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

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Abstract

How did deposit interest rate ceilings, an important feature of the U.S. regulatory regime until the mid-1980s, affect individual banks' lending and the transmission of monetary policy to credit? I estimate the effect of deposit rate ceilings inscribed in Regulation Q on commercial banks' credit growth using a historical bank level data set starting in 1959. Banks' credit growth contracted sharply when legally fixed deposit rate ceilings were binding. Interaction terms with monetary policy suggest that the policy impact on bank level credit growth was non-linear and significantly larger when rate ceilings were in place. Bank size and capitalization mitigate these effects. At the bank level, short-term interest rates exceeding the legally fixed deposit rate ceilings identify policy induced credit supply shifts that disappeared with deposit rate deregulation and thus weakened the bank lending channel substantially since the early 1980s.

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

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

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1 Introduction

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

Policy interest rates and their expected future paths transmit to the real economy via asset markets and commercial banks, thus altering households' consumption and firms' investment decisions via inter- (e.g. through interest rates) and intratemporal (e.g. through exchange rates) substitution. Additionally, policy transmission through commercial banks depends on the state of their balance sheets. This is typically referred to as the *bank lending channel*. In an environment where restrictions are placed on the ability of banks to freely set deposit (or lending) interest rates, the impact of policy rate changes on the quantity of loans lent by commercial banks, and the ultimate effect on the economy is uncertain. In the United States, the Federal Reserve imposed a ceiling on the deposit rates that commercial banks could set, called *Regulation Q*, between the years 1933 and 1986. The rationale for the introduction of Regulation Q in the Banking Act of 1933 revolved around financial stability concerns and can be described in today's terminology as a macroprudential policy tool. In the current policy environment the apparent tradeoff between macroprudential concerns and monetary policy transmission has been extensively discussed.[1] In this paper, I examine the cross-sectional impact of Regulation Q on the lending channel and find that deposit rate ceilings' interaction with monetary policy induced significant credit supply shifts that are mitigated for larger and well capitalized banks.

Monetary policy transmission works in part through credit channels that may, at times such as the Great Recession, be dysfunctional. The broader credit channel depends on the state of firms' and households' balance sheets. The narrower bank lending channel relies solely on the state of commercial banks' balance sheets. In order to understand the impact of Regulation Q on the bank lending channel it is important to identify the broader credit channel from the narrow lending channel. This is because observed bank level credit growth confounds the broader credit and the

[1]See for example Kashyap, Tsomocos, and Vardoulakis (2014). The financial crisis of 2008/2009 and the accompanying credit squeeze triggered a sequence of papers incorporating refined versions of financial intermediation and credit frictions into macroeconomic models, 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).

narrower bank lending channel in that the outcome variable is an amalgam of credit demand and credit supply that varies both with the lenders' and the borrowers' balance sheet characteristics.

Examining this issue at the cross-sectional bank level allows us to disentangle the individual impact of bank balance sheets on policy transmission to credit growth. This is the first paper that examines Regulation Q effects at the bank level. The empirical identification of credit supply shifts in this paper relies on Regulation Q working entirely through the narrow bank lending channel without affecting the broader credit channel. Thus the policy effects can unambiguously be attributed to bank level credit supply shifts.

Cross-sectional studies of the credit channel identified loan 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). Their focus on cross-sectional data stems from a critque of the literature on vector autoregressions (VARs). In earlier studies, in order to test for the presence of credit channels, Bernanke and Blinder (1992) estimate VARs that include bank credit with short-run restrictions using aggregate monthly data from 1959 to 1978 (Fig. 1). They find that after a policy contraction, bank loans only respond after half a year and do not adjust completely for over two years. 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 analysis of time-series data requires credible cross-equation restrictions and inference depends on the specific theoretical underpinnings of those restrictions. Note that the sample period Bernanke and Blinder (1992) analyze does not overlap with these three bank level studies of monetary transmission as Fig. 1 illustrates.

More recent approaches use even more granular information for credit supply shift identification. Jiménez, Ongena, Peydró, and Saurina (2012) identify shifts in credit supply using individual businesses' loan applications to banks of differing characteristics. Jiménez, Ongena, Peydró, and Saurina (2014) show, again using loan level data matched with commercial banks' balance sheets, that monetary policy works in part by altering the riskiness of banks' loan decisions —the risk-taking channel of monetary policy. While granular loan-bank data matches of the type employed in Jiménez et al. (2012, 2014) are methodologically appealing such data is unavailable for the United States during the historical time period when deposit ceilings were binding.[2]

[2]The limitations of using changes in the federal funds rate in bank level studies of the credit channel are addressed in a companion paper in Bluedorn, Bowdler, and Koch (2014). Their findings suggest that the estimates

There is a sparse literature on the impact of financial deregulation on monetary transmission. Frame and White (2004) point to a lack of empirical backing on the effects of financial innovation and the accompanying deregulation. Regulation Q provides a *time-varying* constraint on the lending behaviour of banks that was removed by deregulation which in turn was driven by financial innovation.[3] In order to shine some light on some of those effects, I compile a U.S. commercial bank panel from original reporting forms with historical coverage going back more than half a century.[4] I then estimate the impact of deposit rate ceilings on bank loan growth as well as on the transmission of monetary policy to bank credit. I back out cross-sectional variation in the impact of rate ceilings across a range of bank characteristics such as size, capitalization and liquidity.

