Financial Crises and the Transmission of Monetary Policy to Consumer Credit Markets*

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March 23, 2021

Abstract

How does the health of creditors affect the pass-through of monetary policy to households? In a financial crisis, asset losses among creditors can either dampen or amplify the effects of monetary policy on lending, depending on how these losses and policies interact with financial frictions. Frictions such as leverage constraints may hinder creditor responses, however easing may instead alleviate frictions that would otherwise constrain lending. Using data on the universe of US credit unions, I document that asset losses *increase* the sensitivity of consumer credit to monetary policy. Identification exploits plausibly exogenous variation in asset losses and high frequency identification of monetary policy shocks. I find that a one standard deviation asset loss increases the response of credit union lending to a 10 basis point fall in the two-year Treasury rate from a 0.86 to 1.15 percentage point increase. The estimates imply that constraints on monetary policy become more costly in a financial crisis characterized by creditor asset losses and that an additional benefit of monetary easing is that it weakens the causal, contractionary effect of asset losses.

JEL: E44, E52, E58, G01, G21, G28

*First version: October 27, 2015. This version: March 23, 2021. I am extremely grateful to David Berger, Marty Eichenbaum, Guido Lorenzoni, Paul Mohnen, John Mondragon, and Matt Notowidigdo for their guidance and support. This paper benefited from feedback from Sam Bazzi, Enrico Berkes, Gideon Bornstein, Larry Christiano, Cláudia Custodio, Ian Dew-Becker, Itamar Drechsler, Jason Faberman, Dan Greenwald, Valentin Haddad, Erik Hurst, Stephanie Johnson, Simon Kwan, Alice Jun, Atif Mian, Giorgio Primiceri, Rodney Ramcharan, David Scharfstein, Antoinette Schoar, Jesse Schreger, Mario Solis-Garcia, Jeremy Stein, Eileen van Straelen, Adi Sunderam, Max Tabord-Meehan, Skander Van den Heuval, Johannes Wieland, Tom Winberry, Arlene Wong, Chen Yeh, and numerous conference and seminar participants. I also thank Jenny Tang for generously sharing her FOMC announcement date and Fed Funds futures data. Financial support from the Becker Friedman Institute's Macro Financial Modeling Initiative is gratefully acknowledged. This research was supported in part through the computational resources and staff contributions provided for the Social Sciences Computing Cluster (SSCC) at Northwestern University. I thank Caleb Shack for providing excellent research assistance.

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1 Introduction

The collapse of asset-backed security (ABS) markets in 2008 significantly impaired the balance sheets of many creditors holding these assets. The inability of these lenders to extend credit to consumers and firms contributed to the severity of the Great Recession and amplified falls in consumption, employment, and output. US policymakers responded to the crisis with both conventional monetary policy and unconventional policies such as large-scale asset purchases.[1] The goal of these programs was to stimulate bank lending by lowering the cost of capital (conventional policy) and to also combat balance sheet impairments preventing banks from lending (unconventional policy).

An important consideration for policymakers is whether monetary policy works any differently during a *financial* crisis.This paper explores if the credit channel of conventional monetary policy is more or less effective when banks suffer large asset losses. The effect of asset loses on monetary transmission is theoretically ambiguous. Section 2 illustrates this ambiguity using two simple models that give rise to opposing predictions of whether asset losses amplify or attenuate the effects of conventional monetary easing. On one hand, easing could alleviate financial frictions, such as an external finance premium, that would otherwise constrain lending. On the other hand, asset losses could tighten leverage constraints and limit a lender's ability to respond to easing. The answer is not only informative about financial crises, but speaks to the substitutability/complementarity of conventional monetary policy and unconventional monetary policy tools such as bank recapitalization.

This paper contributes new empirical evidence on how financial frictions shape the credit channel of monetary policy. Using data on the universe of US credit unions, I estimate the causal effect of asset losses on the response of consumer credit to monetary policy. Credit unions resemble small banks and specialize in consumer credit. They provide around 10% of US consumer credit and originate 17.6% and 24.1% of US mortgages and auto loans.[2] Identification exploits a natural experiment in which otherwise similar credit unions experienced different asset losses due to plausibly exogenous asset-backed securities (ABS) exposure during the Great Recession.

Consistent with monetary easing alleviating financial frictions, I estimate that asset losses *increase* the lending response to a given change in the two-year Treasury rate induced by monetary policy announcements. Specifically, a one standard deviation asset loss increases the lending response to a 10 basis point fall in the two-year Treasury rate from a 0.86 to 1.15 percentage point increase. This stronger response implies that constraints on policy – such as the zero-lower-bound or political constraints – are more costly

[1] Here, conventional policy refers specifically to targeting the Fed Funds rate, both current and future (therefore including forward guidance). Unconventional monetary policy refers to policies such as large-scale asset purchases (e.g., MBS purchases under quantitative easing and TARP).

[2] The credit union totals come from the *Monthly Credit Union Estimates* produced by the Credit Union National Association. The market share calculations not made available by CUNA are computed using Flow of Funds data.

in financial crises featuring creditor asset losses. Additionally, when banks are in sound financial health, this result suggests policymakers may need to lean harder against the wind to rein in lending. The estimates also indicate that monetary easing combats the contractionary effects of assets losses by both directly stimulating lending and indirectly by *weakening* the causal effect of asset losses. Specifically, a 10 basis point fall in the two-year Treasury rate reduces the decline in loan originations induced by a one standard deviation asset loss from 3.20% to 2.91%. Monetary easing can therefore weaken the need for bank recapitalization as a means to bolster credit supply. Together, these findings imply that monetary easing and bank recapitalization are substitutes, rather than complements.

Estimating the causal effects of monetary policy and asset losses (plus their interaction) presents two distinct identification challenges. Monetary policy responds to current macroeconomic conditions, which may independently affect lending. Since easing tends to happen in downturns, time series comparisons of lending and risk-free rates would *understate* the causal effect of rate reductions on lending. The key challenge in identifying the causal effect of asset losses on lending is disentangling credit supply and demand. The economic conditions driving defaults and creditor asset losses can also reduce loan demand. This would lead cross-sectional comparisons of lending and asset losses to *overstate* the causal effect of asset losses. Additionally, larger asset losses may be correlated with other unobserved lender characteristics such as risk aversion that could also impact lending. I address these identification challenges using an instrumental variables approach.

To estimate the effects of monetary policy, I use high frequency identification (similarly to Swanson and Williams, 2014; Gertler and Karadi, 2015; Nakamura and Steinsson, 2018; Wong, 2019, for example). I instrument for changes in the two-year Treasury rate (a measure of the "policy" rate) using high-frequency changes in Fed Funds futures prices within a narrow window of Federal Open Market Committee (FOMC) announcements. The main identifying assumption is that, within this narrow window, changes in these prices are not driven by other factors affecting lending. The idea is that the pre-announcement price already reflects the latest information on the state of the economy, and the price change is purely due to the policy announcements of the FOMC.

To estimate the effects of asset losses, I exploit plausibly exogenous variation in a unique asset held by credit unions. During the Great Recession, a critical juncture through which financial distress reached credit unions was through their ownership of investment capital in Corporate Credit Unions ("Corporates"). Corporates are a distinct financial entity that invest in financial markets and provide financial services to credit unions. Paid-in equity from credit unions is an important financing source for Corporates. Corporates differed significantly in their exposure to private label ABS in the run-up to the crisis – some had zero exposure while others had invested up to 41% of their assets by 2006. Corporates' ABS-related losses were charged against credit unions' investment capital, creating significant asset losses for some credit unions.

Using measures of credit unions' investment capital, I instrument for changes in credit union assets. As noted in Ramcharan, Van den Heuvel and Verani (2016), variation in credit unions' investment capital is plausibly exogenous with respect to loan demand and other credit union characteristics for several reasons. First, ownership of investment capital is extremely sticky. Minimum duration requirements limit credit unions' ability to adjust their position for up to 20 years. Second, indirect exposure to ABS depends on the credit union's choice of Corporate, which is generally driven by historical relationships and geographic proximity. Third, a credit union's relative share of ownership – which depends on the investment decisions of all other credit unions invested in the same Corporate – determines the impact on their investment capital of a given asset loss.

The identifying variation in investment capital is similar to that of a shift-share instrument. The share of ownership and choice of Corporate determines the impact on credit unions of macro-financial events such as the collapse of ABS markets. Two main assumptions are required to identify the effect of asset losses and the interaction with monetary policy. Namely, credit unions experiencing larger investment capital losses do not face different loan demand nor loan demand that is more sensitive to monetary policy. In support of these assumptions, two placebo tests find no differences in lending during the run-up to the 2008 crisis nor different lending responses to easing in 2001 for credit unions that experienced larger investment capital losses in the crisis.

This paper contributes to several areas of literature. First, it adds to existing research on the state dependence of monetary policy by focusing on the role of financial sector health. Prior work finds that monetary easing stimulates more consumer credit when home equity is high (Beraja, Fuster, Hurst and Vavra, 2019), households are younger (Wong, 2019), consumer loans are less illiquid (Wieland and Yang, 2020), interest rates have been higher (Eichenbaum, Rebelo and Wong, 2019; Berger, Milbradt, Tourre and Vavra, 2020), creditors have less market power (Scharfstein and Sunderam, 2016), and inflation is higher (Jordà, Schularick and Taylor, 2020). Examining unconventional monetary policy, Di Maggio, Kermani and Palmer (2020) finds that quantitative easing (QE) stimulated more mortgage refinancing at times when bank health was weaker. My findings suggest conventional policy is also more potent during times of a weakened financial sector, and that the effect of financial sector health is causal. Analyzing monetary policy over the business cycle, Tenreyro and Thwaites (2016) finds easing is less powerful in recessions. My findings complement this work, suggesting that this relationship can differ when a recession is accompanied by a *financial crisis*.

