020), age (Cloyne *et al.*, 2018), liquidity (Jeenas, 2018) and size (Gertler and Gilchrist, 1994).

[8] While I exploit the Call Reports data from 1976 to 1980 to study the effects of the deregulation of time deposits on business lending, my main analysis focuses on the period from 1986 to 2015 (excluding the period of the Global Financial Crisis). The focus on the post-1986 period is twofold. First, the data on a number of

Deposit data. I use the data on deposit quantities at the individual branch level from the Federal Deposit Insurance Corporation (FDIC). The data comes at an annual frequency from 1994 to 2015. I aggregate the branch-level data to the bank-county level.

Small business lending. I complement the information from Call Reports with bank-county-time level information on small business lending from the National Community Reinvestment Coalition (NCRC). I collect the small business lending data from 1997 to 2015. This data allows be to examine new small lending for credit below $1 million.[9]

Syndicated lending. Thomson Reuters Dealscan database collects loan-level information on syndicated credit from Securities and Exchange Commission (SEC) filings, company statements, and other sources. Consistent with the large body of literature using Dealscan data, I focus on all loans issued to non-FIRE businesses. I restrict the sample to working capital or corporate purpose loans from 1992 to 2015. Following the approach in Chodorow-Reich (2014), I use the information on the syndicate structure to assign loan shares to lead arrangers and participants.

Firm-level data. I use firm-level variables from Compustat at quarterly frequency from 1992 to 2015 that provides a panel data of publicly listed firms in the U.S.. Using Compustat data for non-financial firms, I construct two measures of firm investments. First, I use the book value of the tangible capital stock of a firm at the end of the quarter. Second, I compute a share of capital expenditures (CAPX) to lagged value of capital stock.

I further add firm-level information on bond market financing from Mergent Fixed Income Securities Database (FISD). I supplement it with the information on firm credit rating from S&P Capital IQ. This allows me to construct the measure of firm access to bond financing.

New firm creation. I collect the information on new firm created at the industry-county-time level from Quarterly Workforce Indicators, which is provided by the Census Bureau.[10] I use quarterly data from 1995 to 2015. In addition, I also use the data on county-level employment, population and salaries from County Business Patterns and the Bureau of Labor Statistics.

Fed funds rate data. Finally, I draw the effective Fed funds rate series from Federal Reserve Economic Data (FRED). In addition, I also use monetary policy surprises identified using high frequency surprises from Gertler and Karadi (2015).

balance sheet and income statement components is available only after 1986. Second, I want to avoid confounding effects related to the interaction of monetary policy with Regulation Q. As shown by Drechsler *et al.* (2021b), Regulation Q, which was in place prior to 1986, affected the transmission of monetary policy to bank balance sheets.

[9] I consider the lending outcomes with at least $100,000 at the bank-county level.

[10] I exclude the following industry codes from my analysis: 52 (Financials), 53 (Real Estate) to focus on non-FIRE sectors as in the rest of the analysis.

2 How do banks fund business loans?

2.1 Time-series analysis

Aggregate analysis. Figure 1 Panel (a) plots the aggregate trends of business C&I loans[11] and time deposits (shown as a share to total assets of the banking sector). Business loans and time deposit shares are very strongly positively related (the correlation is 89%). Both series are closely following a similar long-run trend and are decreasing over time. Figure 2 Panel (a) further shows this close relationship also holds for the evolution of real year-over-year growth rates of time deposits and C&I loans (the correlation is 77%).

The strong positive relationship between business loans and time deposits is not only striking but it is also distinct from the relationship of C&I loans with other deposit products and time deposits with other asset classes. For instance, the correlation between the changes in C&I loans and savings deposits is -27%, and the correlation between the change in securities and real estate loans vs. time deposits is -14%.

From Panels (a) of Figures 1 and 2, business loans appear to be funded with time deposits. By contrast, Panels (b) of Figures 1 and 2 suggests that securities and real estate loans are funded with savings deposits. Panel (b) of Figure 1 shows the close co-movement between savings deposits, and security holdings and real estate loans in terms of shares to total assets of the banking sector (correlation of 89%). Panel (b) of Figure 2 highlights that changes in security holdings and real estate loans also strongly respond to savings deposit growth rate (correlation of 58%).

Cross-sectional analysis. I corroborate the results from the aggregate time-series analysis with a cross-sectional evidence. Figure 3 shows the relationship between the dynamics of different deposit (time and savings deposits) and asset classes (C&I loans and security holdings) in the cross-section of banks. For each of the considered deposit and asset types, I compute a year-over-year log change in their shares to individual bank total assets (TA). I sort banks by their time deposit dynamics (in Panels (a) and (c)) and savings deposits dynamics (in Panels (b) and (d)) into 100 bins. For the respective bins, I compute the average change in C&I loans (in Panels (a) and (b)) and security holdings (in Panels (c) and (d)) and graph the bin scatter plots. The plots confirm that the strong positive relationship between time deposits and C&I loans

[11] A commercial and industrial (C&I) loans are loans made to businesses. Usually, C&I loans provide funding for working capital or capital expenditures. In the remainder of this paper, I use the terms business loans and C&I loans interchangeably.

(Panel (a)), and savings deposits and security holdings (Panel (d)) observed in the aggregate time series is also present in the cross-section of banks. Panel (c) and (d) document instead a negative relationship between savings deposits and C&I loans, and time deposits and securities, respectively. Taken together, the aggregate and cross-sectional evidence strongly suggest that banks fund business lending with time deposits, and long-term lending (real estate loans and security holdings) with savings deposits.

2.2 Shock to the supply of time deposits

The aggregate time series analysis suggests that banks tend to fund different asset classes with different deposit products. In what follows, I provide additional evidence by using the deregulation of small time deposits in 1970s as an exogenous shock to the supply of time deposits.

I use the repeal of interest rates ceilings on small time deposits which marked "the beginning of the end for Regulation Q" (Drechsler *et al.*, 2021b).[12] Novelty of this paper is that it uses the regulatory change as an exogenous shock to the supply of time deposits to examine the effect on bank *business lending*. Specifically, I use the introduction of two deregulated small-time deposit products: Money Market Certificate (MMC) accounts in Q3 1978 and Small Saver Certificate (SSC) accounts in Q3 1979. MMCs had maturity of six months and denomination of $10,000 or more. SSCs had a maturity of at least 30 months and no minimum denomination.

First, I find that the deregulation of small time deposits in late 1970s increased the supply of time deposits. Figure 4 Panel (a) illustrates that in response to the introduction of SSC and MMC accounts, the share of time deposits to total deposits (red line) dramatically increased from around 36% prior to the regulation repeal to 42% in Q1 1981. In dollar value, the MMCs quickly grew to $68 billion just after one quarter, and by Q1 1981 these two new products totalled to $557 billion.

Second, using aggregate time series, I show that the rise of time deposits is associated with the rise of C&I loans. Figure 4 Panel (a) further documents a close co-movement of the business lending and time deposits around the regulatory change. Importantly, I do not find a similar effect for other asset types. Panel (b) plots the evolution of securities and time deposits. The two series do not seem to co-move and if anything, the share securities to total deposits started to decrease already prior to the regulatory changes and remained stable since 1979. Panel

[12] For details about Regulation Q, see Drechsler *et al.* (2021b) who use the deregulation of small deposits to provide a new explanation for the end of the Great Inflation of 1965–1982.

(c) shows the evolution of real estate (RE) loans. The RE loan category does not appear to be impacted by the deregulation of small time deposits. The RE loans had been trending up already in the pre-period and the trend continued throughout the sample period (1976–1980).

Third, I corroborate the time-series results by presenting a cross-sectional evidence. Figure 4 Panel (d) shows the relationship between the change in small time deposits and C&I loans between 1977 and 1979 at the cross-section of banks. I sort banks by their small time deposit dynamics into 100 bins and plot the average change in small time deposits and C&I loans (normalized by total deposits in 1977) for each bin.[13] The cross-sectional relationship is consistent with the aggregate time series. Banks experiencing more pronounced growth in small time deposits also increase their C&I loans the most.

2.3 Evidence using small business lending

Finally, I present an analysis using small business lending. The focus on small business lending allows me to address the concern that the previously documented effects could be driven by credit demand.[14] Specifically, the county-bank-level credit data allows me to implement a within-county estimation that controls for county-time variations (including the county-level changes in demand) and compare lending outcomes of banks facing similar lending opportunities within the same county. To this end, I estimate the following OLS regression:

$$\mathrm{y}_{b,c,t} = \alpha_{b,c} + \alpha_{c,t} + \beta \Delta \log(\text{Time Deposits}_{b,t-1}) + \gamma X_{b,c,t-1} + \epsilon_{b,c,t}, \tag{1}$$

where $\mathrm{y}_{b,c,t}$ denotes the log of new lending by bank b in county c in year t. I exploit the variation at the cross-section of banks. Specifically, $\Delta \log(\text{Time Deposits}_{b,t-1})$ denotes the log change in time deposits of bank b in year $t-1$. As motivated, I introduce county-time fixed effects ($\alpha_{c,t}$) to absorb any county-time variation including local lending opportunities. Bank-county fixed effect ($\alpha_{b,c}$) absorb any time-invariant bank, county or bank-county characteristics. Finally, I control for the lagged local deposit growth of bank b in county c (denoted as $X_{b,c,t-1}$). The standard errors are clustered at the bank-time and county level.

Table 1 shows the results. Column (1) presents the baseline estimates, as described in

[13] I winsorize the data at 10% to address the effect of outliers.

[14] A large body of literature has contributed to the importance of disentangling credit demand and credit supply (e.g., Khwaja and Mian, 2008; Schnabl, 2012; Jimenez *et al.*, 2020). In case of the availability of loan-level credit data, the estimation relies on the use of firm(-time) fixed effect. In the absence of granular loan-level data, the literature has relied on the use of county(-time) fixed effects to absorb demand-side confounding factors (e.g., Cortés *et al.*, 2020; Drechsler *et al.*, 2017; Luck and Zimmermann, 2020).

Equation 1. Within the same county and in the same year, banks with larger change in time deposits supply more new business lending by more than banks with smaller change in time deposits. The effect is statistically and economically significant at the 1% level. In Column (2), I further control for the log change in savings deposits. It shows that while the role of time deposits remains positive and statistically significant, the estimate of savings deposits is negative and statistically insignificant. Taken together, these results highlight that banks tend to fund their business loans with time deposits.

3 Why do banks fund business loans with time deposits?

The previous section provides evidence that banks tend to fund business loans with time deposits. In this section, I explore the reasons behind why this is happening. I start by focusing on key characteristics of business loans and time deposits.

Figure 5 plots the evolution of average effective rates for time (solid red) and savings (dashed orange line) deposits against the movement of the Fed funds target rate. The effective rate for time (savings) deposits is computed as a ratio of time (savings) deposits interest expense to lagged time (savings) deposits volume.[15] Different deposit products are associated with different interest rates levels and different sensitivities to short-rate changes depending on their liquidity. For liquid savings deposits, banks offer lower rates that are also less responsive to the changes in the Fed funds rate. Specifically, Banks charge high savings deposits spreads that are increasing in the While savings deposits are demandable, time deposit are illiquid as they cannot be withdrawn until the end of the term without penalty. As a result, time deposits not only pay higher rates than savings deposits but they are also the most sensitive to the Fed funds rate changes.

Business loans are floating rate or short-rate assets whose cash flows are highly sensitive to the Fed funds rate. Commercial and Industrial loans are also considered illiquid regardless of their maturity because banks cannot easily dispose of them to meet liquidity needs (Berger and Bouwman, 2009; Hanson *et al.*, 2015).

3.1 Interest-rate sensitivity matching

Aggregate analysis. Figure 5 also plots the effective rates for two asset classes: C&I loans and security holdings. First, I start by examining the relationship between C&I loans and time

[15] The effective rates are computed using the Call Reports data for banks.

deposits. C&I loan effective rate (solid blue) is computed as a ratio of C&I interest income to C&I loan volume. As C&I loans are primarily floating-rate products, their rates are very sensitive to the Fed funds rate changes. As discussed above, time deposits rates also exhibit strong sensitivity to short-rate changes.

Figure 5 further shows the evolution of effective rates of security holding (dashed green) and savings deposits (dashed orange). Both series exhibit weaker sensitivity to Fed funds rate changes. To formally compare the differences in the interest-rate sensitivity of the all four discussed balance sheet items, I estimate the following regression:

$$\Delta\text{EffectiveRate}^{y}_{b,t} = \alpha_b + \sum_{\tau=0}^{4} \beta^{y}_{\tau} \Delta R_{t-\tau} + \epsilon_{b,t}, \tag{2}$$

where $\Delta\text{EffectiveRate}^{y}_{b,t}$ is the change in the effective rate of a balance sheet item y of bank b at time t. I control for time-invariant bank characteristics with bank fixed effects (α_b). $\Delta R_{t-\tau}$ denotes the change in the Fed funds target rate from $t-\tau-1$ to $t-\tau$. Similarly to Drechsler *et al.* (2017), I introduce time lags to address the issues that it takes time for some loans to update their rates and that the Call Report data is based on average deposit expenses. As a result, for each of the assets (liability) item, I estimate the *average* Interest Income (Expense) Beta (β^{y}).

Table 2 summarizes the results. Column (1) shows that a 1 percentage point (pp) increase in the Fed funds rate is associated with a 58 basis points increase in the effective time deposit rate. Column (2) shows that the effect of monetary policy rate on savings deposits is much weaker. When the Fed funds rate rises by 1pp, the savings deposit effective rate rises only by 32 bps. This evidence is consistent with Drechsler *et al.* (2017) who show that banks increase the deposit spreads (liquidity premia) when the Fed funds rate rises. As the time deposit is less liquid than the savings deposit, banks increase time deposit rates by more. Column (3) and (4) focus on the effect of short-rate changes on the effective rate of bank assets. I find that the balance sheet items match each other very closely. Specifically, the sensitivity of C&I loans effective rate is quantitatively very similar to the sensitivity of time deposits rates (the estimates are 0.58 in Column (1) and 0.53 in Column (3)). Similarly, the coefficient for securities has a similar magnitude as the one for savings deposits (0.29 in Column (4) and 0.32 in Column (2)).

So far, this aggregate analysis suggests that banks choose to finance C&I loans with time deposits, and security holdings with savings deposits as this strategy hedges them from the interest rate risk. Such a strategy enables banks to maintain stable net interest margin (NIM)

with respect to interest rate volatility. As a next step, I examine this behavior using the cross-section of banks.

Cross-sectional analysis. The cross-sectional analysis consists of three steps. I present the methodology on the relationship between time deposits and C&I loans.[16] Specifically, I run the following OLS regressions:

$$\Delta \text{EffectiveRate}^{y}_{b,t} = \alpha_b + \sum_{\tau=0}^{4} \beta^{y}_{b,\tau} \Delta R_{t-\tau} + \epsilon_{b,t}. \tag{3}$$

First, I use time deposits effective rate as an outcome variable. I estimate bank-specific time deposit interest expense sensitivity to the Fed funds rate changes and denote it as Time Deposit Interest Expense Beta of bank b.[17] Second, I repeat the same estimation procedure, as described by Equation 3, using bank-level C&I effective rate as the outcome variable. This allows be to obtain the C&I Loan Interest Income Beta. Third, I use the two beta coefficients to investigate the relationship of interest-rate sensitivity of time deposits and business loans at the cross-section of banks. To this end, I sort banks into 100 bins based on their Time Deposit Interest Expense Beta and compute the average C&I Interest Income Beta for each bin.

Panel (a) of Figure 6 presents the results. Consistent with the aggregate analysis, the cross-sectional evidence highlights a very strong and positive relationship between the Time Deposit Interest Expense Beta and C&I Loan Interest Income Beta in the cross-section of banks. The results show that banks match the high interest exposure of time deposits with C&I loans. In other words, financing C&I loans with time deposits hedges banks from interest rate risk. This strategy allows banks to achieve stable net interest margin (NIM) that is insensitive to interest rates. Next, I repeat the same approach to examine the relationship between savings deposits and securities. Panel (b) of Figure 6 reports the results. Similarly to the Panel (a), I observe a strong matching of assets and deposits with low interest-rate sensitivity, savings deposits and securities, also at the cross-section of banks.

Finally, I turn the attention to the net interest margin (NIM) analysis. Banking literature generally focuses on bank-level NIM and computes it as the difference between bank's total interest income and total interest expense. Drechsler *et al.* (2021a) showed that bank-level NIM is insensitive to interest rate changes. For the purpose of my analysis, I unpack the bank-level

[16] I repeat the same approach for the analysis of the relationship between securities and savings deposits.

[17] The set-up presented in Equation 3 is similar to the Equation 2 but while Equation 2 examines the average effect, Equation 3 allows me to estimate a bank-specific betas.

NIM and construct four partial NIMs based on two sources of income (C&I loans and securities) and two sources of expense (time and savings deposits). Formally, I compute the net interest margins for a combination of an asset class a matched with a deposit type d for bank b at time t:

$$\text{NIM}_{b,t}^{a,d} = \text{Interest Income}_{b,t}^{a} - \text{Interest Expense}_{b,t}^{d}, \tag{4}$$

where a denotes either securities or C&I loans, and d denotes either savings or time deposits. I use the changes in the partial NIMs to analyze the interest-rate sensitivity:

$$\Delta\text{NIM}_{b,t}^{a,d} = \alpha_b + \sum_{\tau=0}^{4} \beta_{\tau}^{a,d} \Delta R_{t-\tau} + \epsilon_{b,t}. \tag{5}$$

Table 3 summarizes the results. Column (1) shows that partial NIM for C&I loans and time deposits is insensitive to short-rate changes. Therefore, financing C&I loans with time deposits *hedges* banks from interest rate risk. This relates to the previous finding that both balance sheet items exhibit similar, high interest-rate sensitivity. Column (2) instead finds that financing C&I loans with savings deposits *exposes* banks to interest rate risk (beta is 0.21). As a result, if banks were to use savings deposits to finance C&I loans, their profits would decline when Fed funds rate falls. Similarly to Column (2), Column (3) shows that financing securities with time deposits increases NIM volatility. Finally, Column (4) finds that the the matching of savings deposits and securities hedged banks from interest rate risk (estimate is -0.03). Summing up, my results show that banks' stable and interest-rate insensitive NIM can be explained by the fact that they match assets and deposits of similar interest-rate sensitivity. Specifically, using time deposits to fund C&I loans and savings deposits to finance long-term fixed-rate lending (securities such as MBS and Treasuries, and fixed-rate real estate loans) ensures banks' NIM is unaffected by changes in interest rates.

3.2 Liquidity matching

Banks fund C&I loans with time deposits also due to liquidity matching motive. As time deposits cannot be withdrawn on demand without penalty, they represent a stable source of financing for illiquid C&I loans, whose rapid liquidation may come at the fire-sale cost (Berger and Bouwman, 2009; Hanson *et al.*, 2015). If liquidity motive was important for banks, we would observe that on the margin banks with longer-maturity time deposits will extend longer-maturity business loans.

Figure 7 presents the relationship between liquidity of time deposits and loans in the cross-section of banks. Panel (a) reports the maturity for all bank loans (expect for real-estate credit). It shows that the maturity of time deposits closely lines up with the maturity of loans. Panel (b) exploits syndicated lending which allows me to explicitly focus on corporate adjustable-rate loans. It shows a similar positive cross-sectional relationship between the maturities of time deposits and business lending. Taken together, both Call report and syndicated lending data highlight that on the margin, banks with more illiquid time deposits also make more illiquid business loans suggesting asset-deposit liquidity matching can help explain why banks fund C&I loans with time deposits.

4 Monetary policy, time deposits and business loans

How does monetary affect business lending? So far, I have established that banks fund different assets classes with different deposit products due to interest-rate sensitivity and maturity matching. In this section, I investigate the role of monetary policy. Specifically, I reconcile the puzzling evidence from the existing literature that according to the data, contractionary monetary policy *increases* C&I lending (e.g., Gertler and Gilchrist, 1993). I start by examining the heterogeneous effects of monetary policy on different deposit products which allows me to shed new light on the effect of monetary policy on different asset classes.

4.1 The response of different deposit products to monetary policy

Aggregate evidence. I begin by focusing on the time-series evolution of the nominal short rate and the aggregate deposit volumes. Figure 1 presents the relationship between the level of the Fed funds rate and the share of bank financing coming from time deposits in Panel (a) and savings deposits in Panel (b). Time deposits share of banking sector total assets tracks very closely the Fed funds rate both in the trend and over the cycle. As the rates have been falling, there has been a shift in banks' funding mix away from time deposits towards savings deposits. Time (savings) deposits and Fed funds rate also strongly positively (negatively) co-move over time in terms of growth rates. Figure 8 presents the relationship between the year-over-year growth rates of different deposit products and the year-over-year change in the effective Fed funds rate. Panel (a) illustrates a strong co-movement between the growth of time deposits and the Fed funds rate. It shows that when the Federal Reserve raises rates, time deposits expand.

Panel (b) presents the evidence for savings deposits. It shows that savings deposit growth rates are negatively correlated with the Fed funds rate.

Local projections. Next, I investigate the response of different deposit products to the monetary policy using the local projections exercise.[18] Following Jordà (2005), I estimate the deposit response of banks:

$$y_{b,t+h} - y_{b,t-1} = \alpha_{b,h} + \beta_h \Delta R_t + \delta_1 X_{t-1} + \delta_2 B_{b,t-1} + \epsilon_{b,t+h}, \tag{6}$$

where $y_{b,t}$ denotes the log of the respective (time or savings) deposit product of bank b in time t and $h = 0, 1, ..., 16$ (quarters). The vector X_{t-1} controls for four lags of the GDP growth, four lags of inflation, and $B_{b,t-1}$ controls for four lags of total assets and four lags of the growth of the outcome variable. I also saturate the specification with bank fixed effects estimated for each time-horizon h ($\alpha_{b,h}$).

My coefficient of interest β_h captures the effect of the monetary policy on the growth rate of time or savings deposits. In the baseline specification, I use the changes in the Fed funds rate, ΔR_t, as a measure of monetary policy. This choice is dictated by the mechanism of the deposits channel of monetary policy, which I explore in this paper. As argued by Drechsler *et al.* (2017), in the deposits channel any rate change, both expected and unexpected, has an impact on the economy and thus represents an act of monetary policy. To overcome the concerns regarding the endogeneity of the Fed funds rate, the regressions include business cycle controls (GDP growth and CPI inflation) as in line with the Taylor-type interest rate rule logic. This is similar in spirit to the approach in Christiano *et al.* (1999).

As a robustness, I also use the monetary policy shocks identified using high frequency surprises around policy announcements by Gertler and Karadi (2015) which I denote as Δf_t.

Panels (a) and (b) of Figure 9 summarize the impulse responses of time deposits and savings deposits, respectively, to the 100 basis point increase in the Fed funds rate over h horizons. The results from the local projection exercise at the bank level are in line with the aggregate time-series evidence. In particular, in response to contractionary monetary policy banks experience an inflow of time deposits (Panel (a)) and an outflow of savings deposits (Panel (b)). The behavior of different deposit products in response to changes in the short-rate is consistent with

[18] For the analysis of the effects of monetary policy on bank balance sheets I focus on the sample period 1986-2008. I stop my sample right before the Global Financial Crisis in order to avoid the potentially confounding effects stemming from the unconventional monetary policy actions introduced by the Federal Reserve in response to the crisis.

the deposits channel of monetary policy in Drechsler *et al.* (2017). Specifically, the increase in the Fed funds rate is associated with a rise in the opportunity cost of holding cash. As a result, banks face less competition from cash(-like products) in providing liquid savings deposits which allows them to charge higher deposit spreads. As discussed in Section 3, banks increase rates on savings deposits only very modestly in response to a rise in Fed funds rate. As time deposits are illiquid, they directly compete with other short-term less-liquid products whose interest rates follow the Fed funds rate (e.g., short term treasuries or other money market instruments). Hence, when the Federal Reserve raises rates, banks raise time deposits rates by more as shown in Section 3. Consequently, as savings deposits become relatively more expensive, depositors substitute away from deposits in aggregate, and critically from (liquid) savings deposits to (illiquid) time deposits.

The results are robust to replacing Fed funds rate changes with monetary policy shocks identified using high frequency surprises as in Gertler and Karadi (2015). Appendix Figure A1 plots the response of time deposits (Panel (a)), and savings deposits (Panel (b)). In response to contractionary monetary policy shock, banks experience an outflow of savings deposits and an inflow of time deposits.

Taken together, the findings presented from both (i) the aggregate time series co-movement with the Fed funds rate, and (ii) local projections exercise, consistently highlight the special behavior of time deposits. While contractionary monetary policy leads to an outflow of savings deposits, time deposits move in the opposite direction. As shown, this relates to the fact that time deposits behave less like other (demandable) deposit products and instead they resemble less liquid short-term money market instruments or T-bills. When the Fed funds rate rises, depositors reallocate from liquid assets (demandable deposits) to more illiquid assets that pay higher interest rates. This is findings is similar in spirit to the evidence on the rise of shadow banks in Xiao (2020). This paper shows that such reallocation occurs also inside the banks' balance sheets.

4.2 The effects of monetary policy on business lending

While the overwhelming body of work has documented the bank-lending channel of monetary policy (e.g., Bernanke and Blinder, 1988; Kashyap and Stein, 2000; Jimenez *et al.*, 2012; Drechsler *et al.*, 2017), the literature has also highlighted a puzzling result in the data that business lending tends to rise following a contractionary monetary policy (Gertler and Gilchrist, 1993;

Kashyap and Stein, 1995; Den Haan *et al.*, 2007; Greenwald *et al.*, 2021). In the section, I replicate the counter-intuitive result on business lending and reconcile it with the evidence on time deposits.

