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Deposit Interest Rate Ceilings as Credit Supply Shifters: Bank Level Evidence on the Effects of Regulation Q

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Deposit Interest Rate Ceilings as Credit Supply Shifters: Bank Level Evidence on the Effects of Regulation Q*

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Abstract

Shocks emanating from and propagating through the banking system have recently gained interest in the macroeconomics literature, yet they are not a feature unique to the 2008/09 financial crisis. Banking disintermediation shocks occured frequently during the Great Inflation era due to fixed deposit rate ceilings. I estimate the effect of deposit rate ceilings inscribed in Regulation Q on the transmission of federal funds rate changes to bank level credit growth using a historic bank level data set spanning half a century from 1959 to 2013 with about two million observations. Measures of the degree of bindingness of Regulation Q suggest that individual banks' lending growth was smaller the more binding the legally fixed rate ceiling. Interaction terms with monetary policy suggest that the policy impact on bank level credit growth was non-linear at the ceiling "kink" and significantly larger when rate ceilings were in place. At the bank level, short-term interest rates exceeding the legally fixed deposit rate ceilings identify bank loan supply shifts that disappeared with deposit rate deregulation and thus weakened the credit channel of monetary transmission since the early 1980s.

Keywords: Monetary Transmission, Lending Channel, Regulation Q, Deregulation, Great Moderation

JEL Codes: E51, E52, E58, G18, G21

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Contents

List of Tables

List of Figures

"All the legislative proposals need to be judged first of all against the central objective: We need to strengthen our ability to implement monetary policy in a variety of possible circumstances..."

- Paul Volcker (1979)
Statement to Committee on Banking, Housing and Urban Affairs, U.S. Senate.

1 Inflation, Disintermediation and the Lending Channel

The financial crisis of 2008/2009 and the accompanying credit squeeze triggered a number of papers in macroeconomics that examine the importance of financial intermediation and credit frictions for output fluctuations, see, for example, Curdia and Woodford (2010), Gertler and Karadi (2010), Gertler, Kiyotaki, and Queralto (2012) or Gertler and Kiyotaki (2013), some building on earlier work by Bernanke, Gertler, and Gilchrist (1999). Yet, disintermediation shocks emanating from the banking sector were prevalent long prior to the recent financial crisis and are not confined to "rare disasters" (Barro, 2006) like the Great Depression and the Great Recession. I show that disintermediation shocks were prevalent at business cycle frequency during the Great Inflation due to an interaction of elevated inflation induced high nominal rates and nominally fixed deposit interest rate ceilings. I provide bank level evidence on the effects of deposit rate ceilings engrained in Regulation Q, and on how these effects differ by bank characteristics like bank size, capitalization or liquidity position.

These findings have important implications. If policy makers at the time had been aware of those disintermediation wedges, then there would have been a rationale for monetary policy responses during the Great Inflation period more muted than prescriptions derived from variants of Taylor (1993) and Orphanides (2003) type rules that focussed on (forecasted) output and inflation gaps. My findings suggest a broader historical interpretation of recent macroeconomic models designed to capture features of the recent crisis that include policy makers' responses to disintermediation shocks like Curdia and Woodford (2010). More generally, the micro evidence presented here casts doubt on output and inflation gaps being sufficient statistics for macroeconomic imbalances. Finally, heterogeneity in the impact across the bank size dimension empirically supports Lucas' (2013) claim that Regulation Q and the financial innovation it set off induced the growth of the shadow banking sector.

To illustrate the effect of the regulation, consider the constraints imposed by legally fixed deposit rate ceilings in figure 1 on the asset-liability interaction on banks balance sheets (see table 1). When short-term interest rates exceeded the legally binding ceiling, depositors have an incentive to move out of deposits at this “kink”, say, into state savings bonds. This made it difficult for U.S. commercial banks to maintain their current levels of lending unless they were able to costlessly substitute the outflow of deposit funds by other means such as issuing bonds, notes or equity. This induced credit crunches. Figure 2 shows how the expected negative co-movements between core deposits and other managed liabilities, primarily time deposits also subject to the rate ceilings, only turned negative, thus sheltering credit by offsetting core deposit outflows, from the early 1980s. The positive co-movement induced by binding ceilings is only a feature of the Great Inflation era.

Table 1: Commercial Bank Stylized Balance Sheet

Assets	**Liabilities**
Reserves	Equity
Securities	Debt
Loans ($L_{i,t}$)	Deposits
· C&I Loans	· Demand Deposits
· Individual Loans	· Time Deposits
· Mortgages · · ·	· · ·

What was the impact of deposit rate ceilings embodied in Regulation Q on individual banks, and on monetary policy transmission via bank credit during the era of the Great Inflation? I address this question by estimating the lending dynamics of the population of U.S. commercial banks with about two million quarterly bank level observations from 1959 to 2013. I analyze the response of bank level credit growth to policy and non-policy macroeconomic factors and to the bindingness of the regulatory constraint on bank behavior which vanished with the abolition of Regulation Q in the *Depository Institutions Deregulation and Monetary Control Act of 1980* (DIDMCA). I also examine how the impact of deposit rate deregulation varies across bank level proxies for financial constraints such as bank size, liquidity (Kashyap and Stein, 2000) and capitalization (Kishan and Opiela, 2000) that are traditionally employed in the lending channel literature to identify policy induced loan supply shifts.

This paper relates to the bank level credit channel literature, macroeconomic studies of changes in the policy transmission mechanism and the emergence of the shadow banking sector. First, I extend a number of important empirical studies on the credit channel (Kashyap and Stein, 2000; Kishan and Opiela, 2000; Ashcraft, 2006) in method and sample time coverage.

Second, I provide microeconomic bank level context to macroeconomic and sectoral studies exploring the effects of deposit deregulation either using aggregate data, for example analyzing the structural change in the interest rate sensitivity of GDP due to disintermediation (Duca, 1995; Duca, 1998; Mertens, 2008; Duca and Wu, 2009), or sectoral data, for instance examining the effects of deregulation on housing (Duca, 1996). My analysis corroborates VAR and DSGE based evidence on deposit deregulation by Mertens (2008) by an institution based panel analysis. In their handbook chapter, Boivin, Kiley, and Mishkin (2010) point out that "changes at the macroeconomic level are difficult to detect. Relatively unrestricted approaches using macroeconomic data, such as analyses using VARs, suffer from the curse of dimensionality and have reached different conclusions regarding the importance of time variation in the links between monetary policy and macroeconomic activity; more restricted structural approaches are more controversial." The panel method employed in this paper yields insights on detectable changes in the credit channel which may help inform macroeconomic models.

Third, the shadow banking sector and reinterpretations of the core function and uniqueness of banks has recently gained the attention of policy makers and academics alike, see Stein (2012); Gorton and Metrick (2011); Dang, Gorton, Holmström, and Ordoñez (2014); Hanson, Shleifer, Stein, and Vishny (2014). In his requiem for the Glass-Steagall Act Lucas (2013) points to Regulation Q as one of the two defects of the Banking Act of 1933. He emphasizes that Regulation Q triggered the development of deposit substitutes, like Eurodollars, money market deposit accounts, and sweeps, that "are simple work-arounds designed to evade the restrictions imposed by Regulation Q" (Lucas, 2013). The measure of bindingness of rate ceilings employed in my estimates incorporates adjustments for financial innovation, yet, I still find significant differences in bank level credit growth responses across the bank size dimension indicating that larger banks, that were in a better position to offer non-deposit alternatives to their depositors, were less affected.

I highlight three contributions to the empirical bank level analysis of monetary transmission through the credit channel: (i) The compilation of a unique and novel historic bank level data set covering the whole population of U.S. commercial banks for more than half a century at quarterly frequency, (ii) the identification of the loan supply shifts induced by interactions between inflation and deposit rate ceilings, and (iii) more realistic, less restrictive assumptions about the heterogeneity in cyclical loan demand facing individual banks.

1.1 A Novel Historical Bank Level Data Set (1959 – 2013)

First, I compile a bank level data set from original reporting forms with historic coverage ranging over more than half a century. Beyond consistently backdating the data set to the late 1950s, I also update the data to include the most recently available quarterly observations up to the fourth quarter of 2013. Most previous bank level studies focus on single events, one or two interest rate cycles and the earliest start in the late 1970s (figure 4). It is worthwhile emphasizing the uniqueness of this historic entity level data set since in studying aggregate activity, economists commonly rely on aggregate data for longer time horizons. Entity level data on economic actors other than financial intermediaries like households and firms have only been available recently and not consistently or at quarterly frequency. In terms of historical and cross-section coverage, sample frequency, and data consistency, the bank level data set underlying the analysis has potential to help us understand business cycles and monetary transmission if financial frictions pertain to those cyclical fluctuations.

1.2 Estimating Financial Disintermediation Due to Regulation Q

Second, Frame and White (2004) point to a lack of empirical backing on the effects of financial innovation and the accompanying deregulation. I refine our understanding of the effects of deregulation by including controls for the bindingness of Regulation Q in bank level lending regressions, thus empirically capturing the effects of deposit deregulation at the bank level. Figure 4 displays a time-series of the difference between short-term interest rates and the legally fixed deposit rate ceilings for commercial banks. Note the sample overlap with previous empirical bank level studies on the lending channel. Also notice how the data underlying the analysis of these papers hardly overlap with the data covered by the aggregate evidence on the lending channel by Bernanke and Blinder (1992). Regulation Q provides a *time-varying* constraint on the lending behaviour of banks that was removed by liberalization. It would be realistic to assume that individual households or businesses applying for loans from commercial banks would not be directly affected by this additional constraint on bank behavior, insofar as their idiosyncratic loan demand is concerned. Thus, the bindingness of Regulation Q can be interpreted as a first-order shifter of bank level *loan supply*. Given the challenges in the bank level literature to identify loan supply shifts, this is a valuable contribution.

Interest rate ceilings in the U.S. date back to the Banking Act of 1933, but were not binding for the first three decades of their existence (Gilbert, 1986). The Banking Act of 1933 was codified three months after President Roosevelt had declared the nationwide banking holiday in March 1933. Amongst other provisions of the Banking Act, including the creation of the Federal Deposit Insurance Corporation (FDIC), was the regulation of deposit interest rates. This regulation was justified by three arguments: First, excessive interest rate competition contributed to financial instability, because the higher the interest rate paid on deposits, the higher the cost of doing business to the banker and thus the lower bank profitability. Second, it was argued that banks, due to competitive pressures, were forced to pay higher deposit rates and would be induced to seek riskier investments and make high risk loans in order to recoup the higher interest rate costs. A third and final argument was that the deposit interest rate ceiling would compensate banks for the costs incurred by the newly introduced compulsory deposit insurance premiums (Gilbert, 1986).

The regulation of deposit interest rates became known as Regulation Q. Section 11(b) of the Banking Act of 1933 prohibited all member banks from paying interest on demand deposits. The same section empowered the Federal Reserve Board with the authority to set the interest rate which could be paid by member banks on time and savings deposits. Regulation Q went into effect in November 1933 at which time the Federal Reserve Board set a maximum rate of three percent on time and savings deposits. For a more detailed historical review see Hendrickson (2011), especially pp. 143-148.

Problems of financial disintermediation arose as nominal interest rates rose in the 1960s and the interest rate ceiling was not adjusted by the Federal Reserve (see figure 1). Narrative accounts of such disintermediation highlight the credit crunch of 1966:

> "By the third quarter of 1966, nonfinancial firms were cut off from the commercial loan market. It was largely monetary policy that kept banks from extending further credit to the corporate sector. Specifically, the Federal Reserve tightened monetary policy at the end of 1965 and increased the discount rate from four percent to 4.5 percent. ... At the same time, the Federal Reserve refused to raise the Regulation

> Q ceiling on large time deposits and, in the summer, the market interest rate rose above the regulated rate for both long- and short-term certificates of deposit (CDs). These policies of the Federal Reserve made it difficult for banks to continue to lend which is why the corporate sector was shut out of the credit market towards the end of 1966. (...) [T]he credit crunch of 1966 exposed weaknesses in the regulatory regime; specifically in the constraints caused by binding price ceilings." (Hendrickson, 2011, p. 177)

My estimates support this narrative and reveal that the abolition of regulatory ceilings caused a significant muting in the transmission of monetary policy through credit.