The empirical results in this paper most directly build on Kashyap and Stein (2000, 1995), by using new approaches to identification and studying the effect of asset *losses*. These papers document that the lending of smaller banks comoves more strongly with measures of monetary policy. The causal evidence here bolsters their interpretation that small banks are more sensitive due to the financial frictions they face.

This paper contributes to the literature on role of financial frictions in monetary transmission (Bernanke, 1983; Bernanke and Gertler, 1995; Gertler and Kiyotaki, 2010; Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru and Yao, 2017; Drechsler, Savov and Schnabl, 2017; Greenwald, 2018; Piazzesi, Rogers and Schneider, 2019; Ottonello and Winberry, 2020; Zentefis, 2020). The estimates imply that the dominant financial friction in the Great Recession shaping the credit channel was one that monetary easing could alleviate, such as an external financing premium. This fact is useful for disciplining models of the Great Recession. The stylized model here also suggests that if we suspect the dominant friction is different in future crises, updating the friction in our models is important for accurately predicting the effects of monetary policy.

The finding that monetary easing weakens the *causal* effect of asset losses is an important result for the literature on the macroeconomic consequences of credit supply shocks. Impaired creditor balance sheets played an important role in the initial credit crunch during the Great Recession (Cornett, McNutt, Strahan and Tehranian, 2011; Ramcharan, Van den Heuvel and Verani, 2016). Spilling over to the real economy, reductions in household credit explain a significant fraction of the decreases in output, employment, and consumption during this crisis (Midrigan and Philippon, 2016; Mondragon, 2017). Expanded credit access played an important role fueling the house price boom (Di Maggio and Kermani, 2017), and the credit crunch may have similarly added to the severity of the bust. Further amplifying the downturn, falls in housing net worth significantly reduced consumption (Mian, Rao and Sufi, 2013; Mian and Sufi, 2014; Berger, Guerrieri, Lorenzoni and Vavra, 2017).[3] The ability of monetary easing to weaken the contractionary effects of asset losses makes it an even more powerful tool in a financial crises. And constraints on conventional monetary policy may become especially costly in a financial crisis.

The next section presents two stylized models of financial intermediation to illustrate how different financial predictions yield opposing predictions for the effect of asset losses on lending's sensitivity to the policy rate. Section 3 provides background information on credit unions and describes the data. Section 4 outlines the empirical strategy and discusses identification. Section 5 presents the empirical findings and section 6 presents additional results that help interpret the main results. Section 7 concludes.

2 Theory: Asset Losses and the Credit Channel of Monetary Policy

It is theoretically ambiguous whether asset losses increase or decrease lending's sensitivity to the policy rate. This section illustrates this ambiguity by presenting two simple models of financial intermediation that give rise to opposing predictions. These predictions hinge on the nature of the financial frictions facing lenders. The simplified models feature stylized, reduced-form representations of frictions from richer models (e.g. Kiyotaki and Moore, 1997; Bernanke et al., 1999; Gertler and Karadi, 2011; Gertler and Kiyotaki, 2010).

[3]This literature estimates an elasticity of non-durable consumption to house prices on the order of 0.3-0.4%.

The first model features a bank whose lending to households is subject to a constraint on lending that varies with the size of their balance sheet. In this setting, the lending of banks with *better* balance sheets is *more* sensitive to changes in the risk-free (policy) rate. Here, a weak balance sheet can cause the lending constraint to bind, limiting the bank's ability to take advantage of a lower cost of capital.

In the second model, the bank instead faces frictions in raising funds. Risk neutral external creditors perceive the bank as decreasingly likely to repay as the value of its assets decrease, and thus require a risk premium. This model implies that the lending of a bank with *weaker* balance sheets is *more* sensitive to the policy rate. This is because the risk premium magnifies the pass-through of changes in the policy rate to the bank's cost of capital.

In reality, both types of frictions likely affect lending. However, the empirical analysis sheds light on the nature of the frictions that dominate and shape the response of lending to monetary policy. Moreover, the ability of richer models to match these empirical finding of a stronger response among weaker banks is a useful criterion for assessing their empirical validity in the context of the Great Recession.

2.1 Model 1: Lending Constraint

A monopolist bank faces a lending/capacity constraint and household demand for loans that is decreasing in the interest the bank charges (R_L). The bank chooses how much to lend in order to maximize profits. The bank can borrow at the gross (risk-free) policy rate R, lending all borrowed funds L to households. The bank already owns legacy assets B, the value of which define its maximum loan capacity. Given loan demand $R_L(L)$ and legacy assets B, the bank solves

$$\begin{aligned} \max_{L\geq 0} \quad & R_L(L)L - RL \\ \text{s.t.} \quad & L \leq \bar{L}(B) \quad \text{(lending constraint)} \end{aligned}$$

where $R_L(L)$ is inverse demand for loans and $\bar{L}(\cdot)$ is an increasing function. The lending constraint proxies for capital requirements limiting the amount of risk-weighted assets (including loans) that the bank can purchase. A fall in the value of legacy assets B reduces the amount of consumer lending the bank can do.

Equilibrium lending – when the lending constraint is non-binding – is uniquely characterized by the first order condition when loan demand is strictly decreasing and strictly concave (i.e. $R_L'(L) < 0$ and $R_L''(L) < 0$). Denote unconstrained lending by $L^\star(R)$. Equilibrium lending is

$$L(R, B) = \min\left\{L^\star(R), \bar{L}(B)\right\}.$$

Under these assumptions on the first and second derivatives of loan demand, equilibrium lending is strictly decreasing in the policy rate (R). When the cost of funds is higher, the bank restricts lending to equate the marginal revenue of lending to its marginal cost. Additionally, equilibrium lending is weakly increasing in legacy assets B because a higher value can relax the lending constraint.

How does a lower value of legacy assets affect the response of lending to the policy rate? In this model, lending exhibits increasing differences in $(-R, B)$. That is, a *decline* in assets B *decreases* the growth in lending caused by a fall in the policy rate R. This result is formalized below.

Proposition 1. *Equilibrium loan supply $L(R, B) = \min\{L^\star(R), \bar{L}(B)\}$ has increasing differences in $(-R, B)$ if $\bar{L}(\cdot)$ is an increasing function, $R_L'(L) < 0$, and $R_L''(L) < 0$. That is, $R' < R$ and $B' > B$, imply*

$$L(R', B') - L(R, B') \geq L(R', B) - L(R, B).$$

The proof is in Appendix B.

Increasing differences implies that lending is more responsive to changes in the policy rate when balance sheets are stronger (B is larger). Improving the bank's balance sheet raises its lending capacity, *enhancing* the positive effects of lowering the cost of capital. Another interpretation of this result is that conventional (lowering R) and unconventional monetary policies such as large-scale asset purchases (increasing B) are complements. Rearranging the inequality above, this result also implies that lending is more responsive to assets B when the policy rate is lower R. However, this also means that asset losses are more contractionary when the policy rate is lower. In the next model, the opposite predictions arise for the interaction of conventional and unconventional monetary policy.

2.2 Model 2: External Finance Premium

In the second model, the bank no longer faces a lending constraint but the price at which it can borrow depends on the value its balance sheet. Risk neutral external creditors believe that the bank will fail to repay them with probability $\Delta(B)$ where $\Delta(\cdot) \in [0, 1]$ is a weakly decreasing function of legacy assets B. The external creditor can borrow/lend at the gross risk-free policy rate R and lends to the bank at the gross rate $\widetilde{R}$. No arbitrage requires that

$$\widetilde{R} = \frac{R}{1 - \Delta(B)} = R + \underbrace{R\frac{\Delta(B)}{1 - \Delta(B)}}_{\text{external finance premium}}.$$

When default risk is non-zero, the bank pays an external finance premium.

The intermediary chooses lending L to maximize profits given inverse demand $R_L(L)$ and legacy assets B:

$$\begin{aligned} \max_{L \geq 0} \quad & R_L(L)L - \widetilde{R}L \\ \text{s.t.} \quad & \widetilde{R} = \frac{R}{1 - \Delta(B)} \quad \text{(no arbitrage)}. \end{aligned}$$

When demand is strictly decreasing and strictly concave, equilibrium lending is characterized by the first order condition:

$$R_L'(L)L + R_L(L) = \widetilde{R}.$$

As before, denote equilibrium lending by $L(R, B)$.

As lending constraint model, lending is increasing in legacy assets B and decreasing in the policy rate R. The assumptions on the shape of loan demand imply equilibrium lending is decreasing in the bank's cost of capital $\widetilde{R}$. Because default risk $\Delta(B)$ is weakly decreasing in B, a higher value for legacy assets B lowers the bank's cost of capital, increasing lending. Additionally, a lower (risk-free) policy rate R reduces the bank's cost of capital and also increases lending.

In contrast to the lending constraint model, the lending response to a given change in the policy rate R is now *larger* when legacy assets are lower. This result is formalized below.

Proposition 2. *Equilibrium loan supply $L(R, B)$ has decreasing differences in $(-R, B)$ if $\Delta(\cdot)$ is a weakly decreasing function and $R_L'(L), R_L''(L) < 0$. That is, if $R' < R$ and $B' > B$, then*

$$L(R', B) - L(R, B) \geq L(R', B') - L(R, B').$$

The proof is in Appendix B.