First, I replicate the puzzling effect of monetary policy on bank C&I lending. To this end, I estimate the local projections in line with Equation 6 and use the log level of C&I lending by bank b in time t as the outcome variable ($y_{b,t}$). Panel (c) of figure 9 presents the response of bank business lending to a 100 bp increase in the Fed funds rate. In contrast to the conventional wisdom, the results show that monetary tightening is associated with an increase in bank C&I lending – thereby confirming the existing puzzle in the data. Panel (d) of figure 9 presents the response for bank security holdings. In contrast to C&I loans, banks reduce their security holdings in response to higher Fed funds rate. This result is consistent with the standard view of monetary transmission through bank balance sheets. The results are robust to using monetary policy shocks of Gertler and Karadi (2015) instead of changes in the Fed funds rate directly. Appendix Figure A1 shows that in response to a contractionary monetary policy shock, C&I loans increase while bank security holdings fall.

Second, I look inside the cross-section of banks. I follow the approach used in Section 3, previously used for the analysis of rates to now examine the effect on quantities. Formally, I estimate the bank-specific response of a log change in the quantity of a balance sheet variable y of bank b in time t to Fed funds rate changes by running the following OLS regression:

$$\Delta \log(y_{b,t}) = \alpha_b + \sum_{\tau=0}^{4} \beta_{b,\tau} \Delta R_{t-\tau} + \delta_1 X_{t-1} + \delta_2 B_{b,t-1} + \epsilon_{b,t}. \tag{7}$$

where the vector X_{t-1} controls for four lags of GDP growth and four lags of inflation, and $B_{b,t-1}$ controls for four lags of bank total assets. As in the local projection exercise, the business cycle controls are used in line with the Taylor-type interest rate rule logic to overcome the endogeneity concerns related to setting the Fed funds rate.

I start by estimating for each bank b the response of C&I lending to monetary policy and denote the sum of bank-specific beta estimates, $\sum_{\tau=0}^{4} \beta_{b,\tau}$, as a C&I Loan Beta . Next, I repeat the procedure using the log change in time deposits as an outcome variable to obtain the Time Deposit Beta for each bank b. Finally, I sort banks into 100 bins based on their Time Deposit Beta, compute the average C&I Loan Beta within each bin, and present a scatter plot of the relationship between the two betas.

Figure 10 Panel (a) shows a relationship between the Time Deposit Beta vs. C&I Loans

Beta. The average response to monetary policy beta coefficients are positive suggesting that as the Fed funds rate rises, banks increase both time deposits and business lending, consistent with the evidence shown in Sections 4.1 and 4.2. The cross-section also demonstrates a strong positive correlation between the two betas. In other words, banks with a stronger time deposit response also expand business lending by more, consistent with my previous finding that banks fund C&I loans with time deposits.

As a next step, I repeat the cross-sectional analysis to investigate the relationship between savings deposits and security holdings. Figure 10 Panel (b) presents the results. In contrast to Panel (a), the average effects are negative: when the Fed funds rate rises, savings deposits and security holdings contract. Similarly to Panel (a), there is a very strong positive relationship between the Savings Deposit Beta and Securities Beta. Thus, when the Federal Reserve raises rates, banks that face stronger outflow of savings deposits also decrease security holdings by more, in line with my previous result showing that banks use savings deposits to finance security holdings.

5 What is the role of loan demand vs. loan supply?

While the aggregate and bank-level results established so far provide a useful suggestive evidence, they are also subject to a common identification challenge – time deposit supply can be responding to changes in bank business lending opportunities rather than directly to monetary policy. If banks' lending opportunities increase when the Federal Reserve raises the rates, banks would make more loans to firms and therefore also collect more time deposits.

In this chapter, I present three pieces of evidence in support of the loan supply rather than loan demand effects. First, I exploit the cross-sectional evidence on bank market power in pricing and attracting small time deposits. Second, I present small business and syndicated lending analyses that allow me to control for time-varying demand factors. Third, I show the effects on both loan quantities and loan spreads.

5.1 Monetary policy, time deposits and market power

I start by presenting a cross-sectional analysis of bank market power in pricing and attracting retail time deposits. Specifically, I measure bank market power in two ways.

First, I proxy for bank market power with Time Deposit Spread Beta as established in

Drechsler *et al.* (2017).[19] Time deposit spread is defined as a difference between the effective Fed funds rate and the time deposits rate. Similarly as in the previous analyses, I estimate Time Deposit Spread Beta as the bank-level sensitivity of time deposit *spread* to changes in the Fed funds rate:

$$\Delta\text{Time Deposit Spread}_{b,t} = \alpha_b + \sum_{\tau=0}^{4} \beta_{b,\tau} \Delta R_{t-\tau} + \epsilon_{b,t}, \tag{8}$$

and compare them with Time Deposit *Quantity* Beta across banks. This allows me to test the hypothesis that when monetary policy tightens, banks with less market power (lower Time Deposit Spread Beta) increase their spreads by less and experience higher inflow of time deposits (compared to banks with more market power.)

Second, I proxy for bank market power in time deposit market with the Herfindahl–Hirschman Index (HHI). I use branch-level data provided by the FDIC to compute the HHI for deposit market by squaring deposit-market shares of all banks operating in a given county in a given year, and averaging over the time. Using the cross-sectional variation in HHI as a proxy for market power, I test the hypothesis that an increase in the Fed funds rate is associated with a stronger increase in time deposit quantities and smaller increase in spreads for banks with lower HHI (compared to banks with higher HHI).

Figure 11 presents the cross-sectional relationship between bank market power in local deposit markets and the response of their time deposits quantity to increases in the Fed funds rate. In this graph, I proxy for market power with Time Deposit Spread Beta. The plot illustrates an inverse relationship between the market power and the response of time deposit quantity (measured with Time Deposit Quantity Beta). In other words, following an increase in the Fed funds rate, banks with less market power obtain more time deposits than banks with more market power. In Appendix Figure A2 I also proxy for bank market power with HHI in deposit markets. The results remain robust to this alternative measure of bank market power.

I further formally investigate the role of market power on time deposit quantity response to monetary policy by estimating the following OLS regression:

$$\Delta y_{b,t} = \alpha_b + \gamma \Delta R_t + \zeta(\Delta R_t \times \text{Market Power}_b) + \delta_1 X_{t-1} + \delta_2 B_{b,t-1} + \epsilon_{b,t}. \tag{9}$$

[19] While Drechsler *et al.* (2017) document the importance of Deposit Spread Beta as a comprehensive measure of market power in the (overall) deposit market, I specifically focus on the market power in the *time* deposit market.

where: Market Power$_b$) is a measure of bank market power in deposit markets proxied by either Time Deposit Spread Beta or Bank HHI. Table 4 reports the results. First, in Column (1) I examine the effect on the change in time deposit spreads. The positive and statistically significant coefficient suggests that when the Fed funds rate increases, banks with higher HHI increase time deposits spreads by more. This evidence provides further assurance that Time Deposit Spread Beta is indeed a consistent measure of bank market power in time deposit markets. Column (2) presents the average response of time deposits (quantities) to the change in the Fed funds rate. In line with the previous evidence, a rise in the Fed funds rate is associated with an increase in time deposit volumes.

Columns (3) and (4) exploit the Time Deposit Spread Beta as a source of heterogeneity of the bank market power. The interaction coefficient of ΔR_t and Time Deposit Spread Beta is negative and statistically significant and the effect does not attenuate after controlling for time fixed effects in Column (4). This suggests that when the Federal Reserve raises rates, time deposits increase by less for banks with higher market power (proxied with high Time Deposit Spread Beta). In Columns (5) and (6), I present the results using deposit HHI as a measure of market power. Similarly to the first market power proxy, the negative and statistically significant interaction coefficient demonstrates that in response to the monetary tightening, time deposits expand by less for banks with higher HHI. Taken together, the presented evidence supports the hypothesis that when the Fed funds rate rises, banks with less market power increase their time deposit spreads by less and experience a larger inflow of time deposits compared to banks with more market power.

Finally, I use the heterogeneity in bank market power in deposits market to investigate the effect on C&I lending. To this end, I estimate the differential effect of monetary policy on C&I lending depending on bank Time Deposit Spread Beta. In particular, I use Specification 9 with the log change in C&I loans as a dependent variable.

Table 5 Panel (a) presents the results. Column (1) confirms the evidence established through local projections that C&I loans increase in response to monetary policy tightening. Column (2) reports the heterogeneous effect using the cross-sectional variation in Time Deposit Spread Beta. It shows that banks with lower market power in local deposit markets increase their business lending more strongly. The magnitude of the effect does not attenuate even after introducing time fixed effects in Column (3). Overall, these results show that deposit market power impacts the sensitivity of C&I loans to monetary policy which is the first piece of evidence in support

of the role of credit supply.

5.2 Time-varying demand factors in small business and syndicated lending

To further disentangle the role of credit supply from credit demand, this section uses loan-level data that allow me to better control for time-varying demand for credit with fixed effects.

Small business lending. I start with the small business lending data and estimate the following regression:

$$\log(\text{New Small Business Credit}_{b,c,t}) = \alpha_{b,c} + \alpha_{c,t} + \zeta(\Delta R_t \times \text{Market Power}_b) + \epsilon_{b,c,t}, \quad (10)$$

where the dependent variable denotes a log of new small business credit by bank b in county c in year t. Similarly to the analysis presented in Section 2.3, I saturate the specification with bank-county and county-time fixed effects. Notably, the county-time fixed effects allow me to compare lending behavior by different banks facing similar lending opportunities within the same county. I exploit the heterogeneity in the market power at the cross-section of banks measured by the Time Deposit Spread Beta to analyze the difference in responses of bank lending to monetary policy.

Table 5 Panel (b) summarizes the results. In order to estimate the average effect of monetary policy on small business loans, specifications in Columns (1) and (2) are estimated without county-time fixed effects. Instead, I control for aggregate economy business cycle (through lags of GDP growth and inflation) and local, county-level business cycle variation (through lagged changes in county-level wages and employment as well as lagged county-level deposit growth). Column (1) shows that the average effect of monetary policy on credit is positive: higher Fed funds rate is associated with an increase in new small business lending, consistent with the findings obtained in Panel (a) for the total bank-level C&I lending. Column (2) finds that the effects is stronger for bank with less market power. Column (3) introduces county-time fixed effects to absorb any county-time variation. The estimates with county-time fixed effect are quantitatively very close to the results in Column (2). This suggests that even after controlling for county-level demand for business credit, banks with less market power in deposit markets, that are able to attract more time deposits when interest rates increase, extend more new small business loans.

Syndicated lending. As a next step, I examine the effect of time deposits and monetary policy on syndicated lending using Dealscan data. The focus on syndicated lending allows me to introduce sector-time or even firm-time fixed effects that absorb any sector or firm time-variation that can drive demand for credit. Equation 11 summarizes the set up:

$$\log(\text{New Syndicated Credit}_{b,l,f,t}) = \alpha_b + \alpha_{f,t} + \zeta(\Delta R_t \times \text{MktPower}_b) + \gamma X_{b,l,f,t} + \epsilon_{b,l,f,t}, \quad (11)$$

where the outcome variable denotes the log of newly issued syndicated loans l to a firm f by bank b at time t. Following the approach in Chodorow-Reich (2014), I use the information on the syndicate structure to assign loan shares to lead arrangers and participants. The regression is saturated with time-varying macroeconomic controls (four lags of GDP and inflation), time-varying bank controls (total assets), time-varying firm controls (size, current assets, sales growth) as well as bank, loan-type, loan-purpose and rating fixed effects. In addition, in Columns (3) and (4) I introduce sector-time and firm-time fixed effects, respectively. This allows me to absorb time-varying sectoral demand in Column (3) and time-varying firm demand for credit in Column (4). To this end, I compare the behavior of two banks with different time deposits market power (proxied by Time Deposit Spread Beta) lending to the same sector (or firm) when monetary policy tightens.

Table 6 reports the results. Column (1) shows that when the Fed funds rate rises, banks on average increase syndicated lending. Columns (2), (3) and (4) exploit the Time Deposit Spread Beta heterogeneity at the cross-section of banks. Negative and statistically significant interaction coefficients demonstrate that when the Fed funds rate rises, the lending response is stronger for banks with less market power in deposits market even after controlling for credit demand through sector-time or firm-time fixed effects. These findings are consistent with the previously documented aggregate evidence as well as the evidence from the small business lending.

5.3 Prices and quantities

Aggregate evidence. In this section, I examine the effect of monetary policy not only on quantity of business credit but also on its price measured with C&I loan spreads. C&I loan spread is computed as a C&I effective rate minus the effective Fed funds rate.[20] As before, I

[20] For details about the C&I effective rate, its definition and time evolution, see Section 3.1.

start by focusing on the aggregate evidence. Figure 12 plots the evolution of C&I loan spread against the year-over-year C&I loan growth.

Figure 12 reveals striking negative relationships between the C&I loan spread and the C&I loan growth. Strong negative relationship between C&I quantities and prices suggests that the bank loan supply effects play an important role.

Figure 13 further illustrates the relationship between loan spreads and the Fed funds rate. Panel (a) shows a remarkably strong negative relationship between C&I loans spread and the Fed funds rate. In addition, we can observe an upward trend in the C&I loan spread, which increased from around 2.5 pp at the beginning of 1990s to 4 pp in 2015. In Panel (a), I use effective C&I rate from Call reports to construct the spread. In order to address a potential worry that the increase in spread can be associated with an increase in riskiness of banks' loan portfolio (banks change the composition of borrowers towards riskier firms), in Panel (b) I control for the riskiness of firms by using the data from Dealscan. Specifically, I plot the spread only for new loans issued to speculative grade or unrated firms (the highest risk category). Similarly to the C&I loan spread from Call Reports, the Dealscan based spread for new loans exhibits an upward trend (increases from around 1.5 pp at the beginning of 1990s to around 2.5 pp in 2015) and a strong negative relationship with the Fed funds rate.[21].

Further, Appendix Figure A3 plots the evolution of spreads on C&I loans and 1-year adjustable-rate mortgages (ARMs). It shows that C&I loan spreads co-move strongly with spreads on other floating-rate loans products such as ARMs. This finding is consistent with bank interest-rate sensitivity matching of assets and deposit. Furthermore, the similar sensitivity of different loan products lends support to the supply effects rather than demand effects as it is unlikely that different types of borrowers (of different loan products) would respond in such a remarkably consistent manner.

To summarize, I find that when monetary policy rates fall, C&I loan spreads increase and that high loan spreads are associated with low C&I loan growth. These findings are inconsistent with predictions from models with credit demand shocks. According to the demand story, a sudden fall in the Fed funds rate should shift the demand outwards which would lead to both higher spreads and higher loan volumes. Instead, the presented evidence illustrates that high interest spreads are associated with lower C&I volumes which lends support to credit supply shock-based models (similarly to Mian *et al.*, 2017). The aggregate evidence suggests that a fall

[21]This evidence is consistent with the results in Roberts and Schwert (2020) who show that interest rates are inversely related to the cash flow rights and positively related to the control rights granted to creditors

in the Fed funds rate leads to an inward shift of the C&I credit supply which is accompanied with a decrease in loan quantities and increase in spreads. In what follows, I examine the relationships further using the local projections and cross-section of banks.

Local projections. Next, I investigate the response of C&I loan spreads to monetary policy using the local projection exercise following Equation 6. Figure 14 Panel (a) shows the impulse response to 1 percentage point increase in the Fed funds rate for C&I loan spreads based on Call reports data. In line with the aggregate evidence, monetary tightening is associated with a decrease in loans spread. This result together with a positive response of loan quantities (as shown in Figure 9 Panel(c)) provides an additional evidence in support of the role of bank loan supply.

As a next step, I use Dealscan data on new business loans to further investigate the effect of contractionary monetary policy on business loan spreads. The benefit of Dealscan data is that it allows me to observe rating categories and thus either control for or examine the heterogeneity based on borrower riskiness (rating). I start by controlling for riskiness with rating category fixed effects and estimate local projections as follows:

$$\text{Loan Spread}_{r,t+h} - \text{Loan Spread}_{r,t-1} = \alpha_h + \alpha_r + \beta_h \Delta R_t + \gamma X_{t-1} + \epsilon_{t+h}, \tag{12}$$

where $\text{LoanSpread}_{r,t}$ denotes an average spread of loans at rating category r.

Figure 14 Panel (b) reports the results. It shows that in response to a 100 bps increase in the Fed funds rate, loan spreads fall. In Appendix Figure A4, I further differentiate the effect by rating categories. For the group of the safest borrowers in Panel (a) measured as AAA–A rated, I do not find effects that would be statistically different from zero. Panel (b) reports the effect for riskier BBB-rated firms and Panel (c) shows the effects for the speculative grade and non-rated firms. While both Panels (b) and (c) find that spreads drop following a contractionary monetary policy, the results are the strongest for the riskier firms in Panel (c).

Cross-sectional analysis. Finally, I exploit the cross-sectional variation in bank market power in deposit markets to estimate the effect of changes in Fed funds rate on loan spreads by running the following regression:

$$\text{Loan Spread}_{b,l,f,t} = \alpha_b + \alpha_{s,t} + \zeta(\Delta R_t \times \text{MktPower}_b) + \gamma X_{b,l,f,t} + \epsilon_{b,l,f,t}. \tag{13}$$

The regression is saturated with time-varying macroeconomic controls (four lags of GDP and

inflation), time-varying bank controls (total assets), time-varying firm controls (size, current assets, sales growth) as well as bank, loan-type and loan-purpose fixed effects. In addition, I control for loan riskiness with rating fixed effects and in Column (3) I introduce sector-time fixed effects that control for time-varying demand for credit at the sector level.[22]

Table 7 summarizes the results. Column (1) reports the average effects showing that when the Fed funds rate rises, spreads fall, consistent with the aggregate and local projection evidence. In Column (2), I exploit the heterogeneity in banks' market power in deposit markets using Time Deposit Spread Beta as a proxy. The results show that the effects are stronger for banks with less market power (low Time Deposit Spread Beta). Finally, Column (3) introduces sector-time fixed effects to control for time-varying demand at the sector level. The estimate of the interaction coefficient remains positive, statistically significant and quantitatively similar to Column (2).

In summary, the loan quantity and loan spread results in Tables 6 and 7 further corroborate that even at the cross-section of banks, Fed funds rate hikes are associated with higher volume of C&I loans and lower spreads, with the effects stronger for banks with less market power (that are able to attract more time deposits). This cross-sectional evidence provides additional support in favor of the supply effects.

6 Evidence from other asset classes

Local projections. In this section, I investigate whether my findings are special to the case of C&I loans or whether they could be generalized to other floating-rate asset classes. I revisit the local projections exercise as presented in Equation 6 to examine the effect of monetary policy on a range of other adjustable and fixed rate assets. Specifically, I consider the following six asset classes: securities (short-term and fixed-term long-term), real estate loans (adjustable-rate and floating-rate), and other loans (adjustable-rate and fixed-rate).

Figure 15 presents the results. Panels (a) and (b) illustrate the results for short-term (less than three-year maturity) and fixed-rate long-term security holdings, respectively.[23] The impulse response functions show that following a 100 bps increase in the Fed funds rate, banks

[22] The loan-spread regressions do not allow to control for firm-time fixed effects because spread on the loan at the facility level is the same for all banks in the syndicate and in most cases firms only receive one loan per period.

[23] Call Reports data on the repricing maturity of bank assets starts only in 1997. Thus, I estimate the impulse responses of different asset classes for up to 8 quarters only. The amount of data is insufficient to estimate the responses for longer horizons (beyond 8 quarters).

increase their short-term securities holding and decrease the size of the long-term security portfolio. Similarly, to Panel (a) and previous evidence on C&I loans (as examined in Panel (c) of Figure 9), Panels (c) and (e) show the positive response of adjustable-rate loans (mortgages and other loans) with respect to the contractionary monetary policy. In contrast, Panels (b), (d) and (f) illustrate a negative effect for all fixed-rate asset classes.

Taken together, these results demonstrate that not only (floating-rate) C&I loans but also other asset classes with interest-rate sensitive cash flows respond positively to Fed funds rate increases. Interest-rate insensitive assets, on the other hand, fall when the Federal Reserve raises rates. These findings demonstrate that C&I loans are not special when it comes to the sensitivity to monetary policy rates. Other assets, that share the same interest-rate sensitivity characteristics, behave similarly.

Cross-sectional analysis. Appendix Figure A5 highlights that the evidence from cross-sectional analysis of C&I loans and security holdings (Figure 10) also holds for other assets. Panels (a), (c), (e) of Appendix Figure A5 show that for interest-rate sensitive assets, there is a strong positive relationship between the Time Deposits Quantity Beta and the Quantity Betas of the asset class with interest-rate sensitive cash flows. This means that banks with larger inflow of time deposits increase their holdings of short-term (floating-rate) securities, adjustable-rate mortgages and other floating-rate loans. This pattern strongly resembles the striking positive relationship in Figure 10 Panel (a) for C&I loans. In contrast, Panels (b), (d) and (f) illustrate a strong positive correlation between the Savings Deposits Beta and the Quantity Betas of the respective interest-rate insensitive assets. To summarize, the presented cross-sectional evidence reveals that banks match interest rate (in)sensitive assets with interest rate (in)sensitive deposits.

7 Falling interest rates and investment

So far, I have documented that falling interest rates lead to a lower supply of business lending by banks. As a next step, I examine the effects of lower interest rates on business investment. Figure 16 plots the time series evolution of business investment normalized by firms' gross operating surplus (profits) and business loans normalized by non-financial sector debt. It shows that the two series very closely co-move with one another. They were increasing from 1960s until the beginning of 1980s and declining over the last four decades. I document a similar

pattern if I rescale investment to non-financial sector debt (Panel (a) of Appendix Figure A6) or business sector value added (Panel (c) of Appendix Figure A6). The observed decline in investment over the past decades and the potential reasons for it have been at the forefront of a recent academic debate (e.g., Crouzet and Eberly, forthcoming; Gutiérrez and Philippon, 2016). In this paper, I argue that a lower supply of lending to firms induced by falling rates contributed to the decline in business investment.

Figure 17 focuses on the dynamics. Panel (a) plots the year-over-year growth of business investment and C&I loans. It finds a strong positive relationship (with a correlation of 0.6). Panel (b) plots the dynamics of investment and corporate bonds and finds negative weak correlation between the two variables. The weak correlation of business investment and bond financing is consistent with the fact that only a small fraction of firms has access to the bond market, primarily large and high rated firms.[24]

In light of this aggregate evidence, I test two hypotheses regarding the effect of changes in interest rates on investment at the firm level.[25] First, when the Fed funds rate falls, firms solely relying on banks experience a cut in loan supply and decrease investment. Second, when the Fed lowers rates, firms with bond market access substitute a decrease in bank loan supply with bond market financing. To this end, I proxy for the access to bond market financing with the availability of firm rating.[26]

I start by running the following regression:

$$y_{f,t} = \alpha_f + \beta_1 \Big(\Delta R_t \times (\text{Rating Exists}_{f,t-1} = 0) \Big) + \beta_2 \Big(\Delta R_t \times (\text{Rating Exists }_{f,t-1} = 1) \Big) + \\ + \gamma F_{f,t-1} + \epsilon_{f,t}. \quad (14)$$

where the dependent variable is the log of new external financing a firm f receives in time t. I, specifically, examine two types on news financing: new bank loans and new bonds, respectively. In the regressions, I either examine the effect of monetary policy measured by changes in the Fed funds rate (ΔR_t) or monetary policy surprises (Δf_t). Dummy variable $\text{Rating Exists}_{f,t-1}$ takes the value of one if the firm has had a rating in period $t-1$, and zero otherwise. My main coefficients of interest (β_1 and β_2) examine the heterogeneous response of firms with and without

[24] Among publicly traded firms in Compustat, only 20% of firms have bond market access.

[25] For the rest of this analysis, the credit data are from the syndicated lending in Dealscan and bond financing is from Mergent Fixed Income Securities Database (FISD).

[26] As a robustness, I also proxy for access to bond market financing with firm's previous borrowing through the bond market and the results are consistent.

rating to the Fed funds rate changes. Finally, I control for firm time invariant characteristics with firm fixed effects and introduce additional firm-time controls such as sales growth, size and current assets as a share of total assets.

Table 8 presents the results. Columns (1)–(4) focus on new bank loans. Columns (1) and (2) revisit the average lending effects: softer monetary policy (measured with a cut in the Fed funds rate in Column (1) or an expansionary monetary surprise in Column (2)) is associated with a decrease in new bank loans at the firm level. Column (3) splits firms into two groups: with and without rating. It finds that for both types of firms, the coefficient is positive and statistically significant and I can rule out that two magnitudes are statistically different. Column (4) repeats the heterogeneous analysis using monetary surprises and finds similar results. To summarize, the presented evidence shows that when the Fed funds rate falls, all firms relying on banks (both with and without bond market access) experience a cut in loan supply.