I find that deposit rate ceilings embodied in Regulation Q significantly affected bank lending and altered monetary transmission to credit non-linearly through the rate ceiling spread. Bank size and capitalization shield commercial banks from the ensuing contraction in credit due to the interaction of regulation and policy. These microeconometric findings externally validate 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), or sectoral data, for instance examining the effects of deregulation on housing (Duca, 1996).

The importance of external microeconometric validation is emphasized by Boivin, Kiley, and Mishkin (2010) who, in their handbook chapter, point to difficulties in detecting changes at the macroeconomic level because relatively unrestricted approaches using macroeconomic data, such as analyzes 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. They further highlight that more restricted structural approaches are even more controversial. Previous aggregate studies like Dynan, Elmendorf, and Sichel (2006) and

using federal funds rate changes *under*estimate the true impact of monetary policy, thus the estimates presented in my paper constitute a lower bound of these effects.

[3] 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).

[4] It is worthwhile emphasizing the uniqueness of this historical entity level data set since in studying aggregate activity, economists commonly rely on aggregate data for longer time horizons like the National Income and Product Accounts (NIPA). Entity level data on economic actors other than financial intermediaries like households and firms have been available only recently. Firm and household data sets are rarely available consistently or at quarterly frequency. In terms of historical and cross-section coverage, sample frequency, and data consistency, the bank level data set underlying my analysis has time coverage comparable to NIPA and, thus, has potential to help understand business cycles and monetary transmission if bank-related financial frictions pertain to those cyclical fluctuations.

Mertens (2008) do find evidence that financial deregulation like the abolition of deposit ceilings (Regulation Q) might be part of the story explaining the Great Moderation. However, 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 restrictions on the behavior of time-series have to be imposed. Yet, in panel data the feedback from any individual bank back to regulation, aggregate shocks, structural changes in transmission or policy is negligible. Such microdata-based evidence on changes in the credit channel may inform theoretical macroeconomic models that include financial frictions.

This paper is structured as follows. Section 2 comprehensively discusses the history and nature of Regulation Q with an emphasis on its implications for monetary transmission. Section 3 describes the underlying bank level and macroeconomic data. Section 4 lays out the hypotheses and methods. Section 5 discusses the empirical findings in detail. Section 6 concludes.

2 Regulation Q and Monetary Policy

This paper examines the interaction between regulation and monetary policy. In particular, it attempts to assess the impact of interest rate ceilings and their interaction with monetary policy. Interest rate ceilings in the United States date back to the Banking Act of 1933 that 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.

Rate ceilings were justified by three arguments (Gilbert, 1986), two of which have a macroprudential flavor: First, excessive interest rate competition was thought to contribute 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. Finally, the deposit interest rate ceilings would compensate banks for the costs incurred by the newly introduced compulsory deposit insurance premiums.

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 (FRB) with the authority to set the interest rate on time and savings deposits, an important source of commercial banks' funding (Table 1). Regulation Q went into effect in November 1933 at which time the FRB set a maximum rate of three percent on time and savings deposits. Regulation Q was not binding for the first three decades of its existence (Gilbert, 1986). Fig. 2 shows the historical evolution of 3-month treasury rates and the binding Regulation Q ceilings on time and savings deposits.

The Depository Institutions Deregulation Act of 1980 phased out the Federal Reserve Regulation Q deposit rate ceilings. Regulation Q was phased out until March 31, 1986 at which point all interest rate ceilings were completely eliminated (Fig. 2).[5] 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).

To illustrate the effect of the regulation, consider the constraints imposed by legally fixed deposit rate ceilings in Fig. 2 on the asset-liability interaction on banks balance sheets. When market interest rates exceeded the legally binding ceiling, depositors were induced 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. In fact, the very phrase "credit crunch" was termed in the 1966 deposit ceiling induced credit crunch. Narrative evidence on the effects of Regulation Q is abundant, see e.g. Bordo and Haubrich (2010, p. 8) or Hendrickson (2011, pp. 143-148), and the FOMC itself appears to have viewed Regulation Q, in part, as a macroprudential tool.[6] At the aggregate time-series level, Fig. 3 shows how the expected negative co-movements between core deposits and other managed liabilities, primarily time deposits subject to rate ceilings, only turned negative, thus sheltering credit, starting in the early 1980s. Interestingly, the positive co-movement induced by binding ceilings is only a feature of the Great Inflation era.

What was the quantitative 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 a panel of U.S. commercial banks starting in 1959. I analyze the response of bank level credit growth to policy and non-policy

[5]For a more detailled description of the act see Allen and Wilhelm (1988). Details on the phase out can be found in Gilbert (1986, p. 31). For more narrative evidence see Owens and Schreft (1995).

[6]See, for example, the historical FOMC minutes from June 7, 1966 or June 28, 1966 available online at the Federal Reserve Board of Governors.

macroeconomic factors and to the deposit rate ceiling induced regulatory wedges as well as their interaction with policy. I also examine how the impact of deposit rate deregulation varies across bank level proxies for financial constraints such as bank size, liquidity and capitalization that are traditionally employed in the lending channel literature to identify policy induced loan supply shifts. The next section turns to the data underlying this empirical exercise.

3 Data

3.1 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 2014. This time frame covers about twice that of other U.S. bank level studies applying similar methods (Fig. 1).