1.3 Accounting for Loan Demand Heterogeneity

Third, as a contribution to the bank lending channel literature, I allow for banks to face different cyclical loan demand variations. I explicitly control for differences in the sensitivity of credit growth among banks of different sizes, liquidity positions, and capitalization to macroeconomic factors other than monetary policy, thus capturing heterogeneity in loan demand facing different banks. Consider figure 5 that plots cross-sectional percentiles of year-over-year bank level credit growth. If you focus on the shading around the median (50th percentile) highlighted in white you will find that when lending growth is relatively high, there is more dispersion above the median. When lending growth is relatively low, there is more dispersion below the whitened median. This indicates meaningful heterogeneity in the cyclical lending behavior of individual banks that my specification captures by also interacting non-policy macrofactors with bank level characteristics.

2 Credit Supply, Regulation Q and the Great Moderation

2.1 Identifying Credit Supply Shifts in the Empirical Literature

Classic interest rate channels suggests that monetary policy affects the macroeconomy via portfolio shifts that induce asset price changes, altering households' consumption and firms' investment decisions via inter- (e.g. through interest rates) and intratemporal (e.g. through exchange rates) substitution. Over and beyond these "price" channels, credit channels are operative (figure 8).

Bernanke and Blinder (1992) estimate VARs using aggregate data from 1959 to 1978 to find that after a policy contraction, bank loans only respond after half a year and do not adjust completely for over two years (see figure 9). Such results are consistent with both a price channel and a credit channel, given that real activity also takes about two years to fully adjust. The time period Bernanke and Blinder (1992) examine, 1959 to 1978, does not overlap with important bank level studies of monetary transmission discussed below as figure 4 illustrates.

Given that aggregate data records aggregates of equilibrium outcomes rather than identifying loan demand and supply shifts, the empirical literature has moved on to exploit the underlying heterogeneity. Studies attempted to identify credit supply changes by estimating differences in lending growth responses to monetary policy across bank level proxies for financial constraints. These financial constraints range from size and liquidity (Kashyap and Stein, 2000) to capitalization (Kishan and Opiela, 2000) and membership in a bank holding company (Ashcraft, 2006).

The seminal paper by Kashyap and Stein (2000) studies a panel of banks from 1976 to 1993 and finds that the impact of monetary policy on lending is stronger for banks with less liquid balance sheets. This pattern is largely attributable to smaller banks in their sample, those in the bottom 95 percent of the size distribution. Kishan and Opiela (2000) examine the lending channel using bank level data covering the period 1980 to 1995. They distinguish banks by size categories and capitalization. Examining the different lending growth responses to monetary policy by analyzing six different size and three different capitalization categories, they show that smaller banks respond more strongly to monetary policy and within that group less well-capitalized banks are more responsive.

Building on Kashyap and Stein (2000) and Kishan and Opiela (2000), Ashcraft (2006) uses membership in a multi-bank holding company in order to identify shifts in loan supply from shifts in loan demand. He also controls for heterogeneity in the loan demands facing individual banks by interacting bank characteristics and non-policy macroeconomic factors. Ashcraft (2006) contrasts the response of stand-alone banks and banks affiliated with a multibank holding company, finding that the lending of multibank holding companies is less responsive to monetary policy, and that stand-alone banks have the strongest lending growth responses to monetary policy. In more recent contributions, Jonas and King (2008) examine the relationship between a bank's efficiency and its responsiveness to monetary policy. Cetorelli and Goldberg (2012) examine the international exposure of banks and their lending dynamics. Interesting recent approaches combine loan level data with bank balance sheet data (Jiménez, Ongena, Peydró, and Saurina Salas, 2012; Jiménez, Ongena, Peydró, and Saurina Salas, 2014, Forthcoming) or bank level responses to SLOOS, the senior loan officer opinion survey (Bassett, Chosak, Driscoll, and Zakrajšek, 2014), but such data is unavailable for the historic sample period and question considered in this paper.

2.2 Political Economy of Regulation Q

Deregulation is clearly endogenous to the economic environment. A number of papers examine the political economy of Regulation Q. Timberlake (1985) analyses the political economy of the DIDMCA and its subsections. Allen and Wilhelm (1988) also address political economy issues by investigating the differential impact of the passage of DIDMCA on three portfolios of different depository institutions FRS banks, non-FRS banks, and Savings and Loans using intervention analysis and financial market data. Whilst many regulatory changes are endogenous, my paper does not attempt to explain deregulation by looking at the process that brought it about as in Timberlake (1985) or at its distributional repercussions as in Allen and Wilhelm (1988). Rather, I treat deregulation as a given and examine the impact of the time variation in its bindingness driven by nominal rates on the lending behavior of commercial banks.

2.3 Regulation Q, Monetary Transmission and the Great Moderation

Most advanced economies have experienced a striking decline in the volatility of aggregate economic activity since the early 1980s as illustrated in figure 7. Volatility reductions are evident for output and employment at the aggregate level and across most industrial sectors and expenditure categories. Inflation and inflation volatility have also declined dramatically. Whilst the sources of the "Great Moderation" (Bernanke, 2004) are still debated, surveys like Stock and Watson (2002) put forward three nonexclusive explanations for "the long and large decline in US output volatility" (Blanchard and Simon, 2001).

One interpretation of the Great Moderation is to consider it as a marked reduction in the variance of exogenous structural shocks ("good luck"). A second set of explanations focusses on structural changes in the economy like innovations in financial market that facilitate intertemporal smoothing of consumption and investment (Blanchard and Simon, 2001), better inventory management through information technology (McConnell and Perez-Quiros, 2000; Kahn, McConnell, and Perez-Quiros, 2001) and the marked shift in output from goods to services (Burns, 1960; Moore and Zarnowitz, 1987). The third and final set of explanation centers around improved policy ("good policy") and, in particular, monetary policy (Taylor, 1999; Cogley and Sargent, 2001).

Previous aggregate sector studies like Dynan, Elmendorf, and Sichel (2006) and Mertens (2008) find evidence that financial deregulation like the abolition of deposit ceilings (Regulation Q) might be part of the story explaining the Great Moderation. Dynan, Elmendorf, and Sichel (2006) note that feedback relationships among sectors of the economy make it difficult to separate impulse from propagation. Clearly this is true for aggregate data, where theory-based cross-equation restrictions have to be imposed. Yet, here I use individual bank level data where the feedback from any individual bank back to regulation, aggregate shocks, structural changes in transmission or policy is negligible.

3 Data

3.1 Individual Bank Level Data

The source for all bank-level variables is the "call" Reports of Condition and Income (RCRI) where all insured commercial banks operating in the United States submit quarterly balance sheet data to their regulator. I use bank level data spanning from the fourth quarter of 1959 to the fourth quarter of 2013. This time frame covers about twice that of other major bank level studies as figure 4 illustrates.

The total number of observations is about two million quarterly bank balance sheets. To ensure bank level data are consistent across time, all historical regulatory report forms for the individual items were carefully consulted, taking into account major shifts in reporting forms such as the break in March 1984. Furthermore, implausible negative and zero entries have been removed as well as banks that were involved in mergers.

The variables used in the estimates below are total loans, bank size as measured by assets, the cash-assets ratio, the securities-asset ratio and capitalization as measured by the capital-asset ratio. The ratios are demeaned and normalized by one standard deviation. Furthermore, the size variable is an integer between -49 and 50 divided by one hundred with zero designating a bank at the size median in the respective quarter and 0.50 a bank in the top asset size percentile within the quarter. The smallest banks in the bottom asset size percentile in the respective quarter have an entry of -0.49.

Whilst bank level data was regularly collected prior to 1975 the period between 1963 Q3 and 1971 Q4 posed a challenge in that data was occasionally only available semi-annually rather than quarterly. The dotted lines in panel 6a of figure 6 show when this was the case. The dotted top of the panel shows the actual collection dates whilst the bottom solid lines show the end of quarter dates, which is the due date for the reports post 1975. The bank level data is generated here by linear interpolation as illustrated in 10a. The key assumption here is that the bank level measurement error between the interpolated path and the actual realized, yet unmeasured, path is not systematically related to any other regressors included in the empirical specification. Panels 6b, 6c, and 6d of figure 6 focus on subperiods to illustrate the interpolation exercise more clearly.

You can also see in panels 6b, 6c, and 6d that for some cases the timing of the call report dates in the earlier period do not exactly coincide with the end of quarter as in the most recent three decades. The first quarter of 1960 is a good example of that. In the period prior to 1975, the reports were "called" from the commercial banks at specific dates to avoid situations like (in)famous Repo 105 at Lehman Brothers Inc, hence the term "call" reports. Most of the "called" dates coincide with the end of the quarter. Yet, for some of the dates we need to make another assumption that is illustrated in figure 10b. As in the case of interpolation there is measurement error. The assumption here, again, is that this measurement error is not systematically related to other bank level regressors in the empirical specifications. Furthermore, it is assumed the period denoted Δt illustrated in figure 10b does not contain meaningful aggregate shocks that correlate with the macroeconomic controls.

3.2 Macroeconomic Data

In line with the literature the estimations include different macroeconomic controls: real, nominal and policy. The real macroeconomic control is the growth rate of real Gross Domestic Product (code GDPH in Haver Analytics Database USECON). I disentangle real and nominal effects by including real rather than nominal GDP growth in the lending regressions. The nominal macroeconomic control is the change in the last month of the quarter core Personal Consumption Expenditure Chain Price Index (code JCXFEBM in Haver Analytics Database USECON). Both growth rates are computed as the less noisy year-over-year growth rates. In order to assess the direct impact of monetary policy, I compute the end-of-quarter difference in the level of the federal funds rate. This follows the convention of the bank level data which reports the balance sheet variables at the end-of-quarter level. Please find more detailed discussion and analysis of monetary policy measures in empirical bank level lending studies in Bluedorn, Bowdler, and Koch (2014).

3.3 Effective Bindingness of Regulation Q

The abolition of Regulation Q was part of the 1980 Depository Institutions Deregulation and Monetary Control Act (DIDMCA). For further details, I refer to Friedman (1970); Ruebling (1970); Cook (1978); Allen and Wilhelm (1988); Gilbert and Lovati (1979); Berger, Kashyap, and Scalise (1995) and the more recent treatment by Mertens (2008). The DIDMCA phased out government-imposed interest rate ceilings on banks and other institutions. Prior to the passing of DIDMCA, Regulation Q limited the rate of interest that could be paid by banks on time deposits. Figure 1 shows the evolution of 3-month treasury rates and the binding Regulation Q ceilings.

The measurement of the bindingness of Regulation Q requires a brief discussion of market-based deposit substitutes. There were two types of partially regulated deposits prior to 1983: small-saver certificates (SSCs) and money market certificates (MMCs). Table 9, adopted from Gilbert (1986, p. 31), highlights the steps pertaining to SSCs and MMCs in the phasing-out of Regulation Q. MMCs had a high minimum requirement of $10,000. I follow the treatment in Duca (1995) in that I use a financial-innovation adjusted Regulation Q bindingness measure, that takes into account rate differentials relevant for SSCs, which (i) in terms of their lot size ($500 to $1,000) were closer to core deposits and (ii) in terms of their maturity structure (2 to 4 years) were more relevant to funding mortgages. In the early part of the sample the measure of bindingness (RegQ_t) is the difference between the three month treasury rate and the legally fixed interest rate ceiling. In the later sample period it is the relevant rate for the respective substitute (SSCs) above the legally prescribed limit (see Duca, 1995, for details). Figure 4 displays the Regulation Q bindingness indicator (RegQ_t). Due to the financial innovation adjustment the bindingness measure is muted during the regulatory phase-out compared to a "naive", non-financial innovation adjusted Regulation Q measure, that is the difference between the "formal" price ceiling and the 3-month treasury rate depicted in figure 1.