In this model, the risk-premium $R\frac{\Delta(B)}{1-\Delta(B)}$ magnifies the pass-through of changes in the policy rate to the bank's cost of capital. An asset loss (reduction in B) therefore causes lending to respond more to a given change in the policy rate. Rearranging the inequality above also reveals that the negative impact of asset losses on lending is *smaller* when the policy rate is lower. The policy rate amplifies the impact of changes in default risk. Thus when the policy rate is low, a given change in default risk leads to a small change in the bank's cost of capital. These predictions match the empirical estimates presented in the upcoming section.

This result implies that conventional monetary easing (reductions in R) and unconventional policies that raise the value of legacy assets B (such as large-scale asset purchases) are substitutes, rather than complements. The impact of conventional policy on lending is strongest when balance sheets are in worse shape (lower B). Unconventional policy is weaker when interest rates are lower, however the contractionary effects of assets losses are also weakest when rates are low. In a crisis characterized by asset losses, a secondary benefit of monetary easing is that it alleviates the financial frictions limiting lending.

3 Background on US Credit Unions & Data

The empirical analysis focuses on US credit unions because they experienced plausibly exogenous variation in their exposure to collapse of the ABS market in The Great Recession.

This section provides relevant background on credit unions, how they became exposed to ABS, and describes the data used in the analysis.

3.1 US Credit Unions

Credit unions resemble small banks and are an important provider of consumer credit in the US. In 2017, credit unions accounted for 13% of mortgage originations and 28% of auto originations (Experian, 2017). Typically smaller than banks, the average credit union owned $102 million in assets during the period of analysis (2004-2011). Primarily engaging in consumer lending, credit unions do not originate commercial and industrial loans, though small business loans comprise a small share of their lending.

A unique feature of credit unions is that they are often formed around a shared association, typically related to geography or employment.[4] The residential and occupational requirements of many credit unions make it difficult to substitute between credit unions. Additionally, credit unions are structured as not-for-profits, and therefore reinvest earnings instead of paying them out to shareholders. Another importance difference between credit unions and small banks is that until 2017, credit unions could not securitize loans and would instead hold them on their balance sheets.

Credit unions are regulated by the National Credit Union Administration (NCUA), acting in a similar capacity as the Federal Deposit Insurance Corporate (FDIC) does for banks. Credit unions face similar style liquidity and leverage rules compared to banks. However, credit unions face stricter regulations on the types of asset they can hold, which in practice resulted in few credit unions directly owning private label ABS.[5]

Credit unions ultimately became exposed to the ABS market through investments in Corporate Credit Unions ("Corporates"). To improve credit union access to correspondent services, the NCUA permitted the formation of Corporates in the 1970s to provide these services.[6] Corporates grew to play an important role in allowing credit unions to gain exposure to higher yield non-loan assets. This exposure came in the form of owning an equity-like position in a Corporate. Equity in Corporates was sold to members in two forms: paid-in capital and membership capital. Paid-in and membership capital have minimum duration requirements of three and twenty years, respectively, during which the credit union cannot sell its stake. The inability to adjust this position meant many credit unions locked in their exposure to the ABS market collapse long before it occurred.

[4] For example, members of the Anoka Hennepin credit union must have ties to one of several Minnesota counties. There are also credit unions for IMF employees, Chicago firefighters, and teachers in the Duluth school district. See Table D.16 in Appendix A for a breakdown of credit union affiliations in 2009 Q1.

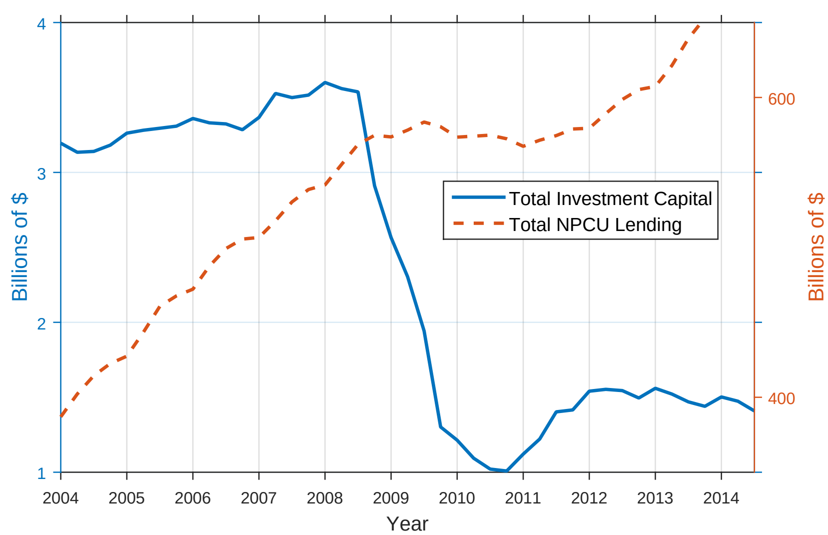
[5] The Federal Credit Union Act defines the securities in which credit unions can invest, prohibiting the holding of some risky securities. NCUA regulations 12 C.F.R. §703.14 and §703.16 outline permissible and prohibited investments, respectively.

[6] These services include securities safekeeping, electronic payment services, and automatic settlement. Small banks typically rely on large commercial banks for such services.

Credit Union Asset Losses During the Great Recession. Some Corporates gained significant exposure to private label ABS in the early 2000s. While some Corporates fully avoided these assets, others held as much as 41% of their balance sheet in private label ABS alone by 2006.[7] During the 2007-2009 collapse of the ABS market, Corporates experienced nearly $30 billion in total unrealized losses while having $2.4 billion in retained earnings between all Corporates. During 2005-2010, $5.6 billion of these losses were passed on to credit unions through their equity positions in Corporates, while an additional $1.4 billion in special assessments was levied on credit unions by the NCUA to cover Corporate losses. These special assessments were charged in proportion to each credit union's share of insured deposits relative to all deposits insured by the NCUA. By the end of the crisis, several Corporates failed and were liquidated.

Following Ramcharan et al. (2016), I define "investment capital" as the sum of paid-in and membership capital less the special assessments. This variable captures both types of variation in Corporate-related losses passed on to credit unions. Figure 1 plots the total value of investment capital owned by credit unions as well as the total value of loans owned by credit unions. Total credit union lending slowed in 2008 and plateaued by 2009 until 2012. Prior to the ABS market collapse, credit union lending was around $40 billion per year (see Figure 1, right axis). The slowdown in loan originations coincides with the large decrease in investment capital.

Figure 1: Investment Capital and Lending



Notes: This graph plots the sum of all membership and paid-in capital at corporate credit unions owned by credit unions less assessments levied by the NCUA (left y-axis). The right y-axis is total lending by all credit unions.

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[7]See Tables D.17 and D.18 for more information on Corporates' balance sheets.

3.2 Data

The main source of credit union data for the analysis are the NCUA's 5300 Call Reports. Every quarter since 2004, credit unions file detailed financial reports.[8] The NCUA data report loan originations year-to-date, both in terms of total lending and separately for 30-year fixed-rated mortgage lending. Additionally, the number and volume of both lending measures are available, making it possible to decompose the contribution of the intensive and extensive margins of total lending. Summary statistics for the NCUA and other datasets described below are available in Appendix Tables A.1, A.2, and A.3.

The NCUA data include total credit union assets and the variables needed to measure investment capital. In addition to these main variables, the NCUA data also contain other useful measures. The NCUA data include the total number of members, which is a useful measure of size in that membership counts are less correlated with local and aggregate business cycles than total deposits or total assets. Measures such as loan loss allowances and the net worth ratio help account for the initial financial health of the credit union, prior to asset losses. Lastly, the reports contain a "low-income credit union" (LICU) flag if more than 50% of the creidt unions members are low-income.

Monetary Policy Data. This paper's measure of the policy rate is the two-year Treasury rate. I use quarterly Treasury rates to match the frequency of the credit union call report data. An advantage of using the two-year rate is that two years is roughly the horizon at which the Fed's forward guidance policy operates (Bernanke, Reinhart and Sack, 2004; Gürkaynak, Sack and Swanson, 2005; Swanson and Williams, 2014; Hanson and Stein, 2015). This makes the two-year Treasury rate better able to capture the effect of policy announcements on *both* current rates and the expected path of future rates (the "target" and "path" factors, respectively, in the terminology of Gürkaynak, Sack and Swanson, 2005). This is especially important for the Great Recession, as the the federal funds rate reached the zero lower bound in 2008, after which forward guidance became an increasingly important part of the approach to monetary policy. Here, monetary surprises are constructed from the daily change in one-month Fed Funds futures contract prices on days when the Federal Open Market Committee (FOMC) makes monetary policy announcements. Section 4 provides further detail on the construction.

Additional Data. I use several additional covariates to control for local economic conditions in the empirical analysis. I obtain quarterly county-level unemployment rates for all states and Puerto Rico from the Bureau of Labor Statistics. I use quarterly CBSA-level

[8] Data are available back to 1994, but prior to 2004 some credit unions only appear in the sample with a semi-annual frequency. The credit unions reporting every quarter tend to be larger than those that reported semi-annually.

house price indexes produced by the Federal Housing and Finance Agency (FHFA).[9] To capture housing market distress, I also use quarterly county-level measures of the delinquent share of mortgage debt.[10]

Table A.3 provides summary statistics for these control variables. Importantly, these county-level controls are uncorrelated with the asset losses implied by changes in investment (see Appendix Table E.21). This is consistent with variation investment capital losses *not* being driven by local economic conditions, but instead the credit union's idiosyncratic exposure to ABS through Corporates.