The total number of bank-quarter observations is about two million quarterly bank balance sheets. The primary sample underlying our baseline estimates running from 1959 Q4 to 1986 Q4 contains about one million bank-quarter observations. To ensure bank level data are consistent across time, all historical regulatory report forms for the individual items were carefully consulted, taking into account 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 regressand of the empirical models is year-over-year percent growth of total loans (call variable code rcfd1400). Bank level regressors include bank specific quarterly dummies to capture the idiosyncratic loan cyclicality, transformations of bank size as measured by total assets (rcfd2170), capitalization as measured by the capital-asset ratio (rcfd3210/rcfd2170), the cash-assets ratio (rcfd0010/rcfd2170), and the securities-asset ratio ([rcfd1754 + rcfd1773]/rcfd2170).[7] The balance sheet ratios are demeaned and normalized within quarter by dividing them by one standard deviation. In contrast, the bank size variable is transformed to an integer denoting its

[7] The construction of the bank held securities varies over time: From 1959 Q4 to 1965 Q3 it is the sum of rcfd0400, rcfd0900, and rcfd0950, from 1965 Q4 to 1968 Q4 it is the sum of rcfd0400, rcfd0600, rcfd0900, and rcfd0950, from 1969 Q1 to 1983 Q4 it is the sum of rcfd0400, rcfd0600, rcfd0900, rcfd0950, and rcfd1000, between 1984 Q1 and 1993 Q4 rcfd0390 and from 1994 Q1 on the sum of rcfd1754 and rcfd1773.

within quarter size percentile. I then subtract 50, so the integer is between -49 and 50, and then divide by one hundred. Thus a zero entry designates a bank at the size median in the respective quarter, 0.50 a bank in the top asset size percentile within the quarter, and the smallest banks in the bottom asset size percentile in the respective quarter have entries of -0.49.

Whilst bank level data was regularly collected prior to 1975, the sample start date of many prior bank level studies (Fig. 1), data in the period between 1963 Q3 and 1971 Q4 was occasionally available only semi-annually rather than quarterly. The bank level data for those dates is generated by linear interpolation of the semi-annual data points. The assumption for the empirical estimates 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 specification.

Moreover, in the period prior to 1975, the regulator "called" the reports from commercial banks at specific, random dates around quarter-end to avoid situations like (in)famous Repo 105 at Lehman Brothers Inc., hence the term "call" reports. However, most of the "called" dates coincide with the end of the quarter. Yet, for some of the dates we need to make another assumption. For instance, in the year 1960 the bank data for the first quarter call reports were collected on March 15, on June 15 for the second quarter and on October 3 for the third quarter instead of the regular dates March 31, June 30, and September 30, 1960. As in the case of interpolation there is measurement error in terms of the timing, even if just by a few days. 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 time periods that the call reports are off do 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 as well as the tradition of the bank level literature on the credit channel. Meulendyke (1998) contains a rich, in-depth description of the Federal Reserve's 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). In a companion paper, Bluedorn, Bowdler, and Koch (2014) discuss and analyze the role of monetary policy measures in empirical bank level studies and their findings imply that my estimates likely *under*state the policy effects. Here, I emphasize the choice of the change in the federal funds rate to enable a meaningful comparison with the existing bank level literature.

3.3 Effective Bindingness of Regulation Q

Fig. 1 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 on 3-year bank deposit interest rates and the 3-year treasury rate. 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). 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, that in terms of their lot size (\$500 to \$1,000) and their maturity structure (2 to 4 years) were closer to common time deposits. Until June 1979 the measure of bindingness (RegQ_t) is the difference between the 3-year treasury rate and the legally fixed interest rate ceiling for 3-year bank time deposits. In July 1979 SSCs described above were introduced with higher, occasionally adjusted rate ceiling caps (11.75 percent). From July 1979 RegQ_t is the difference between the 3-year treasury rate and the relevant moving ceiling rate for the respective substitute (SSCs or differences to 3-year deposit rate ceilings at thrifts, whichever difference is larger, see Duca, 1995, for more details). Finally, in May 1982 a new time deposit was created with no interest rate ceiling, no minimum denomination and an initial maturity of 3.5 years, so since May 1982 the bindingness measure RegQ_t is set to zero.

4 Empirical Specification and Hypotheses

4.1 Baseline Specification

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

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

So four quarter bank level credit growth $\Delta L_{i,t}$ is regressed on a constant, its own lags $\Delta L_{i,t-\ell}$ (throughout the paper lags are indexed by the letter ℓ), macroeconomic controls $\mathbf{M}$, bank characteristics $\mathbf{B}_i$, as well as interactions between bank characteristics and macroeconomic controls.

The other controls in specification (1) include bank-specific seasonals to capture idiosyncratic credit portfolio cyclicality and 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) to capture *mean* shifts in credit growth. I also include interactions of this Great Moderation dummy with policy, to capture changes in monetary transmission unrelated to deposit deregulation. This specific interaction is also important methodologically. Notice in Fig. 1 how the support of RegQ_t is $\mathbb{R}_0^+$ due to its kink. The mean of RegQ_t is thus strictly positive. So to ensure that the interaction of Regulation Q wedges with policy is not merely a *conditional mean* effect and not driven by the time-series variation in RegQ_t one can either de-mean the time-varying RegQ_t variable, thus making the coefficients in row 3 and 4 of the main results Tables 2 and 3 difficult to interpret, or introduce a binary dummy either during the period of Regulation Q, or during all periods but Regulation Q (Great Moderation) and interact that with policy rate changes. Either specification is fine and does not, by construction, affect the results. I opt for the later version because it eases the interpretability and consistent, intuitive reporting of the results, in particular with respect to rows 1, 3, 4, and 8 of the results table.

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.