4 Empirical Specification and Hypotheses

In this section I first describe the baseline empirical models in detail. I then explain how the baseline specification (1) is augmented to include the proxy of the bindingness of Regulation Q and its effect on monetary transmission to credit.

4.1 Baseline Specification

Following the empirical literature on the lending channel, the baseline specification (1) without controlling for deposit deregulation is

$$\begin{aligned}\Delta L_{i,t} &= \alpha + \sum_{\ell=1}^{4} \rho_\ell \cdot \Delta L_{i,t-\ell} + \sum_{j=1}^{3}\sum_{\ell=0}^{4} \beta_{j,\ell} \cdot \mathbf{M}_{j,t-\ell} \\ &+ \sum_{k=1}^{3} \delta_k \cdot \mathbf{B}_{i,k,t-1} + \sum_{k=0}^{3}\sum_{j=1}^{3}\sum_{\ell=0}^{4} \gamma_{k,j,\ell} \cdot \mathbf{B}_{i,k,t-1} \cdot \mathbf{M}_{j,t-\ell} \\ &+ \text{other controls} + \varepsilon_{i,t}\end{aligned} \tag{1}$$

So four quarter bank level credit growth is regressed on a constant, its own lags ΔL_i (throughout the paper lags are indexed by the letter ℓ), macroeconomic controls $\mathbf{M}$, bank characteristics $\mathbf{B}_i$, interactions between bank characteristics and macroeconomic controls and other controls, including entity specific seasonals.

The $j = 3$ different macroeconomic controls $\mathbf{M}_t = [\Delta y_t, \Delta p_t, \Delta \text{ff}_t]'$ are four quarter real GDP growth, core inflation as measured by the core Personal Consumption Expenditure Chain Price Index as well as monetary policy measured as the end-of-quarter difference in the level of the federal funds rate so as to mirror end-of-quarter balance sheets of the commercial banks. See Meulendyke (1998) for an in-depth description of the Federal ReserveâĂŹs choices of policy instrument over time. Alternative monetary policy measures which have been used in the literature on bank lending include those due to Boschen and Mills (1991); Boschen and Mills (1995), Strongin (1995), and Bernanke and Mihov (1998). Bluedorn, Bowdler, and Koch (2014) estimate the impact of an augmented Romer and Romer (2004) measure on bank lending. Here, I emphasize the choice of the change in the federal funds rate to enable a meaningful comparison with the existing bank level literature.

The $k = 4$ different bank level controls $\mathbf{B}_{i,t} = \left[\text{Assets}_{i,t}, \text{Equity}_{i,t}, \text{Cash}_{i,t}, \text{Securities}_{i,t}\right]$ are bank size, capitalization, cash and securities holdings i at time t normalized as discussed in section 3.1. They are lagged by one period to mitigate potential endogeneity.

The parameters δ_k estimates how mean lending growth varies for banks of different sizes ($k = 1$), capital ratios ($k = 2$), cash ratios ($k = 3$), and security holdings ($k = 4$). β_j estimates the impact of real GDP growth ($j = 1$), nominal factors ($j = 2$) and the direct impact of monetary policy ($j = 3$) on lending growth.

Consider parameter γ and note how the individual bank characteristics that proxy for bank level financial constraints not only interact with monetary policy, but also with real and nominal aggregates. So for instance, the hypothesis that loan demand is homogenous at the bank level, that is loan demand does not vary by individual bank characteristic implies

$$H_0 : \sum_{\ell=0}^{4} \gamma_{k,j,\ell} = 0 \qquad \text{with} \quad \text{j = 1, 2} \quad \text{k = 1, 2, 3,4} \qquad \text{(Homogenous Loan Demand)}$$

where ℓ again denotes lags.

A rejection of the null implies significant heterogeneity in the loan demand facing individual banks based on their characteristics. That is, larger or more liquid or better capitalized banks face different shifts in loan demand in response to the same shifts in overall real or nominal macroeconomic factors. It is important to control for the underlying heterogeneity in loan demand because differentials in lending growth across banks along size, liquidity or capitalization in response to monetary policy, that is

$$H_0 : \sum_{\ell=0}^{4} \gamma_{k,3,\ell} = 0 \qquad \text{with} \quad \text{k = 1, 2, 3, 4} \qquad \text{(Bank Level Loan Supply Shifts)}$$

otherwise might be interpreted as loan supply shifts, whereas they are in fact driven by the underlying heterogeneity in loan demand. Some earlier studies of the lending channel made the more restricted assumption of homogenous loan demand facing individual banks.

The other controls in specification (1) include a time trend, bank specific quarterly dummies, a binary Great Moderation dummy from break-point 1984 Q1 identified by Kim and Nelson (1999), McConnell and Perez-Quiros (2000), and Stock and Watson (2002) including interactions of this dummy with policy, to capture changes in monetary transmission unrelated to deposit deregulation.

In order to deal with other exceptional movements in the data, I follow Ashcraft (2006) in fitting all regressions by OLS for the largest possible sample and then eliminating outliers. These are defined as observations for which the absolute *DFITS* statistic (the scaled difference between the fitted values for the n^{th} observation when the regression is fitted with and without the n^{th} observation) exceeds the threshold $2\sqrt{\frac{K}{N}}$, where K is the total number of explanatory variables and N is the overall sample size (Welsch and Kuh, 1977). Standard errors are robust and clustered at the bank level.

4.2 Regulatory Controls in Levels

Now in order to estimate Regulation Q loan supply effects at the bank level, the baseline specification (1) will be augmented by including the Regulation Q bindingness proxy (RegQ_t) in levels:

$$(1) \quad + \quad \sum_{\ell=0}^{4} \varrho_{\ell}^{level} \cdot \text{RegQ}_{t-\ell} + \sum_{k=0}^{3} \sum_{\ell=0}^{4} \varrho_{k,\ell}^{inter} \cdot \mathbf{B}_{i,k,t-1} \cdot \text{RegQ}_{t-\ell} \tag{2}$$

Naturally, the measure of financial disintermediation RegQ_t is exogenous to each individual bank in the sample in the same way that macroeconomic controls like prices or real growth are exogenous to each bank level observation. When short-term interest rates move above the legally fixed regulatory deposit interest rate ceiling, depositors will substitute their deposit holdings and allocate their funds to other non-regulated assets. This shrinks the funding base of individual banks and if it is not possible to replace the outflow of deposits with other funds without frictions, e.g. by issuing equity or debt, then the excess of short-term rates over the legally fixed maximum rate will act as a credit supply shifter at the bank level. Thus, the null hypothesis regarding the impact financial disintermediation due to Regulation Q at the bank level is

$$H_0 : \sum_{\ell=0}^{4} \varrho_{\ell}^{level} = 0 \qquad \text{(Regulation Q Credit Supply Shifter)}$$

A rejection of the null implies a direct impact of Regulation Q at the bank level suggesting banks effectively faced different constraints under Regulation Q than they have faced since its phasing out. The estimated coefficients will help us determine the magnitude and economic significance of these constraints.

The Regulation Q proxy is also interacted with the individual bank level characteristics in order to check whether this additional constraint was binding to varying degrees for different banks.

$$H_0 : \sum_{\ell=0}^{4} \varrho_{k,\ell}^{inter} = 0 \qquad \text{with} \quad \text{k = 1, 2, 3, 4} \qquad \text{(Heterogeneity in Regulatory Impact)}$$

This is to account for the possibility, for instance, that larger banks (i.e. $k = 1$) were better able to evade Regulation Q because they were closer to the innovation frontier offering their clients alternatives to regulated deposits.

4.3 Regulatory Controls and Monetary Policy

We are also interested in how these additional bank level constraints impacted the *transmission of monetary policy to bank level credit growth*. Thus, I augment specification (1) by interaction effects of the bindingness of deregulation (RegQ_t) and monetary policy in specification (3):

$$(1) \quad + \quad \sum_{\ell=0}^{4} \varrho_{\ell}^{pol\ level} \cdot \text{RegQ}_{t-\ell} \cdot \Delta\text{ff}_{t-\ell} \qquad (3)$$
$$+ \quad \sum_{k=1}^{3} \sum_{\ell=0}^{4} \varrho_{k,\ell}^{pol\ inter} \cdot \mathbf{B}_{i,k,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta\text{ff}_{t-\ell}$$

This specification tests how lending growth is affected by monetary policy when Regulation Q was binding. The respective null hypothesis is:

$$H_0 : \sum_{\ell=0}^{4} \varrho_{\ell}^{pol\ level} = 0 \qquad \text{(Policy Transmission)}$$

That is the monetary policy impact on bank level credit growth is invariant to the bindingness of Regulation Q. What is the interpretation of that? The interaction is basically meant to capture the "kink" in the households optimization problem. At this kink, the incentives to move out of deposits in other asset classes increases. Narratives and adverts of the time suggest that commercial banks and thrifts pursued depositors using non-monetary rewards like toasters to induce them to keep or increase their deposit balances with their depository. Estimates of the overall impact of monetary policy on lending growth can be obtained by testing

$$H_0 : \sum_{\ell=0}^{4} \beta_{3,\ell} + \sum_{\ell=0}^{4} \varrho_{\ell}^{pol\ level} = 0 \qquad \text{(Overall Policy Transmission)}$$

Further estimates of how financial disintermediation impacted monetary policy transmission vary across different types of banks, that is, hypotheses regarding $\varrho_{k,\ell}^{pol\ inter}$ will be discussed in detail in sections 5.2 to 5.3.

Third, I combine both the level (2) and the interaction specification (3) in a single empirical model (4):

$$
\begin{aligned}
(1) \quad &+ \sum_{\ell=0}^{4} \varrho_{\ell}^{level} \cdot \text{RegQ}_{t-\ell} + \sum_{k=1}^{3}\sum_{\ell=0}^{4} \varrho_{k,\ell}^{inter} \cdot \mathbf{B}_{i,k,t-1} \cdot \text{RegQ}_{t-\ell} \\
&+ \sum_{\ell=0}^{4} \varrho_{\ell}^{pol\ level} \cdot \text{RegQ}_{t-\ell} \cdot \Delta\text{ff}_{t-\ell} \qquad (4)\\
&+ \sum_{k=1}^{3}\sum_{\ell=0}^{4} \varrho_{\ell}^{pol\ inter} \cdot \mathbf{B}_{i,k,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta\text{ff}_{t-\ell}
\end{aligned}
$$

5 Estimated Credit Growth Responses

I present and discuss the baseline estimation results before moving on to analyzing how the impact of deregulation varies across banks with different characteristics.

5.1 Deposit Rate Ceilings as Bank Level Credit Supply Shifters

Estimation results for the baseline regression (1) and the three empirical models (2), (3) and (4) testing the impact of deposit deregulation are reported in table 3. The column labels correspond to the models estimated.

The first row (1) displays the estimates of the direct effects of monetary policy on loan growth taking as a given that policy transmission has changed during the Great Moderation (see row 8). In the empirical model (1) that does not account for the effects of Regulation Q, a one hundred basis point rise in the federal funds rate implies a reduction in bank level lending growth of between -0.44 percentage points befr the Great Moderation (row 1) and -0.17 percentage points during the Great Moderation (adding rows 1 and 8). This response reflects changes in loan demand and loan supply induced by monetary policy. If the change is solely due to credit supply effects this should represent an upper bound on the policy effects via credit supply.