Columns (5) and (6) examine the effect on monetary policy on new bond financing. Since the new bond borrowing occurs vastly for firms with existing rating, I only estimate the effects for rated firms. The negative and statistically significant estimates demonstrate that when the Fed funds rate falls, firms increase their bond market financing. Taken together, the results illustrate that when the Federal Reserve cuts rates, firms without the access to bond market suffer from a decrease in bank credit. To better understand the effect for firms with bond financing, I next present the following within-firm analysis:

$$\log(1+\text{New Debt}_{i,f,t}) = \alpha_{f,t} + \beta(\Delta R_t \times \text{Bond}_i) + \gamma \text{Bond}_i + \delta F_{f,t-1} + \epsilon_{i,f,t}, \tag{15}$$

where the outcome variable denotes the log of new external debt of type i (where i is either a bank loan or a bond) taken by firm f at time t. Most importantly, the specification uses firm-time fixed effects that allow me to control for time-varying firm-level demand for external financing. The main coefficient of interest (β) thus estimates the differential response of bond financing with respect to bank financing within the same firm f at the same time t.[27]

Table 9 summarizes the results. Similarly to Table 8, I find that in response to lower Fed funds rate, bank credit falls (estimate of ΔR_t in Column (1) is positive) and the difference in the reliance of bank vs. bonds increases (beta estimate of the interaction coefficient from Equation 15 is negative). This holds even after controlling for firm-time fixed effects in Column (2). The

[27] In the regressions without firm-time fixed effects, I include time-varying firm controls, i.e. sales growth, size, current assets as a share of total assets, as well as macro controls, i.e. four lags of quarterly GDP growth and CPI inflation.

results are economically and statistically relevant both when the monetary policy is measured with the Fed funds rate in Columns (1)–(2) and high-frequency monetary policy shocks in Columns (3)–(4). Taken together, the results suggests that conditioning on firm demand for external financing (through firm-time fixed effects), lower interest rates are associated with more financing received by firms through the bond market. This indicates that firms with bond market access substitute towards bond financing when experiencing lower supply of bank credit due to lower interest rates.

Finally, I study the aggregate credit and investment effects at the firm-level. This allows me to understand what happens to overall (bank and bond financing) as the Fed funds rate falls. Equation 16 summarizes the set-up:

$$y_{f,t} = \alpha_f + \beta_1\Big(\Delta R_t \times (\text{Rating Exists}_{f,t-1} = 0)\Big) + \beta_2\Big(\Delta R_t \times (\text{Rating Exists }_{f,t-1} = 1)\Big) + \\ + \gamma F_{f,t-1} + \epsilon_{f,t}. \quad (16)$$

First, I examine the effect on total firm credit. The dependent variable denotes a log change in total debt (bank and bond debt) of firm f in time t. Columns (1) and (2) of Table 10 present the results. The estimates show that when the Fed funds rate falls, firms without bond access (measured as firms without rating) suffer from a decrease in total debt. For firms with access to the bond market, I find that the change in debt is zero. In other words, firms with bond market access substitute a decrease in bank loan supply with bond market financing.

In the remainder of Table 10, I present the results on the effect of monetary policy on firm investment. Columns (3)–(4) report the effect on a log change in capital of firm f in time t.[28] Columns (5)–(6) show the effect on firm investment (CAPX) as a share of lagged capital. In both cases, I find that when Fed cuts interest rates, firms solely relying on banks (without bond market access) experience a cut in loan supply and consequently they decrease investment. Instead, firms with bond market access substitute a decrease in bank loan supply with market financing and their investment remains unaffected.

These findings document the importance of interest rate changes (through bank time deposits) on supply of business lending and investment. When firms do not have access to the bond market, this channel bears real consequences. A 1 pp decrease in the Fed funds rate is associated with a 1.9% cut in firm credit and a 1% drop in firm investment (on impact) for

[28]Capital is computed using perpetual inventory method as in Ottonello and Winberry (2020).

firms without access to bond market.

Finally, I examine whether the negative investment effects of softer monetary policy are indeed related to a lower amount of credit. For this purpose, I estimate firm-specific sensitivity of credit and investment to interest rate changes, by running the following regression:

$$y^i_{f,t} = \alpha_f + \sum_{\tau=0}^{4} \beta^i_{f,\tau} \Delta R_{t-\tau} + \gamma F_{f,t-1} + \epsilon_{f,t}, \tag{17}$$

where I first use the change in log of firm debt $\Delta\log(\text{Debt}_{f,t})$ as my outcome variable to estimate firm level sensitivity to monetary policy and I denote it as Firm Debt Beta. Second, I repeat the estimation using $\Delta\log(\text{Capital}_{f,t})$ as a dependent variable to estimate Firm Investment Beta. Finally, I sort firm into 100 bins based on their Firm Debt Beta and plot the relationship between the Firm Debt Beta and Firm Investment Beta in a scatter plot. Appendix Figure A7 illustrates the results. It shows that the response of firm debt and firm investment to Fed funds rate changes are strongly, positively correlated. Taken together, my results suggest that the investment effects of monetary policy are strongly related to the credit effects. This result is consistent with the strong co-movement between bank loan financing and investment observed in aggregate data.

8 The effects of lower interest rates on new firm creation

Time deposits and business loans have been on a decline since 1980s. Panel (a) of Figure 1 documents this secular trend.[29] The U.S. banking sector has been running out of time deposits and business loans both in terms of a share to non-financial sector debt (Panel (a)) and total banking sector assets (Panel (b)). At the same time, a new firm creation has also been falling over the last four decades (see e.g., Decker *et al.*, 2016). Figure 18 Panel (a) illustrates a strong positive correlation between time deposits and jobs created in new firms. Panel (b) shows consistent co-movement for the slowdown in time deposits and firm creation. Understanding the role of a decline in time deposits and business lending in the decline of firm creation is particularly important given that banks are the main source of financing for small and young firms.

In this section, I test the hypothesis that lower interest rates contributed to a decline in

[29]Similar pattern holds if business loans and time deposits are normalized by total non-financial sector debt as presented in Appendix Figure A8.

firm creation. Specifically, I examine the role of time deposits in the transmission mechanism through bank balance sheets. Lower Fed funds rate led to a decrease in time deposits which serve as a key source of funding for business loans. As supply of bank credit to businesses contracted, new firms creation deteriorated.

To study the effect of monetary policy on firm creation, I exploit county-time panel data on new firm creation and additional heterogeneity across industries with respect to their external finance dependence. I construct a Bartik-style instrument that allows me to measure an ex-ante exposure to time deposit growth on a county level:

$$\Delta\log(\text{Time Deposits}_{c,t}) = \sum_{b} \Big(\Delta\log(\text{Time Deposits}_{b,t}) \times \text{Lending Share}_{b,c,t-1}\Big), \tag{18}$$

that computes an average of the log change in (national) time deposits of bank b from quarter $t-1$ to t weighted by the lending share of the bank b in county c in the previous year.

My analysis focuses on both short-run and long-run effects. In the short-run, I examine whether counties exposed to banks with stronger time deposit growth have more new firms created within the same quarter. In the long run, I test the hypothesis that a downward trend in firm creation is stronger for counties more exposed to banks with (i) a larger decline in time deposits and (ii) a higher ratio of time deposits to total assets.

Short-run analysis. I start by examining the pooled data on new firm creation across counties and time, and time deposit growth of banks operating in the county. Appendix Figure A9 presents a strong positive relationship between the new firm creation and time deposit growth.[30] Motivated by this evidence, I examine the relationship between time deposits and new firm creation by estimating the following OLS regression:

$$\log(\text{New Firms}_{c,t}) = \alpha_c + \alpha_t + \beta\Delta\log(\text{Time Deposits}_{c,t-1}) + \delta X_{c,t-1} + \epsilon_{c,t}, \tag{19}$$

where the outcome variable denotes the log number of new firms established in county c in period t. I exploit the variation in county-level exposure to time deposit growth, as defined in Equation 18. In addition, the regression absorbs any time-invariant county and time-varying aggregate characteristics by introducing county and time fixed effects. Finally, across all specifications, I control for a change in per capita income of the county and change in population and I

[30] While Appendix Figure A9 shows the results on pooled county-time data, Appendix Figure A10 confirms the same pattern at different points in time (exploiting only the county cross-section).

progressively introduce additional county-time control variables discussed below.

Table 11 summarizes the results. Regardless of the specification, all three columns show that the effect of county-level time deposit growth is positive, statistically significant and the magnitude does not attenuate.[31] This finding shows that counties exposed to banks with stronger time deposit growth have more new firms created. Using baseline estimates in Column (2), a one standard deviation increase in time deposits growth is associated with a 2% increase in firm creation.

To further corroborate the findings, in Appendix Table A1, I replace the Bartik-type measure of county-level deposit growth with the county-time level Time Deposit Spread Beta interacted with the change in the Fed funds rate. Consistently to the baseline, I find that when the Fed funds rate rises, counties exposed to banks with low market power in time deposit markets have more new firms created (after controlling for local deposits growth).

Finally, I exploit additional industry-level heterogeneity to examine whether the effect are stronger for industries that are more reliant on external financing. To this end, I estimate the following regression:

$$\log(\text{New Firms}_{i,c,t}) = \alpha_{i,c} + \alpha_t + \beta_1 \Delta\log(\text{Time Deposits}_{c,t-1}) + \beta_2 \Big(\Delta\log(\text{Time Deposits}_{c,t-1}) \times H_i\Big) + \delta X_{c,t-1} + \epsilon_{c,t}, \quad (20)$$

where $\log(\text{New Firms}_{i,c,t})$ denotes the log number of new firms created in industry i in county c in time t. In addition to the measure of the change in county's time deposits (based on Equation 18), I examine the heterogeneity based on the industry i's dependence on external finance (Rajan and Zingales, 1998; Gilje, 2019) and I denote it as H_i.

Table 12 presents the results. Column (1) confirms the average effect, i.e. counties with the largest increase in time deposits are also witnessing the strongest new firm creation. Columns (2) and (3) split the firms by industry. In Column (2), I use the External Finance index that ranges between -1 and 1. The estimates show that the effect of time deposits on firm creation is stronger for industries with larger dependence on external finance. In Column (3), I introduce a dummy variable which takes the value of one if the industry is associated with high dependence on external finance (the index has positive values), and zero otherwise. Here,

[31] Column (1) controls for a change in savings deposits of banks operating in county c, and this control variable has no effect. In Column (2), I instead control for a change in total local deposits and the control is positive suggesting that counties with stronger local deposit growth also have more firm creation. In Column (3), I split the deposits into local time deposits and local savings deposits.

only the interaction coefficient remains positive and statistically significant. This emphasizes that the effect of time deposits on firm creation is fully driven by industries with high external finance dependence.

Long-run analysis. Figure 19 looks at the long-run changes (1995–2015) in deposits vs. C&I loans as a share of banking sector total assets at the cross-section of banks. It highlights two facts. First, effectively all growth rates are negative which shows that the importance of time deposits (on liability side) and C&I loans (on asset side) has been shrinking. Second, there is a strikingly strong positive correlation between the decline of the two variables. This further confirms that banks are matching business loans with time deposits and a decline in time deposits had triggered a decline in C&I loans.

Next, I examine the link between ex-ante reliance on time deposits in 1995 and the long run trends in time deposit and C&I loans at the bank-level by running the following regression:

$$\Delta\log(\mathrm{y}_{b,2015-1995}) = \alpha + \beta\left(\frac{\text{Time Deposits}}{\text{Total Assets}}\right)_{b,1995} + \epsilon_b. \tag{21}$$

where: $\left(\frac{\text{Time Deposits}}{\text{Total Assets}}\right)_{b,1995}$ is the share of bank financing obtained from time deposits in 1995, and $\Delta\log(\mathrm{y}_{b,2015-1995})$ denotes either the long-run change in time deposits or C&I loans for bank b between 1995 and 2015. First, in Table 13 Column (1), I analyze the relationship between ex-ante share of time deposits and the dynamics in time deposits. The negative and statistically significant estimate shows that banks with higher ex-ante time deposit share experienced a larger decline in time deposits. Second, Table 13 Column (2) focuses on the effect for a long-run change in the C&I loans issued by bank b in 2015 vs. 1995. Similarly to the case of the deposit dynamics, the negative estimates point out to the fact that banks with higher ex-ante dependence on time deposits suffered from the sharpest decline in C&I loans. Third, Column (3) puts the two pieces together and shows the estimates when I regress the C&I loan growth on time deposits growth. The positive estimates reveal that bank which lose the most time deposits also cut C&I lending by the most.

The final missing piece is to examine the long run effect on firm creation. Table 14 presents the long run effect by reporting coefficients from the regression:

$$\Delta\log(\text{New Firms}_{c,2015-1995}) = \alpha + \beta\text{Time Deposit Exposure}_c + \gamma X_{c,2015-1995} + \epsilon_c, \tag{22}$$

where I measure county-level exposure to the decline in time deposits, Time Deposit Exposure$_c$, in two ways. In Column (1), I rely on average of bank ex-ante shares of time deposits weighted by their county lending shares:

$$\left(\frac{\text{Time Deposits}}{\text{Total Assets}}\right)_{c,1995} = \sum_b \left(\left(\frac{\text{Time Deposits}}{\text{Total Assets}}\right)_{b,1995} \times \text{Lending Share}_{b,c,1995}\right). \tag{23}$$

The negative and statistically significant estimate shows that counties with higher ex-ante dependence on time deposits suffered from the largest drop in new firm creation. In Column (2), I define county-level exposure to the decline in time deposits using a weighted average of long-run changes in time deposits of banks operating in county c:

$$\Delta\log(\text{Time Deposits}_{c,2015-1995}) = \sum_b \Big(\Delta\log(\text{Time Deposits}_{b,2015-1995}) \times \text{Lending Share}_{b,c,1995}\Big). \tag{24}$$

The findings demonstrate that over the 1995–2015 period, counties with banks experiencing the largest outflow of time deposits also experienced the strongest fall in new firm creation. Taken together, these results suggest that a decline in interest rates and a resulting outflow of time deposits played an important role in the decline in new firm creation observed over the past decades.

9 Model

To rationalize and quantify the empirical results, I develop a quantitative macro-finance general equilibrium model with banks exposed to liquidity and interest rate risk. In the model, there are five main types of agents: households, banks, financially constrained firms, unconstrained firms and monetary authority.

9.1 Households

The representative household maximizes utility over consumption, C_t, liquidity services, L_t, and labor, N_t (as in Galí (2015); Walsh (2017)):

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{Z_t^{1-\gamma} - 1}{1-\gamma} - \frac{N_t^{1+\psi_N}}{1+\psi_N} \right)$$

where Z_t is a CES aggregator of consumption and liquidity:

$$Z_t = \left(\lambda_C C_t^{\frac{\rho-1}{\rho}} + (1-\lambda_C) \left(\frac{L_t}{P_t} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}$$

Household can save using four types of assets: money, M_t, savings deposits, $D_{s,t}$, time deposits, $D_{T,t}$, and short-term risk-free nominal bond, X_t. These assets differ in the return and amount of liquidity they provide, as described below. Household's budget constraint is given by:

$$P_t C_t + M_t + D_{S,t} + D_{T,1} + X_t = M_t + D_{S,t-1}(1 + r_{S,t-1}) + D_{T,t-1}(1 + r_{T,t-1}) + X_t(1 + f_{t-1}) + W_t N_t$$

where: $r_{S,t-1}$ and $r_{T,t-1}$ are nominal deposit rates on savings deposits and time deposits, respectively. Nominal bonds pay a short-term rate, f_{t-1}, set by the central bank. It is useful to define prices of deposits and money. We can define the price of deposit products as a deposit spread, $s_{i,t} = f_t - r_{i,t}$ for $i = \{S, T\}$. The price of money is the foregone nominal interest rate f_t.

Liquidity services are derived from money, savings deposits, and time deposits.[32] Time deposit is the least liquid asset while money is the most liquid asset.[33] Savings deposit is assumed to be a closer substitute for money than time deposit. The three assets provide imperfectly substitutable services according to a CES aggregator:

$$L_t = \left((1-\lambda_T) L_{H,t}^{\frac{\epsilon-1}{\epsilon}} + \lambda_T D_{T,t}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}$$

where:

$$L_{H,t} = \left(\lambda_S D_{S,t}^{\frac{\xi-1}{\xi}} + (1-\lambda_S) M_t^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}}$$

denotes the liquidity services provided by assets of highest liquidity, money and savings deposits. ξ denotes the elasticity of substitution between money and savings deposits, while ϵ is

[32] For simplicity but without the loss of generality, I assume that nominal bonds provide no liquidity.

[33] Money can be associated with not only currency but also demandable deposits and checking accounts.

the elasticity of substitution between time deposits and highly liquid assets. This formulation of liquidity services allows for different level of substitution within highly liquid assets (money and savings deposits) and between highly liquid assets and time deposits. As a result, it can allow for savings deposits to be a closer substitute for money than time deposit.

While money does not earn any interest, savings and time deposits pay the interest rate of $r_{S,t}$ and $r_{T,t}$, respectively. The deposit rates will be set by the profit maximizing bank that will take the household's demand curve for deposit products as given. We can define the price of deposit products as a deposit spread, $s_{i,t} = f_t - r_{i,t}$ for $i = \{S, T\}$. The price of money is the foregone nominal interest rate f_t.

9.2 Banks

Banks use net worth, savings deposits and time deposits to invest in two types assets. First, banks can lend to firms through long-term, illiquid floating rate loans. Second, banks can invest in long-term fixed-rate government bonds. There are two frictions affecting banks. First, banks are subject to dividend adjustment costs (e.g. Begenau, 2020; Elenev *et al.*, 2021). As a result, banks have an incentive to smoothen their dividends and are averse to variations in Net Interest Margin. This assumption is consistent with Floyd *et al.* (2015), who show that banks have a higher and more stable propensity to pay dividends. Second, liquid savings deposits are subject to bank-idiosyncratic withdrawal shock, $\omega_{b,t}$, in which case $\omega_{b,t} D_{S,t}$ savings deposits are withdrawn.[34] Upon the withdrawal shock, bank needs to rapidly liquidate their assets to satisfy the outflow of savings deposits. While liquid government bonds can be sold at a market value, selling illiquid business loans results in a fire-sale discount. Specifically, only a fraction $1-\chi$ of the value of a business loan can be recovered quickly enough to absorb a funding shock. Because of the fire sale, it takes $1/(1-\chi)$ dollars of the business loan to meet one dollar of redemption, and each dollar sold incurs χ dollars of fire sale losses. The modeling of withdrawal shocks and fire sales has its roots in the banking literature that has extensively studied the liquidity transformation of banks (e.g. Diamond and Dybvig, 1983; Shleifer and Vishny, 1997; Drechsler *et al.*, 2018). Banks solve the following problem:

$$J_b\left(G_t, B_{c,t}, D_{S,t}, D_{T,t}, \omega_{b,t}\right) = -\frac{\chi}{1-\chi} \max\left[\omega_{b,t} D_{S,t} - q_{G,t} G_t, 0\right] + V_b\left(G_t, B_{c,t}, D_{S,t}, D_{T,t}\right)$$

[34] The withdrawal shock is following a distribution with the CDF denoted by $F(\omega_{b,t})$.

where:

$$V_b\left(G_t, B_{c,t}, D_{S,t}, D_{T,t}\right) = \max_{\substack{d_{b,t}, B_{c,t+1}, G_{t+1} \\ r_{S,t+1}, r_{T,t+1}}} \left\{d_{b,t} + E_t M_{t,t+1} J_b\left(G_{t+1}, B_{c,t+1}, D_{S,t+1}, D_{T,t+1}, \omega_{b,t+1}\right)\right\}$$

subject to the balance sheet constraint:

$$d_{b,t} + \phi_{b,d}\left(d_{b,t}\right) + q_{B,t}\left(B_{c,t+1} - \left(1-\eta_B\right)B_{c,t}\right) + q_{G,t}\left(G_{t+1} - \left(1-\eta_G\right)G_t\right) + D_{S,t} + D_{T,t} =$$
$$\left(f_t + \eta_B\right)B_{c,t} + \left(c + \eta_G\right)G_t + \frac{D_{S,t+1}}{1+r_{S,t+1}} + \frac{D_{S,t+1}}{1+r_{T,t+1}}$$

and the demand curves for savings and time deposits obtained from the household's problem:

$$D_{S,t+1} = g\left(r_{S,t+1}, f_t, L_t, L_{H,t}\right)$$

$$D_{T,t+1} = h\left(r_{T,t+1}, f_t, L_t, L_{H,t}\right)$$

with $\bar{\omega}_{b,t} = \frac{q_{G,t}G_t}{D_{S,t}}$ being a threshold level of $\omega_{b,t}$ above which bank incurs fire sale losses and $M_{t,t+1}$ denoting a stochastic discount factor of households.

9.3 Firms

There are two types of intermediate good producing firms: financially constrained ones and unconstrained ones.

9.3.1 Financially constrained firms

The setup of financially constrained firm is similar to Jermann and Quadrini (2012). A financially constrained firm uses equity and debt. Debt is preferred to equity because of its tax advantage. Firm is subject to leverage constraint and dividend adjustment cost that limit their debt borrowing and equity issuance policies. Firm borrows from a bank to finance investment. Bank borrowing takes the form of long-term floating-rate debt. In every period a fraction η_B of the principal is paid back, while the remaining $(1-\eta_B)$ remains outstanding. This means that the debt has an expected life of $1/\eta_B$. It solves the following problem:

$$V_c\left(K_{c,t}, B_{c,t}; S_t\right) = \max_{d_{c,t}, B_{c,t+1}, K_{c,t+1}, N_{c,t}} \left\{d_{c,t} + E_t\left(M_{t,t+1} V_c\left(K_{c,t+1}, B_{c,t+1}; S_t\right)\right)\right\}$$

subject to the balance sheet constraint:

$$d_{c,t} + \phi_c\left(d_{c,t}\right) + q_{K,t}K_{c,t+1} + \left(f_t\left(1-\tau\right) + \eta_B\right)B_{c,t} =$$
$$F\left(K_{c,t}, N_{c,t}\right) - w_t N_{c,t} + q_{K,t}\left(1-\delta\right)K_{c,t} + q_{B,t}\left(B_{c,t+1} - \left(1-\eta_B\right)B_{c,t}\right)$$

and leverage constraint:

$$\theta_c q_{K,t} K_{c,t} \geq B_{c,t}$$

The leverage constraint, familiar from Kiyotaki and Moore (1997), limits the total new borrowing of the firm to a fraction θ of its new capital valued at market prices. The price of bank debt, $q_{B,t}$, will be determined in equilibrium as the price that clears demand for debt by firms and its supply by banks.

9.3.2 Unconstrained firm

An unconstrained firm operates in Modigliani-Miller world and solves a standard firm problem:

$$V_u\left(K_{u,t}, B_{u,t}; S_t\right) = \max_{d_{u,t}, K_{u,t+1}, N_{u,t}} \left\{d_{u,t} + E_t\left(M_{t,t+1}V_u\left(K_{u,t+1}, B_{u,t+1}; S_t\right)\right)\right\}$$

subject to the balance sheet constraint:

$$d_{u,t} + q_{K,t}K_{u,t+1} = F\left(K_{u,t}, N_{u,t}\right) - w_t N_{u,t} + q_{K,t}\left(1-\delta\right)K_{u,t}$$

9.3.3 Final good producers and total labor supply

The intermediate goods from each type of firm are packaged by competitive final goods producers using the CES aggregator:

$$Y_t = \left(\omega_c Y_{c,t}^{\frac{\zeta_Y - 1}{\zeta_Y}} + \left(1-\omega_c\right)Y_{u,t}^{\frac{\zeta_Y - 1}{\zeta_Y}}\right)^{\frac{\zeta_Y}{\zeta_Y - 1}}$$

where: $Y_j = F\left(K_{j,t}, N_{j,t}\right)$ for $j = \{u, c\}$ and ω_c denotes the share of financially constrained firms in the economy.

Total labor supply is a CES aggregate of labor supplied to financially constrained and unconstrained firms:

$$N_t = \left(\omega_c N_{c,t}^{\frac{\zeta_N - 1}{\zeta_N}} + \left(1-\omega_c\right)N_{u,t}^{\frac{\zeta_N - 1}{\zeta_N}}\right)^{\frac{\zeta_N}{\zeta_N - 1}}$$

9.3.4 Capital producers

Capital producers combine the final good, I_t, with the last period capital goods, K_{t-1}, in order to produce new capital goods that competitively sell to entrepreneurial firms at price $q_{K,t}$. The representative capital-producing firm is owned by the household and maximizes the expected discounted value of profits:

$$\max_{I_{t+j}} \mathbb{E}_t \sum_{j=0}^{\infty} M_{t,t+j} \left[q_{K,t+j} S\left(\frac{I_{t+j}}{K_{t+j-1}} \right) K_{t+j-1} - I_{t+j} \right]$$

where $S\left(\frac{I_{t+j}}{K_{t+j-1}}\right) K_{t+j-1}$ gives the units of new capital produced by investing I_{t+j} and using K_{t+j-1}. The increasing and concave function $S(\cdot)$ captures the existence of adjustment costs, which we specify as in Jermann (1998): $S\left(\frac{I_{k,t}}{K_{t-1}}\right) = \frac{a_{k,1}}{1-\frac{1}{\psi_k}} \left(\frac{I_t}{K_{t-1}}\right)^{1-\frac{1}{\psi_k}} + a_{k,2}$, where $a_{k,1}$ and $a_{k,2}$ are chosen to guarantee that in the steady state the investment-to-capital ratio is equal to the depreciation rate and $S'(I_t/K_{t-1})$ equals one.

9.4 Monetary policy, markets clearning and equlibrium

Nominal interest rate is set by the monetary authority and follows an AR(1) process:

$$\log(1+f_t) = \rho_f \log(1+f_{t-1}) + (1-\rho_f)\log(1+\bar{f}) + \epsilon_{f,t}$$

where exogenous monetary policy shock, $\epsilon_{f,t}$, is normally distributed with zero mean and standard deviation σ_f.[35]

I assume that cash, M_t, short-term bonds, X_t, and long-term bonds, G_t, are elastically supplied by the government and backed by taxes.