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 parameter 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. Some earlier studies of the lending channel made the more restricted assumption of homogenous loan demand facing individual banks. For the relevance of this point, consider Fig. 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 potentially driven by non-policy factors that my specification captures by also interacting those non-policy macrofactors with the bank level characteristics.

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 empirically discern loan supply effects due to Regulation Q at the bank level, I augment the baseline specification (1) by including the Regulation Q bindingness proxy (RegQ_t), displayed in Fig. 1, in levels and interacted with the characteristics:

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

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 market 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 commercial banks' funding base more than during the period of deregulation, and if it is impossible to costlessly replenish the outflow of deposits with other funds, for example, by issuing equity or debt, then the excess of market 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 of 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 spreads at the bank level suggesting banks effectively faced different constraints under Regulation Q than they have faced since its phasing out. The Regulation Q bindingness spread 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:

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

4.3 Regulatory Controls and Monetary Policy

We are also interested in how these additional time-varying 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):

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

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

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

meaning the monetary policy impact on bank level credit growth is invariant to the bindingness of Regulation Q. What is the interpretation of this interaction? The interaction is introduced to capture the "kink" in the households' and firms' optimization problems. At this kink, the incentives to move out of regulated deposits into other comparable asset classes increase due to an arbitrageable spread. Narratives and commercial advertisements of the time suggest that commercial banks pursued depositors using non-monetary rewards like toasters to induce them to maintain or increase their deposit balances. Estimates of the overall impact of monetary policy on lending growth can be obtained by testing

$$H_0 : \sum_{\ell=0}^{4} \beta_{3,\ell} + \sum_{\ell=0}^{4} \varrho_{\ell}^{pol\ level} = 0 \qquad \text{(total policy transmission)}$$

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 the discussion of the findings in section 5.2.

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

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

5 Discussion

5.1 Policy Impact

Estimation results for the baseline regression (1) and the three empirical models (2), (3) and (4) testing the impact of deposit deregulation for the sample period when Regulation Q was formally in place from 1959 Q4 to 1986 Q1 are reported in Table 2. Full sample estimates from 1959 Q4 to 2014 Q4 are reported in Table 3. The column labels correspond to the four empirical models discussed in the previous section 4.

The first rows (1) of Tables 2 and 3 display the estimates of the direct effects of monetary policy on loan growth prior to the Great Moderation. 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 -0.41 (Table 3) and -0.75 (Table 2) percentage points before the Great Moderation (row 1). 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. Notice how, if you move along the columns (1) to (4) in Tables 2 and 3 the estimated conditional credit growth responses to policy change qualitatively with the introduction of the interaction terms in row (3). In fact, in the full sample estimate Table 3 the combined effect during both the Great Moderation and the Regulation Q era is a qualitatively ambiguous, insignificant credit growth response to policy (obtained by adding rows 1 and 8) if one ignores the non-linear Regulation Q effects. In other words, large parts of the credit growth responses at the bank level can be explained by the interaction between rate ceilings and monetary policy during the Regulation Q era, whilst afterwards during the Great Moderation monetary policy had only very minor effects on bank level credit growth.

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 market interest rate was one hundred basis points above the legally fixed deposit rates, bank level lending growth would be between -0.15 (model 2) and -0.27 (model 4) percentage points smaller than in the absence of 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 firms' demand for credit. Under this assumption, row (2) may validly be interpreted as a pure regulation induced loan supply shift working through banks balance sheets.

Binding rate ceilings inscribed in Regulation Q caused marked non-linearities in the transmission of monetary policy to bank level credit growth. Particularly, the kink in the deposit pricing schedule impacts monetary policy transmission, because, exactly at the kink, portfolio reallocations away from banking deposits were likely to pick up, draining the commercial banks of required funding. Thus, row (3) displays estimates of the interaction between the deposit ceiling bindingness proxy RegQ_t and monetary policy. Estimates across Tables 2 and 3 range between -0.61 and -0.77. A comparison of both tables suggest this non-linearity is qualitatively and quantitatively robust to the sample period. Suppose the relevant market interest rate was 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, again the overall impact reported in row (4) does not differ much between Tables 2 and 3.

These estimates suggest that, all else being equal, the propagation of monetary policy through bank loan supply shifts has diminished substantially. This points to attenuation of shock *propagation* driven by deregulation. These findings are in line with a number of recent macroeconomic papers such as Giannone, Lenza, and Reichlin (2008), who identify changes in the transmission mechanism rather than shocks as a source of the Great Moderation, and Galí and Gambetti (2009), who point to a shrinking contribution of non-technology shocks to output volatility. Note also from figure 1 that the time-period between 1979 and 1982 when Regulation Q wedges were 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 are also important for policy. First, Bernanke, Gertler, and Watson (1997) note that U.S. post-oil price hike recessions might be caused, in part, 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 shocks are less likely to emerge from credit variations induced by monetary policy responses to oil price increases. Second, for credit channels, greater instrument variability in scale and scope might be necessary in order to offset macroeconomic shocks. The unconventional quantitative easing policies currently pursued by the Federal Reserve may be evidence of greater variability in terms of scale. Macroprudential tools like regulatory cyclical adjustments of loan-to-value ratios in residential lending or of bank capital buffers are examples of a feasible greater instrument variability of scope.

To summarize, the result of deposit rate ceiling deregulation is primarily the diminished ability of the Federal Reserve to directly shift loan supply schedules of individual banks, implying that the traditional bank lending channel at the business cycle frequency is orders of magnitudes weaker overall, if not completely defunct, today. Other channels, like the risk-taking channel in examined in Jiménez et al. (2014) might be more important in the current regulatory environment.