The second row (2) displays estimates of the direct impact of the bindingness of deposit rate ceilings on lending growth. For instance, if the relevant interest rate was one hundred basis points above the legally fixed deposit rates, bank level lending growth would be between -0.25 and -0.31 percentage points smaller than in the absence of Regulation Q. Note, how compared to the benchmark specification (1) almost all of the effect is accounted for by Regulation Q.

Conditional on Regulation Q being in place, the average of the RegQ_t variable in sample is 0.71. I assume deposit rate ceilings had a direct effect only on the bank as a supplier of funds, not on households and businesses and on their demand for credit. Under this assumption, row (2) may validly be interpreted as a pure loan supply shift working through banks balance sheets.

Binding rate ceilings induced marked non-linearities in the transmission of monetary policy to bank level credit growth. The kink in the deposit pricing schedule induced by the Regulation Q ceiling (see figure 1) is likely to have impacted monetary policy transmission exactly when the kink was reached. Thus, row (3) displays estimates of the interaction between the deposit ceiling bindingness proxy RegQ_t and monetary policy. Estimates here range between -0.16 and -0.38. Suppose the relevant interest rates were 100 basis points above the legally mandated deposit rate ceiling. Now, row (4) reports an estimate of the impact of a 100 basis points rise in the federal funds rate under these conditions. Notice how the policy impact is larger than under normal circumstances, even accounting for changes in the monetary transmission channel during the Great Moderation (row 8) and mean shifts due to higher inflation (row 7).

The estimates suggest that the propagation of monetary policy through bank loans has diminished. This likely points to changes in shock *propagation* driven by deregulation. This structural change in monetary transmission would be supportive of Giannone, Lenza, and Reichlin (2008) who identify changes in the transmission mechanism rather than shocks as a source of the Great Moderation. Unlike the gradual phasing out of branching restrictions over the 1980s, the phasing out of Regulation Q coincides with what Stock and Watson (2002) identify as the break point between the Great Inflation and the Great Moderation:

> "Both univariate and multivariate estimates of the break date center on 1984. When we analyze 168 series for breaks in their conditional variance, approximately 40 percent have significant breaks in their conditional variance in 1983 to 1985. Our 67 percent confidence interval for the break date in the conditional variance of four-quarter GDP growth (given past values of GDP growth) is 1982 Q4 to 1985 Q3, consistent with Kim and Nelson's (1999) and McConnell and Perez-Quiros's (2000) estimate of 1984 Q1." (Stock and Watson, 2002, p. 161)

Furthermore, this interpretation is also in line with a number of other recent empirical papers using aggregate data. Galí and Gambetti (2009) point to a shrinking contribution of non-technology shocks to output volatility. Herrera and Pesavento (2009), employing VAR techniques, find

> "regarding the role of the systematic monetary policy response, it appears to have dampened fluctuations in economic activity during the 1970s, but to have had virtually no effect after the Great Moderation (...) Both the impulse responses and the variance decomposition suggests that, after the Great Moderation, the role of monetary policy in mitigating the effect of an oil price shock is considerably smaller."

The findings presented here are also important for policy. Bernanke, Gertler, and Watson (1997) note that U.S. post-oil price hike recessions might be caused by oil price rises themselves but also, to a significant extent, by contractionary monetary responses to those oil prices hikes. My estimates imply that more muted responses would have been desirable in the 1970s whereas today's shocks are less likely to emerge from credit variations induced by monetary policy responses to oil price increases as well. Note also from figure 4 that the time-period between 1979 and 1982 when Regulation Q was most binding due to the nominal uncertainty is the period for which Bernanke and Mihov (1998) estimate a significant increase in the variance of monetary policy shocks. The findings further imply that, for credit channels, greater instrument variability might be necessary in order to offset macroeconomic shocks. The aggressive quantitative easing policies currently pursued by the Federal Reserve may be evidence of that.

Rows (5) and (6) give estimates of the impact of non-policy macroeconomic aggregates. Credit growth at the bank level is procyclical with regards to real and nominal factors. For example, every thing else being equal, a one percentage point increase in real GDP increases bank level lending growth by between 0.08 and 0.10 percentage points. A one percent increase in the core price level measured by one percent change in the core PCE price index significantly increases lending growth by between 0.07 and 0.14 percentage points.

The dependent variable, bank level lending growth, is measured in nominal terms. Row (7) displays the estimates of the direct impact of the binary dummy that is zero during the Great Moderation and unity prior to the Great Moderation. Mean nominal lending had been 1.47 and 1.75 percentage points greater prior to the Great Moderation. Row (8) reports estimates of the interaction between the binary Great Moderation and monetary policy. Note the switch in sign once the specification takes into account the bindingness of the deposit rate ceilings. So the structural change in the transmission of policy to bank level credit decisions is unlikely to be caused by the Great Moderation itself, but driven by the evaporation of an important loan supply shifter due to financial liberalization.

The regressions estimate the impact of federal funds rate changes on observable *equilibrium* lending growth, rather than on loan supply. It could be argued that the greater responsiveness of equilibrium lending growth in the earlier sample period when Regulation Q was binding may result from a higher interest rate sensitivity of *loan demand*, although the GMod_t variable will take care of that. Similarly sized shifts in loan supply (potentially policy induced through to the bank level financial frictions) will lead to estimates of much larger lending growth responses when faced with a loan demand curve that is more sensitive to interest rate changes. A flatter loan demand schedule due to a higher interest rate sensitivity results in greater shifts in equilibrium lending when faced with similarly sized shifts in loan supply. However, access to credit and the competition between suppliers of credit has widened substantially over the last decades rather than narrowed. Thus, it is more plausible that the loan demand sensitivity has increased rather than decreased since Regulation Q was abolished. Thus quantitatively the estimates provided here *underestimate* rather than overestimate the relative importance of financial disintermediation shocks as supply shifters.

Becketti and Morris (1992) argue that this is true: A contemporaneous rise in financial innovation means that the demand for loans becomes flatter because the number of other available financing alternatives increases. Therefore, a contemporaneous rise in financial innovations makes it more likely that the interest rate sensitivity of loan demand for bank loans has become larger given the entry of a number of non-bank financial firms and the variety of financial products that has come to the market in recent decades. So the argument that loan demand was more sensitive to interest rates during Regulation Q when compared to the recent period seems implausible. Furthermore, my main argument is that the legislative changes controlled for here most directly affected banks rather than households or firms and their finance requirements.

To summarize, given the non-experimental nature of the data analyzed in this paper, while it is *possible* that other simultaneous, non-accounted for, events increased the interest rate sensitivity of loan demand until deposit interest rate deregulation was fully implemented and decreased it substantially during the 1980s, 1990s, and 2000s, it seems rather *implausible*. This suggests that the impact of deregulation is primarily on the diminished ability of the Federal Reserve to directly shift loan supply schedules of individual banks, implying that the lending channel is much weaker overall if not defunct. Table 8 that confines the sample up until 1990 show that these effects are robust.

Having identified and discussed the financial disintermediation due to deposit rate ceilings and their effects on monetary transmission, I now turn to a more detailed analysis of the role of individual bank characteristics in that process. Notice no new regressions are reported, the next results tables merely focus on different sets of parameters related to different bank characteristics. Table 4 displays the results for bank size, table 5 for capitalization, table 6 for cash, and table 7 for securities.

5.2 Bank Size Matters – Casting a Shadow on Banking?

First, focus on the parameter estimates related to bank size, that is the normalized assets of a banks' balance sheet. Table 4 displays all estimates related to bank size. For convenience, the direct impact of monetary policy from table 3 is reiterated in row (1).

Larger institutions have smaller lending growth (row 2), respond more strongly to policy (row 3), and have a more cyclically sensitive loan portfolio (row 4 and 5). Macroeconomic interactions indicate a positive lending growth cyclicality with respect to real activity (row 4), and somewhat looser evidence for positive bank level growth cyclicality with respect to nominal factors (row 5). Significant evidence for stronger nominal loan procyclicality of larger banks is only present in specifications that control for Regulation Q effects. According to row (6) Regulation Q seems to have a negative effect on the mean lending growth of larger banks. Structural breaks regarding the role of bank size in *transmission* from monetary policy to lending growth (rows 7 and 8), rather than structural breaks in the *level* of lending growth (row 6) suggest that bank size helped mitigate Regulation Q effects in specification (4). This may be due to that fact that larger banks were better able to attract (or were early innovators of) alternative unregulated non-deposit sources of funding. These effects are not merely due to larger banks being able to tab non-depository funding in general, as this is already captured by row 3.

5.3 Bank Capitalization

Let us turn to bank capitalization's impact on monetary transmission and differentials in rate ceilings impacts. Coefficient estimates related to capitalization from specifications (1) to (4) are displayed in table 5. Kishan and Opiela (2000) find a shielding effects on banks that are better capitalized, and my estimates confirm that better capitalized banks are in fact shielded from rate ceiling effects, see row 7. On the other hand, lending growth is less procyclical for better capitalized banks. According to row 4, a bank one standard deviation above the quarterly mean has a loan portfolio that is less procyclical by between 0.02 and 0.06 percentage points in response to a one percentage point growth in real GDP. If interactions between nominal and real factors and bank capital were omitted some of these effects would show up in the policy capital interaction with an interpretation of having a shielding effect from bank capitalization. This highlights why it is important to control for loan demand heterogeneity across bank characteristics.

5.4 Bank Liquidity – Cash and Security Holding

Many previous empirical bank level studies did not treat cash and securities holdings separately, but combined them into a liquidity category serving as a liquidity buffer to shield against monetary contractions (Kashyap and Stein, 2000). However, more recent interpretations that contrast money market mutual funds with banks as "patient fixed income investors" (Hanson et al., 2014) point out that bank securities portfolios do not seem to be precautionary liquidity buffers and thus should be treated separately from cash.

Estimated coefficients related to the cash position of an individual bank are displayed in table 6, estimates related to security holdings in table 7. Again, the first rows in either of the tables shows estimates of the direct lending growth responses to policy.

Lending by banks with greater securities and cash holdings is more procyclical with respect to nominal factors (row 5 in tables 6 and 7). Yet, the real procyclicality differs. Banks with more cash hold a more procyclical portfolio than the average bank (row 4 in tables 6), whereas banks with greater security holdings hold a less procyclical portfolio (row 4 in tables 7).

Mean lending growth is lower for banks holding more cash and for banks holding more securities. Cash-rich bank, that is banks one standard deviation above the quarterly sample mean cash-to-asset ratio have a lower lending growth of between 0.62 and 0.64 percentage points. Similarly, banks that are one standard devation above the quarterly sample mean securities-to-asset ratio on average grow their lending by 0.39 percentage points less. The monetary policy response, especially at the Regulation Q kink, is more muted for both cash and securities holdings (row 7 of tables 6 and 7). That is higher cash and security holdings unambiguously shielded commercial banks' credit growth from deposit rate ceiling effects. This might be one of the reasons that the cross-section of banks had greater proportional cash holdings during that period, as figure 11 suggests.

6 Conclusion

I use bank level data to explore the question of how deposit deregulation affected the monetary transmission mechanism thus contributing to two previously disparate streams in the literature. First, the paper contributed to empirical research of the lending channel and, second, to the analysis of the macroeconomic consequences of entity level deregulation. The empirical analysis revealed that structural changes in the lending channel stemming from the deregulation of deposit interest rate ceilings known as Regulation Q implemented through the *Depository Institutions Deregulation and Monetary Control Act of 1980* were crucial in reducing the direct causal effect of monetary policy on individual bank level lending through removing an important source of bank level loan supply shifts.