An equlibrium is a set of i) household policy functions for money, savings deposits, time deposits, nominal bonds, consumption and leisure; ii) bank policy functions for dividends, the supply of loans to constrained firms, demand for long-term government bonds, demand for savings and time deposits; iii) constrained firm policy functions for dividends, capital, loan and labor demand; iv) unconstrained firm policy functions for capital and labor demand; v) capital producing firm policy function for investment; vi) monetary authority decisions on interest rates; vii) prices of money, short-term bonds, long-term bonds, business loans, savings deposits, time deposits and wages; such that all agents optimize and all markets clear.

[35] The results are robust to setting nominal interest rates according to Taylor-type rule: $\log(1+f_t) = \rho_f \log(1+f_{t-1}) + (1-\rho_f)\left(\log(1+\bar{f}) + \rho_\pi \log(\pi_t/\bar{\pi}) + \rho_Y \log\left(Y_t/\bar{Y}\right)\right) + \epsilon_{f,t}$

9.5 Calibration

The model is calibrated to quarterly data. The calibration of the model follows a two-step procedure. First, some parameters are set to commonly used values in the literature or values directly corresponing to data counterparts. Second, I calibrate the parameters pinning down the portfolio choices of households and banks to match moments from 1985Q4, when the Fed funds rate was 8%, and 2016Q4, when the Fed funds rate was 0.5%.

Households. Discount rate of households, β, is set to 0.99, which implies a real rate of 4%. I set the Intertemporal Elasticity of Substitution (IES), γ, to 2 and the Frisch elasticity of labor supply, ψ, to 1. Following Walsh (2003), I set the elasticity of substitution between liquidity services and consumption, ρ, to 0.39.

Firms. Both constrained and unconstrained firms use Cobb-Douglas technology to produce the output with capital share in production, α, set to 0.33. I set capital depreciation rate $\delta = 0.025$ and the capital adjustment cost parameter, ψ_k, is set to 0.5, which is a typical value used in the literature. Using firm-level Compustat data, I classify a firm as financially constrained if the firm uses bank financing. I consider the firm to be bank dependent if either it does not have a rating or its rating is below investment grade.[36] Following this classification, the share of financially constrained firms, ω_c, is set to 0.56 which matches the average share of output (proxied by sales) produced by bank dependent firms. For the final goods and labor aggregator, I follow the literature and set an elasticity $\zeta_Y = 6$ and $\zeta_N = 6$, respectively.

Financially constrained firms. The tax wedge, τ, is set to 0.35, which corresponds to the marginal tax rate of 35 percent. The maximum loan-to-value (LTV) ratio, θ_c, is set to 0.31, which corresponds to the average loan to asset ratio of bank dependent firms in Compustat. The average maturity of syndicated business loans is around 12 quarters which pins down $\eta_B = 1/12$. I specify the dividend adjustment cost function for constrained firms as $\phi_c\left(d_{c,t}\right) = \kappa_c\left(d_{c,t} - \bar{d_c}\right)^2$, where κ_c is set to 0.15 as in Jermann and Quadrini (2012) and $\bar{d_c}$ is the long-run payout target which is pinned down by the equilibrium of the model.

Banks. The average maturity of long-term fixed rate securities and real estate loans held by banks in Call Reports data is about 38 quarters which pins down $\eta_G = 1/38$. The functional form for the dividend adjustment cost is specified in an analogous way as for the constrained firms. Following Elenev et al. (2021), I set the dividend adjustment cost parameter κ_b equal to

[36] Rauh and Sufi (2009) show that investment grade firms use bonds as their primary source of external financing.

7 and the long-run payout target $\bar{d}_b$ to 6.8% of bank's book equity ($n_{b,t}$) per year. The funding shock, ω_b, is assumed to be uniformly distributed on the interval $[0, 1]$.

Monetary Policy. The parameters of the AR(1) process for nominal interest rate are estimated from the detrended series of Fed funds rate for the period 1985Q4-2016Q4. The estimation implies $\rho_f = 0.953$ and $\sigma_f = 0.0052$.

Parameters calibrated jointly to match data moments. The rest of the parameters is calibrated jointly to match a number of moments in the banking and macro data. In order to calibrate the share and elasticity of substitution parameters in the CES aggregator for liquidity services, I match moments from both high nominal rate period (1985) and low nominal rate period (2016). Specifically, I solve the model for two levels of $\bar{f}$, 8% and 0.5%, while keeping the rest of the parameters the same. The moments implied by the model solved with $\bar{f} = 8\%$ ($\bar{f} = 0.5\%$) correspond to moments in the data in 1986 (2016).

Although the second stage parameters are set jointly, some parameters can be linked to specific targets. Elasticity of substitution between money and savings deposits, ξ, and share of savings deposits in high liquidity assets, λ_S, help to match the ratio of money in total liquidity in 1985 and 2016 from the Flow of Funds data and the savings deposit spread in 1985 computed from Call Reports data.[37] Elasticity of substitution between time deposits and high liquidity assets, ϵ, and share of time deposits in liquidit assets, λ_T, are pinned down by the ratio of time deposits in total deposits in 1985 and 2016 and the time deposit spread in 1985 computed from Call Reports data. The share of consumption in the composite of consumption and liquidity services, λ_C, is used to match the ratio of consumption to total liquidity in 1985. Finally, the fire-sale cost parameter, χ, helps match the share of business loans in total bank assets in Call Reports data.[38]

The parameters of the model are summarized in Table 15. Table 16 compares the moments implied by the model with the ones observed in the data and shows that the model matches the data targets reasonably well. Importantly, the model is able to reproduce high share of time deposits in the high nominal interest rate environment and a substantial fall in the importance of time deposits in a low nominal rate economy. The model can also account for the fact that savings deposits are more liquid and as a result banks exercise their market power by setting higher spreads compared to time deposits which are less liquid.

[37] In the data, money is defined as currency and demand deposits. Total liquidity is defined as the sum of money, savings deposits and time deposits.

[38] Banks' total assets are defined as the sum of busines (C&I) loans, real estate loans and security holdings.

9.6 Results

In equilibrium, differences in liquidity of deposits give rise to differences in their short-rate sensitivity. Specifically, as savings deposits are more liquid than time deposits, banks set higher prices (deposit spreads) for savings deposits. As a result, savings deposit rates are lower and less volatile compared to time deposit rates. On the other hand, time deposits protect banks against the funding shock. In the model, banks manage interest rate and liquidity risk by funding loans to firms with time deposits and long-term government bonds with savings deposits. Both time deposits and business loans are illiquid and have a high short-rate sensitivity. In contrast, savings deposits and long-term bonds are liquid and exhibit low interest rate sensitivity.

I use the calibrated model to examine the effects of a decline in nominal rates on equlibrium outcomes. For that purpose, I solve and simulate the model for different levels of $\bar{f}$, while keeping other parameters unchanged. When changing $\bar{f}$, the steady-state inflation, $\bar{\pi}$, adjusts such that the steady-state real rate remains constant and equal to $1/\beta$. Figure 20 plots the mean values of deposit spreads, time deposits share, business loans share and capital of financially constrained firms from simulated data for nominal interest rates vaying between 0.5% (the level of Fed funds rate in 1985) and 8% (level in 1985).

Consistent with the deposits channel (Drechsler *et al.*, 2017), in response to lower nominal rates, the opportunity cost of holding money falls which decreases banks' effective market power. As a result, banks decrease the spreads on the savings and time deposits. As savings deposit is the closest substitute for money, the savings deposit spread falls by relatively more (from 2.5 pp to 0.25 pp) consistent with the data. The difference between time and savings deposit rates falls by 2.1 pp. In response to the falling relative price of savings deposits, households substitute away from illiquid time deposits towards liquid savings deposits. Consequently, the share of bank financing from time deposits falls significantly from 42% to 17% in line with the patterns observed in the data. As a reaction to the decline in time deposits, banks decrease their supply of business loans which falls from around 40% to around 22% of banks' total assets. The model implied decline in business loans is quantitatively significant and accounts for the entire decrease in C&I loans observed in the data. Consistent with the supply effects, the business loan spread increases by 2 pp. in line with the empirical values. Finally, the fall in nominal rates induces a 16% drop in investment/gross operating surplus. Taken together, the model suggests that decline in nominal rates played a quantitatively important role in the decline of time deposits, business lending and investment.

10 Conclusion

This paper documents a monetary transmission through time deposits to business outcomes. I show that banks use time deposits to finance business lending in order to hedge their interest-rate and liquidity exposures. Falling interest rates decrease the price of liquidity and trigger an outflow of time deposits. This, in turn, leads to a decrease in business lending. Consistent with the supply effects, while the quantity of business loans falls, its price (loan spread) increases. The decline in business lending supply has important macroeconomic consequences. In response to lower rates, bank-dependent firms reduce investment and entry.

I present a battery of evidence using a range of granular data (such as bank-level balance sheet, small business lending, syndicated lending, firm-level investment and county-industry-level firm creation) to corroborate my findings. For identification, I exploit cross-sectional variation in bank market power in attracting time deposits. My findings reveal the importance of the shift in supply of bank business lending.

To quantify the importance of the mechanisms observed in the data, I develop a general equilibrium model with banks and monetary policy. In the model, banks conduct dynamic portfolio optimization on both liabilities and assets side. Banks optimally manage interest rate and liquidity risk by funding business loans with time deposits. The simulation of the model in different interest rate environments suggest that the effect of lower interest rates on business lending and investment is quantitatively significant. Taken together, this paper introduces a new perspective on the effects of falling interest rates for the banking sector and macroeconomy.

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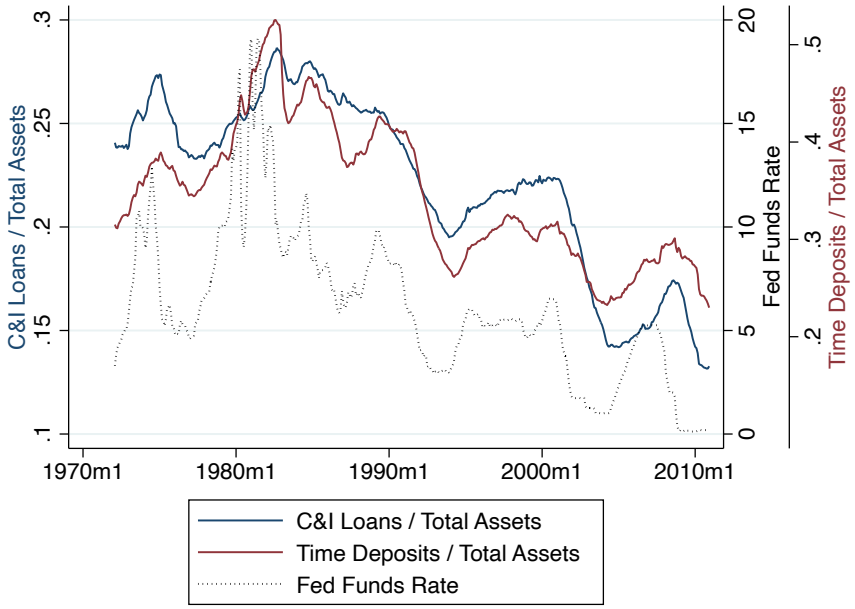
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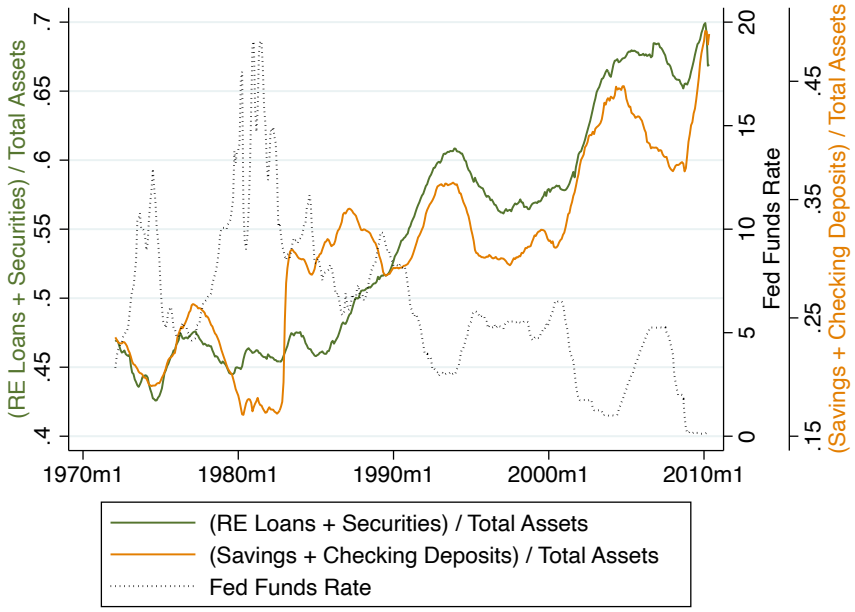
Figures and Tables

Figure 1: Nominal short rate and shifts in assets and liabilities on bank balance sheets

(a) C&I loans vs. time deposits



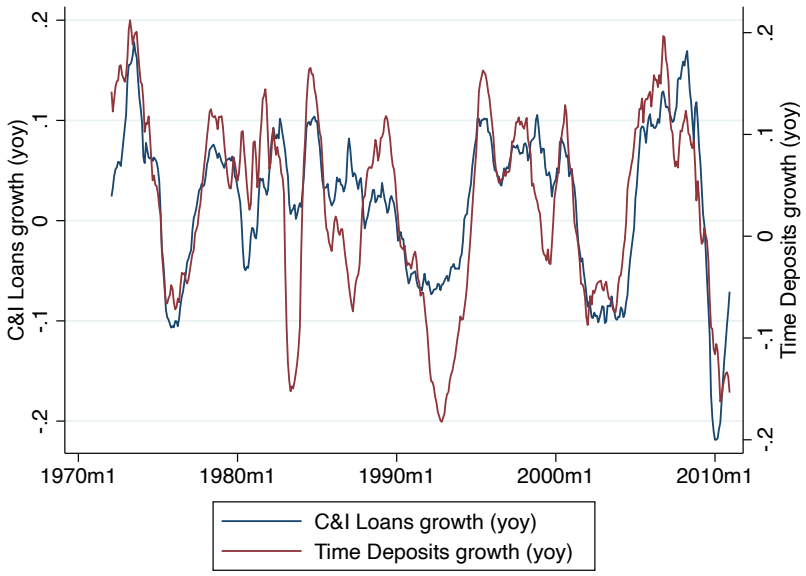
(b) Real estate loans and securities vs. savings and checking deposits



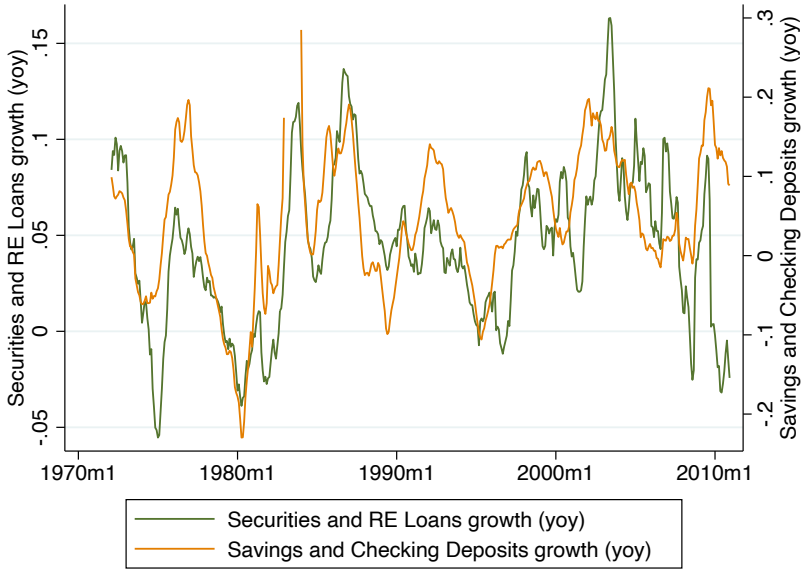
Notes: This figure presents the time-series evolution of C&I loans vs. time deposits in Panel (a), and real estate loans and securities vs. savings deposits in Panel (b) against the Fed funds rate. Bank balance sheet items are expressed as a share of total banking sector assets.

Figure 2: Growth rates of bank balance sheet items

(a) C&I loans vs. time deposits



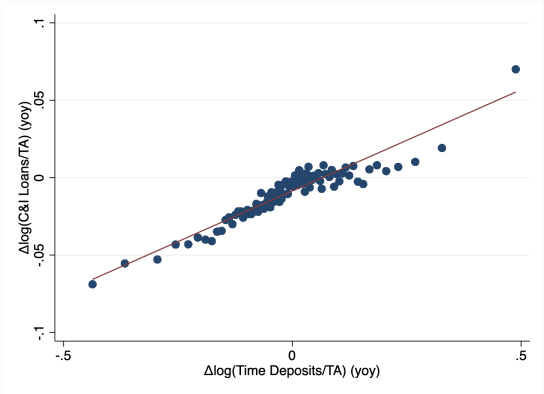
(b) Real estate loans and securities vs. savings and checking deposits



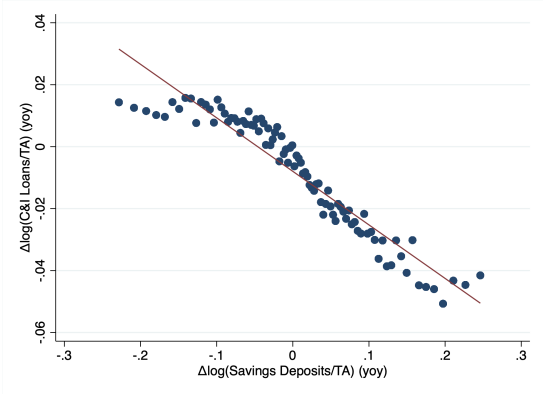
Notes: This figure presents the year-over-year growth rates of C&I loans vs. time deposits in Panel (a), and real estate loans and securities vs. savings deposits Panel (b). During the deregulation period for savings deposits between 1982 and 1983, savings deposits experienced an abnormal growth rate of above 30% on annual basis. Including these data points in the graph would obscure the evolution of the series in periods outside of the deposit deregulation. Therefore, the scale for savings and checking deposits in Panel (b) was adjusted to values between -20% and 30% on annual basis to allow for clear presentation of the entire time series over the period 1970–2010.

Figure 3: Relationship between deposit and asset classes in the cross-section of banks

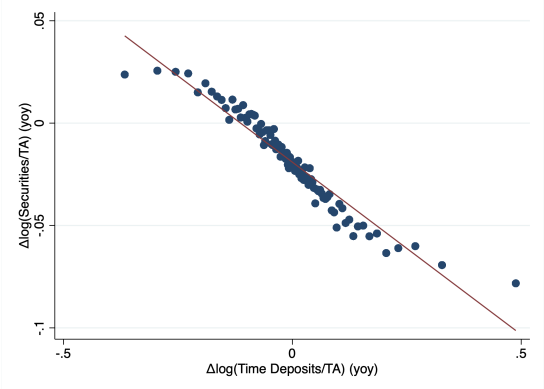
(a) Time Deposits vs. C&I Loans



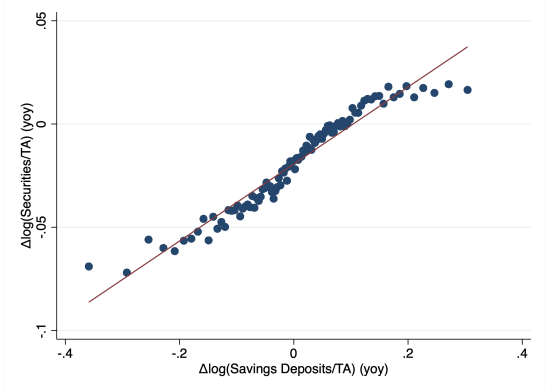
(b) Savings Deposits vs. C&I Loans



(c) Time Deposits vs. Securities



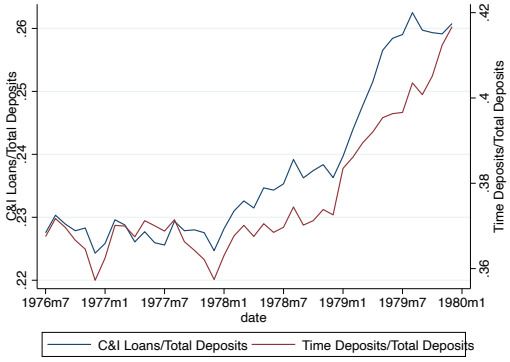
(d) Savings Deposits vs. Securities



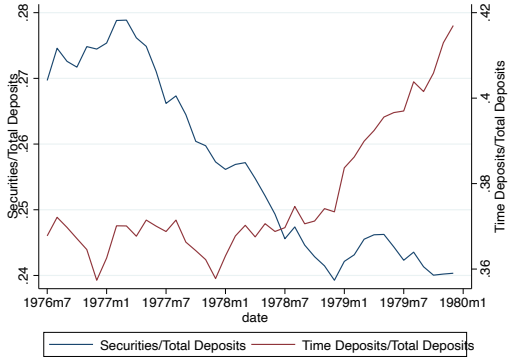
Notes: This figure presents the relationship between different deposit (time and savings deposits) and asset classes (C&I loans and security holdings) in the cross-section of banks. I compute year-over-year log changes in shares of a balance sheet item to individual bank total assets (TA). I sort banks by their time deposit dynamics (in Panels (a) and (c)) and savings deposits dynamics (in Panels (b) and (d)) into 100 bins. For the respective bins, I compute the average change in C&I loans (in Panels (a) and (b)) and security holdings (in Panels (c) and (d)) and graph the bin scatter plots.

Figure 4: Deregulation of small time deposits

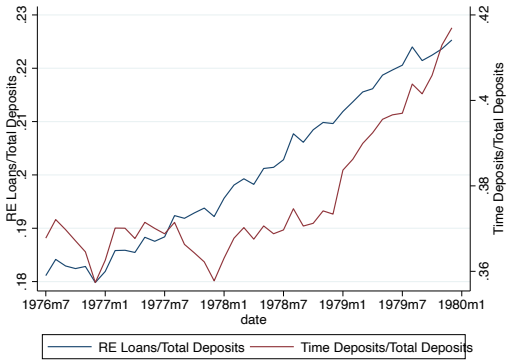
(a) C&I loans and time deposits



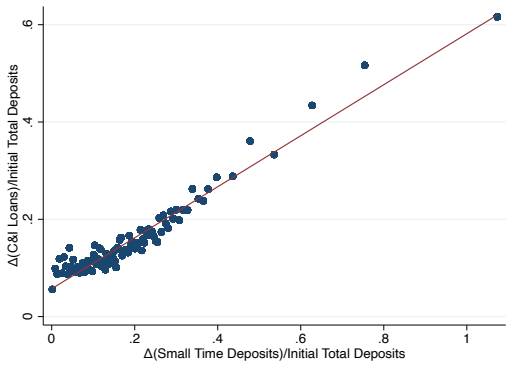
(b) Securities and time deposits



(c) RE loans and time deposits

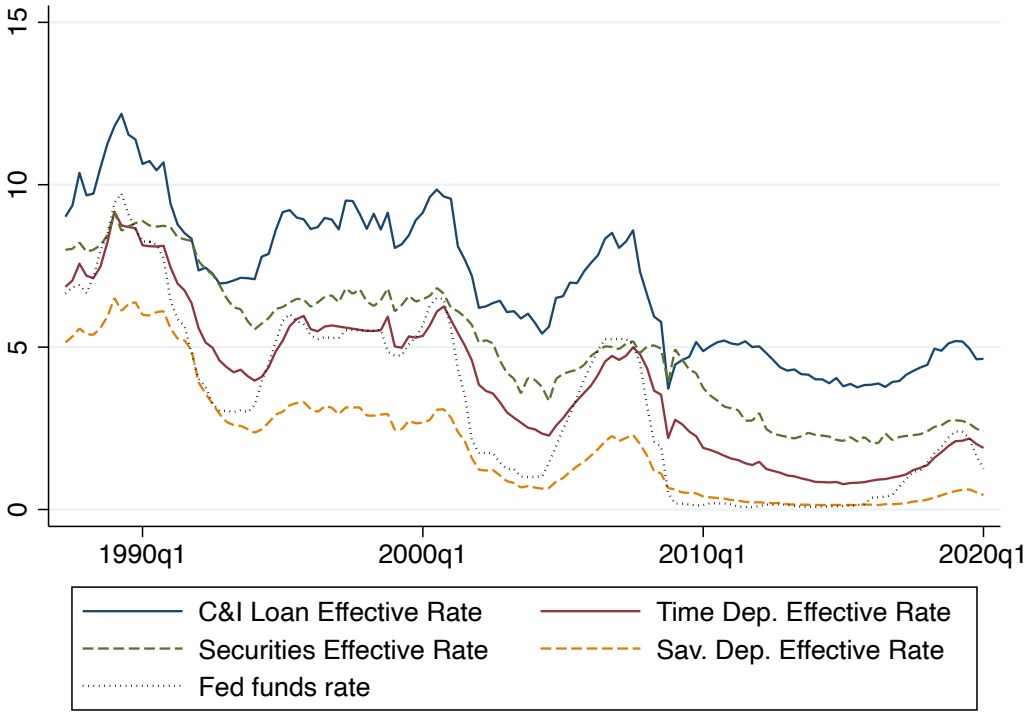


(d) C&I loans and time deposits: Cross-section



Notes: This figure presents the relationship between the evolution of time deposits and a range of asset classes during the deregulation of small time deposits 1978–79 (as a part of Regulation Q). Panel (a) documents a close co-movement of the business lending and time deposits around the regulatory change. Panel (b) plots the diverging evolution of securities and time deposits. Panel (c) shows the evolution of real estate (RE) loans – a loan category that does not appear to be impacted by the deregulation of small time deposits (the series had been trending up already in the pre-period and the trend continued throughout the 1976–1980 sample period). Panel (d) shows the relationship between the change in small time deposits and C&I loans between 1977 and 1979 at the cross-section of banks. I sort banks by their small time deposit dynamics into 100 bins and plot the change in small time deposits and C&I loans (normalized by total deposits in 1977) for each bin in a scatter bin plot.