5.2 Heterogeneity Across Commercial Banks

Having discussed the financial disintermediation due to deposit rate ceilings and their effects on monetary transmission for a representative bank at the sample mean in terms of capitalization, cash and securities ratios and at the size median, I now turn to a more detailed analysis of the role of individual bank characteristics in policy transmission. Notice no new regressions are reported, the next results tables merely focus on different sets of parameters from empirical models (1) to (4) related to different bank characteristics.

Estimates relating to the cross-sectional heterogeneity are presented in Table 4. For convenience, the direct impact of monetary policy prior to the Great Moderation from Table 2 is reiterated in row (1). Regardless of the impact of Regulation Q, larger, better capitalized and more liquid banks have slower mean credit growth at the bank level. The cross-sectional differences in the level of credit growth across bank size (row A.1), bank capitalization (row E.1), cash holdings (row C.1) and security holdings (row S.1) are fairly stable across the different specifications.

Differences emerge in the level impact of Regulation Q across the characteristics. Better capitalized commercial banks are less effected by Regulation Q which is unsurprising given that capital and (regulated) deposits are substitutes in funding the banks' assets. The impact of Regulation Q wedges is more pronounced for larger banks and banks that hold more cash and more securities.

Regarding the impact of characteristics on the *transmission of policy* when rate ceiling wedges were present cash holdings (row C.3), capital (row E.3) and size (row A.3) mitigate the impact of policy whereas security holdings amplify it (row S.3). The latter finding might in part be due to the fact that securities themselves were close substitutes for those depositors who chose to draw down their time and saving deposits and thus there might have been larger than usual valuation effects due to Regulation Q ceilings. So bank level findings on the impact of capital (Kishan and Opiela, 2000) and bank size and liquidity (Kashyap and Stein, 2000) are also validated for the Regulation Q era.

6 Conclusion

These findings have important implications. If policy makers at the time had been aware of the disintermediation wedges empirically examined in this paper, 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 focus on (forecasted) output and inflation gaps. The findings cast some doubt on the "divine coincidence", whether the output gap is a sufficient statistic for economic imbalances. Policy tradeoffs may be more refined when nominal frictions are not the major source of (intertemporal) inefficiency (Stein, 2012; Sheedy, 2014). Optimal policy ought to 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).

Finally, one interpretation of these findings is in terms of the contributions of monetary transmission to the Great Moderation cross-validating previous theoretical work by Mertens (2008). Most advanced economies have experienced a striking decline in the volatility of aggregate economic activity since the early 1980s. 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 explanation of the Great Moderation is 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 explanations centers around improved policy ("good policy") and, in particular, monetary policy (Taylor, 1999; Cogley and Sargent, 2001). My results suggest that the reduced direct interaction between (macroprudential) regulation and policy may have had some part to play in reducing credit shocks.