One interpretation of these findings is in terms of the contributions of monetary transmission to the Great Moderation corroborating previous aggregate work by Mertens (2008) at the micro level. In terms of policy implications, the findings of this paper cast doubt on the "divine coincidence", whether the output gap is a sufficient statistic for economic imbalances and whether "good policy" may be characterized by simple stabilizing policy rules as in Taylor (1993) and Orphanides (2003). Tradeoffs could be more refined when nominal frictions are not the major source of (intertemporal) inefficiency (Stein, 2012; Sheedy, 2014). Optimal policy may take into account the underlying (time-varying) transmission mechanism as documented in aggregate data by Cogley and Sargent (2005) and financial imbalances such as credit spreads or credit volumes (Curdia and Woodford, 2010).

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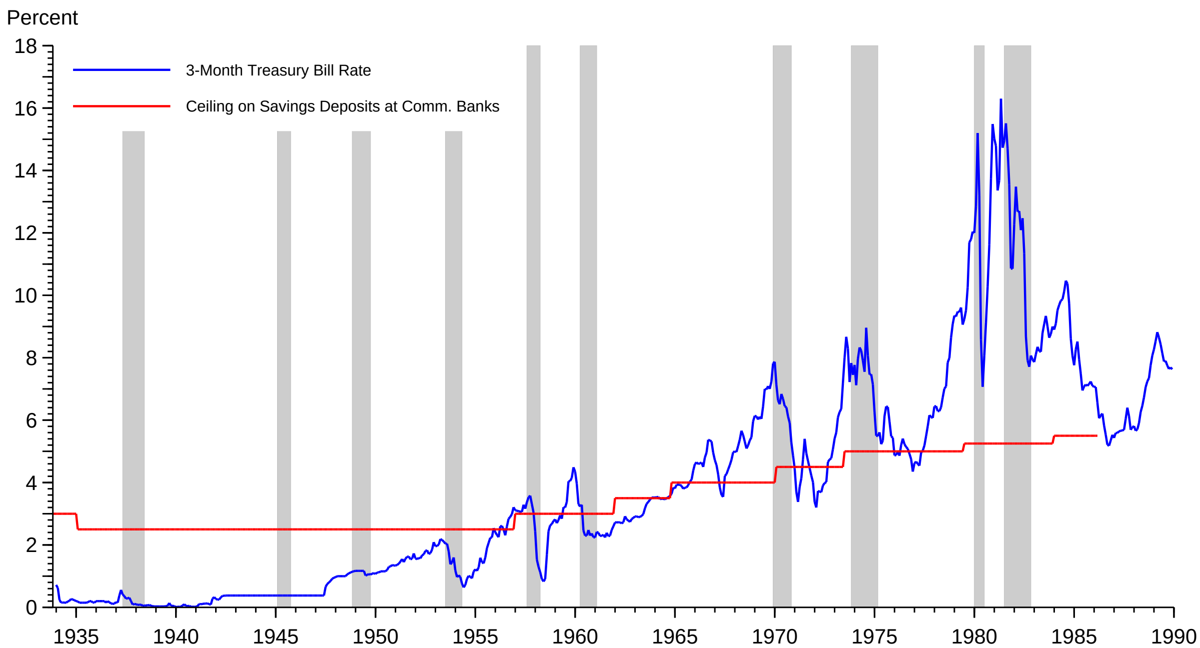
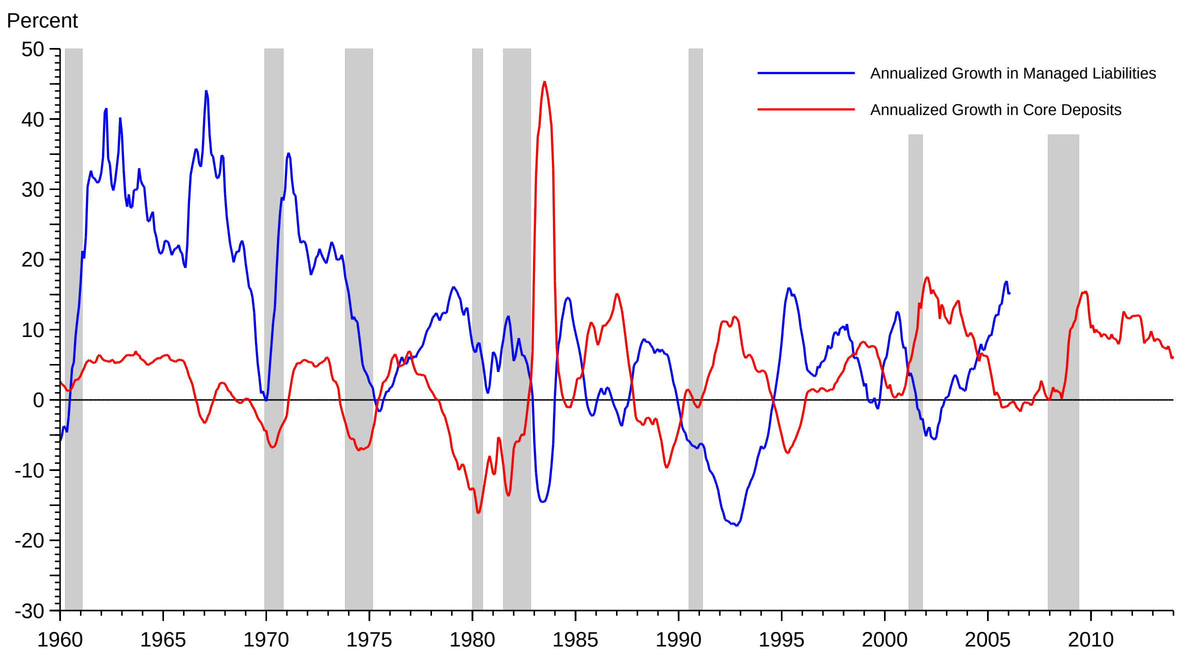
Figures

Figure 1: Fixed Rate Ceilings and Short-term rates



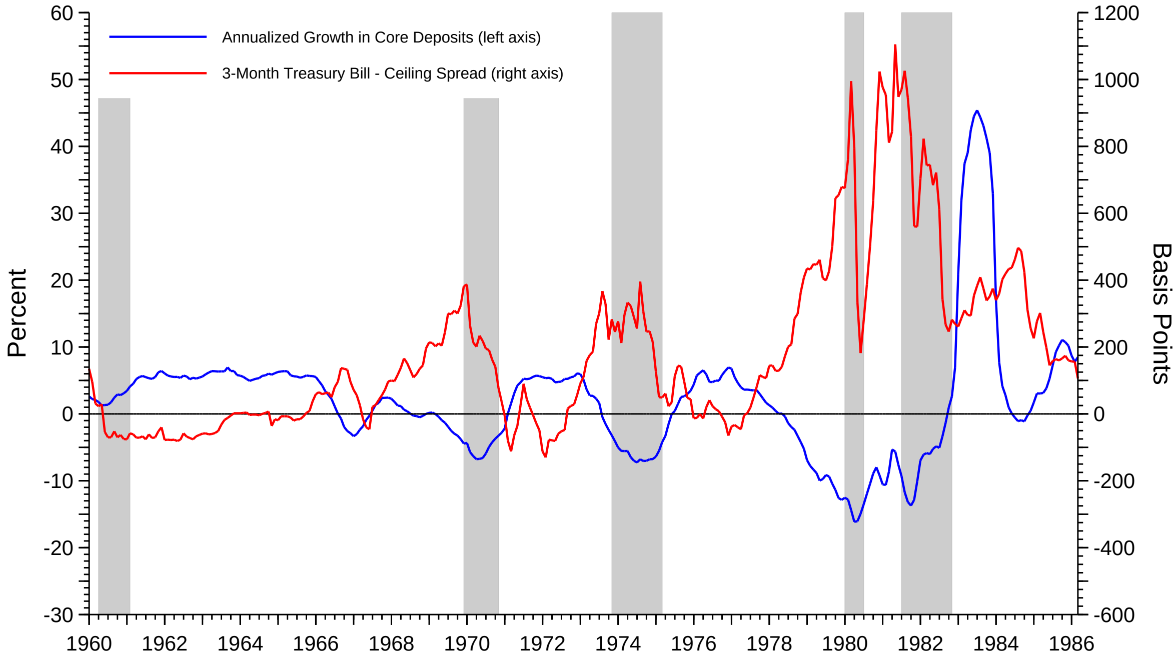
Note: Shaded area indicates NBER recession.
Sources: Federal Reserve Board; Mertens (2008).

Figure 2: Changing Co-Movements in Bank Liabilities Due to Deposit Rate Deregulation



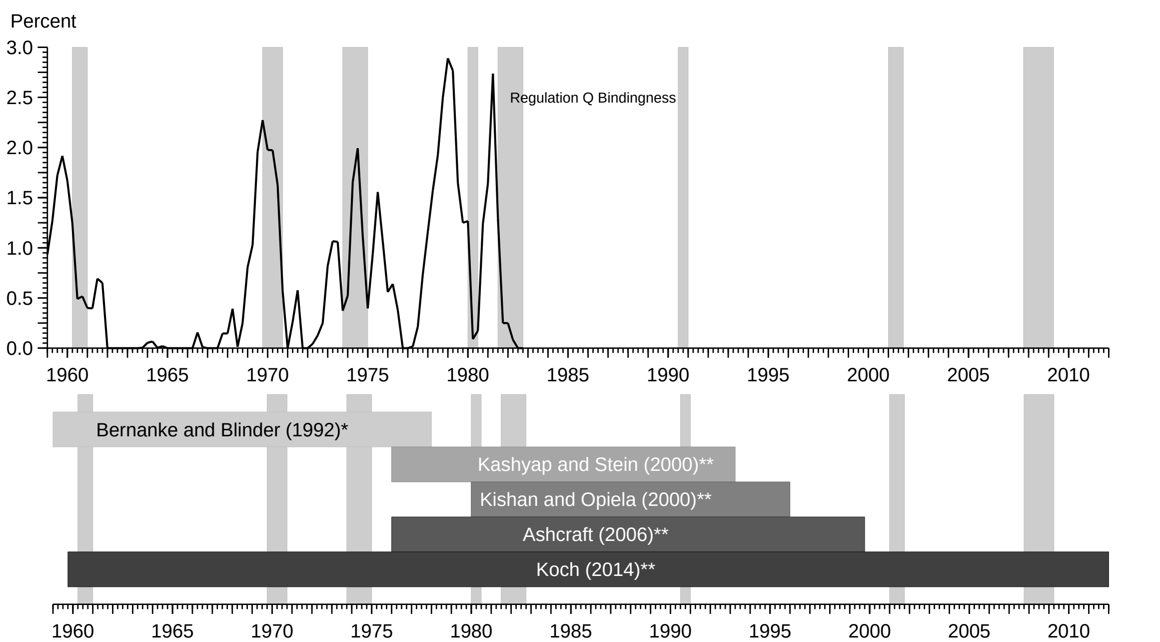
Note: Shaded area indicates NBER recession.
Sources: Federal Reserve Board; author's own calculations.