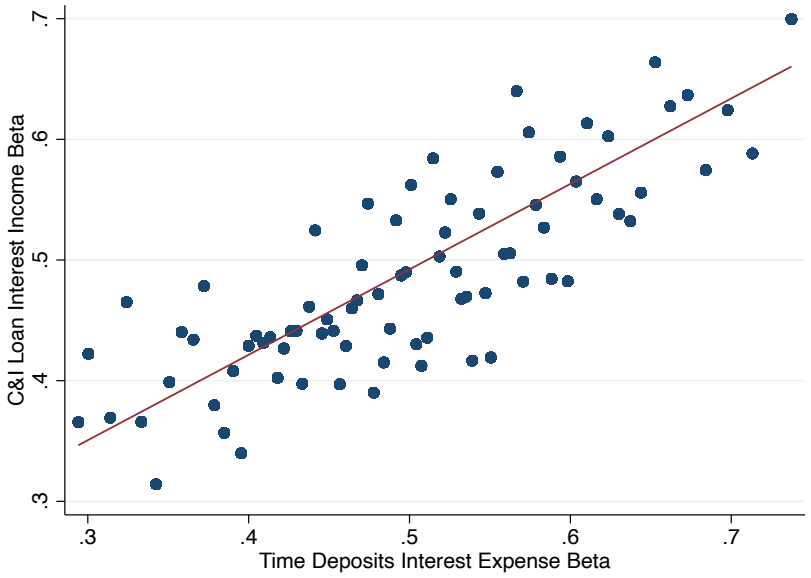
Figure 5: Effective rates on assets and deposits



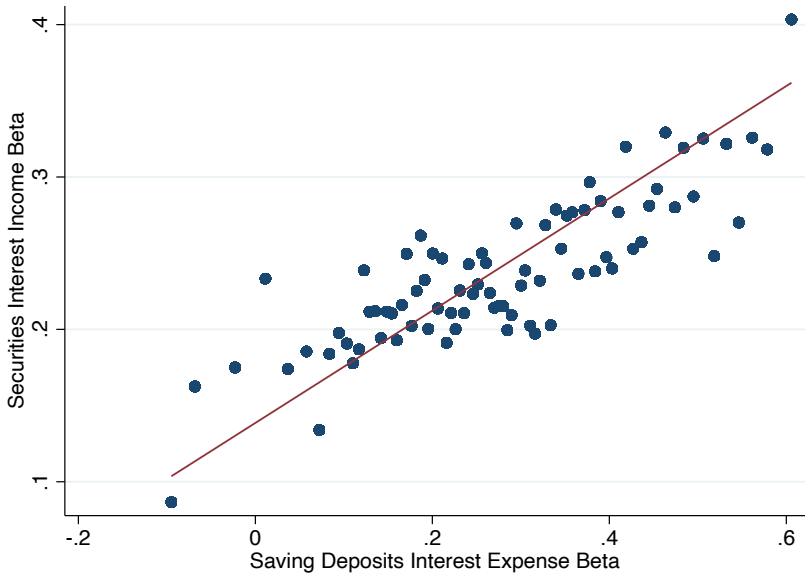
Notes: This figure shows the aggregate interest-rate sensitivity of a range of balance sheet items. C&I loan effective rate (in blue) is computed as a share of C&I loan interest income to lagged C&I loan volume. Time deposit effective rate (in red) is the interest expense on time deposits divided by lagged volume of time deposits. Securities effective rates (in green) denotes interest income on security holdings divided by quantity of securities in $t-1$. Savings deposit effective rate (in orange) is a share of interest expense on savings deposit to savings deposit volume in $t-1$. Finally, EFFR (dashed black) denotes effective Fed funds rate.

Figure 6: Interest-rate sensitivity matching: Cross-sectional evidence

(a) C&I loans and time deposits



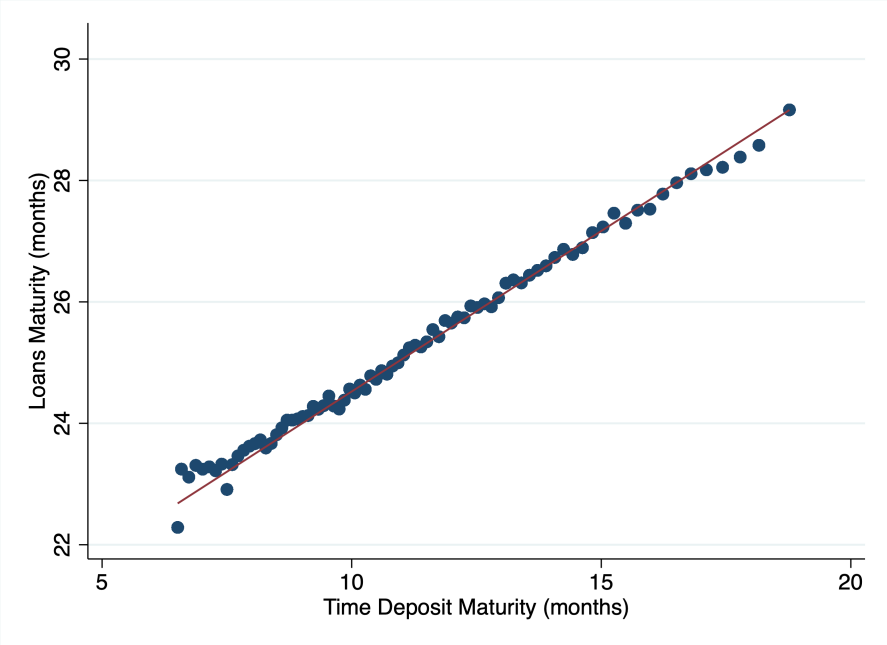
(b) Securities and savings deposits



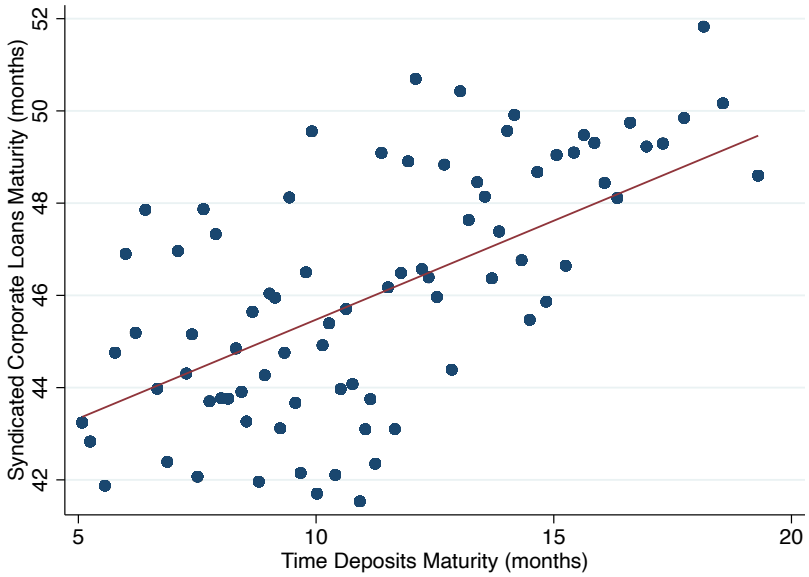
Notes: This figure presents the bin scatter plots for interest-rate sensitivity matching. Panel (a) illustrates the *high* short-rate sensitivity matching between time deposits and C&I business loans. Panel (b) shows the *low* short-rate sensitivity matching between savings deposits and security holdings. The figure is constructed in following steps. The first step is to estimate the sensitivity of bank b time deposit effective rate to changes in the Fed funds rate, following Equation 3. The sum of the beta coefficients for each bank is denoted as Time Deposits Interest Expense Beta. Second step is to repeat the estimation for C&I loans, savings deposits and securities and denote the respective bank betas as C&I Loan Interest Income Beta, Savings Deposits Interest Expense Beta and Securities Interest Income Beta. Third step is to sort the banks into 100 bins based on their Time Deposits Interest Expense Beta in Panel (a) and their Savings Deposits Interest Expense Beta in Panel (b). Fourth step is to compute the average interest expense/income betas for each bin and graph the bin scatter plots.

Figure 7: Liquidity matching: Cross-sectional evidence

(a) All loans (Call reports)



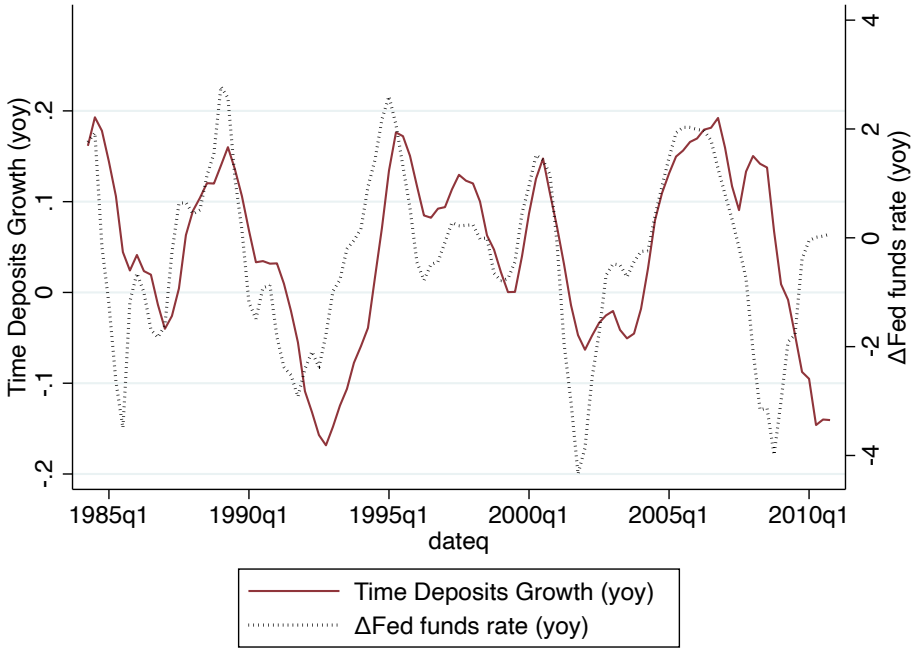
(b) Syndicated lending (Dealscan)



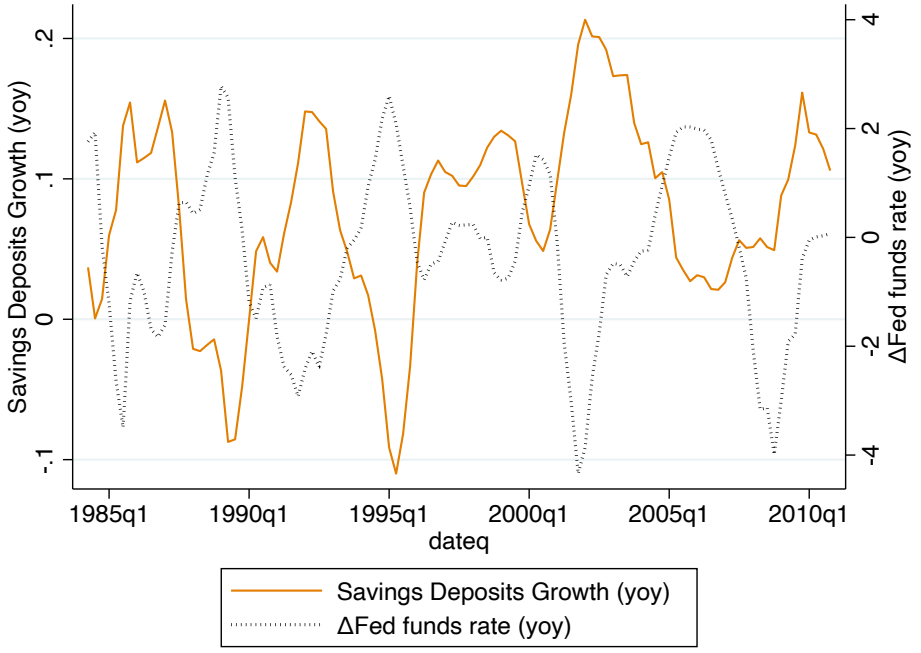
Notes: This figure presents the bin scatter plots for liquidity matching. It plots the relationship between time deposit maturity (in months) and loan maturity (in months). Panel (a) shows loan maturity for all bank lending except for the real-estate credit based on Call reports data. Panel (b) uses Dealscan syndicated lending data and shows loan maturity only for syndicated business loans. The figure presents banks sorted into 100 bins based on their time deposit maturity.

Figure 8: Monetary policy and deposit products: Aggregate growth rate series

(a) Time deposits

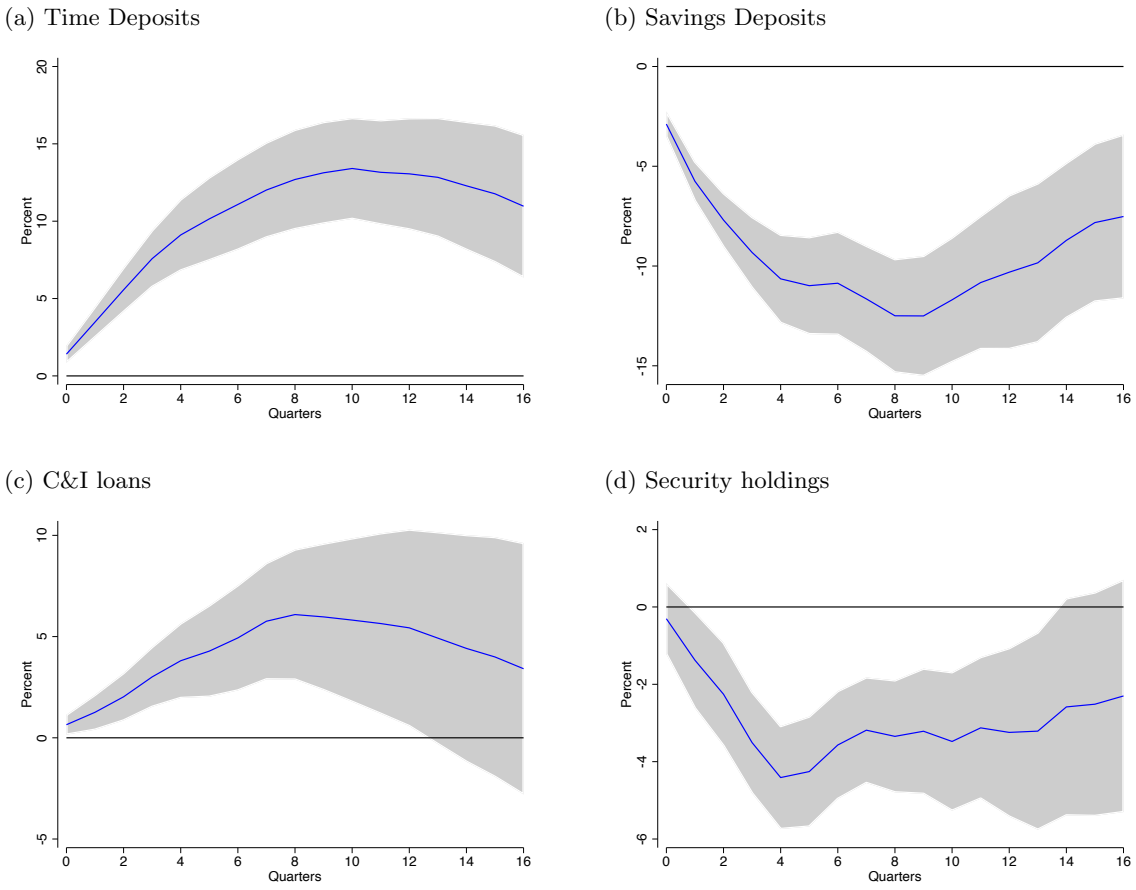


(b) Savings deposits



Notes: This figure presents the evolution of the year-over-year changes in Fed funds rate and aggregate year-over-year growth rates of deposit products. Panel (a) shows the growth rate on the volume of time deposits against the change effective Fed funds rate (EFFR). Panel (b) plots the growth rate of savings deposits against the change in EFFR.

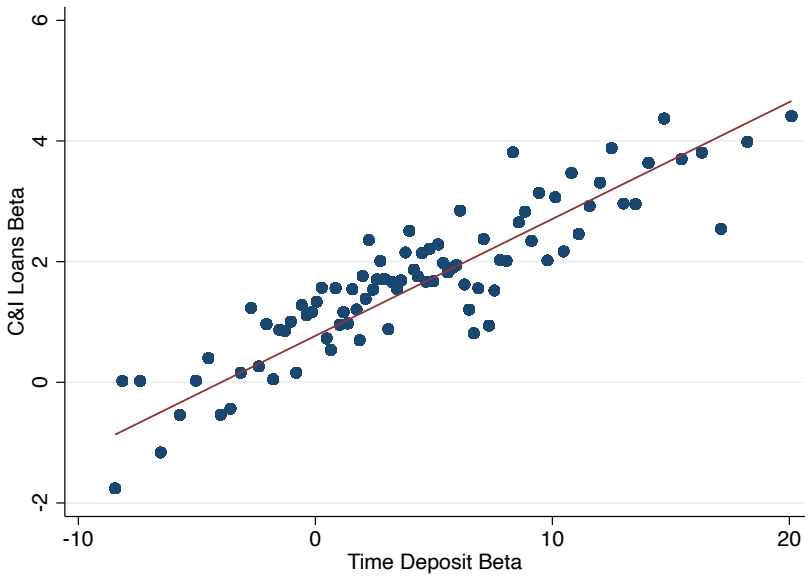
Figure 9: Monetary policy, bank deposit and asset classes: Local projections



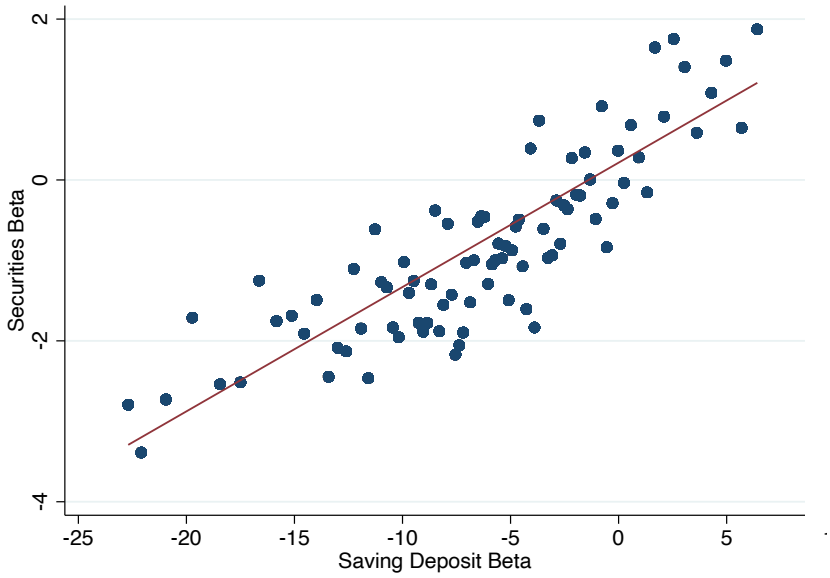
Notes: This figure presents impulse response to a 100 basis point increase in the Fed funds rate based on the local projections approach, as described by Equation 6. The response of the cumulative growth (log-difference) of time deposits is plotted in Panel (a), savings deposits in Panel (b), C&I loans in Panel (c) and security holdings in Panel (d). 90 percent confidence bands are shown using standard errors that are clustered at the bank and time level.

Figure 10: Monetary policy and deposit products: Cross-sectional evidence

(a) C&I loans and time deposits

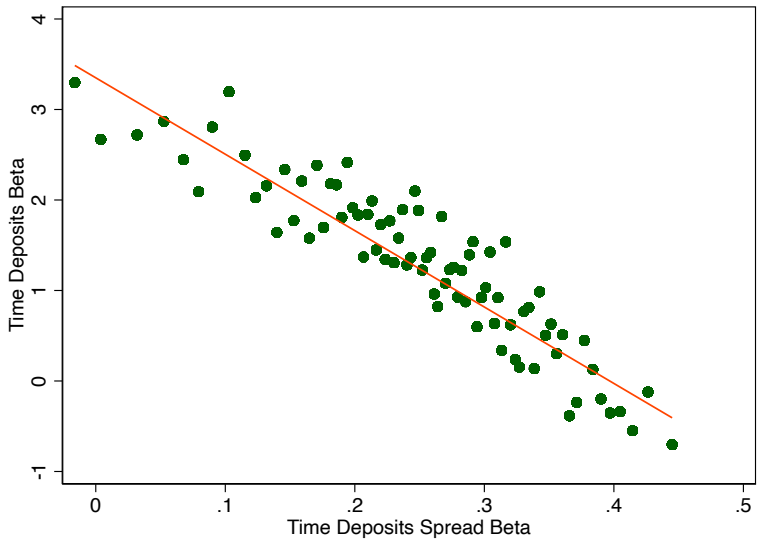


(b) Securities and savings deposits



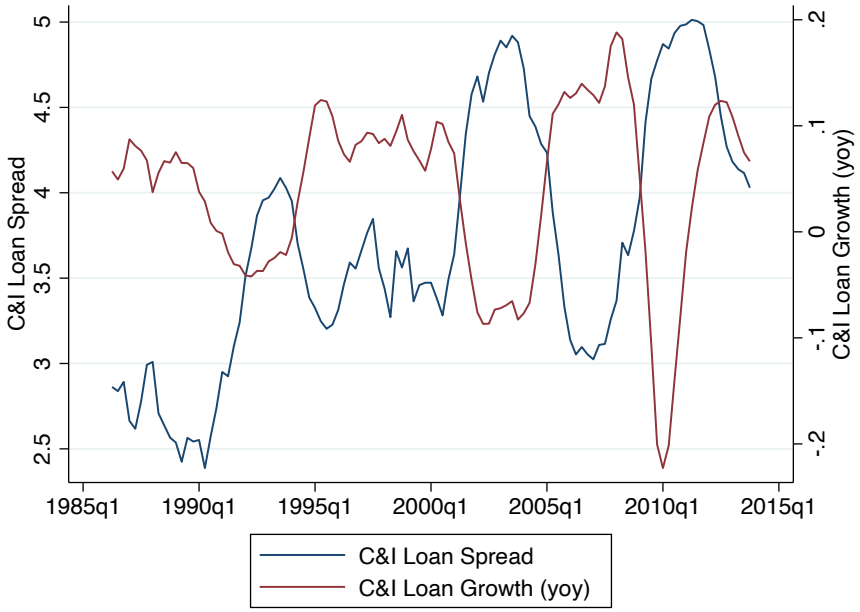
Notes: This figure presents the bin scatter plots for the relationship between the sensitivity of deposit and asset *quantities* to the Fed funds rate. Panel (a) illustrates the relationship between time deposit and C&I loan volumes to the Fed funds rate. Panel (b) shows the relationship between savings deposit and security holdings quantities. The figure is constructed in following steps. The first step is to estimate the sensitivity of bank's log change in time deposit volume to changes in the Fed funds rate, following Equation 7. The sum of the beta estimates is denoted as Time Deposits Beta. Second step is to repeat the estimation for C&I loans, savings deposits and securities volumes and denote the respective betas as C&I Loan Beta, Savings Deposits Beta and Securities Beta. Third step is to sort the banks into 100 bins based on their Time Deposits Beta in Panel (a) and their Savings Deposits Beta in Panel (b). Fourth step is to compute the average betas for each bin and graph the bin scatter plots.

Figure 11: Monetary policy, time deposits and market power



Notes: This figure presents the bin scatter plots for the relationship between bank market power and the sensitivity time deposit quantities to the Fed funds rate. The figure is constructed in following steps. First, I proxy for bank market power with Time Deposit Spread Beta which is estimated following the Equation 8. Second, vertical axis denotes Time Deposits Beta which is constructed by estimating the sensitivity of the bank's log change in time deposit volume to the changes in the Fed funds rate, following Equation 7. The sum of the beta estimates is denoted as Time Deposits Beta. Third, the figure sorts the banks into 100 bins based on their market power proxy: Time Deposits Spread Beta. Fourth, it computes the average betas for each bin and graph the bin scatter plots.