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Figures

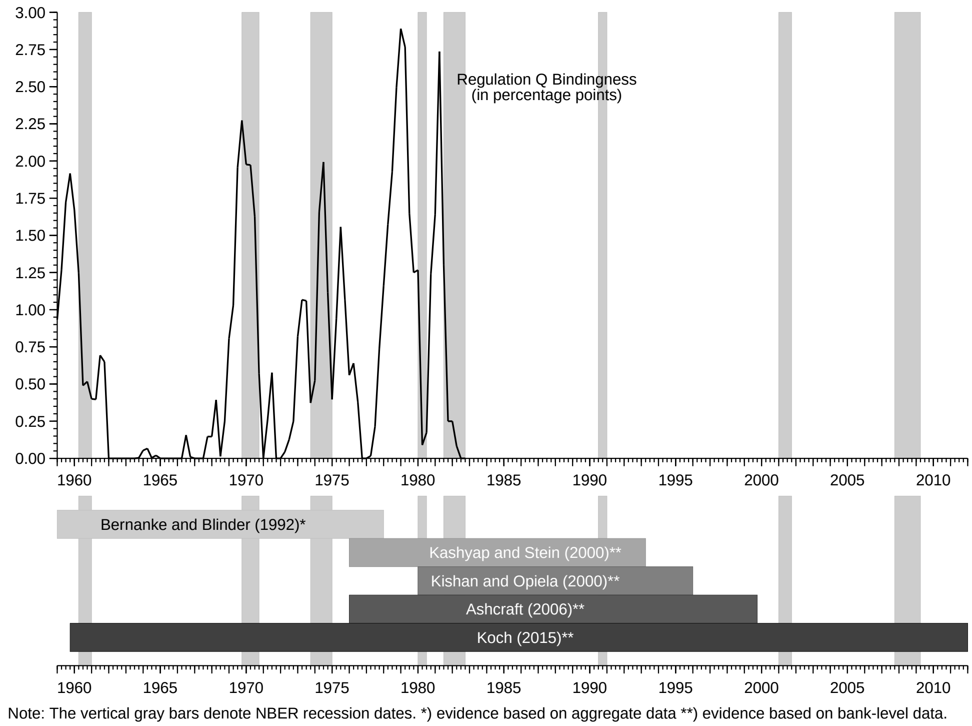


Fig. 1: Time-Series of Regulation Q Controls and Selected Papers

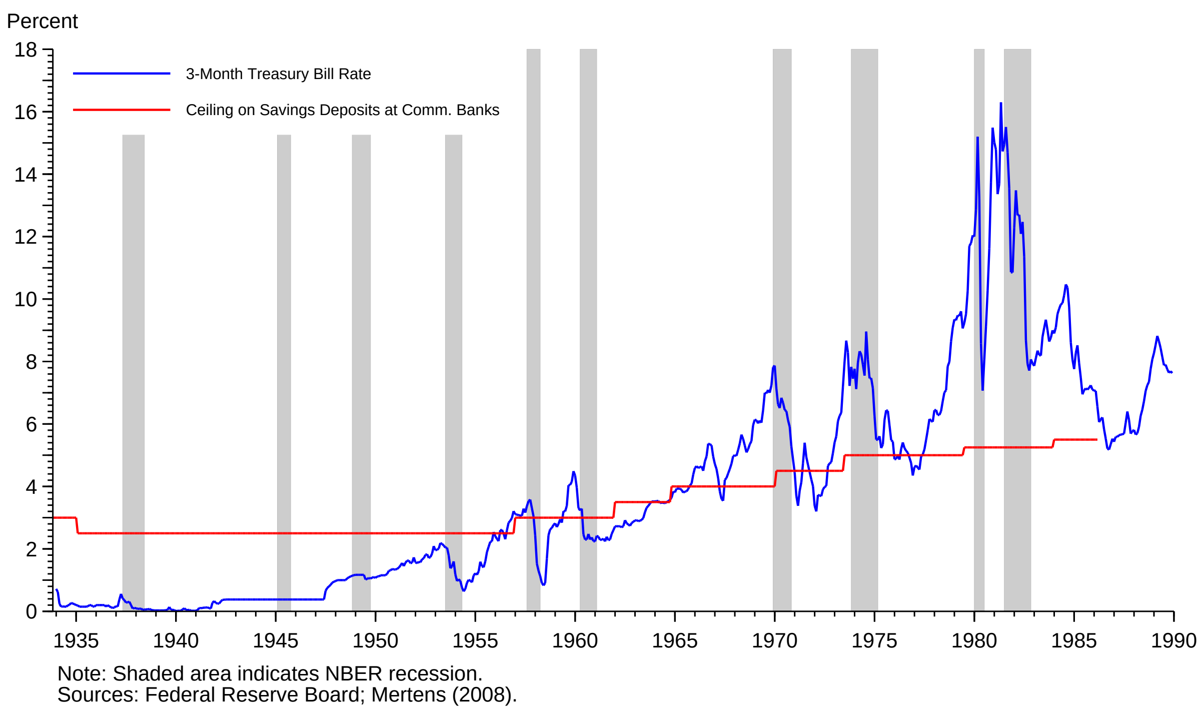
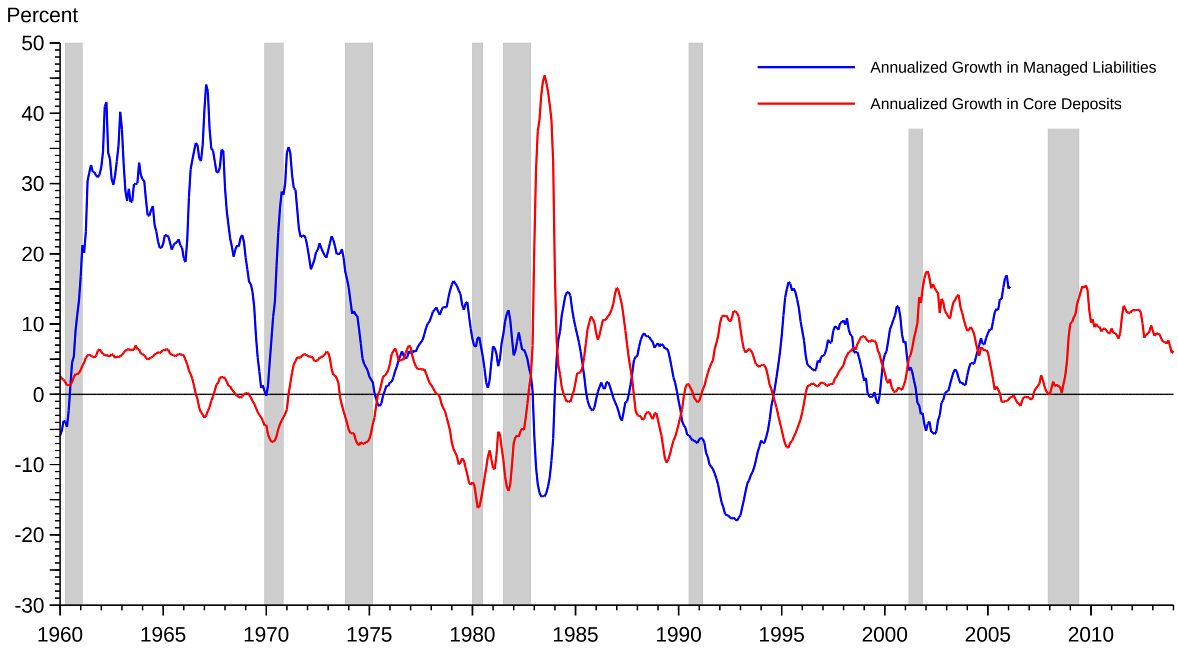
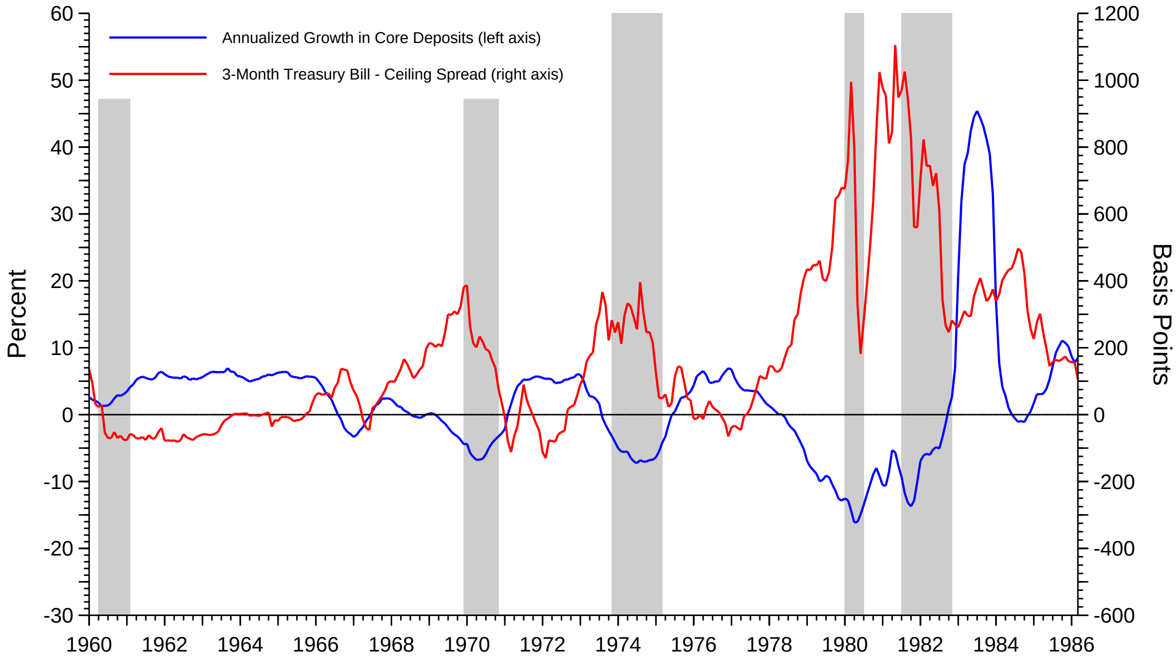