4 Empirical Strategy

4.1 Estimation Approach: Two-Stage Least Squares (TSLS)

I estimate the causal effects and interaction of asset losses and conventional monetary policy on lending using two-stage least squares (TSLS). The second-stage equation is

$$\begin{aligned}\Delta \ln L_{i,t} = \beta_1 \Delta R_{t-1} + \beta_2 \Delta \ln A_{i,t-1} + \beta_3 \left(\Delta R_{t-1} \times \Delta \ln A_{i,t-1}\right) \\ + \tau \text{ Year}_t + \kappa_i + \gamma \text{ Quarter}_t + \zeta X_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{1}$$

where $\Delta \ln L_{i,t}$ is the quarterly change in a log loan originations for credit union i over periods t and $t-1$. The first explanatory variable (ΔR_{t-1}) is change in the two-year Treasury rate from period $t-2$ to $t-1$. The second explanatory variable ($\Delta \ln A_{i,t-1}$) is the change in credit union i's logged total assets $\Delta \ln A_{i,t-1}$ from period $t-2$ to $t-1$. When the coefficient on the interaction term (β_3) is positive, it implies lending is more sensitive to the policy rate when a credit union experiences asset losses. A positive β_3 also implies that changes in assets have a weaker effect on lending in a low policy rate environment. The specification includes year and credit union fixed effects as well as quarter fixed effects to account for seasonality. Time-varying credit union and country-level controls ($X_{i,t}$) help improve the precision of estimates.

There are three first-stage equations, corresponding to both endogenous variables and their interaction. Letting $Z_{i,t}$ denote a 3×1 vector the endogenous regressors, the first-stage equation is

$$\begin{aligned}Z_{i,t} = \alpha_1 \Delta \widetilde{R}_{t-1} + \alpha_2 \Delta \ln C_{i,t-1} + \alpha_3 \frac{C_{i,t-2}}{A_{i,t-2}} + \alpha_4 \left(\Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}\right) \\ + \alpha_5 \left(\Delta \widetilde{R}_{t-1} \times \Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}\right) \\ + \widetilde{\tau} \text{ Year}_t + \widetilde{\kappa}_i + \widetilde{\gamma} \text{ Quarter}_t + \widetilde{\zeta} X_{i,t} + \nu_{i,t}\end{aligned} \tag{2}$$

[9] For credit unions located outside of metropolitan and micropolitan statistical areas I use the FHFA's state-level measures of house prices.

[10] This data is aggregated to the county-level from individual records data in the Federal Reserve Bank of New York's Consumer Credit Panel. I thank John Mondragon for sharing this aggregate data.

where each α term is a 3×1 vector of first-stage coefficients.

In total there are five instruments. The first is the quarterly sum of Fed Funds future price changes within a narrow window of FOMC announcements ($\Delta\widetilde{R}_{t-1}$).[11] The next three instruments capture variation in investment capital. This includes $\Delta \ln C_{i,t-1}$, which is the log change in investment capital. Next is $\frac{C_{i,t-2}}{A_{i,t-2}}$, which is the share of assets comprised by investment capital. The fourth instrument is the product of these two investment capital measures ($\Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}$). Intuitively, this fourth instrument corresponds to an imputation of the percentage change in log assets induced by a change in investment capital. The last instrument is the product of the first and fourth instruments: $\Delta\widetilde{R}_{t-1} \times \Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}$.

The usefulness of including both the second and third instruments is primarily that it makes it possible to capture independent variation in both a credit union's exposure ($\frac{C_{i,t-2}}{A_{i,t-2}}$) and the shock to the value of its investment capital ($\Delta \ln C_{i,t-1}$). It also makes the specification more flexible. Both of these reasons allow for potentially a more powerful first stage. Testing for over-identification is important when the number of instruments exceeds the number of endogenous regressors, and I detect no evidence that the system is over-identified (see Table C.11).

OLS estimation of Equation (1) would likely be biased. Because monetary policy responds to macroeconomic trends – lowering rates at times when lending also declines – OLS estimates of β_1 would likely be biased upwards. Additionally, local economic trends may impact both local loan demand and a credit union's assets through default/delinquency, biasing OLS estimates of β_2 upwards. OLS estimates of β_3 would also likely be inconsistent, but the expected sign of the bias is less obvious. Because lending, Treasury rates, and assets are procyclical, and because most of the in the sample comes from a time when lending was slowing, OLS estimates are likely biased downwards.[12]

It is important to instrument for the Treasury rate and not only asset losses in order to ascertain whether monetary easing is *causing* differential sensitivity to asset losses. Only instrumenting for asset losses would make it difficult to rule out that differences in lending's sensitivity to asset losses is not due to, for example, greater cyclical sensitivity (Kashyap and Stein, 2000).

Throughout, I two-way cluster standard errors by credit union and time (year-quarter). Clustering by time is important because the Treasury rate and the monetary surprises ($\Delta\widetilde{R}_{t-1}$) only vary by time. I also cluster at the credit union level because assets losses

[11]These "monetary surprises" are constructed as in Kuttner (2001). Similarly to Cochrane and Piazzesi (2002), Tang (2015), and Wong (2019), I sum the shocks to a quarterly frequency.

[12]Bias in OLS estimates of β_3 is negative if $\mathbb{E}(\Delta R_{t-1} \times \Delta \ln A_{i,t-1} \times \varepsilon_{i,t}) < 0$. When would this be the case? Note that because lending, Treasury rates, and assets tend to be procyclical, when lending is growing we should expect: $\mathbb{E}(\Delta R_{t-1} \times \Delta \ln A_{i,t-1} \times \varepsilon_{i,t} | \varepsilon_{i,t} > 0) > 0$. However, when lending is declining, we instead expect $\mathbb{E}(\Delta R_{t-1} \times \Delta \ln A_{i,t-1} \times \varepsilon_{i,t} | \varepsilon_{i,t} < 0) < 0$. Thus in principle, this bias could go either way. But if the sample disproportionately contains time periods during which lending is depressed, then OLS estimates of the interaction would have a negative bias. Comparing this paper's TSLS estimates with their OLS counterparts suggests that the OLS bias is indeed negative in this analysis.

vary at the credit union level.

4.2 Identification

The key identifying assumptions for the TSLS framework are that changes in investment capital and the Fed Funds "surprises" are exogeneous with respect to other factors that affect lending. More concretely, this means that these shocks are uncorrelated with local loan demand, credit union characteristics, and macroeconomic trends. Moreover, the exclusion restriction requires that the instruments only affect lending through the two-year Treasury rate and credit union assets. Next, I discuss the plausibility of these assumptions.

Identifying the Effect of Asset Losses. The inflexible nature of investment capital and the idiosyncratic drivers of credit union exposure make it plausibly exogenous (as noted in Ramcharan, Van den Heuvel and Verani, 2016). Paid-in and membership capital have minimum duration requirements of three and twenty years, respectively, during which the credit union cannot sell its stake. The inability to adjust this position meant many credit unions locked in their exposure to the ABS market collapse long before it occurred.

Given the limited ability for a credit union to adjust its exposure to a Corporate, the choice of Corporate was a key determinant of the impact of the ABS market collapse on a given credit union. A credit union's ABS exposure ultimately depended on the their choice of Corporate and that Corporate's decisions. The variation in investment capital is akin to that of a "shift-share" or Bartik-style instrument. The impact of an aggregate shock – the collapse of the ABS market – on a credit union depends on that credit union's idiosyncratic exposure to ABS through its investment in a Corporate.

Credit union exposure to the ABS market collapse depended on several of the Corporate's decisions. Corporates with more investment in private-label ABS experienced greater losses. Some Corporates held no private-label ABS in the run-up to the Great Recession, while one held as much as 41% of its assets in private-label ABS by 2006 (see Appendix Tables D.17 and D.18 for Corporate balance sheet data). Second, variation in Corporate capital structure affected the pass-through of ABS-related losses to investment capital. Corporates with less leverage had more equity to absorb a given loss, lessening the impact on credit unions. Third, for a given asset loss and capital structure, a credit union with a relatively smaller share of ownership experienced would experience less pass-through. The relative share of ownership depends on both the credit union's initial investment decision, often long before the Great Recession, and the past decisions of many other credit unions.

Importantly, Ramcharan et al. (2016) notes that credit unions had little influence on Corporate investment practices, and that managerial idiosyncrasies led to significant variation in ABS exposure. In particular, investigations after the crisis identified failures of corporate governance and misrepresentation of financial risks by sellers of ABS as central drivers of ABS-related losses. Additionally, the choice of Corporate was historically driven by geography, with Corporates being limited to serving credit unions located in a specific state or region up until the late 1990s (NCUA, 2009; Ramcharan, Van den Heuvel and Verani, 2016).

Several tests yield evidence consistent with the assumption that investment capital is exogenous with respect to credit union lending. First, at the credit union level, investment capital is uncorrelated with local economic characteristics such as the unemployment rate, house prices, and mortgage delinquency rates (see Appendix Table E.21). Second, one set of placebo tests finds no differences in the sensitivity of credit union lending to the policy rate over 1994 to 2001 among credit unions that went on to later experience larger versus smaller investment capital losses (Appendix Table C.14). Third, another set of placebo tests finds that investment capital losses in the crisis do not predict different lending growth rates among credit unions over 2004 to 2007 (Appendix Table C.15).