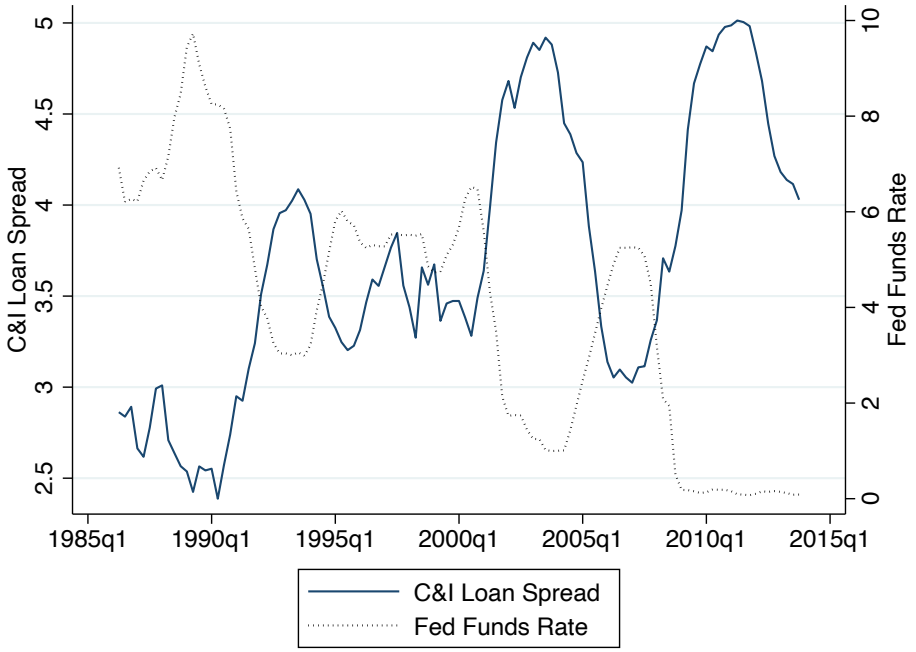
Figure 12: Business loan quantities and spreads



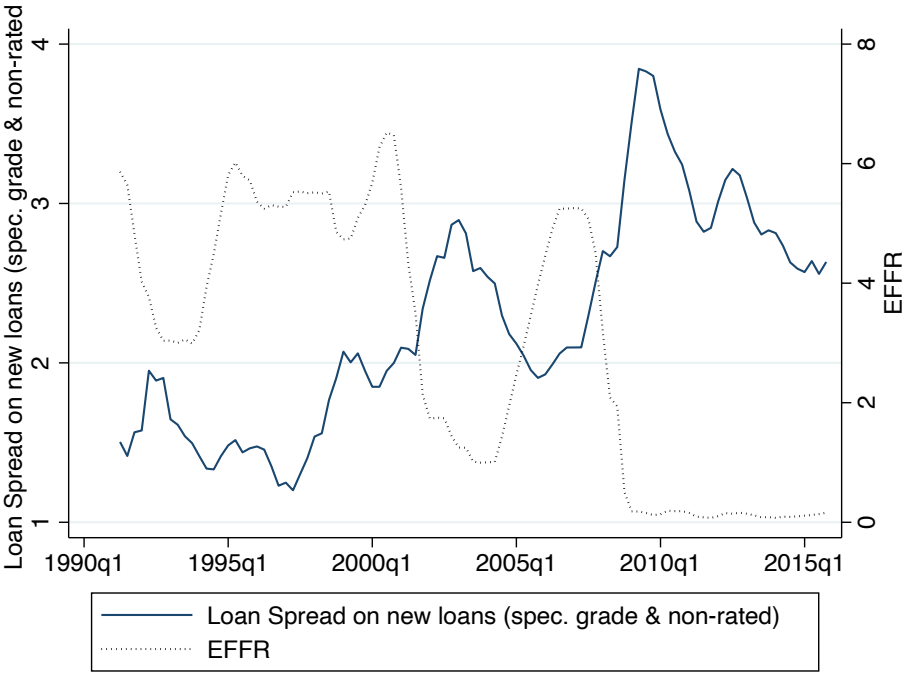
Notes: This figure presents the evolution C&I loans spreads vs. growth rate of the volume of C&I loans. C&I loan spread is computed as a difference between the effective C&I loan rate and the Fed funds rate. C&I loan growth rates is year-over-year real change (reported on the right y-axis).

Figure 13: Monetary policy and business loan spreads

(a) All loans (Call reports)



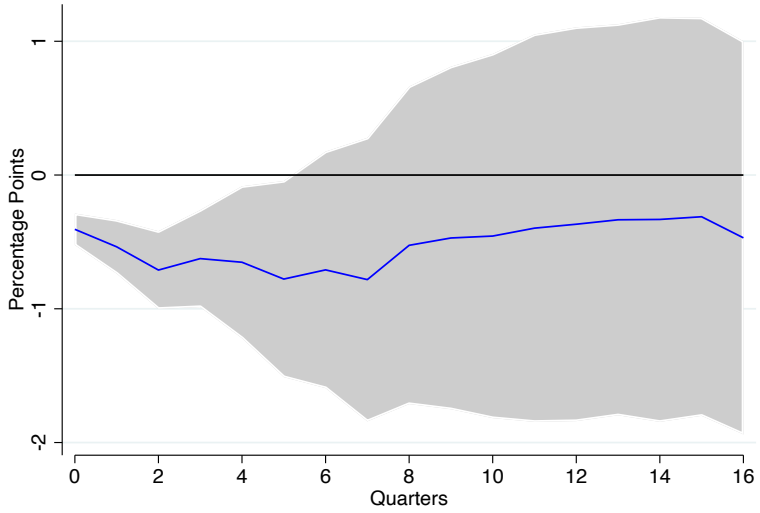
(b) Risky firms (Dealscan)



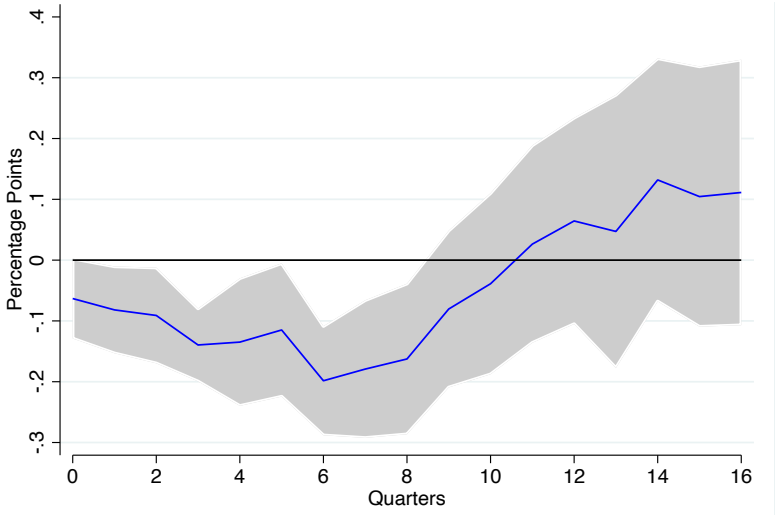
Notes: This figure presents the time-series relationship between the Fed funds rate and business loan spreads. Panel (a) uses Call reports data to construct the C&I loan spread as a difference between the effective C&I rates and the Fed funds rate. Panel (b) controls for riskiness by using Dealscan data for spreads on newly issued loans only to speculative-grade and unrated firms which are the highest risk category. EFFR denotes the effective Fed funds rate.

Figure 14: Local projections: Loan spreads

(a) C&I loans (Call report)

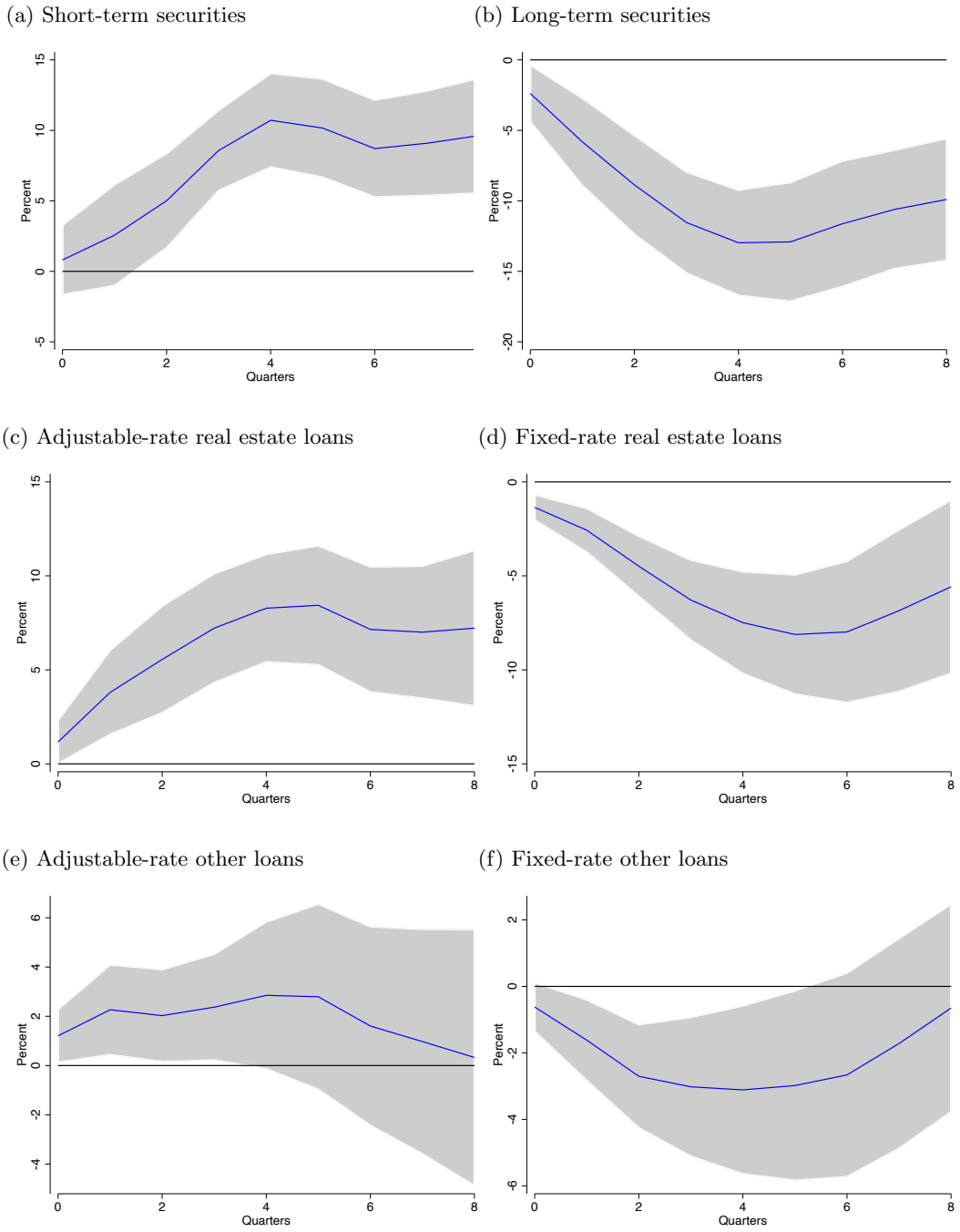


(b) Syndicated lending (Dealscan)



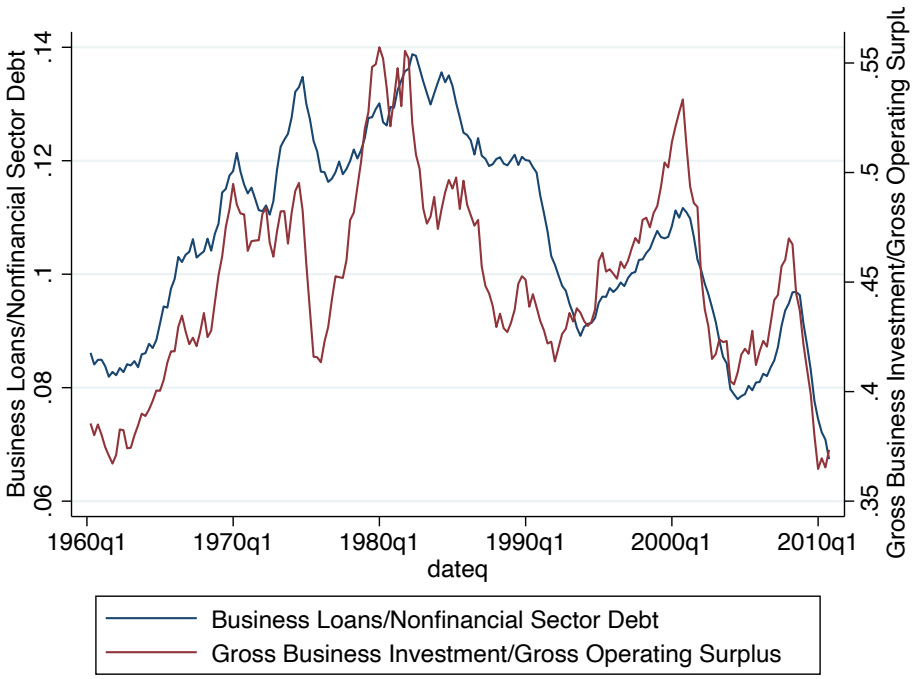
Notes: This figure presents impulse response to a 100 basis point increase in the Fed funds rate for C&I loan spreads based on the local projections approach. Panel (a) uses C&I loan spread data computed from Call reports and estimates local projections, as described by Equation 6. Panel (b) uses spreads on new business loans from Dealscan which allows to further control for riskiness with rating fixed effects, as described by Equation 12. 90 percent confidence bands are shown using standard errors that are clustered at the bank and time level.

Figure 15: Monetary policy and other asset classes: local projections



Notes: This figure presents the impulse response to a 100 basis increase in the Fed funds rate as described by Equation 6. The outcome variable is the growth (log-difference) of a range of asset classes: Panels (a), (c) and (e) report results for a range of adjustable-rate assets (other than C&I loans) while Panels (b), (d) and (f) present the results for fixed-rate asset classes. Specifically, Panel (a) shows the impulse response for short-term securities (with maturity less than one year). Panel (b) plots the results to long-term securities (with maturity of one year and more). Panel (c) focuses on adjustable-rate real estate loans and Panel (d) reports the results for fixed-rate real estate loans. Finally, Panels (e) and (f) show the impulse responses of other adjustable-rate and fixed-rate assets, respectively. 90 percent confidence bands are shown using standard errors that are clustered at the bank and time level.

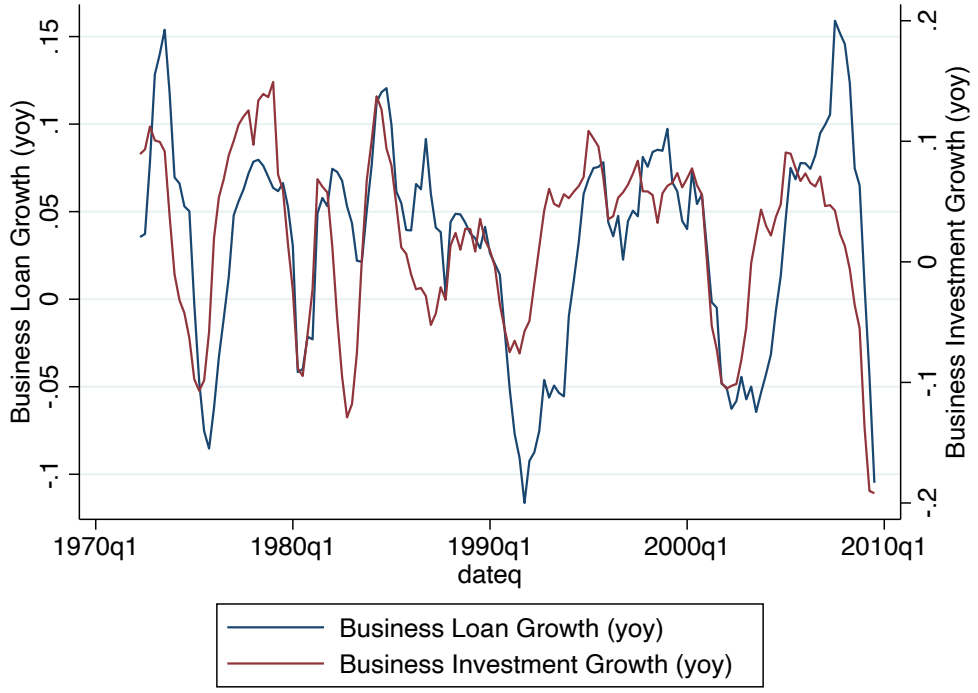
Figure 16: Business investment & loans



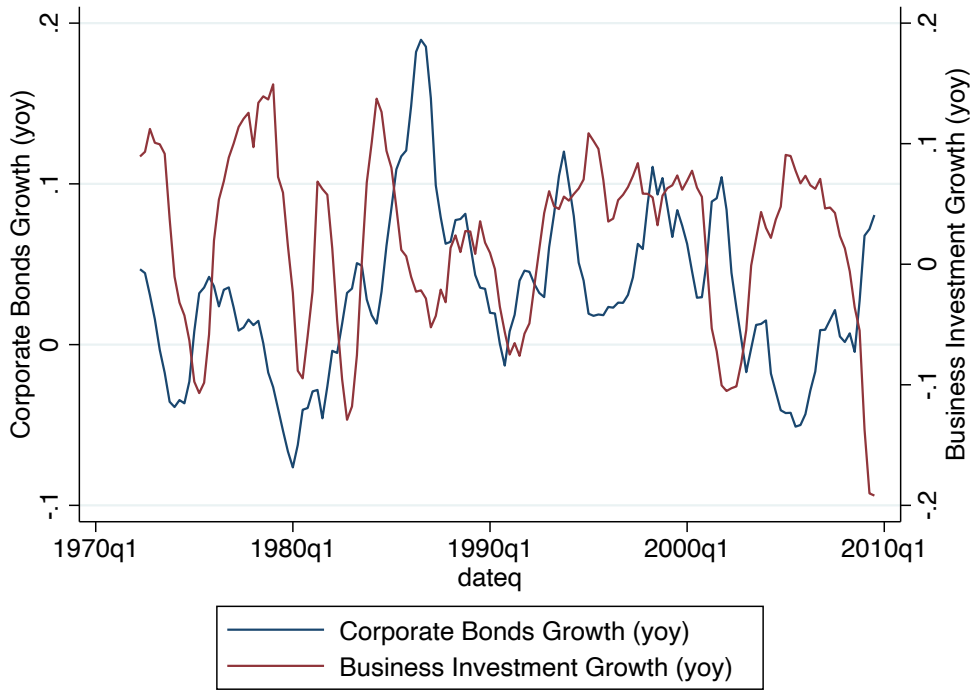
Notes: This figure presents the time-series evolution of business lending and business investment. Business loans are expressed as a share of non-financial sector debt. Business investment is reported as a share of business sector gross operating surplus.

Figure 17: Business investment and funding sources: Growth rates

(a) Business Investment & Loans



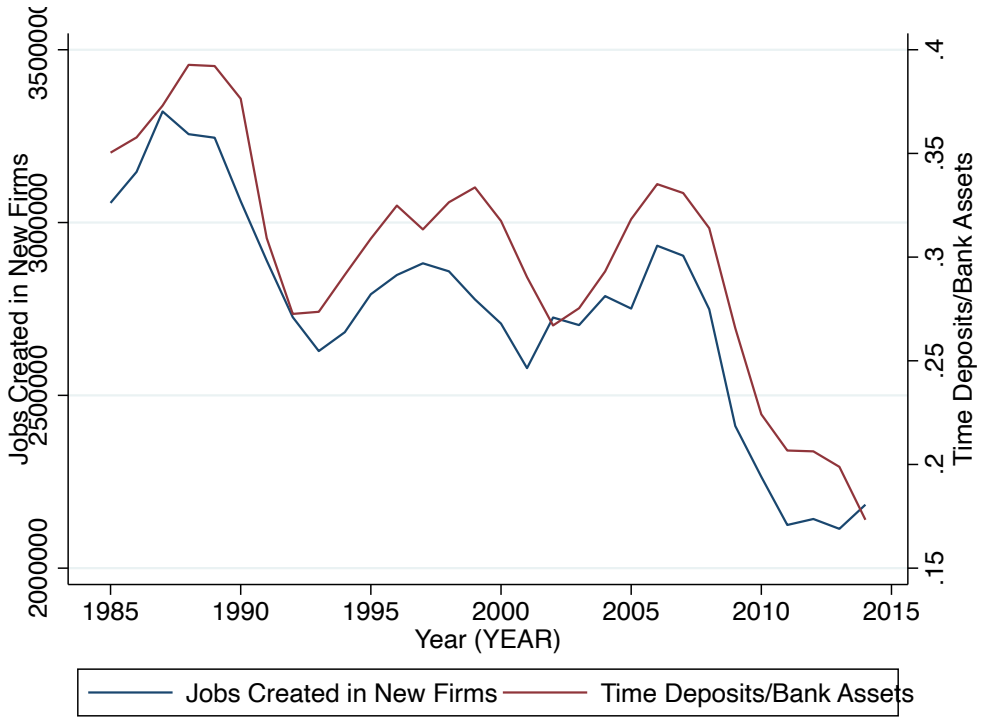
(b) Business Investment & Corporate Bonds



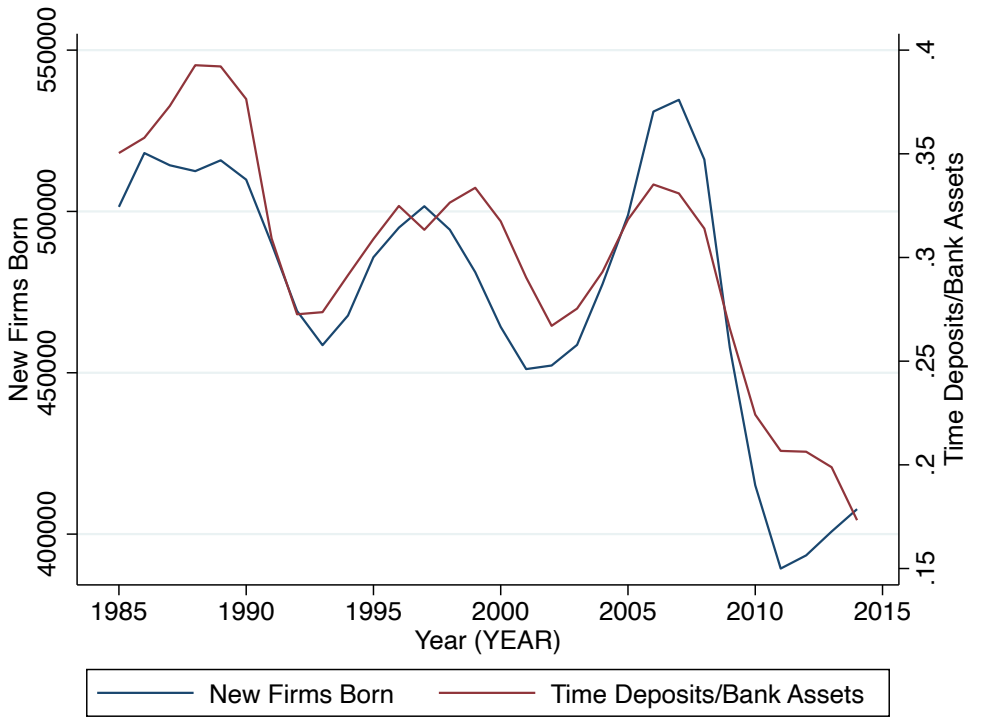
Notes: This figure presents the relationship between the business investment and firm financing. Panel (a) plots the year-over-year real growth rate of business investment and C&I loans. Panel (b) plots the dynamics of year-over-year real business investment growth and corporate bond growth.

Figure 18: Trends in firm entry rate

(a) Jobs created in new firms

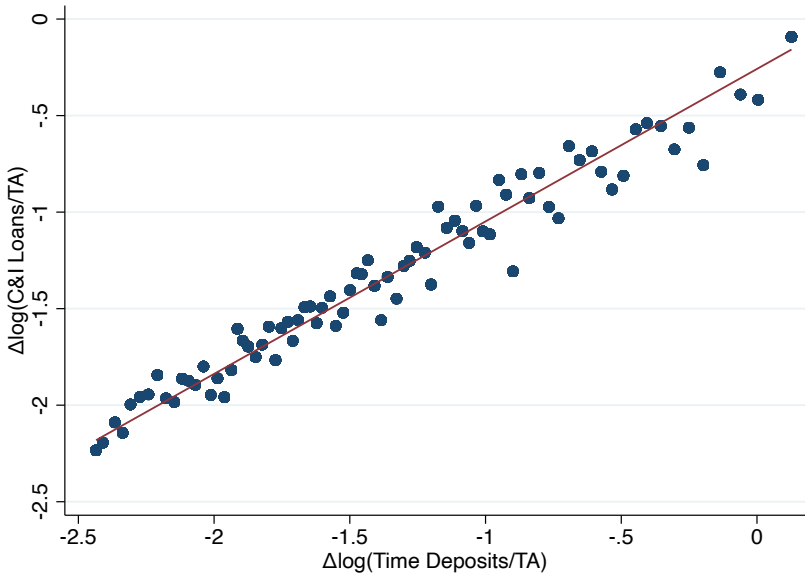


(b) Newly created firms



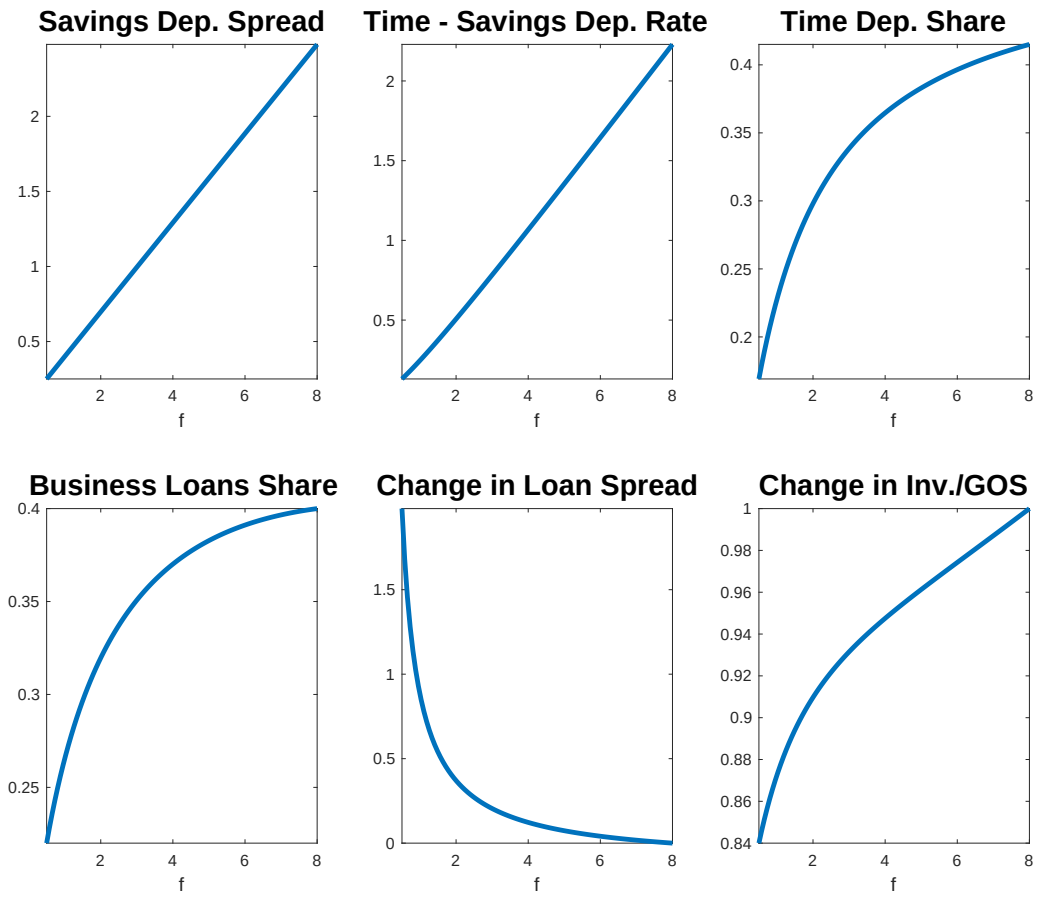
Notes: This figure presents the relationship between time deposits and new firm creation. Panel (a) shows a number of job created in new firms while Panel (b) focuses on the number of new firms born each year. Time deposits are expressed as a share to total assets of the banking sector.