Fig. 2: Fixed Rate Ceilings and Short-term rates



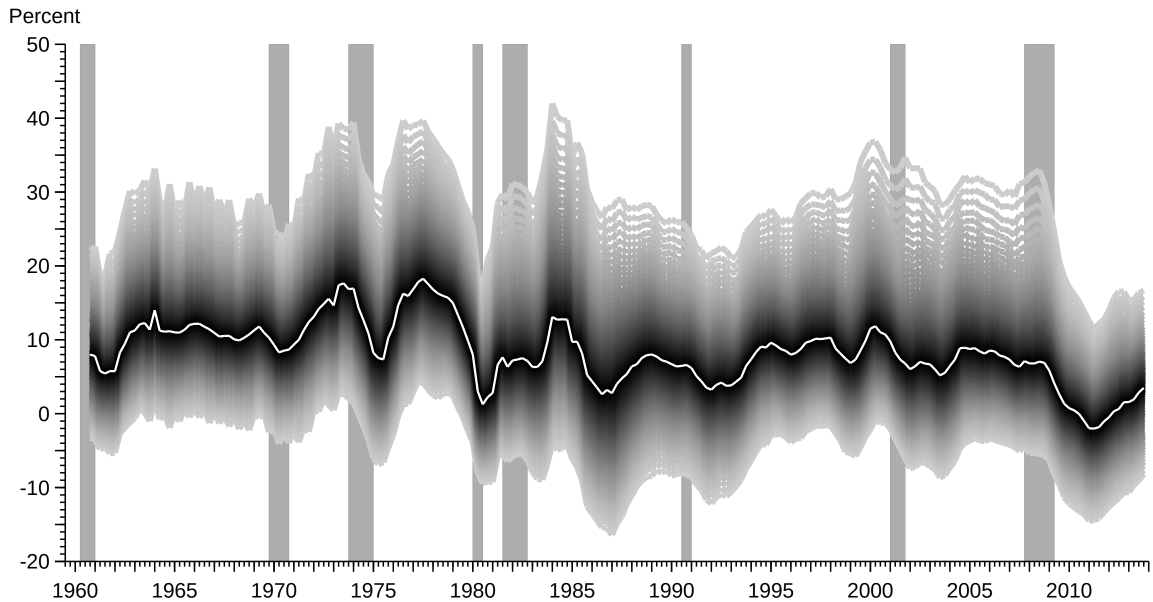
Note: Shaded area indicates NBER recession.
Sources: Federal Reserve Board; author's own calculations.

Fig. 3: Changing Co-Movements in Bank Liabilities Due to Deposit Rate Deregulation



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

Fig. 4: Bindingness of Rate Ceilings and Deposit Growth



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

Fig. 5: Quarterly Cross-Sectional Loan Growth
(10th to 90th percentiles in %)

Tables

Table 1: Bank Characteristics (1960 Q4 – 2010 Q4)

	1960Q4	1970Q4	1980Q4	1990Q4	2000Q4	2010Q4
Total Assets (1000s)	18,257	40,379	115,350	199,898	392,525	1,026,273
	(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)
Time and Savings Deposits ratio	32.6	47.1	61.3	63.9	59.8	62.0
	(16.6)	(13.1)	(11.2)	(11.1)	(12.2)	(12.9)
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)
Number of Observations	12,958	13,317	14,199	11,450	7,859	6,197

All ratios are in percent of total assets. Standard deviations are reported in round brackets.