Identifying the Effect Conventional Monetary Policy. I construct monetary surprises using high frequency data on one-month Fed Funds futures prices. These contracts pay the average of the effective Fed Funds rate over the contract period. On the d^{th} day of a contract that settles at the end of a month with M days, its price should reflect market expectations of the Fed Funds rate for the remaining $M - d$ days. As in Kuttner (2001); Gürkaynak, Sack and Swanson (2005); Tang (2015); Gorodnichenko and Weber (2016); Nakamura and Steinsson (2018); Wong (2019), I calculate monetary surprises as

$$\mu_t = \frac{M}{M-d}(f_t - f_{t-\Delta t})$$

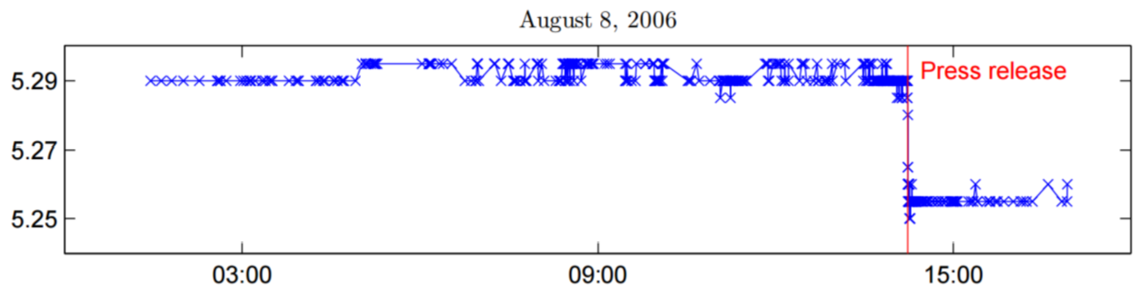
where f_t is the futures contract price after the day t announcement and $f_{t-\Delta t}$ is the price shortly before the announcement. Similarly to Cochrane and Piazzesi (2002) and Wong (2019), I sum these shocks to a quarterly frequency to obtain a quarterly measure of monetary surprises.[13]

The key identifying assumption of this high frequency approach is that movements futures prices in this narrow window around FOMC announcements are uncorrelated with the state of the economy.[14] Intuitively, the idea is that the price just prior to the announcement reflects investor information on the current state of the economy. The price change shortly after the announcement reflects changes to investors' beliefs about the level and path of Fed Funds rate. Identification relies on the assumption that during the announcement, futures prices are responding to unexpected changes in the stance of monetary policy, not other news about the economy. Figure 2 displays an example of tick-by-tick Fed Funds futures price behavior around an FOMC announcement.

[13] Wong (2019) documents that the statistical properties of the raw and quarterly shocks are similar.

[14] When aggregating to a quarterly frequency, identification relies on the assumption that these shocks are uncorrelated with the state of the economy during that quarter Wong (2019).

Figure 2: Fed Funds Futures Surprises



Notes: This figure is reproduced from Gorodnichenko and Weber (2016). The plot displays tick-by-tick prices for Fed Funds futures contracts traded on the Chicago Mercantile Exchange Globex electronic trading platform on a day where an FOMC announcement occurred (the vertical line).

Sample. As in Gertler and Karadi (2015), I truncate my sample at the end of 2011.[15] Even after the federal rates rate target reached zero in December of 2008, the ZLB was not a constraint on the FOMC's ability to influence the two-year rate until 2012 at the earliest (Swanson and Williams, 2014; Gilchrist, López-Salido and Zakrajšek, 2015).

5 Results: The Impact of Asset Losses and Monetary Policy on Lending

This section presents the main results which investigate how the response of an individual credit union's lending to conventional monetary easing is altered by asset losses. These regressions estimate the effect of changes in the policy rate and asset losses on a variety of measures of loan originations. Results of estimating the baseline model

$$\begin{aligned}\Delta \ln L_{i,t} = \beta_1 \Delta R_{t-1} + \beta_2 \Delta \ln A_{i,t-1} + \beta_3 \left[\Delta R_{t-1} \times \Delta \ln A_{i,t-1}\right] \\ + \tau \text{ Year}_t + \gamma \text{ Quarter}_t + \kappa_i + X_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{1}$$

are discussed for both the total volume of all loan originations and originations of fixed-rate 30-year mortgages. Table C.9 summarizes the economic meaning of the regression results discussed within this section. A cutoff rule is applied for each subsample associated with a given dependent variable to remove outliers.[16] Throughout, I two-way cluster standard errors by year-quarter (time) and state. It is especially important to cluster by time as one independent variable (the policy rate) only varies over time. The inclusion of

[15] An additional reason one may have to make this same truncation when studying credit unions is that a number of corporate credit unions that became insolvent during the crisis were officially shut down in 2012 and a number of new regulations were introduced by the NCUA affecting both corporate and natural person credit unions that affected incentives to raise or acquire paid-in and membership capital.

[16] Generally the omitted observations come are those of credit unions that are extremely small or in extremely poor financial health. The most extreme 5% of changes in logged loan originations for each different measure, large or small, are dropped. That is, the 2.5% largest and 2.5% smallest are omitted. I drop credit unions whose logged changes in total assets is in the most extreme 1%. Lastly, I impose the same 5% cutoff rule to logged changes in investment capital and the net worth ratio. I also drop credit unions below the 7.5$^{\text{th}}$ percentile of members.

this variable rules out the possibility of including a time fixed effects. This means that it is likely the error term contains unobserved factors that only vary over time. While these latent factors are assumed uncorrelated with the instrumental variables, which implies estimator consistency, the standard errors will overstate the statistical significance if we do not allow for the residuals to be correlated within each time period. It is also reasonable that there are unobserved NPCU-specific or region-specific characteristics varying over time that also influence lending growth. Therefore I also cluster along the state dimension, which allows for an even more general correlation structure than also clustering by credit unions alone.

The key finding is that asset losses ($\Delta \ln A_{i,t-1} < 0$) increase the positive effect of conventional monetary easing ($\Delta R_{t-1} < 0$) on loan origination growth. Using data on the number of loan originations for both of these groups, I also find that the extensive margin plays a central role and that conventional monetary easing induces substitution towards fixed-rate 30-year mortgages and compared to other types of loans. Next I describe these results in more detail and augment the baseline specification with additional controls. Additional robustness checks are documented in section 6.

5.1 Total Lending

Tables of the regression results discussed throughout this section are available in Appendix C1. Column 1 of Table C.4 displays estimates for the baseline model (which includes year, quarter, and credit union fixed effects) estimated for total loan originations. Generally the estimates of β_1 and β_3 are significant at the 1% and 5% levels (respectively).The estimate of β_2 is statistically insignificant in these specifications when total lending is the dependent variable. Overall the coefficients remain similar with the inclusion of credit union and county-specific control variables and are no less precisely estimated.

The β_2 estimates do become significant when clustering standard errors by *state* and time rather than *credit union* and time. The former may be preferable as it allows for a more general correlation structure – specifically that unobserved determinants of lending within a region are correlated across time. But 50 clusters is the near the minimum number generally accepted as adequate for assuming that estimation yields a good approximation of the asymptotic covariance matrix, meaning one could under or overestimate the standard errors with too few clusters. Given this, I find it more conservative to cluster by credit union and time as these standard errors are most often (but not always) larger throughout the main results. Given this, I also discuss the economic implications of assets losses under the possibility that β_2 is the causal effect of assets losses when there is no change in the policy rate.

The first finding is that conventional monetary easing increases total lending growth ($\beta_1 < 0$). A 10 basis point decrease in the policy rate, holding fixed a credit union's assets, leads to an additional 0.86 percentage points of lending growth. This is large compared to the median growth rate of -1.38%. Asset losses, on the other hand, reduce lending ($\beta_2 > 0$).

A one standard deviation asset loss ($\Delta \ln A_{i,t-1} =$ -1.65%) reduces total lending growth 3.20 percentage points.

The positive interaction term implies that asset losses reduce the sensitivity of lending to the policy rate ($\beta_3 > 0$). The same 10 basis point reduction in the policy rate leads to a 1.15 percentage point rise in loan origination growth when a credit union experiences a 1.65% asset loss. This is 29 additional basis points compared to the response of lending when assets are unchanged. The positive interaction term also implies monetary easing can do more than offset the destructive effects of asset losses on lending growth, it can also reduce a credit union's sensitivity to asset losses. A 1.65% asset loss lowers lending growth by 2.91 percentage points, instead of 3.20, when the policy rate also falls 10 basis points as opposed to when it is unchanged. This number is exclusive of the offsetting, direct effect of lowering the policy rate. The combined effect of a 10 basis point reduction in the policy rate and a 1.65% asset loss lowers lending growth 2.05 percentage points.

How important is this additional benefit of monetary easing? We can compute the amount of the stimulative effect of monetary policy due to its ability to reduce sensitivity to asset losses as

$$\frac{(\beta_3 \Delta \ln A_{i,t-1})\Delta R_{t-1}}{(\beta_1 + \beta_3 \Delta \ln A_{i,t-1})\Delta R_{t-1}}.$$

About 28% of stimulated lending growth is due to the reduced sensitivity of lending to asset losses for 1.65% asset loss. The relative role of this channel is increasing (at a decreasing rate) in the magnitude of the asset loss as $\beta_3 > 0$. To get a sense for how much this role varies, one can compute that a reduced sensitivity to asset losses accounts for 51% and 67% of the stimulative power of conventional monetary policy when asset losses are 5% and 10%, respectively. Thus the importance of this channel is increasing in the severity of the financial crisis.

Another way to gain a sense of how strongly the policy rate and asset losses influence lending is to compute the implied policy rate change necessary to undo a typical asset loss. If during one quarter a credit union has a 1.65% asset loss, it takes an exogenous 29 basis point change to undo this loss. This may appear small, but there are two useful caveats to consider. This is the necessary policy action to offset only one quarter's worth of asset losses. Additionally, we cannot immediately compare this to the typical 25-50 basis point movements in the Fed Funds target rate as it is likely that only a small portion of those announced target changes are typically exogenous. The average negative quarterly futures surprise is -0.10 and the first stage of the estimation suggests that this is associated with a 15 basis point decrease in the two-year Treasury rate. This suggests it takes roughly twice the typical policy rate change induced by surprises during FOMC announcements to undo the effects of a typical asset loss.