Figure 19: Long-run analysis across banks: 1995–2015



Notes: This figure presents the bin scatter plot of a relationship between time deposits and C&I loans over the long run. The horizontal axis expresses the log change (between 2015 and 1995) in the share of time deposit of a bank b to total banking sector assets. The vertical axis denotes the log change (between 2015 and 1995) in the share of C&I loans of bank b to total banking sector assets. The data is sorted into 100 bins based on the bank's time deposit change. For each bin, the figure plots the average value of the two variables.

Figure 20: The effects of changes in nominal interest rates on equilibrium outcomes



Notes: This figure presents the mean values of savings deposit spread, difference in deposit rates, time deposits share, business loans share, loan spread and investment normalized by the gross operating surplus (GOS) from model simulated data for nominal interest rates vaying between 0.5% (the level of Fed funds rate in 1985) and 8% (level in 1985).

Table 1: Time deposits and small business lending

	log(New small business lending$_{b,c,t}$)	
	(1)	(2)
Δlog(Time Deposits$_{b,t-1}$)	0.113***	0.128***
	(0.0361)	(0.0476)
Δlog(Saving Deposits$_{b,t-1}$)		-0.0465
		(0.0692)
Controls	Yes	Yes
Bank-County FE	Yes	Yes
County-Time FE	Yes	Yes
N	359,174	346,286
R^2	0.850	0.851

Notes: This table shows the effect of time deposits on small business lending, as described in Equation 1. The outcome variable denotes the log of new lending by bank b in county c in year t. Δlog(TimeDeposits$_{b,t-1}$) denotes the log change in time deposits of bank b in year $t-1$. Controls include local deposit growth of bank b in county c. Standard errors two-way clustered at the county and bank-time level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Interest-rate sensitivity of bank asset and deposit effective rates

	Time Deposits	Saving Deposits	C&I Loans	Securities
	(1)	(2)	(3)	(4)
$\sum_{\tau=0}^{4} \beta_y^\tau$	0.58	0.32	0.53	0.29
F-test p-val ($\sum_{\tau=0}^{4} \beta_y^\tau = 0$)	0.00	0.00	0.00	0.00
Bank FE	Yes	Yes	Yes	Yes
N	520,785	520,785	520,785	520,785
R^2	0.1885	0.3481	0.022	0.032

Notes: This table shows the interest-rate sensitivity of the effective rates of different assets and deposits as described by Equation 3. The effective rate for deposits is computed as the interest expenses divided by the quantity of deposit (time or savings) and for assets as the interest income divided by the quantity of the asset (C&I loans or securities).

Table 3: Net interest margin analysis

	ΔNIM			
	C&I loans *less*		Securities *less*	
	Time deposits	Savings deposits	Time deposits	Savings deposits
	(1)	(2)	(3)	(4)
$\sum_{\tau=0}^{4} \beta_y^\tau$	-0.01	0.21	-0.30	-0.03
F-test p-val $(\sum_{\tau=0}^{4} \beta_y^\tau = 0)$	0.78	0.00	0.00	0.42
Bank FE	Yes	Yes	Yes	Yes
N	520,785	520,785	520,785	520,785
R^2	0.0613	0.0642	0.131	0.118

Notes: This table shows the interest-rate sensitivity of changes in net interest margin components, as described by Equation 5. I compute the net interest margins for a combination of an asset class a matched with a deposit type d for bank b at time t, as described by Equation 4.

Table 4: Monetary policy and time deposits: Heterogeneity in market power

	ΔTime Deposit Spread$_{b,t}$	Δ log(Time Deposits$_{b,t}$)				
	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_t		3.736***	5.682***		3.972***	
		(0.797)	(0.849)		(0.591)	
$\Delta R_t \times \beta_b^{\text{TimeDepSpread}}$			-9.143***	-8.664***		
			(1.484)	(1.479)		
$\Delta R_t \times \text{HHI}_b$	0.111***				-4.125***	-4.198***
	(0.0300)				(0.800)	(0.853)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	No	No	Yes	No	Yes
N	314,795	646,634	557,883	557,883	429,306	429,306
R^2	0.734	0.153	0.142	0.176	0.174	0.189

Notes: This table shows the heterogeneous effects of monetary policy on time deposit spreads and volumes, as described in Equation 9. Column (1) uses the change in time deposits spreads by bank b in time t as a dependent variable. Column (2)–(6) focus on the log change in the volume of time deposits by bank b in time t. ΔR_t denotes the change in the Fed funds rate. HHI_b denotes the bank's Herfindahl–Hirschman Index (HHI) which is computed using branch-level bank data provided by the FDIC. I calculate the HHI for deposit market by squaring deposit-market shares of all banks operating in a given county in a given year, and averaging over the time. $\beta_b^{\text{TimeDepSpread}}$ denotes the Time Deposit Spread Beta which is estimated as the bank-level sensitivity of time deposit spread to monetary policy, as described by Equations 8. Controls included time-varying macroeconomic controls (four lags of GDP and inflation) and time-varying bank controls (total assets). Standard errors in parenthesis are clustered at the bank and time level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Monetary policy and C&I lending: Heterogeneity in market power

Panel (a): C&I lending

	$\Delta\log(\text{C\&I Loans}_{b,t})$		
	(1)	(2)	(3)
ΔR_t	1.365**	1.792***	
	(0.583)	(0.570)	
$\Delta R_t \times \beta_b^{\text{TimeDepSpread}}$		-2.755***	-2.354***
		(0.901)	(0.780)
Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Time FE	No	No	Yes
N	641,115	552,597	552,597
R^2	0.0711	0.0552	0.0614

Panel (b): Small business lending

	$\log(\text{New small business lending}_{b,c,t})$		
	(1)	(2)	(3)
ΔR_t	15.86***	20.34***	
	(2.271)	(3.242)	
$\Delta R_t \times \beta_b^{\text{TimeDepSpread}}$		-20.78***	-21.54***
		(7.906)	(7.405)
Controls	Yes	Yes	-
Bank-County FE	Yes	Yes	Yes
County-Time FE	No	No	Yes
N	384,293	377,683	373,389
R^2	0.823	0.823	0.850

Notes: This table shows the effect of monetary policy on lending. Panel (a) presents the analysis on C&I lending from Call reports, as described in Equation 9. The outcome variable in Panel (a) is a log change in C&I lending by bank b in time t. Panel (b) shows the results for small business lending, as described in Equation 10. The dependent variable is the log of new small business lending by bank b in county c in time t. ΔR_t denotes the change in the Fed funds rate. $\beta_b^{\text{TimeDepSpread}}$ denotes the Time Deposit Spread Beta which is estimated as the bank-level sensitivity of time deposit spread to monetary policy, as described by Equation 8. In Panel (a), controls included time-varying macroeconomic controls (four lags of GDP and inflation) and time-varying bank controls (total assets). In Panel (b), controls further include county-time controls namely:lagged per capita income growth of the county, growth of population, change in employment and growth of local county-level deposits. Standard errors in parenthesis are clustered at the bank and time level in Panel (a), and at the county and bank-time level in Panel (b). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Monetary policy, time deposits and syndicated lending volumes

	log(New Syndicated Credit$_{b,l,f,t}$)			
	(1)	(2)	(3)	(4)
ΔR_t	6.979***	21.20***		
	(2.162)	(4.416)		
$\Delta R_t \times \beta_b^{\text{TimeDepSpread}}$		-23.21***	-18.04***	-8.387***
		(5.883)	(4.574)	(2.598)
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Rating Group FE	Yes	Yes	Yes	Yes
Loan Purpose FE	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes
Sector-Time FE	No	No	Yes	-
Firm-Time FE	No	No	No	Yes
N	133,223	133,208	133,096	129,121
R^2	0.254	0.255	0.386	0.773

Notes: This table shows the effect of monetary policy on syndicated lending volumes, as described in Equations 11. The outcome variable denotes the log of newly issued syndicated loans l to a firm f by bank b at time t. ΔR_t denotes the change in the Fed funds rate. $\beta_b^{\text{TimeDepSpread}}$ denotes the Time Deposit Spread Beta which is estimated as the bank-level sensitivity of time deposit spread to monetary policy, as described by Equation 8. Controls included time-varying macroeconomic controls (four lags of GDP and inflation), time-varying bank controls (total assets) and time-varying firm controls (size, current assets, sales growth). Standard errors in parenthesis are clustered at the firm and bank-time level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Monetary policy, time deposits and syndicated lending spreads

	Loan Spread$_{b,l,f,t}$		
	(1)	(2)	(3)
ΔR_t	-0.115***	-0.198***	
	(0.0225)	(0.0405)	
$\Delta R_t \times \beta_b^{\text{TimeDepSpread}}$		0.134***	0.106***
		(5.883)	(4.574)
Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Rating Group FE	Yes	Yes	Yes
Loan Purpose FE	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes
Sector-Time FE	No	No	Yes
N	150,143	150,072	149,904
R^2	0.422	0.422	0.551

Notes: This table shows the effect of monetary policy on syndicated lending spreads, as described in Equations 13. The dependent variable in Panel (b) is the spread on newly issued syndicated loans l to a firm f by bank b at time t. ΔR_t denotes the change in the Fed funds rate. $\beta_b^{\text{TimeDepSpread}}$ denotes the Time Deposit Spread Beta which is estimated as the bank-level sensitivity of time deposit spread to monetary policy, as described by Equation 8. Controls included time-varying macroeconomic controls (four lags of GDP and inflation), time-varying bank controls (total assets), time-varying bank controls (total assets) and time-varying firm controls (size, current as-sets, sales growth).. Standard errors in parenthesis are clustered at the firm and bank-time level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Firm financing and monetary policy

	log(new loans$_{f,t}$)				log(new bonds$_{f,t}$)	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔR_t	15.20***				-13.89***	
	(3.345)				(6.659)	
Δf_t		41.36***				-26.81***
		(12.04)				(9.124)
(RatingExists$_{f,t-1} = 0$) $\times$ ΔR_t			14.24***			
			(3.777)			
(RatingExists$_{f,t-1} = 1$) $\times$ ΔR_t			16.16***			
			(3.429)			
(RatingExists$_{f,t-1} = 0$) $\times$ Δf_t				50.68***		
				(13.50)		
(RatingExists$_{f,t-1} = 1$) $\times$ Δf_t				30.24***		
				(9.691)		
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	21,270	21,270	21,270	21,270	95,884	95,884
R^2	0.792	0.791	0.792	0.791	0.0951	0.0949

Notes: This table shows the effects of lower interest rates on firm financing, as described in Equation 14. Columns (1)–(4) focus on new bank loans where the log(new loans$_{f,t}$) denotes the log of new loans received by a firm f in time t. Columns (5) and (6) examine the effect on monetary policy on new bond financing where log(new bonds$_{f,t}$) denotes the log of new bond market financing received by a firm f in time t. ΔR_t denotes a change in the Fed funds rate, or Δf_t denotes monetary policy surprises based on Gertler and Karadi (2015). Dummy variable Rating Exists$_{f,t-1}$ takes the value of one if the firm has had a rating in period $t-1$, and zero otherwise. Controls include firm-time variables, i.e. sales growth, size, current assets as a share of total assets and macro variables, i.e. four lags of quarterly GDP growth and CPI inflation. Standard errors in parenthesis are clustered at the firm and time level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Firm financing and monetary policy: Within-firm analysis

	log(1+ new debt$_{i,f,t}$)			
	(1)	(2)	(3)	(4)
ΔR_t	0.0998***			
	(0.0371)			
$\Delta R_t \times$ Bond$_i$	-0.170***	-0.170***		
	(0.0334)	(0.0153)		
Δf_t			0.275***	
			(0.0922)	
$\Delta f_t \times$ Bond$_i$			-0.425**	-0.425***
			(0.182)	(0.0655)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	–	Yes	–
Firm–Time FE	No	Yes	No	Yes
N	175,646	175,646	175,646	175,646
R^2	0.0708	0.566	0.0704	0.566

Notes: This table shows the withing-firm effect of monetary policy on firm financing, as described in Equation 15. The outcome variable denotes the log of new external debt of type i (where i is either a bank loan or a bond) taken by firm f at time t. ΔR_t denotes a change in the Fed funds rate, or Δf_t denotes monetary policy surprises based on Gertler and Karadi (2015). Bond$_i$ takes the value of one if the external financing i is a bond, and 0 if it is a bank loan. Controls include firm-time variables, i.e. sales growth, size, current assets as a share of total assets and macro variables, i.e. four lags of quarterly GDP growth and CPI inflation. Standard errors in parenthesis are clustered at the firm and time level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Borrowing and investment effects of monetary policy

	$\Delta\log(\text{Debt}_{f,t})$		$\Delta\log(\text{Capital}_{f,t})$		$\text{Investment}_{f,t}/\text{Capital}_{f,t-1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$(\text{RatingExists}_{f,t-1}=0)\times\Delta R_t$	1.853***		1.008**		0.809***	
	(0.484)		(0.479)		(0.190)	
$(\text{RatingExists}_{f,t-1}=1)\times\Delta R_t$	-0.174		-0.194		0.141	
	(0.509)		(0.345)		(0.151)	
$(\text{RatingExists}_{f,t-1}=0)\times\Delta f_t$		5.283***		2.908**		2.178***
		(1.835)		(1.418)		(0.799)
$(\text{RatingExists}_{f,t-1}=1)\times\Delta f_t$		-0.844		-0.122		0.153
		(1.694)		(1.503)		(0.703)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
N	372,774	277,820	514,436	387,712	487,110	367,639
R^2	0.0849	0.0928	0.132	0.145	0.237	0.250

Notes: This table shows the firm-level borrowing and investment response to monetary policy, as described in Equation 16. The dependent variable in Columns (1) and (2) denotes a log change in total debt (bank and bond debt). Columns (3)–(4) report the effect on a log change in capital of firm denoted as $\Delta\log(\text{Capital}_{f,t})$. Capital is computed using perpetual inventory method using Compustat data as in Ottonello and Winberry (2020). Columns (5)–(6) show the effect on firm investment as a share of capital denoted as $\text{Investment}_{f,t}/\text{Capital}_{f,t-1}$ where Investment is a CAPX measure form Compustat data. ΔR_t denotes a change in the Fed funds rate, and Δf_t denotes monetary policy surprises based on Gertler and Karadi (2015). Dummy variable $\text{Rating Exists}_{f,t-1}$ takes the value of one if the firm has had a rating in period $t-1$, and zero otherwise. Controls include firm-time variables, i.e. sales growth, size, current assets as a share of total assets and macro variables, i.e. four lags of quarterly GDP growth and CPI inflation. Standard errors in parenthesis are clustered at the firm and time level. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table 11: Time deposits and firm entry rate: Short-run analysis

	$\log(\text{NewFirms}_{c,t})$		
	(1)	(2)	(3)
$\Delta\log(\text{Time Deposits}_{c,t-1})$	0.0828***	0.0870***	0.0886***
	(0.0246)	(0.0241)	(0.0260)
Δ log(Income Per Capita$_{c,t-1}$)	0.357***	0.355***	0.355***
	(0.0524)	(0.0523)	(0.0523)
Δ log(Population$_{c,t-1}$)	1.649***	1.641***	1.647***
	(0.455)	(0.454)	(0.456)
Δ log(Savings Deposits$_{c,t-1}$)	0.00449		
	(0.0210)		
Δ log(Local Deposits$_{c,t-1}$)		0.0377***	
		(0.0127)	
Δ log(Local Time Deposits$_{c,t-1}$)			0.0383**
			(0.0161)
Δ log(Local Savings Deposits$_{c,t-1}$)			-0.00232
			(0.0158)
Time FE	Yes	Yes	Yes
County FE	Yes	Yes	Yes
N	189,740	189,618	189,598
R^2	0.940	0.940	0.940

Notes: This table shows the effect of the change in time deposits on new firm creation, as described by Equation 19. The outcome variable is the log number of new firms established in county c in time t (quarterly data). $\Delta\log(\text{Time Deposits}_{c,t-1})$ denotes the county-level growth in time deposits computed as a weighted average of deposit growth of banks operating in the county weighted by their lending share, as discussed in Equation 18. All specifications control for lagged growth of county's income per capita and population. Column (1) further controls for a change in savings deposits of bank operating in county c. Column (2) controls for a change in total local deposits. Column (3) splits the local deposits into two control variables: local time deposits and local savings deposit growth. Standard errors are clustered at the county level in parenthesis * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Time deposits and firm entry rate: Short-run analysis (Industry heterogeneity)

	$\log(\text{NewFirms}_{i,c,t})$		
	(1)	(2)	(3)
Δ Time Deposits$_{c,t-1}$	0.106***	0.0897***	-0.0179
	(0.0130)	(0.0149)	(0.0218)
Δ Time Deposits$_{c,t-1}\times$ External Finance (Index)$_i$		0.262***	
		(0.0345)	
Δ Time Deposits$_{c,t-1}\times$ External Finance (Dummy)$_i$			0.209***
			(0.0330)
Controls	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
County-Industry FE	Yes	Yes	Yes
N	1,590,741	1,259,501	1,259,501
R^2	0.821	0.818	0.818

Notes: This table shows the effect of the change in time deposits on new firm creation and exploits additional industry-level heterogeneity to examine the effect for industries with different reliance on external financing, as described by Equation 20. The outcome variable is the log number of new firms established in industry i in county c in time t (quarterly data). $\Delta\log(\text{Time Deposits}_{c,t-1})$ denotes the ex ante county-level growth in time deposits computed as a weighted average of deposit growth of banks in the same county weighted by their lending share, as discussed in Equation 18. Controls include lagged growth of county's income per capita, population and total local deposits. Column (1) report the average effects. Columns (2) and (3) introduce an additional interaction term between the $\Delta\log(\text{Time Deposits}_{c,t-1})$ and a measure for industry's dependence on external finance. Column (2) uses the External Finance Index based on Rajan and Zingales (1998) that ranges between -1 and 1. Column (3) uses a dummy variable that takes a value of 1 if the External Finance Index is positive, and 0 otherwise. Standard errors at clustered at the county level in parenthesis * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: Long-run analysis across banks: 1995–2015

	Δ log(TimeDeposits$_b$)	Δ log(C&I Loans$_b$)	Δ log(C&I Loans$_b$)
	(1)	(2)	(3)
$\left(\frac{\text{TimeDeposits}}{\text{Total Assets}}\right)_{b,1995}$	-3.105***	-0.855***	
	(0.116)	(0.149)	
Δ log(TimeDeposits$_b$)			0.748***
			(0.0137)
N	5,503	5,474	5,454
R^2	0.115	0.00601	0.353

Notes: This table shows the relationship between the long-run trend in time deposits and C&I loans at the bank-level, as described by Equation 21. Column (1) examines the effect of ex-ante bank reliance on time deposits on the dynamics in time deposits between 1995 and 2015. The outcome variable denotes the log change in time deposits for bank b between 1995 and 2015 and the independent variable denotes the ex-ante (1995) bank dependence on time deposits as a share of total assets. Column (2) focuses on the effect for a log change in the C&I loans extended by bank b in 2015 vs. 1995 as the outcome variable. Column (3) puts the two pieces together and shows the estimates for the regression using the C&I loan growth between 2015 and 1995 as dependent variable and time deposits growth between 2015 and 1995 as an independent variable. Standard errors in parenthesis * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 14: Time deposits and firm entry rate: Long-run analysis

	Δ log(NewFirms)$_{c,2015-1995}$	
	(1)	(2)
$\left(\frac{\text{TimeDeposits}}{\text{Total Assets}}\right)_{c,1995}$	-0.347**	
	(0.158)	
Δlog(Time Deposits)$_{c,2015-1995}$		0.132***
		(0.0300)
Controls	Yes	Yes
N	1,186	1,055
R^2	0.133	0.154

Notes: This table shows the long-run effect of time deposits on firm creation, as as described by Equation 22. The outcome variable is the change in log number of new firms established in county c between 2015 and 1995. County-level time deposit exposure is measured in two ways, in two ways. In Column (1) uses an average of bank ex ante exposures weighted by ex-ante lending shares, as described in Equation 23. Column (2) uses the weighted average of changes in time deposit dynamics of banks in county c, as described in Equation 24. Controls include growth of county's income per capita and population. Standard errors in parenthesis * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 15: Parameter values used in the model

Parameter	Symbol	Value
Households		
Discount rate	β	0.99
IES	γ	2
Frish elasticity	ψ_N	1
Elasticity of substitution b/t C_t and L_t	ρ	0.39
Firms		
Depreciation rate	δ	0.025
Capital share in production	α	0.33
Capital adjustment cost	ψ_k	0.5
Share of constrained firms	ω_c	0.56
Elasticity of substitution b/t firm outputs	ζ_Y	6
Elasticity of substitution b/t firm labor demand	ζ_N	6
Financially constrained firms		
Tax wedge	τ	0.35
LTV ratio parameter	θ_c	0.31
Business loan maturity	$1/\eta_B$	12
Firm dividend adjustment cost	κ_c	0.15
Banks		
Long-term bond maturity	$1/\eta_G$	38
Bank dividend adjustment cost	κ_b	7
Bank dividend target	$4 \times \bar{d}_b/n_{b,t}$	0.068
Monetary Policy		
Persistence of interest rates	ρ_f	0.953
Standard deviation of monetary policy shock	σ_f	0.0052
Parameters calibrated to match data moments		
Elasticity of substitution b/t M_t and $D_{S,t}$	ξ	2.33
Elasticity of substitution b/t $L_{H,t}$ and $D_{T,t}$	ϵ	1.15
$D_{S,t}$ share in $L_{H,t}$	λ_S	0.44
$D_{T,t}$ share in L_t	λ_T	0.07
C_t share in Z_t	λ_C	0.91
Fire-sale parameter	χ	0.22

Notes: This table presents the parameter values used in the model.

Table 16: Moments targeted in the model calibration

Moment	Data	Model
Time Deposits/Total Deposits in 1985	0.45	0.42
Time Deposits/Total Deposits in 2016	0.18	0.17
Money/Liquidity in 1985	0.15	0.12
Money/Liquidity in 2016	0.20	0.17
Consumption/Liquidity in 1985	1.02	1.10
Time Deposit Spread in 1985 (pp)	0.20	0.25
Savings Deposit Spread in 1985 (pp)	2.50	2.48
Business Loans/Total Assets in 1985	0.38	0.40

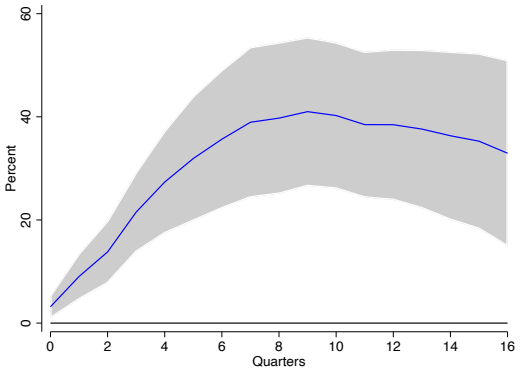
Notes: This table presents the moments targeted by the calibration. Model implied moments are based on simulating the model for 1,000,000 periods. The model is solved for two levels of $\bar{f}$, 8% and 0.5%, while keeping the rest of the parameters the same. The moments implied by the model solved with $\bar{f} = 8\%$ ($\bar{f} = 0.5\%$) correspond to moments in the data in 1986 (2016).