Figure 3: Bindingness of Rate Ceilings and Deposit Growth



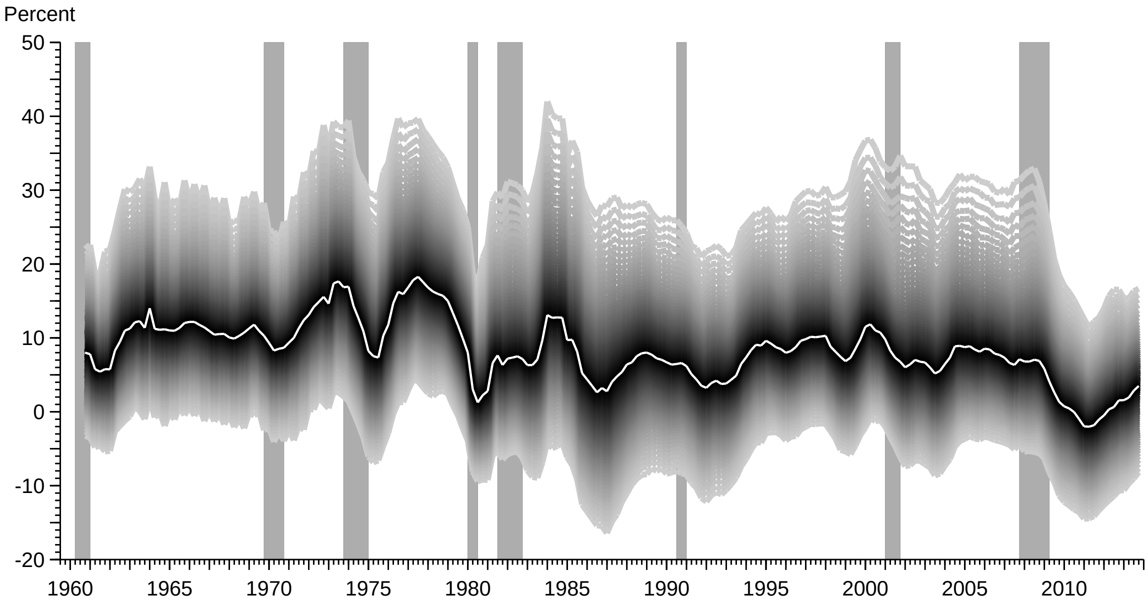
Note: Shaded area indicates NBER recession.
Sources: Federal Reserve Board.

Figure 4: Time-Series of Regulation Q Controls and Selected Papers



Note: The vertical gray bars denote NBER recession dates. *) evidence based on aggregate data **) evidence based on bank-level data.
Source: Duca (1996)

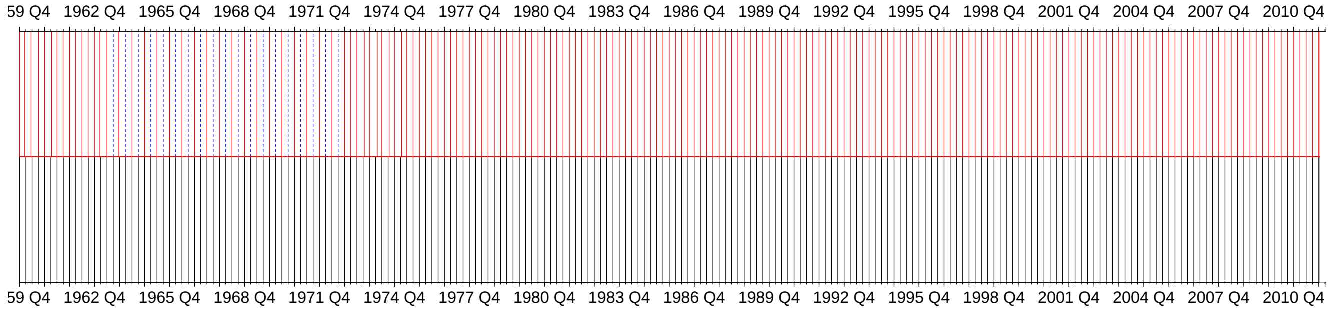
Figure 5: Quarterly Four Quarter Cross-Sectional Loan Growth
(10th to 90th percentiles in %)



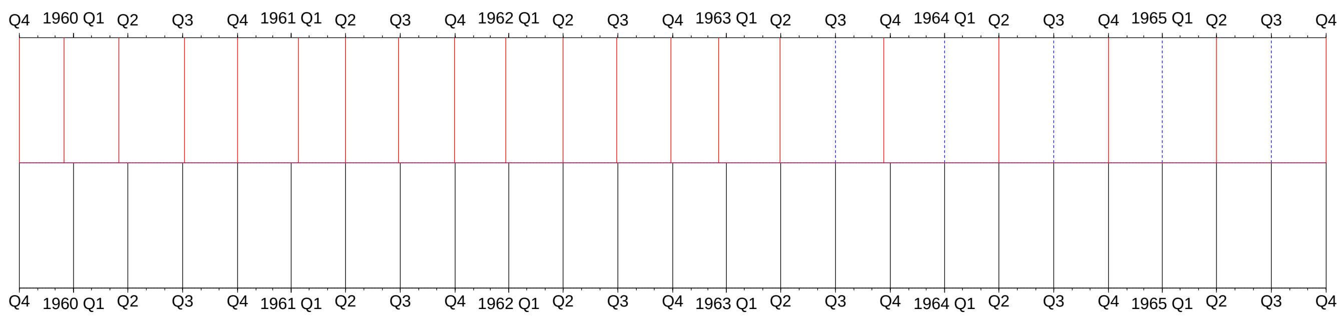
Note: Shaded area indicates NBER recession.
Source: FFIEC Call Reports; author's own calculation.

Figure 6: Bank Sample Availability Since 1959

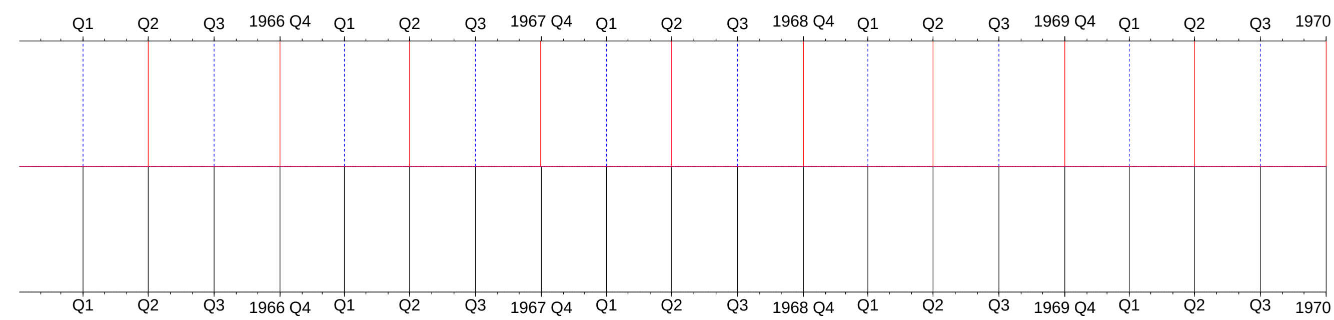
(a) Full Sample (1959-2013)



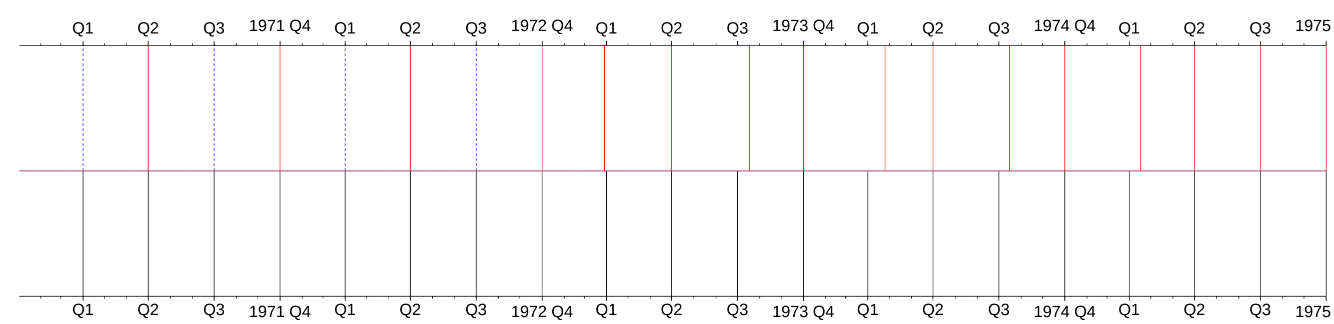
(b) 1959-1965



(c) 1966-1970



(d) 1971-1975



Tables

Table 2: Bank Characteristics, 1960 Q4 – 2010 Q4

	1960 Q4	1970 Q4	1980 Q4	1990 Q4	2000 Q4	2010 Q4
Total Assets (1000s)	18,257	40,379	115,350	199,898	392,525	1,026,274
	(181,465)	(477,448)	(1,683,451)	(2,020,080)	(5,280,087)	(16,897,724)
Loans ratio	40.4	47.9	53.5	53.8	61.6	62.4
	(11.3)	(11.2)	(11.6)	(15.8)	(15.8)	(15.8)
Deposits ratio	89.3	88.6	88.0	87.8	82.7	83.9
	(3.4)	(4.4)	(5.3)	(9.1)	(11.5)	(8.8)
Capital ratio	9.3	8.6	9.0	9.3	11.4	10.9
	(3.2)	(4.1)	(4.1)	(6.0)	(8.2)	(6.0)
Cash ratio	17.8	12.4	9.5	7.4	5.1	9.0
	(7.0)	(5.8)	(5.7)	(5.8)	(5.3)	(9.2)
Securities ratio	39.1	34.3	28.5	29.0	25.0	21.4
	(11.3)	(11.9)	(11.4)	(15.6)	(14.2)	(15.3)
Multi-bank holding company	2.4	7.0	15.9	29.6	25.4	15.7
One-bank holding company	0.0	8.9	17.8	39.8	52.5	66.5
Stand alone	97.6	84.1	66.3	30.6	22.1	17.8
No of Observations	12,958	13,317	14,199	11,450	7,859	6,197

Table 3: Credit Growth Regression Results (1959 – 2013)

$\Delta L_{i,t}$	Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.44***	-0.19***	-0.24***	0.39***
		(0.01)	(0.01)	(0.02)	(0.02)
(2)	$\sum_{t=0}^{4} \text{RegQ}_{t-\ell}$		-0.25***		-0.31***
			(0.01)		(0.01)
(3)	$\sum_{t=0}^{4} \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.16***	-0.38***
				(0.01)	(0.01)
(4)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell} + \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.40***	0.02
				(0.01)	(0.01)
(5)	$\sum_{t=0}^{4} \Delta y_{t-\ell}$	0.08***	0.10***	0.08***	0.10***
		(0.00)	(0.00)	(0.00)	(0.00)
(6)	$\sum_{t=0}^{4} \Delta p_{t-\ell}$	0.07***	0.11***	0.09***	0.14***
		(0.00)	(0.00)	(0.00)	(0.00)
(7)	$\sum_{t=0}^{4} \text{GMod}_{t-\ell}$	-1.47***	-1.59***	-1.53***	-1.75***
		(0.02)	(0.02)	(0.02)	(0.02)
(8)	$\sum_{t=0}^{4} \text{GMod}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$	0.27***	-0.01	0.07***	-0.59***
		(0.02)	(0.02)	(0.02)	(0.03)
	R^2	0.76	0.76	0.76	0.76
	Observations	1,937,368	1,939,641	1,939,789	1,941,249

Robust standard errors after clustering at bank level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Heterogeneous Bank Credit Growth Responses and Bank Size (1959 – 2013)

$\Delta L_{i,t}$	Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.44***	-0.19***	-0.24***	0.39***
		(0.01)	(0.01)	(0.02)	(0.02)
(2)	$\text{Assets}_{i,t-1}$	-2.72***	-2.95***	-2.79***	-2.99***
		(0.08)	(0.09)	(0.09)	(0.09)
(3)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell}$	-1.04***	-0.88***	-0.98***	-0.90***
		(0.03)	(0.04)	(0.05)	(0.05)
(4)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \Delta y_{t-\ell}$	0.16***	0.20***	0.17***	0.22***
		(0.01)	(0.01)	(0.01)	(0.01)
(5)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \Delta p_{t-\ell}$	0.01	0.05***	0.01	0.04***
		(0.01)	(0.01)	(0.01)	(0.01)
(6)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$		-0.20***		-0.17***
			(0.04)		(0.04)
(7)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.04	0.07**
				(0.03)	(0.03)
(8)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell} + \text{Assets}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-1.02***	-0.83***
				(0.03)	(0.04)
	R^2	0.76	0.76	0.76	0.76
	Observations	1,937,368	1,939,641	1,939,789	1,941,249