Adding Additional Controls. Columns 2-7 of Table C.4 add additional controls to the baseline specification. Columns 2-4 augment the baseline specification to include the county-level unemployment rates, growth in log house prices, and the mortgage delinquency rate. Generally the point estimates become slightly larger upon including these variables. Due to data limitations, about 15,000 observations are lost when including the mortgage delinquency rate. These observations tend to come from credit unions in more rural communities, where credit unions tend to be smaller. The higher point estimates may be due to this selection towards larger credit unions, which tend to be more responsive to monetary easing (I discuss this in further detail in a robustness check in section 6.1). The coefficients on these controls are statistically insignificant.

Columns 5-7 add to the baseline specification by conditioning on several time-varying credit union characteristics. These variables do not have a statistically significant effect on the volume of lending. The first characteristic is the logged number of a credit union's members ($\ln members_{i,t-1}$), which reflects the size of a credit union. An advantage of this measure (compared to deposits or total assets) is that it has less cyclical variation. The net worth ratio, $\frac{\text{Net Worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$, reflects the financial health of the credit union. This ratio is measured as net worth to total assets and captures how well-capitalized a credit union is.[17] The difference of logged loan loss allowances ($\Delta \ln \text{LLA}_{i,t-1}$) reflects perceived repayment risk. Loan loss allowances are cash set aside to cover future losses on loans. Therefore, this variable reflects a credit union's expectations of near-term lending conditions and default probabilities.

First Stage and OLS. The first stage of the TSLS estimation and the OLS analogs of the main results overall support the validity of the identifying assumptions. These estimates, along with the standard statistics testing for over and under-identification with multiple endogenous regressors, are displayed in Appendix C2.

Table C.10 reports the first-stage estimation results associated with the baseline specification for total lending.[18] As one would expect, the coefficient on the Fed Funds futures surprises is positive when the dependent variable is the change in the two-year Treasury yield; it is also highly statistically significant. Column 2 shows that there is no statistically significant effect of investment capital on assets when it constitutes 0% of assets. The two interacted instruments and the share of investment capital in total assets are all statistically significant. This column implies that the average change in investment capital (-1.25 percentage points) is associated with a 0.44 percentage point decrease in total assets.[19] Lastly,

[17]In the NCUA data, net worth is defined as the sum of undivided earnings, regular reserves, appropriation for non-conforming investments, other reserves, uninsured secondary capital, and net income. This ratio is one of two used to regulate credit unions and banks. A ratio exceeding 6% implies adequate capitalization, to be well-capitalized it must exceed 7%. The average ratio for the panel I consider is 13%. The corresponding ratios for bank holding companies are 4% and 5% (respectively).

[18]The first stage of the TSLS estimation consists of essentially the same three regressions across all specifications discussed in this paper. The excluded instruments change when additional controls are added and the sample varies slightly based on data availability for the dependent variable. Point estimates for the first stage are similar, as one would expect, across the other specifications. The implications of test statistics are unchanged across specifications too

[19]This is computed using the statistically significant interaction terms in the first stage, the average Fed

the third column shows that the triple interaction term is positively related to the interaction between the Treasury yield and the change in assets with statistical significance at the 10% level.

Tests for weak, under, and over-identification are in Table C.11. With multiple endogenous regressors, two separate tests are used to detect weak and under-identification. This is in contrast to the single endogenous regressor case in which only a single statistic (the first-stage F-statistic) is necessary to test for both weak and under-identification (Stock and Yogo, 2005). Overall the tests are indicative of valid instruments.

In the context of multiple endogenous regressors, under-identification refers to a zero correlation between the instruments and the endogenous regressors. Because standard errors are two-way clustered by credit union and year-quarter, the heteroskedasticity-robust Kleibergen-Paap Lagrange multiplier is the appropriate test statistic for assessing if the instruments are correlated with the endogenous regressors. Under-identification is rejected at the 0.01% level.

Testing for weak identification specifically is also important as a nonzero but weak correlation between the instruments and endogenous regressors can bias TSLS estimates significantly towards their OLS analogs. With i.i.d. standard errors, the statistic for testing for weak identification is the Cragg-Donald Wald statistic. Critical values for the heteroskedasticity-robust analog, the Kleibergen-Paap Wald statistic, are not available. Standard practice is to compare this statistic to the Cragg-Donald Wald critical values even though the implied p-values are not asymptotically correct (Bazzi and Clemens, 2013). The null hypothesis of this test is that the maximal bias due to instrument weakness exceeds 10%. The obtained statistic of 5.26 recommends rejecting weak identification at the 20% level.

While the weak identification test does not lend much support to the absence of weak instruments, comparing the TSLS estimates to the biased OLS estimates (see Table C.12) suggests that at worst TSLS estimates understate the magnitude of the three coefficients of interest. Weak instruments bias TSLS estimates towards their OLS counterparts. Thus the fact that the magnitude of the coefficients is either smaller (the case for the policy rate and changes in assets) or the opposite sign (the interaction term) recommends treating the TSLS estimates as lower bounds in terms of magnitude.

5.2 Mortgage Lending

Next I restrict attention to originations of fixed-rate 30-year mortgages. Mortgages are approximately 35% of credit union lending by volume, the largest lending category among credit unions.[20] Overall I find that mortgage lending is much more sensitive to both asset losses and changes in the policy rate on average, but the relative effects on sensitivity of

Funds futures shock of -0.04 and the average, and the average share of investment capital in total assets (0.78%).

[20]See Figure A.2 in Appendix A.

one of these shocks to the other is similar compared to total lending.

Given the central role of housing and mortgage markets in the Great Recession, it is valuable to be able to consider this variety of lending separately. A reduction in mortgage credit supply in particular can reduce demand through two channels. First, restricted credit supply in general will lead to lower consumption expenditures. But housing is special in that housing net worth comprises a substantial share of most household's net worth.[21] Thus an initial fall in demand can lead house prices to fall and reduce the wealth of households already owning a home. In addition to the pure wealth effect of this loss, the lost collateral value of one's home can limit access to finance a further depress consumption (Berger, Guerrieri, Lorenzoni and Vavra, 2017; Mian, Rao and Sufi, 2013).

The estimation results in Table C.5 suggest that monetary policy significantly affects mortgage lending and that asset losses can significantly alter this sensitivity. A 10 basis point reduction in the policy rate predicts a 4.44 percentage point fall in mortgage origination growth. The impact of this policy on mortgage growth rises to 5.88 percentage points when a credit union has a one standard deviation (1.65%) asset loss. In absolute terms, this rise in the growth rate of 1.44 percentage points is much larger than the 0.29 gain estimated for total lending. However, the relative effect is similar: this same asset loss increases the response to the policy rate by about 30%.

Asset losses do not have a statistically significant effect on the volume of mortgage lending growth. However, as the next section discusses in detail, asset losses do have a large and significant impact on the *extensive* margin of mortgage lending. It is plausible that asset losses, which bring a credit union closer to its regulatory capital minimums, could induce the credit union to be more cautious in its lending. A credit union may become more willing to deny loan applications of riskier low-income borrower who typically demand smaller mortgages and accept a potentially lower-return but safer high-income borrowers. This change in borrower composition could offset the fall in loan volume induced by originating fewer, but larger mortgages.

5.3 Extensive vs. Intensive Margins

Decomposing the response of lending into the number and size of loans suggests that lending primarily responds to both changes in the policy rate and asset losses along the extensive margin. Table C.6 reports regressions of the logged quarterly difference in the number of new loan originations of all types in columns 1-4 and those for the the logged change in the average size of the loans originated in columns 5-8. The same controls as well as year, quarter, and credit union fixed effects are used as in the previous analyses. Table C.7 reports analogous regressions for the number and average size of all fixed-rate 30-year mortgages originated.

Table C.6 suggests that both margins are important, especially the intensive margin,

[21] See Figures A.1 and A.2 in Appendix A.

for total lending. Here a 10 basis point decrease in the policy rate leads to a 0.32 and 0.69 decrease in the growth rate in the volume and size of loans, respectively. In contrast to total lending, the response of mortgage lending is borne out almost entirely by the extensive margin (Table C.7). The extensive margin appears to account for the entire response of mortgages and the point estimates for mortgage sizes are much smaller. A 10 basis point decrease is associated with a 4.34 rise in the growth rate of the number of mortgage originations.

Asset losses affect total and mortgage lending along the extensive margin and only affect the sensitivity of the extensive margin to changes in the policy rate. The coefficients are large and significant for both the extensive margin of total and mortgage lending. The interaction term is also only statistically significant for the extensive margin and the point estimate is small for average mortgage size.

What can rationalize these stark differences in the role of the intensive margin for total and mortgage lending? One explanation is that monetary easing induces substitution towards mortgages and away from other forms of lending. If this were the case, a shift towards issuing fewer loans overall but larger ones like mortgages could make the intensive margin overall appear more important. Table E.19 in the online appendix shows that this composition change does in fact occur. A 10 basis point policy rate reduction increases the share of mortgage originations in the total volume of loan originations by 2.80 percentage points. Interestingly, this response is also strengthened by asset losses.

It is also plausible that there are two offsetting effects from conventional monetary easing or asset losses on loan size. Following a fall in the policy rate, a credit union may offer larger loans than it would have otherwise. But it may also lend to more people who seek smaller loans that would have otherwise not received them. If these marginal borrowers were low-income/wealth they may seek smaller, easier to repay loans. A credit union may perceive these borrowers as too risky unless the cost of capital is sufficiently low or their balance sheet sufficiently strong. Therefore we cannot entirely rule out that the intensive margin does not respond in a meaningful way as borrowers may receive larger loans than they would have otherwise even though the average size of loans made by the credit union does not change.