Table 2: Credit Growth Regression Results (Sample Period: 1959 Q4 – 1986 Q1)

$\Delta L_{i,t}$	Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.75***	-0.80***	0.25***	0.46***
		(0.02)	(0.02)	(0.03)	(0.03)
(2)	$\sum_{t=0}^{4} \text{RegQ}_{t-\ell}$		-0.15***		-0.27***
			(0.02)		(0.02)
(3)	$\sum_{t=0}^{4} \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.65***	-0.77***
				(0.01)	(0.02)
(4)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell} + \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.41***	-0.31***
				(0.02)	(0.02)
(5)	$\sum_{t=0}^{4} \Delta y_{t-\ell}$	0.48***	0.45***	0.39***	0.37***
		(0.01)	(0.01)	(0.01)	(0.01)
(6)	$\sum_{t=0}^{4} \Delta p_{t-\ell}$	0.30***	0.35***	0.18***	0.26***
		(0.01)	(0.01)	(0.01)	(0.01)
(7)	$\sum_{t=0}^{4} \text{GMod}_{t-\ell}$	-2.64***	-2.52***	-3.44***	-3.42***
		(0.05)	(0.05)	(0.05)	(0.05)
(8)	$\sum_{t=0}^{4} \text{GMod}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$	-1.84***	-1.74***	-2.71***	-2.82***
		(0.05)	(0.05)	(0.05)	(0.05)
	R^2	0.83	0.83	0.83	0.83
	Observations	1,159,253	1,160,365	1,160,123	1,160,686

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

Table 3: Credit Growth Regression Results (Sample Period: 1959 Q4 – 2014 Q4)

$\Delta L_{i,t}$	Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.41*** (0.01)	-0.51*** (0.01)	0.40*** (0.02)	0.53*** (0.03)
(2)	$\sum_{t=0}^{4} \text{RegQ}_{t-\ell}$		-0.03* (0.01)		-0.14*** (0.01)
(3)	$\sum_{t=0}^{4} \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.61*** (0.01)	-0.72*** (0.01)
(4)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell} + \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.21*** (0.01)	-0.18*** (0.02)
(5)	$\sum_{t=0}^{4} \Delta y_{t-\ell}$	0.29*** (0.00)	0.28*** (0.00)	0.28*** (0.00)	0.27*** (0.00)
(6)	$\sum_{t=0}^{4} \Delta p_{t-\ell}$	0.04*** (0.00)	0.05*** (0.00)	0.09*** (0.00)	0.12*** (0.00)
(7)	$\sum_{t=0}^{4} \text{GMod}_{t-\ell}$	-1.20*** (0.03)	-1.22*** (0.03)	-1.45*** (0.03)	-1.54*** (0.03)
(8)	$\sum_{t=0}^{4} \text{GMod}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$	0.35*** (0.02)	0.49*** (0.02)	-0.41*** (0.03)	-0.50*** (0.03)
	R^2	0.84	0.84	0.84	0.84
	Observations	1,964,035	1,964,881	1,965,151	1,965,440

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 (Sample Period: 1959 Q4 – 1986 Q1)

$\Delta L_{i,t}$	Model:	(1)	(2)	(3)	(4)
(1)	$\sum_{t=0}^{4} \Delta \text{ff}_{t-\ell}$	-0.75***	-0.80***	0.25***	0.46***
		(0.02)	(0.02)	(0.03)	(0.03)
(A.1)	$\text{Assets}_{i,t-1}$	-1.69***	-1.70***	-1.37***	-1.39***
		(0.20)	(0.21)	(0.21)	(0.21)
(A.2)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$		-0.46***		-0.32***
			(0.06)		(0.06)
(A.3)	$\sum_{t=0}^{4} \text{Assets}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			0.40***	0.21***
				(0.05)	(0.05)
(E.1)	$\text{Equity}_{i,t-1}$	-0.36***	-0.46***	-0.39***	-0.43***
		(0.07)	(0.08)	(0.07)	(0.08)
(E.2)	$\sum_{t=0}^{4} \text{Equity}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$		0.12***		0.17***
			(0.03)		(0.03)
(E.3)	$\sum_{t=0}^{4} \text{Equity}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			0.12***	0.19***
				(0.02)	(0.03)
(C.1)	$\text{Cash}_{i,t-1}$	-0.19***	-0.09*	-0.19***	-0.06
		(0.05)	(0.05)	(0.05)	(0.05)
(C.2)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$		-0.22***		-0.17***
			(0.02)		(0.02)
(C.3)	$\sum_{t=0}^{4} \text{Cash}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			0.17***	0.17***
				(0.01)	(0.02)
(S.1)	$\text{Securities}_{i,t-1}$	-0.74***	-0.61***	-0.76***	-0.60***
		(0.05)	(0.05)	(0.05)	(0.05)
(S.2)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \text{RegQ}_{t-\ell}$		-0.01		-0.07***
			(0.02)		(0.02)
(S.3)	$\sum_{t=0}^{4} \text{Securities}_{i,t-1} \cdot \text{RegQ}_{t-\ell} \cdot \Delta \text{ff}_{t-\ell}$			-0.21***	-0.15***
				(0.01)	(0.02)
	R^2	0.83	0.83	0.83	0.83
	Observations	1,159,253	1,160,365	1,160,123	1,160,686

Robust standard errors after clustering at bank level in parentheses.

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