Robust standard errors after clustering at bank level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Heterogeneous Bank Credit Growth Responses and Capitalization (1959 – 2013)

$\Delta L_{i,t}$		Model: (1)	(2)	(3)	(4)
(1)	$\sum_{\ell=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.44***	-0.19***	-0.24***	0.39***
		(0.01)	(0.01)	(0.02)	(0.02)
(2)	$\text{Equity}_{i,t-1}$	-0.06*	-0.01	-0.02	0.01
		(0.04)	(0.04)	(0.04)	(0.04)
(3)	$\sum_{\ell=0}^{4} \text{Equity}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell}$	0.02	0.10***	-0.11***	-0.03
		(0.02)	(0.02)	(0.03)	(0.03)
(4)	$\sum_{\ell=0}^{4} \text{Equity}_{i,t-1} \cdot \Delta y_{t-\ell}$	-0.03***	-0.06***	-0.02***	-0.05***
		(0.01)	(0.01)	(0.01)	(0.01)
(5)	$\sum_{\ell=0}^{4} \text{Equity}_{i,t-1} \cdot \Delta p_{t-\ell}$	0.09***	0.15***	0.08***	0.14***
		(0.00)	(0.01)	(0.01)	(0.01)
(6)	$\sum_{\ell=0}^{4} \text{Equity}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$		-0.41***		-0.39***
			(0.02)		(0.02)
(7)	$\sum_{\ell=0}^{4} \text{Equity}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			0.16***	0.13***
				(0.02)	(0.02)
(8)	$\sum_{\ell=0}^{4} \text{Equity}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell} + \text{Equity}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			0.05**	0.10***
				(0.02)	(0.02)
	R^2	0.76	0.76	0.76	0.76
	Observations	1,937,368	1,939,641	1,939,789	1,941,249

Robust standard errors after clustering at bank level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Heterogeneous Bank Credit Growth Responses and Cash Holdings (1959 – 2013)

$\Delta L_{i,t}$		Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell}$		-0.44***	-0.19***	-0.24***	0.39***
			(0.01)	(0.01)	(0.02)	(0.02)
(2)	$\text{Cash}_{i,t-1}$		-0.62***	-0.63***	-0.64***	-0.64***
			(0.02)	(0.02)	(0.02)	(0.02)
(3)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell}$		-0.18***	-0.16***	-0.23***	-0.23***
			(0.01)	(0.01)	(0.01)	(0.02)
(4)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \Delta y_{t-\ell}$		0.02***	0.03***	0.03***	0.03***
			(0.00)	(0.00)	(0.00)	(0.00)
(5)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \Delta p_{t-\ell}$		0.06***	0.05***	0.05***	0.05***
			(0.00)	(0.00)	(0.00)	(0.00)
(6)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$			0.02		0.02
				(0.01)		(0.01)
(7)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$				0.05***	0.07***
					(0.01)	(0.01)
(8)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell} + \text{Cash}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$				-0.18***	-0.16***
					(0.01)	(0.01)
	R^2		0.76	0.76	0.76	0.76
	Observations		1,937,368	1,939,641	1,939,789	1,941,249

Robust standard errors after clustering at bank level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Heterogeneous Bank Credit Growth Responses and Securities Holdings (1959 – 2013)

$\Delta L_{i,t}$	Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.44***	-0.19***	-0.24***	0.39***
		(0.01)	(0.01)	(0.02)	(0.02)
(2)	$\text{Securities}_{i,t-1}$	-0.39***	-0.38***	-0.39***	-0.39***
		(0.02)	(0.02)	(0.02)	(0.02)
(3)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell}$	-0.06***	-0.10***	-0.13***	-0.19***
		(0.01)	(0.01)	(0.01)	(0.02)
(4)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \Delta y_{t-\ell}$	-0.03***	-0.03***	-0.02***	-0.02***
		(0.00)	(0.00)	(0.00)	(0.00)
(5)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \Delta p_{t-\ell}$	0.02***	0.01***	0.02***	0.01**
		(0.00)	(0.00)	(0.00)	(0.00)
(6)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$		0.08***		0.07***
			(0.01)		(0.01)
(7)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			0.08***	0.08***
				(0.01)	(0.01)
(8)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \Delta \text{ff}_{t-\ell} + \text{Securities}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.06***	-0.11***
				(0.01)	(0.01)
	R^2	0.76	0.76	0.76	0.76
	Observations	1,937,368	1,939,641	1,939,789	1,941,249

Robust standard errors after clustering at bank level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Credit Growth Regression Results (pre-1990)

$\Delta L_{i,t}$	Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{\ell=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.39***	-0.16***	-0.01	0.72***
		(0.01)	(0.01)	(0.02)	(0.03)
(2)	$\sum_{\ell=0}^{4} \text{RegQ}_{t-\ell}$		-0.20***		-0.28***
			(0.01)		(0.01)
(3)	$\sum_{\ell=0}^{4} \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.28***	-0.54***
				(0.01)	(0.01)
(4)	$\sum_{\ell=0}^{4} \Delta \text{ff}_{t-\ell} + \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.29***	0.18***
				(0.01)	(0.02)
(5)	$\sum_{\ell=0}^{4} \Delta y_{t-\ell}$	0.08***	0.12***	0.06***	0.08***
		(0.00)	(0.00)	(0.00)	(0.01)
(6)	$\sum_{\ell=0}^{4} \Delta p_{t-\ell}$	0.03***	0.08***	-0.00	0.04***
		(0.01)	(0.01)	(0.01)	(0.01)
(7)	$\sum_{\ell=0}^{4} \text{GMod}_{t-\ell}$	-1.89***	-1.91***	-2.30***	-2.66***
		(0.03)	(0.03)	(0.04)	(0.04)
(8)	$\sum_{\ell=0}^{4} \text{GMod}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$	0.16***	-0.11***	-0.29***	-1.11***
		(0.03)	(0.03)	(0.03)	(0.04)
	R^2	0.75	0.75	0.75	0.75
	Observations	1,307,552	1,309,137	1,309,066	1,310,182

Robust standard errors after clustering at bank level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A Appendix

Depository Institutions Deregulation and Monetary Control Act of 1980[1]

DIDMCA began as the Monetary Control Act of 1979 (H.R. 3864), and three different Senate bills. Deliberations on these bills began in early 1979. On February 26, 1979, G. William Miller (then Chairman of the FRS Board of Governors) commented at length on two of the Senate Bills. H.R.7 was the only bill ever passed by either House in that year. In early February of 1980, FRS Chairman Paul Volcker spoke to the Senate about the seriousness of the declining FRS membership problem. In early March, a House and Senate Conference Committee agreed to phase out interest rate ceilings and to require uniform reserve requirements for for all depository institutions. The exact form of the act was still not set at this time. On March 28,1980, the Wall Street Journal reported House approval of a compromise measure that was to become DIDMCA. Senate approval was reported the next trading day (March 31, 1980). President Carter signed the bill into law on that date.

Federal law, enacted in 1980, deregulating deposit interest rates and expanding access to the Federal Reserve Discount Window in the first major reform of the U.S. Banking system since the 1930s. The act has two main sections: Title 1, the Monetary Control Act, which extends Reserve Requirements to all U.S. Banking institutions and also deals with the banking services furnished by the Federal Reserve System; and Title 2, the Depository Institutions Deregulation Act of 1980, phasing out Federal Reserve Regulation Q deposit interest rate ceilings.

The following are highlights of the act:

1. mandatory reserve requirements that banks keep in noninterest earning accounts at Federal Reserve Banks were lowered. State chartered banks that are not members of the Federal Reserve System, as well as thrift institutions, were required to maintain reserve account balances. Mandatory reserves for all depository institutions were phased in over an eight-year period ending in 1988.

2. Federal Reserve Banks were required to begin charging banks for clearing checks through

[1] This appendix draws on the description in Allen and Wilhelm (1988) and table 9 is adopted from Gilbert (1986, p. 31).

the Federal Reserve System, and pricing reserve bank services at levels competitive with private sector pricing.

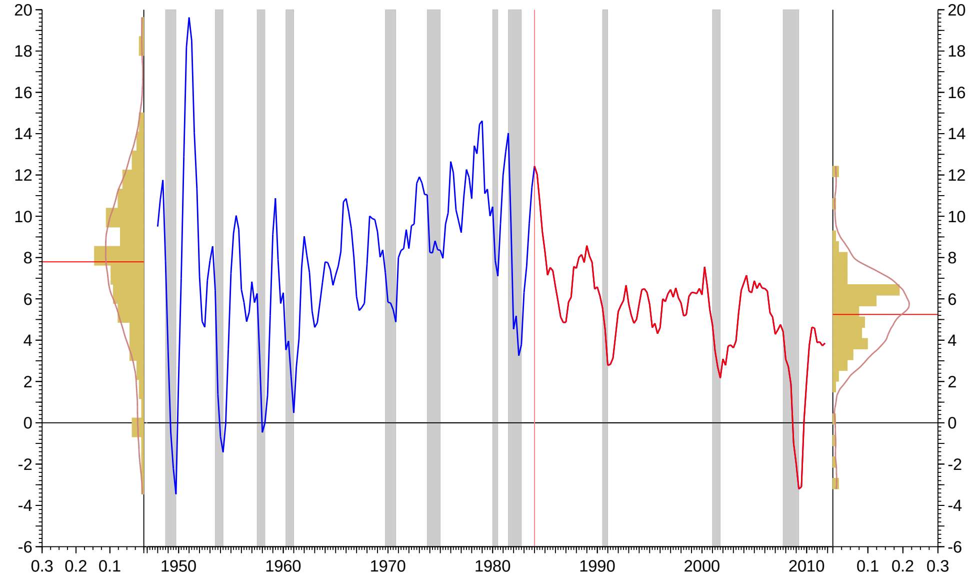
3. a five-member committee, the Depository Institutions Deregulation Committee was created to phase out federal interest rate ceilings on deposit accounts over a six-year period ending in 1986.
4. nationwide Negotiable Order of Withdrawal (NOW) accounts were authorized.
5. federal deposit insurance coverage was raised from $40,000 to $100,000 per insured account.
6. all depository institutions, including savings and loans and other thrift institutions, were given access to the Federal Reserve Discount Window for credit advances.
7. savings and loan associations were authorized to make consumer loans, including auto loans and credit card loans, up to 20% of total assets.
8. savings and loans were authorized to offer Trust accounts.
9. state Usury laws limiting rates lenders could charge on residential mortgage loans were pre-empted.
10. state chartered, federally insured banks were allowed to charge the same interest rates on bank loans as national banks.
11. Federal Reserve Regulation Z implementing the consumer credit protections in the Truth in Lending Act, was simplified.
12. authorized federal credit unions to originate residential mortgages.