5.4 Mortgage Interest Rates

Another important stimulative effect of conventional monetary policy is to lower the interests rate paid by private borrowers. Using data on the common interest rate charged on fixed-rate 30-year mortgages, I find not only do decreases in the policy rate translate to lower mortgage rates, but that asset losses also amplify this channel (see Table C.8).[22] These signs are also predicted by the second model discussed in section 2.[23]

[22] The common rate is the modal rate charged on new originations within the quarter.

[23] In general, if a model (1) is consistent with the signs found for $\{\beta_1, \beta_2, \beta_3\}$ in the main analysis of the volume of lending and (2) has an equilibrium interest rate that depends negatively on the equilibrium quantity

Interest rate pass-through is incomplete, a feature also found in FDIC Call Report data by Scharfstein and Sunderam (2016) between MBS yields and interest rates on refinanced mortgages. I find that a 10 basis point reduction in the policy rate leads to a 1.74 basis point decrease in the mortgage interest rates charged by credit unions, holding assets fixed. The same conventional monetary easing also leads to a larger 2.70 basis point reduction when a credit union experiences a 1.65% asset loss.

In most of the specifications, the strong, positive effect of asset losses on mortgage interest rates is statistically significant. Thus not only can asset losses induce a credit crunch in the sense of restricting the quantity of credit supplied, but another contractionary effect could also be increasing interest rates. With no changes in the policy rate, a 1.65% asset loss leads credit unions to increase mortgage interest rates 3.56 basis points. With 10 basis points of monetary easing, the same asset loss only causes a 2.61 basis point rise in mortgage interest rates. There are significant compared to the average quarterly change of 2.35 basis points.[24]

6 Robustness and Interpretation

This section presents additional evidence supporting the results of the previous section. First, adding additional interactions between the policy rate and lenders/county characteristics has little effect on the estimated interaction between policy rate changes and asset losses. Further, these results suggest that asset losses a relatively important source of heterogeneity in monetary transmission. Second, I investigate whether the effects on lending of monetary easing, asset losses, and their are a short-lived. I find that the effects of both of these shocks are extremely persistent, impacting lending for up to two to three years. Third, to address concerns that there may unobserved characteristics of credit unions that led them to both be exposed to large investment capital losses and have decreased lending growth, I use a placebo test. This test verifies that pre-crisis lending growth is not predicted by a credit union's subsequent investment capital losses during the recession. Lastly, this section concludes with a discussion of how the effects estimated in the previous section could differ under general equilibrium and limitations of external validity.

6.1 Alternative Sources of Sensitivity

The main findings are robust to the inclusion of additional interactions terms and overall asset losses are a relatively important determinant of the sensitivity of lending to monetary policy. I augment the baseline specification to include both the credit union and county-level control variables discussed earlier as well as interactions of these variables with the change in the policy rate. I instrument for these interactions for each control $X_{i,t}$ with the product of the control and the futures surprises (i.e., $X_{i,t} \times \Delta\widetilde{R}_{t-1}$). The robustness of the

of loans, then it must be that the coefficients for the regression with mortgage rates on the left-hand-side will have the opposite sign.

[24] The signs of these effects are to be expected in a model when equilibrium lending is negatively related to the equilibrium interest rate.

coefficient on the interaction of asset losses and the policy rate and its statistical precision in spite of the inclusion of these additional interactions suggests that the main results are not spuriously driven by these other determinants of loan demand.

Regression results for total lending and mortgage lending (for volume, number, and average size of originations) are available in Table C.13. The unemployment rate and house price growth do not appear to affect the sensitivity of credit union lending to monetary policy. On the other hand, the credit union characteristics do appear to affect lending's sensitivity to the policy rate. The first finding is that larger credit unions, measured by the log number of members, is associated with greater sensitivity to monetary policy. This is in contrast to Kashyap and Stein (1995), which found smaller banks, measured by total assets, to be more sensitive to the policy rate.[25]

Generally asset losses have a larger effect on the sensitivity of lending to monetary policy, but credit union size does appear to be an important determinant overall. Using the point estimates for the interaction between the policy rate and asset losses from these regressions, we can compare the additional impact of a 10 basis point policy rate decrease in the presence of a one standard deviation asset loss and increase in members. A one standard deviation increase in logged credit union members (1.46) corresponds to an additional 0.25 and 0.99 percentage points of total and mortgage lending growth (respectively) in response to a 10 basis point decrease in the policy rate. A 1.65% is associated with 0.20 and 1.53 additional growth for total and mortgage lending in response to the same shock. Size appears slightly more important in affecting sensitivity but the additional stimulative effect associated with asset losses on mortgage lending's response is more than 50% greater. Along the extensive margin, a standard deviation increase in size leads to 0.10 and 0.86 additional percentage points of total and mortgage lending growth (respectively) following a 10 basis point policy rate reduction. The additional stimulative benefits associated with a 1.65% asset loss are 0.20 and 1.21, respectively.

A lower net worth ratio is associated with enhanced sensitivity to the policy rate. This result is similar to the main findings of this paper and Kashyap and Stein (2000) in that it suggests by another measure of balance sheet quality, more financially impaired lenders are more sensitive to conventional monetary policy.[26] Following a 10 basis point drop in the policy rate, a one standard deviation (4.68 percentage points) decline in the net

[25]This difference may stem from my use of log members to measure size compared to their measure based on total assets. It is also possible that the relationship between size may be nonlinear, with lenders the size of large banks less sensitive compared to small banks, small banks more sensitive, and extremely small lenders less sensitive than small banks. Large credit unions are more similar in size to banks considered small in Kashyap and Stein (1995). The smallest credit unions, which are quite small compared to most small banks, may behave differently from small banks/large credit unions. It could also be that if the variation in assets they used to identify the effects on monetary policy was more related to valuation effects/asset losses than fundamental changes in "size", then their measure could have reflected asset losses rather than size.

[26]In contrast to the quarterly asset losses considered in the main analysis, net worth reflects more of a summary of overall financial health. Therefore it more accurately describes the history of many balance sheet shocks rather than a recent, single asset loss.

worth ratio is associated with 0.15 and 0.51 percentage points greater volume of total and mortgage originations (respectively). Along the extensive margin, growth in the number of mortgage originations responds with 0.54 further percentage points to this same monetary policy shock at a credit union with net worth one standard deviation lower.

Changes in loan loss allowances appear to influence the effect of monetary policy on the average size of loans. This variable is also related to asset losses and a credit union's financial health in that an increase suggests the credit unions anticipates *future* losses on assets. A standard deviation increase in log loan loss allowances (1.75) is correlated with 0.23 additional percentage points of average loan size growth. Section 5.3 presented evidence suggesting monetary easing affects the intensive margin of total lending by also stimulating a shift in loan composition towards mortgages. The findings of this section are consistent with perceptions of greater loan losses amplifying the composition switch towards mortgages in response to monetary easing.

While these additional findings have interesting implications for the determinants of lenders' responsiveness to asset losses and changes in the policy rate, we should remain slightly skeptical of these estimates. This is because we do not have reasons to believe that the unemployment rate, size, net worth, etc. are exogenous with respect to lending – unlike investment capital. However, these findings suggest it may be worthwhile for future research to more rigorously explore how, for example, expectations of loan losses differentially affect the stimulative power of conventional and unconventional monetary policy.

6.2 Persistence

To analyze the persistence of monetary policy shocks and asset losses, I separately estimate the baseline the baseline model for eleven additional horizons. Specifically, the dependent variable in these regressions is now $L_{i,t+\tau} - \ln L_{i,t-1}$, where $\tau =$ indicates the number of quarters ahead to which we are looking ($\tau = 0$ corresponds to the one-quarter horizon used in the main analysis). Overall, the effects of monetary easing persist about 1-2 years and the impact of asset losses persists about 2-3 years.

Generally the effect of policy rate changes on lending grows over the first year. For total lending, the largest effects are near the end of the 2$^{\text{nd}}$ year. While a positive impact for mortgage lending persists for about the same amount of time, the effect begins to diminish after the 1$^{\text{st}}$ year. We see a similar pattern of growing effect sizes for asset losses as well, with the response of mortgage lending now beginning to diminish after about two years. Interestingly, most of the effect on mortgage size manifests about a year after the asset loss. Lastly, the interaction term persists for about 2 years as well. This suggests monetary easing can shape a credit union's response to asset losses for long time (and vice versa).

6.3 Placebo Test

To give further evidence supporting the identifying assumption that investment capital losses are unrelated other determinants of lending, I perform a placebo test. One concern is that an unobserved characteristic of credit unions caused them to have high exposure to investment capital losses and also diminished lending growth. This could be the case if credit unions differ in their risk aversion and were aware that some CCUs were riskier than others. To the extent that this is a fixed characteristic, this addressed by the inclusion of a credit union fixed effect. But if, for example, preferences towards risk changed among credit unions shortly before the crisis, this could mean that the instruments based on investment capital are not truly exogenous with respect to lending.

Continuing with this example of attitudes towards risk, one might expect that credit unions that developed a greater appetite for risk to have to have significantly increased lending in the years leading up to the crisis. Additionally, if they were aware that investment capital was also a risky investment, they may have also had a stronger preference to seek exposure to this asset. This would be problematic for identification if this new preference for risk also led these credit unions reduce lending during the crisis. A reason why lending might fall during the crisis is less risk averse credit union may prefer to lend to riskier borrowers who loan demand fell relatively more during the financial crisis. In equilibrium this could result in lower lending among these credit unions.