Appendix

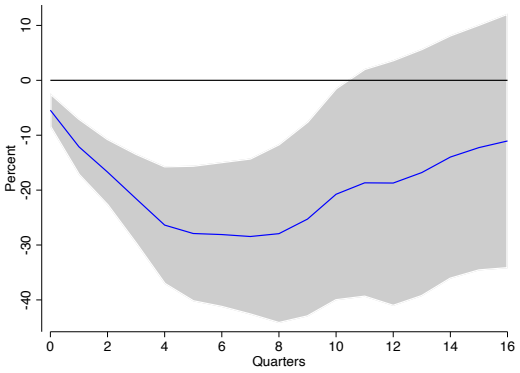
A Additional Figures and Tables

Figure A1: Monetary policy and bank balance sheet items: Local projections with monetary policy shocks

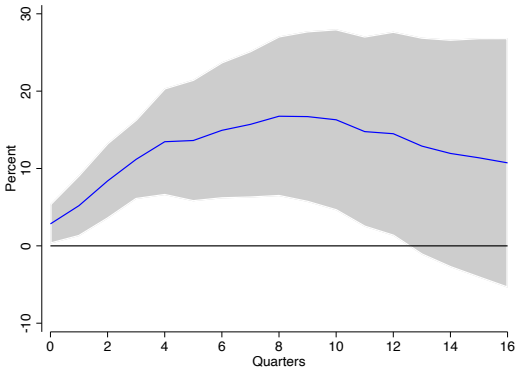
(a) Time Deposits



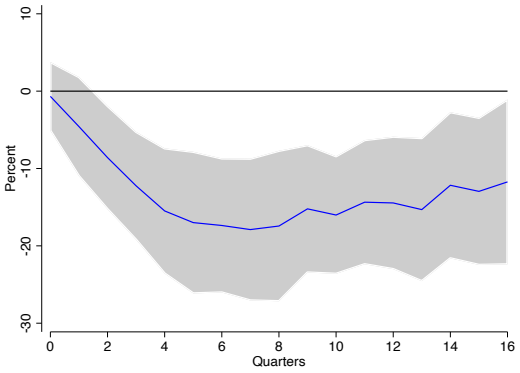
(b) Savings Deposits



(c) C&I Loans

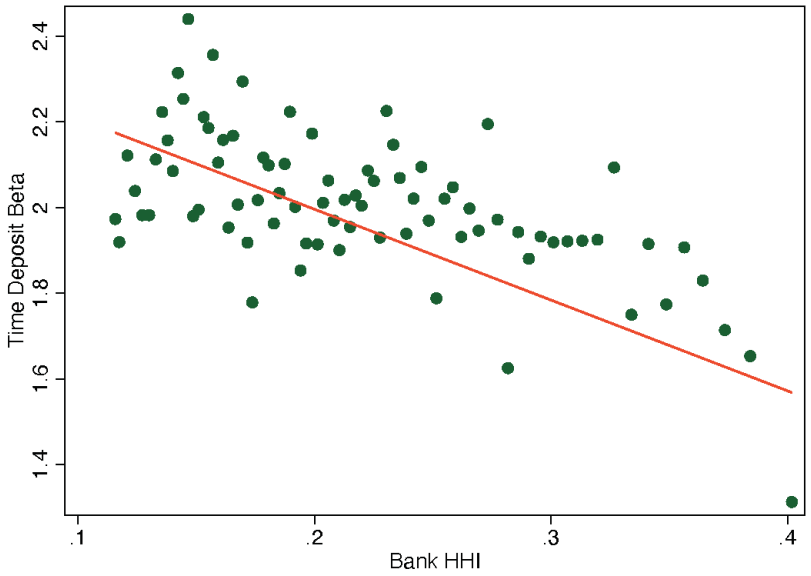


(d) Security Holdings



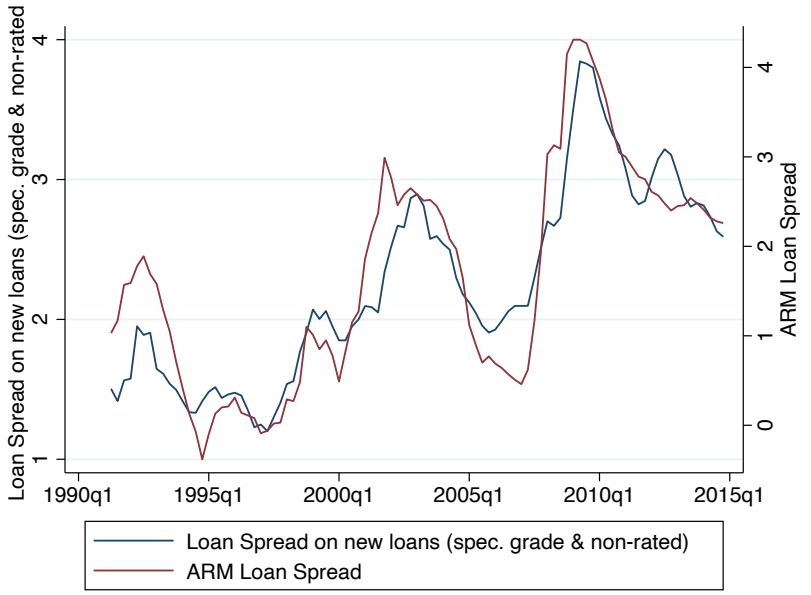
Notes: This figure presents impulse response to a 100 basis point contractionary monetary policy shock based on the local projections approach, as described by Equation 6. Panel (a) shows the response to the growth (log-difference) of time deposits. Panel (b) plots the response to the growth of savings deposits. Panel (c) plots the response to the growth of C&I loans. Panel (d) plots the response to the growth of security holdings. The monetary policy shocks are based on high frequency surprises around policy announcement by Gertler and Karadi (2015). 90 percent confidence bands are shown using standard errors that are clustered at the bank and time level.

Figure A2: Monetary policy, time deposits and market power: robustness



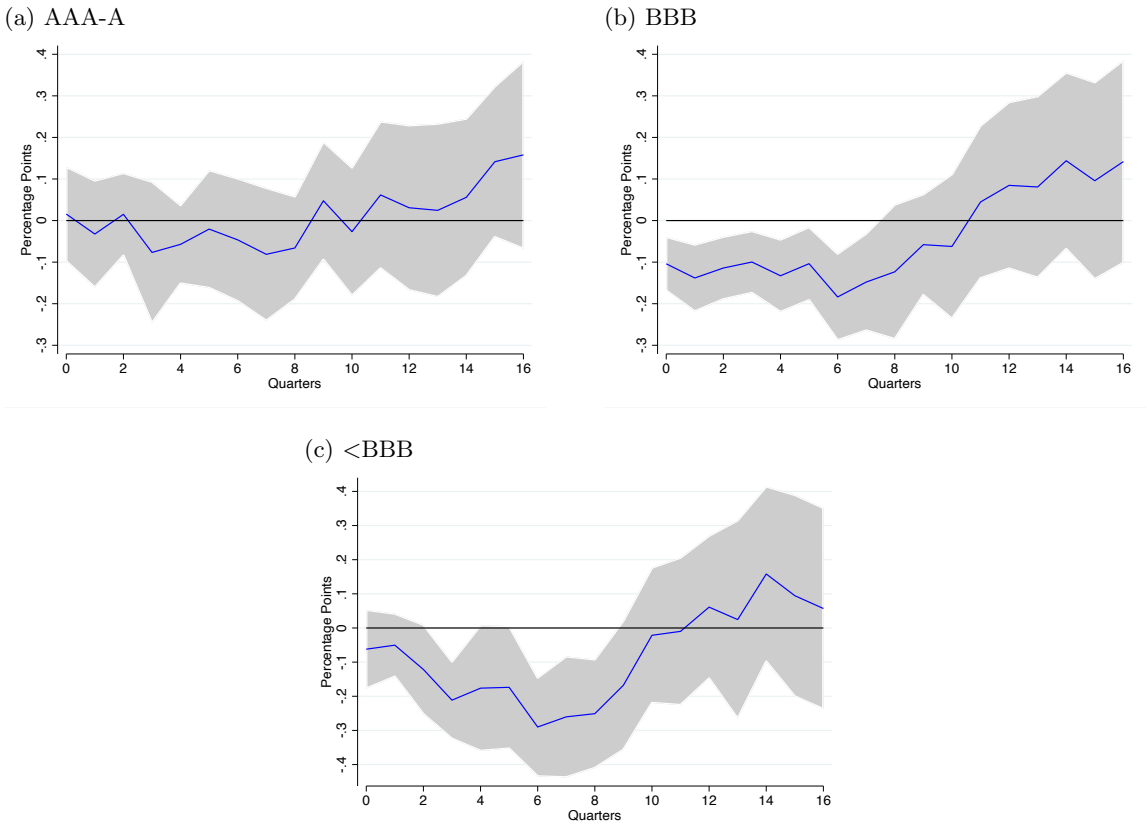
Notes: This figure presents the bin scatter plots for the relationship between bank market power and the sensitivity time deposit quantities to the Fed funds rate. I proxy for bank market power with the Herfindahl-Hirschman Index (HHI). Vertical axis denotes Time Deposits Beta which is constructed by estimating the sensitivity of the bank's log change in time deposit volume to the changes in the Fed funds rate, following Equation 7. The sum of the beta estimates is denoted as Time Deposits Beta. The figure sorts the banks into 100 bins based on HHI, computes the average betas for each bin and graph the bin scatter plots.

Figure A3: Loan Spreads on C&I Loans and ARMs



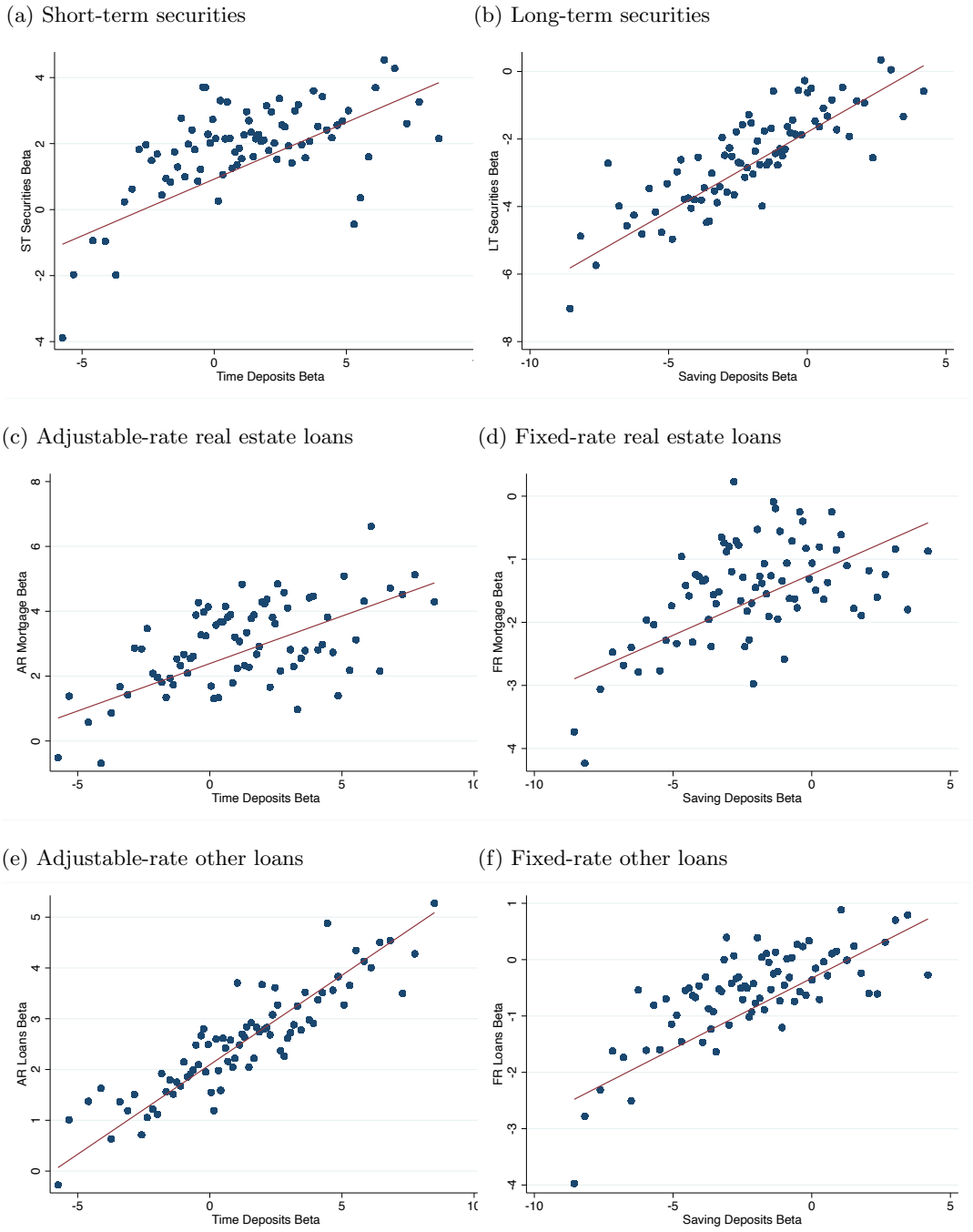
Notes: This figure presents the evolution of spreads for C&I loans and adjustable-rate mortgages (ARMs). C&I loans spreads are computed from Dealscan data as a difference between the newly issued loans to speculative-grade and unrated firms which are the highest risk category and the Fed funds rate. ARM Loan Spread is computed as a difference between a 1-Year Adjustable Rate Mortgage Average (from Freddie Mac) and 1-Year Treasury Rate.

Figure A4: Monetary policy and loan spreads on new loans: Heterogeneity by riskiness



Notes: This figure presents impulse response to a 100 basis point increase in the Fed funds rate based on the local projections approach, as described by Equation 12. The outcome variable is the change in the average spread of loans at a respective rating category. Panel (a) uses the safest borrowers, measured as AAA to A rated firms. Panel (b) focuses on BBB rated firms. Panel (c) presents the results for riskiest borrowers: firms rated either below a BBB notch or non-rated firms. 90 percent confidence bands are shown using standard errors that are clustered at the bank and time level.

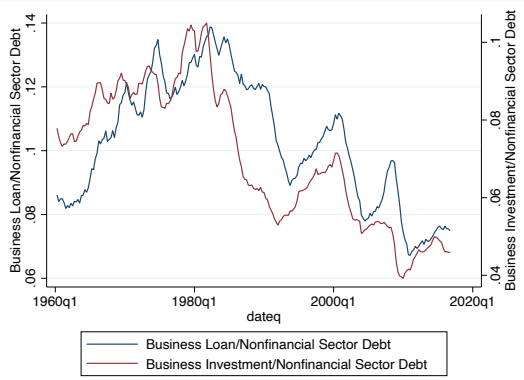
Figure A5: Monetary policy and other asset classes: Cross-section



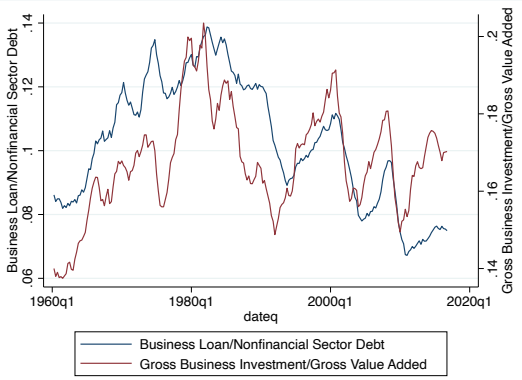
Notes: This figure presents the bin scatter plots for the relationship between the responses of time (savings) deposits quantity and quantity of various adjustable-rate (fixed-rate) asset classes to Fed funds rate changes. Panels (a), (c) and (e) report results for a range of adjustable-rate assets while Panels (b), (d) and (f) present the results for fixed-rate asset classes. Specifically, Panel (a) focuses on short-term securities (with maturity less than one year). Panel (b) plots the results for long-term securities (with maturity one year and more). Panel (c) focuses on adjustable-rate real estate loans and Panel (d) reports the results for fixed-rate real estate loans. Finally, Panels (e) and (f) show the responses for other adjustable-rate and fixed-rate assets, respectively. The figure is constructed in following steps. The first step is to estimate the sensitivity of bank's log change in time (savings) deposit volume to changes in the Fed funds rate, following Equation 7. The sum of the beta estimates is denoted as Time (Savings) Deposits Beta. Second step is to repeat the estimation for all six asset classes and construct their respective quantity beta denoted on the y-axis in each panel. Third step is to sort the banks into 100 bins based on their Time (Savings) Deposits Beta. Fourth step is to compute the average betas for each bin and graph the bin scatter plots.

Figure A6: Business investment & loans

(a) Investment as a share of non-fin. sector debt

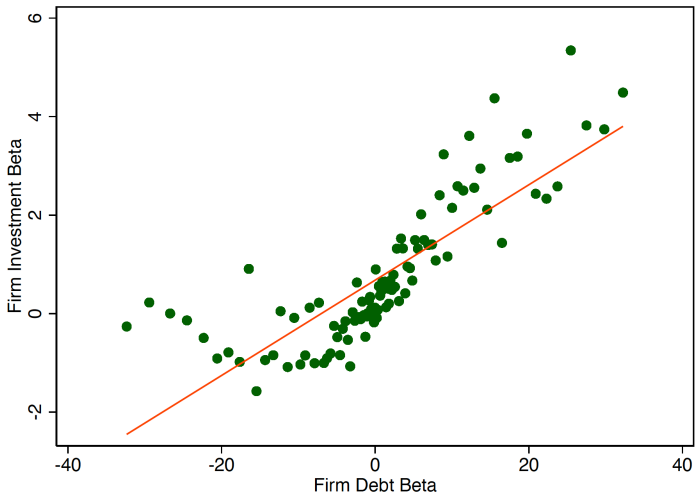


(b) Investment as a share of gross value added



Notes: This figure presents the time-series evolution of business lending and business investment. Business loans are expressed as a share of non-financial sector debt. Business investment is reported as a share of non-financial sector debt in Panel (a) and as a share of business sector gross value added in Panel (b).

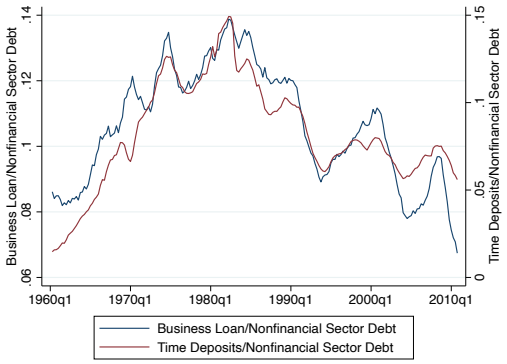
Figure A7: Borrowing and investment effects of monetary policy: Cross-section of firms



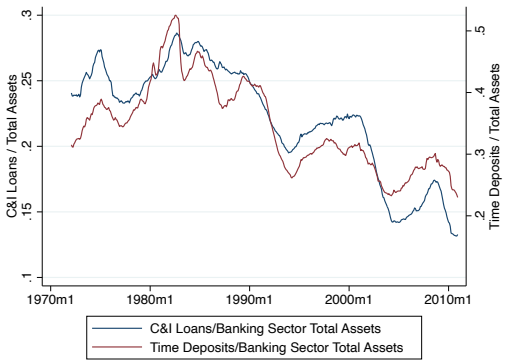
Notes: This figure presents the bin scatter plots for the relationship between the firm-level credit and investment sensitivity to monetary policy. The figure is constructed in following steps. The first step is to estimate the sensitivity of the change in log of firm debt to the Fed funds rate following Equation 17. The sum of the beta estimates is denoted as Firm Debt Beta. Second step is to repeat the estimation using log change in capital as a dependent variable to estimate Firm Investment Beta. Capital is computed using perpetual inventory method using Compustat data as in Ottonello and Winberry (2020). Third step is to sort the firms into 100 bins based on their Firm Debt Beta. Fourth step is to compute the average betas for each bin and graph the bin scatter plots.

Figure A8: Trends in time deposits and business loans

(a) As a share of non-financial sector debt

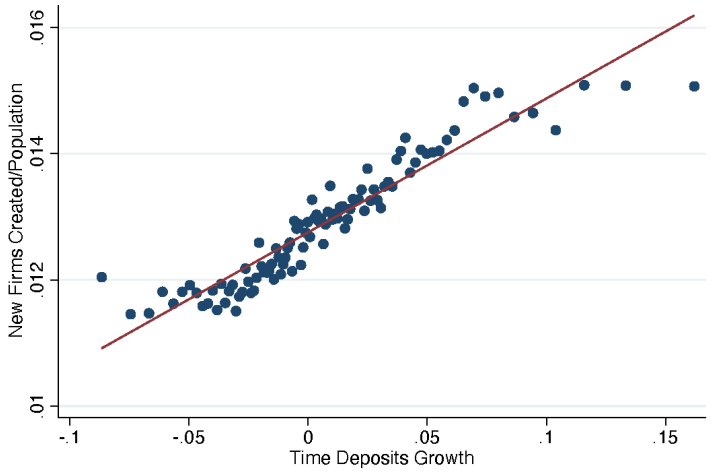


(b) As a share of banking sector total assets



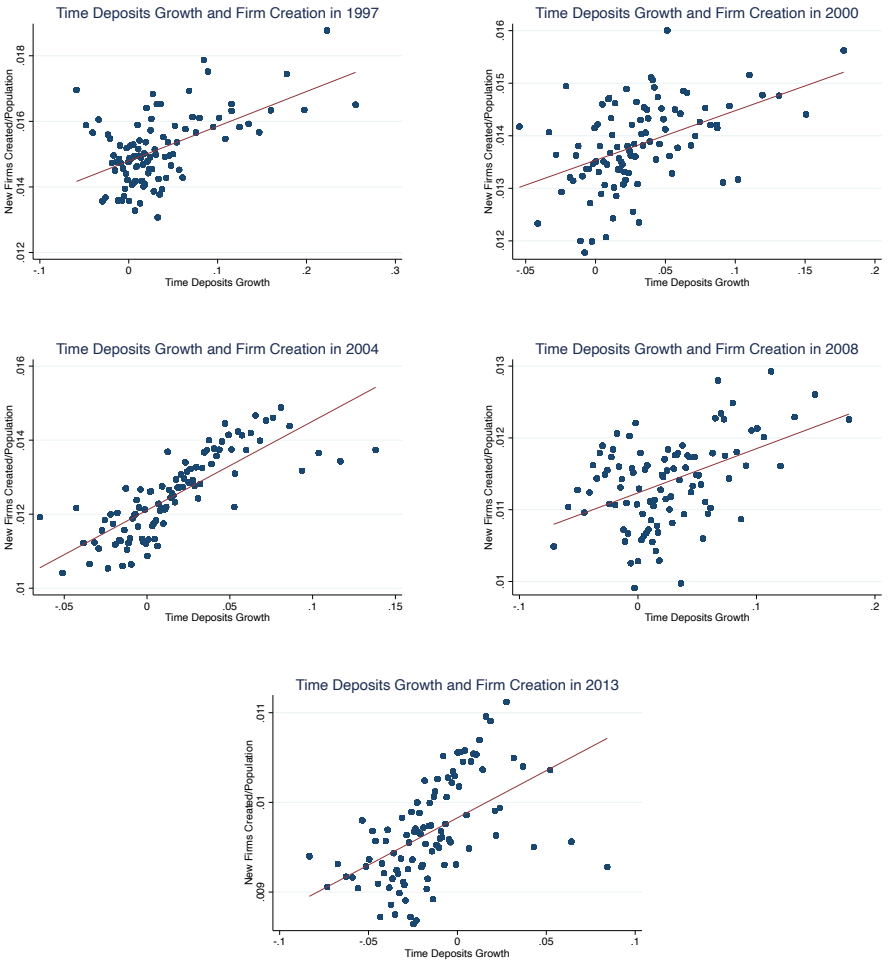
Notes: This figure presents an evolution of time deposits and business loans. Plan (a) shows the series in terms of a share to non-financial sector debt. Panel (b) scales the series to total assets of the banking sector.

Figure A9: Short-term analysis: Time deposits and firm entry



Notes: This figure presents the bin scatter plot of a relationship between the new firm creation and time deposits growth using pooled data across all years. Time deposit growth is a quarter-over-quarter change in time deposits of banks operating in county c computed as described in Equation 18. The vertical axis denotes number of new firms created in county c in quarter t over county-level population in quarter t. The data is sorted into 100 bins based on the time deposit growth. For each bin, the figure plots the average value of the two variables.

Figure A10: Time deposits and firm entry: Sub-samples



Notes: This figure presents the bin scatter plot of a relationship between the new firm creation and time deposits growth using pooled data for a respective year: 1997, 2000, 2004, 2008 and 2013. Time deposit growth is a year-over-year change in time deposits in county c computed as described in Equation 18. The vertical axis denotes number of new firms created in county c in year t over county-level population in year t. The data is sorted into 100 bins based on the time deposit growth. For each bin, the figure plots the average value of the two variables.

Table A1: Time deposits and firm entry rate: Short-run analysis (Robustness)

	$\log(\text{NewFirms}_{c,t})$	
	Baseline	
	(1)	(2)
$\Delta\log(\text{Time Deposits}_{c,t})$	0.0870***	
	(0.0241)	
$\Delta R_{t-1} \times \beta_{c,t-1}^{\text{TimeDepSpread}}$		-0.0682**
		(0.0300)
Controls	Yes	Yes
Time FE	Yes	Yes
County FE	Yes	Yes
N	189,618	189,618
R^2	0.940	0.940

Notes: This table shows the robustness results for the effect of the change in time deposits on new firm creation, as described by Equation 19. The outcome variable is the log number of new firms established in county c in time t (quarterly data). $\Delta\log(\text{Time Deposits}_{c,t})$ denotes the lagged county-level growth in time deposits computed as a weighted average of deposit growth of banks in the same county weighted by their lending share, as discussed in Equation 18. Controls include lagged growth of county's income per capita, population and total local deposits. Column (1) reports the baseline effect (as in Column (2) of Table 11). Column (2) presets the robustness measure using a lagged Time Deposit Spread Beta (computed as in Equation 8 and aggregated at the county-level based on the same approach as time deposits growth, see Equation 18) interacted with the lagged change in the Fed funds rate. Standard errors are clustered at the county level in parenthesis * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.