Table 9: Steps in the Phase-Out of Regulation Q

Effective Date of Change	Nature of Change
1 June 1978	MMCs established, with minimum denomination of $10,000 and maturities of 26 weeks. The floating ceiling rates for each week were set at the discount yield an six-month Treasury hills at S&Ls and MSBs. 25 basis paints less at CBs.
1 November 1978	CBs authorized to offer ATS accounts, allowing funds to be transferred automatically from savings to checking accounts as needed to avoid overdrafts. The ceiling rate on ATS accounts was set at 5.25 percent, the same as the ceiling rate on regular savings accounts at CBs.
1 July 1979	SSCs established with no minimum denomination, maturity of 30 months or more and floating ceiling rates based on the yield on 2 1/2-year Treasury securities, but 25 basis points higher at S&Ls and MSBs. Maximums of 11.75 percent at CBs and 11 percent at S&Ls and MSBs.
2 June 1980	The floating ceiling rates on MMCs raised 50 basis points relative to the yield on 2 1/2-year Treasury securities at S&Ls and MSBs and at CBs. The maximum ceiling rates set in June 1979 were retained.
5 June 1980	New floating ceiling rates on MMCs. All depository institutions may pay the discount yield on 6-month Treasury bills plus 25 basis points when the bill rate is 8.75 percent or higher. The ceiling rate will be no lower than 7.75 percent. A rate differential of up to 25 basis points favors S&Ls and MSBs if the bill rate is between 7.75 percent and 8.75 percent.
31 December 1980	Now accounts permitted nationwide at all depository institutions. Ceiling rates on NOW and ATS accounts set at 5.25 percent.
1 August 1981	Caps on SSCs of 11.75 percent at CBs and 12 percent at S&Ls and MSBs eliminated. Ceiling rates float with the yield on 2 1/2-year Treasury securities.
1 October 1981	Adopted rules for the All Savers Certificates specified in the Economic Recovery Act of 1981.
1 November 1981	Floating ceiling rates on MMCs each week changed to the higher of the 6-month Treasury bill rate in the previous week or the average over the previous four weeks.
1 December 1981	New category of IRA/Keogh accounts created with minimum maturity of 1-1/2 years, no regulated interest rate ceiling and no minimum denomination.
1 May 1982	New time deposit created with no interest rate ceiling, no minimum denomination and an initial minimum maturity of 3-1/2 years. New short-term deposit instrument created with $7,500 minimum denomination and 91-day maturity. The floating ceiling rate is equal to the discount yield on 91-day Treasury bills for S&Ls and MSBs, 25 basis points less for CBs. Maturity range of SSCs adjusted to 30-42 months.
1 September 1982	New deposit account created with a minimum denominatino of $20,000 and maturity of 7 to 31 days. The floating ceiling rate is equal to the discount yield on 91-day Treasury bills for S&Ls and MSBs, 25 basis points less for CBs. These ceiling rates are suspended if the 91-day Treasury bill rate falls below 9 percent for four consecutive Treasury bill auctions.
14 December 1982	MMDAs authorized with minimum balance of not less than $2,500, no interest ceiling, no minimum maturity, up to six transfers per month (no more than three by draft), and unlimited withdrawals by mail, messenger or in person
5 January 1983	Super NOW accounts authorized with same features as the MMDAs, except that unlimited transfers are permitted. Interest rate ceiling eliminated and minimum denomination reduced to $2,500 on 7- and 31-day accounts. Minimum denomination reduced to $2,500 on 91-day accounts and MMCs of less than $100,000.
1 April 1983	Minimum maturity of SSCs reduced to 18 months.
1 October 1983	All interest rate ceilings eliminated except those on passbook savings and regular NOW accounts. Minimum denominations of $2,500 established for time deposits with maturities of 31 days or less (below this minimum, passbook savings rates apply.
1 January 1984	Rate differential between commercial banks and thrifts on passbook savings accounts and 7- to 31-day time deposits of less than $2,500 eliminated. All depository institutions may pay a maximum of 5.50 percent.
1 January 1985	Minimum denominations on MMDAs, Super NOWs and 7-to 31-day ceiling free time deposits reduced to $1,000.
1 January 1986	Minimum denominations on MMDAs, Super NOWs and 7-to 31-day ceiling free time deposits eliminated.
31 March 1986	All interest rate ceilings eliminated, except or the requirement that no interest he paid on demand deposits.

Supplementary Figures and Tables

Figure 7: Four Quarter Percentage Change in Nominal GDP (Great Moderation)



Note: Shaded area indicates NBER recession.

Figure 8: Transmission Channels of Monetary Policy

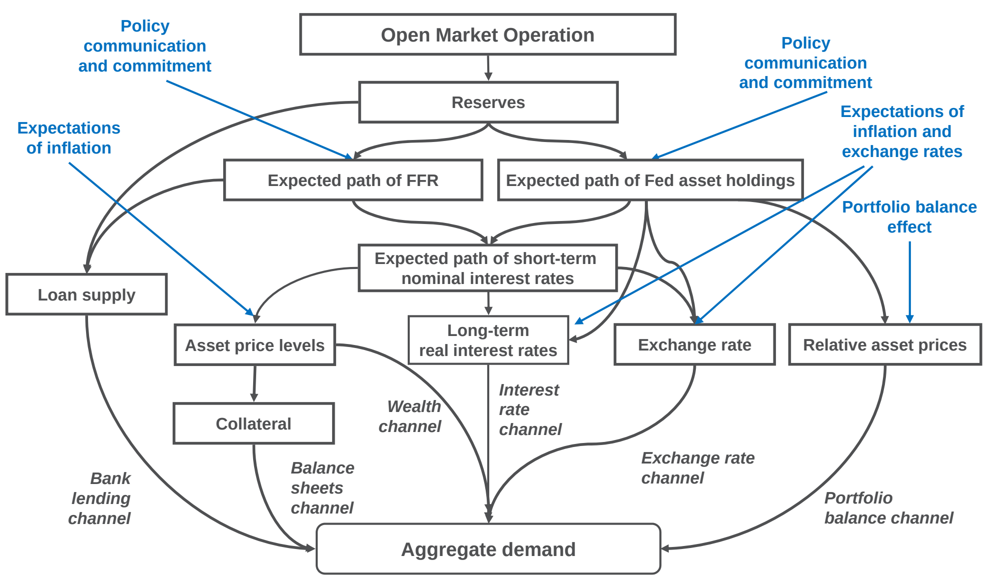


Figure 9: Bernanke and Blinder (1992) VAR Impulse Responses

918 THE AMERICAN ECONOMIC REVIEW SEPTEMBER 1992

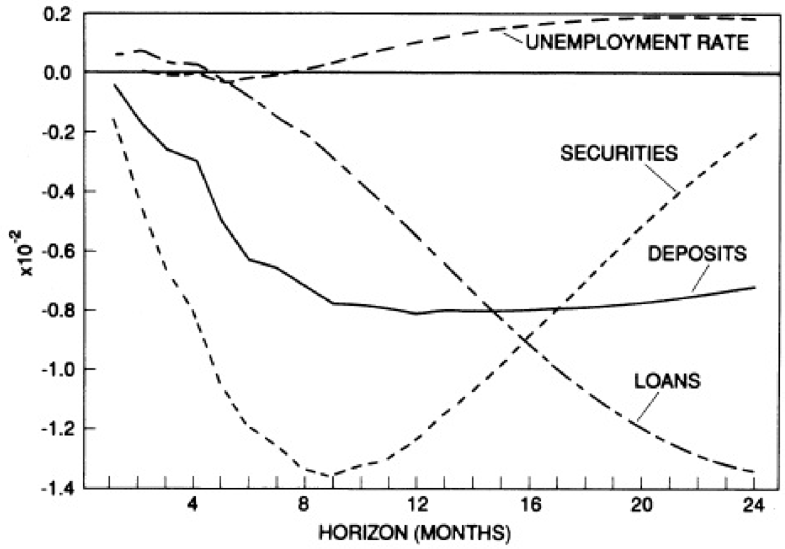
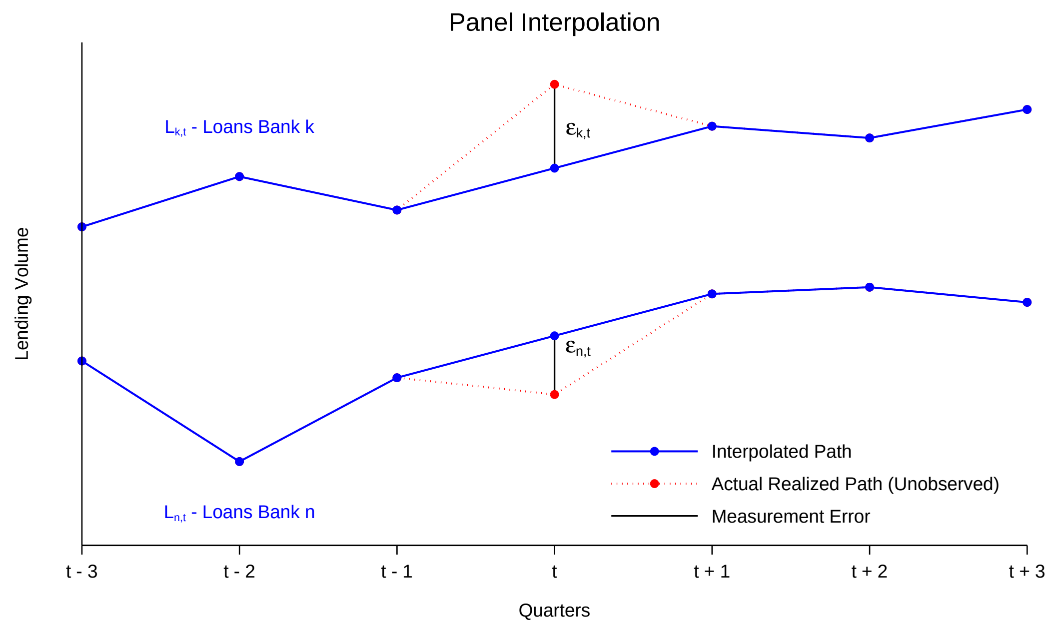


FIGURE 4. RESPONSES TO A SHOCK TO THE FUNDS RATE

Figure 10: Data Interpolation and Measurement Error (1959 Q4 - 1975 Q2)

(a) Interpolation



(b) Measurement Error Due to Irregular Timing

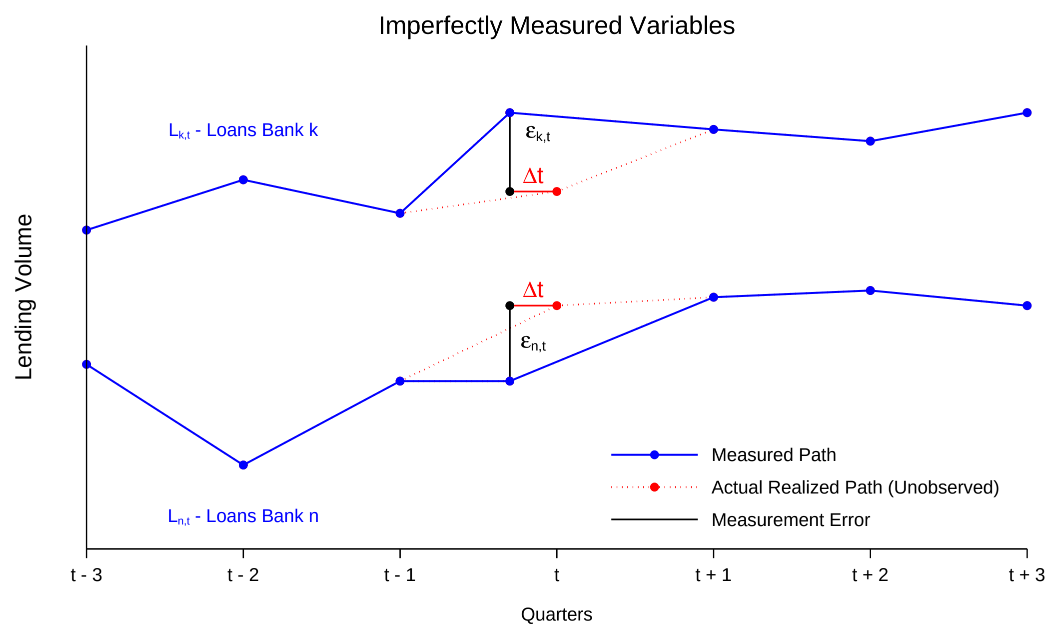


Figure 11: Bank Cash Ratios (10th to 90th percentile)