This scenario gives us a testable prediction: lending growth was systematically different in the run-up to the crisis among credit unions that experienced different-sized asset losses. The expected sign is not obvious. It is possible that uncertainty was lower in the boom and therefore risk averse credit unions had a relatively stronger incentive to lend. It could also be that lower risk aversion led these credit unions to lend more aggressively if they were less worried about default risk overall.

To this end, I estimate a series of cross-sectional regressions of pre-crisis lending on asset losses during the Great Recession, instrumenting for these asset losses with changes in investment capital during the Great Recession.[27] The second stage of these regressions have the form

$$\Delta \ln L_i^{PC} = \beta \Delta \ln A_i^{TGR} + \phi \text{ FOM} + \lambda \text{ County} + \nu_i \tag{3}$$

where PC and TGR denote pre-crisis and the Great Recession, respectively. I consider a variety of windows for measuring defining the pre-crisis and Great Recession periods, which I describe in detail in Appendix C4 alongside the regression results. Since the regression is cross-sectional I can no longer include a credit union fixed effect. However, I can exploit within county and with field of membership variation by including fixed effects for these

[27] The full set of instruments used in these regressions are the log change in investment capital losses, the initial ratio of investment capital to total assets, and the interaction of these terms.

characteristics.

In support this paper's identification strategy, I find that future asset losses, instrumented for by investment capital losses, do not predict pre-crisis lending growth. Generally, the point estimates for the coefficients on future asset losses are small and statistically insignificant. Overall, this finding lends greater credibility to the assumption that investment capital is unrelated to other determinants of a credit union's lending.

6.4 General Equilibrium

A decrease in credit from credit unions may be offset in "local" general equilibrium by an increase in credit from other lenders, namely healthy credit unions and banks. This would mean the estimated effect of asset losses would *overstate* the equilibrium impact on credit. However, borrower switching would be unlikely for three reasons.

First, it is difficult to substitute between credit unions. Many credit unions have strict membership requirements. Typically, members must live within a certain county or have a particular employer (or be related to such a person). The difficulty in qualifying for membership at a different credit union makes it less likely that a potential borrower, already a member at one credit union, would be able to switch to another.

Second, it is unlikely members found it desirable to switch from credit unions to banks. Credit unions consistently offer more favorable rates to borrowers than banks.[28] This makes it less likely that the marginal borrower not receiving a loan at a credit union would instead obtain it from a bank. The competitive rates offered by credit unions make it reasonable that the marginal borrower may find it more profitable to wait out the credit crunch and then obtain a loan from their credit union. Overall, credit would decline and not merely shift to different providers. In fact, the market share of credit unions in auto and housing loans markets rose during and after the crisis (Ramcharan, Van den Heuvel and Verani, 2016). This suggests that this sort of substitution away from credit unions was not significant.

Recent work gives evidence that bank-borrower relationships are very persistent. These findings suggest, that at least over the course of a year or two, general equilibrium effects are unlikely to undo the predicted partial equilibrium effects of negative shocks to factors of credit supply. Chodorow-Reich (2014) finds that within syndicated lending, client-supplier relationships are extremely persistent for lead lenders and also persistent for non-lead lenders. This relationship is even stronger for smaller firms. Since most NPCU member business loans are for small businesses, NPCU borrowers would likely face similar difficulties in switching lenders. Greenstone, Mas and Nguyen (2015) also finds that a one-standard deviation fall in projected lending, as forecasted by pre-crisis county market share and national trends, for a particular lender predicts a 17% fall in county-level small business loan originations during 2009-2010.

[28]Credit unions are not-for-profit institutions and use their profits to offer higher deposit interest rates and lower interest rates on loans.

Third, most people tend to live nearby the banks from which they borrow.[29] Whatever frictions prevent households from borrowing at distant banks likely slow the process of searching for a new lender. If households apply to one bank for a loan but are denied, they must recommence a possibly costly search.

In terms of "global" general equilibrium, an initial credit crunch can amplify over time and trigger subsequent asset losses. Contractions in credit lead to lower demand for durables and non-durables, house prices, and employment (Mondragon, 2017). A decline in real economic activity can further depress asset prices and compound losses on creditor balance sheets. With these forces at play, the estimated coefficients would *understate* the the full equilibrium impact of asset losses on lending. Additionally, amplification over time could contribute to the persistent of the effect of asset losses on lending.

6.5 External Validity

Credit unions an important provider of consumer credit in the US. Therefore, this paper directly studies a major source of consumer credit. In terms of assets, credit unions appear small relative to many banks. As of March 2015, Credit unions owned $1.2 trillion in assets while US banks owned $15.8 trillion.[30] The average credit union owned $185 million in assets in March 2015 while the average US bank owned $ 2.5 billion.

By volume, credit unions provide 9.2% of consumer loans as of May 2015.[31] Banks and savings institutions accounted for 39.2% of non-revolving consumer consumer credit, financial companies another 20%, and the remaining 31.6 % of the market share goes to non-financial corporations. Although credit unions only owned 4.3% of US housing loans by value in 2010, they owned 17.6% of the *number* US housing loans at this same time. Additionally, credit unions accounted for 24.1% (by number) of auto loans.[32] Because credit unions are responsible for a large number of consumer loans, this means that studying the determinants of NPCU-supplied consumer credit speaks to the financial resources of a large population.

Credit unions and banks comove together and appear similar in a number of ways. Total US consumer credit and the amount owned by credit unions has a correlation coefficient of 0.87.[33] Credit unions and banks have consistently had similar net worth to assets ratios; as of March 2015 this ratio was 10.8 % for credit unions and 11.2 % for US banks on average.[34] The regulatory minimum for adequate capitalization under this ratio is 6% for credit unions and 4% for banks. The stricter capital requirements credit unions face may

[29] Amel, Kennickell and Moore (2008) find that the majority of households in the Survey of Consumer Finances obtain mortgages from banks within 25 miles of their home.

[30] This figure is from the Q1 2015 US Credit Union Profile produced by CUNA.

[31] This figure is from the May 2015 *Monthly Credit Union Estimates* produced by the Credit Union National Association (CUNA). Additionally, credit unions have consistently provided about 9-11% of consumer credit since the late 1980's.

[32] Market share calculations not made available in CUNA are computed from Flow of Funds data.

[33] Computed from monthly Flow of Funds data spanning January 2004 to May 2015.

[34] These figures are from the Q1 2015 US Credit Union Profile produced by CUNA.

make them more sensitive to asset losses compared to a similar bank.

Lending at credit unions is also more local. Credit unions are formed around a common association and thus members tend to live in the same region, often the same county. This is in contrast to banks which tend to draw on larger populations for depositors and lenders. Credit unions also tend to have fewer branches, making their lending confined to a much more narrow market. In March, the average credit union had only three branches while the average US bank had fifteen.[35] A potential limit for generalizing the findings of this study to banks is that in general equilibrium bank borrowers may be able to more easily switch to a different credit provider. Banks do not impose the same membership requirements and are generally at a competitive disadvantage compared to credit unions in terms of their interest rates. However, the evidence cited in the previous section regarding the local nature of banking suggests it is possible that policy rate changes and asset losses among banks could lead to reductions in the total amount of credit supplied.

7 Conclusion

This paper examined panel data on credit unions and found that asset losses are associated with a reduced sensitivity of lending to the Fed Funds rate. The effects of monetary policy are identified with the help of Fed Funds rate futures surprises. Variation in an asset unique to credit unions, investment capital, is used in constructing instruments for asset losses.

The main finding is that credit supply responds more to monetary easing among creditors experiencing an asset loss. A corollary to this finding is that conventional monetary easing also reduces the sensitivity of lending to asset losses. This is on top of the direct stimulative effect of lowering the cost of capital. Dampening the negative effects of asset losses on lending is an additional benefit of conventional monetary easing during a financial crisis. This particular benefit accounts nearly 30% of the stimulative effects of reducing the policy rate for typically asset losses, and the role of this channel grows with the size of asset losses. This suggests that conventional monetary policy is a useful tool for not only stimulating lending, but also for mitigating a consumer credit crunch brought about by asset losses.

Mortgage lending is relatively more sensitive to both the policy rate and asset losses. The benefit from monetary easing of reduced sensitivity to asset losses from monetary easing is especially large for mortgages as well. Asset losses also lead to larger mortgage interest rates, but the pass-through of policy rate changes to mortgage rates is also higher for credit unions experiencing an asset loss.

Breaking down the response of lending into its intensive and extensive margins for both total and mortgage lending suggest that monetary easing primarily operates along the extensive margin of lending but it can also induce compositional changes in the types

[35] Source: Q1 2015 US Credit Union Profile produced by CUNA.

of loans provided. Mortgage lending responds almost entirely to the policy rate along the extensive margin. The intensive margin appears most important when considering the response to total lending to the policy rate. But, monetary easing induces substitution away from other forms of consumer credit (student, auto, and credit card loans, mainly) and towards fixed-rate 30-year mortgages. This can largely account for the seeming importance of the intensive margin for total lending. Credit unions do not offer larger loans within lending categories but switch to providing types of loans which are generally larger.

Robustness checks support the importance of the interaction between asset losses and conventional monetary policy and the identifying assumptions used to estimate their effects. It appears that asset losses are a relatively important determinant of sensitivity to monetary policy compared to other regional and credit union characteristics. Additionally, both asset losses and monetary policy have persistent effects on credit union lending. It takes slightly more than a year for loans originations to return to their pre-shock level following either a policy rate change or asset loss. Lastly, a placebo test provides evidence that investment capital losses during the Great Recession were unrelated to pre-crisis lending growth. This suggests credit unions that ended up experiencing these losses did behave in a systematically different way prior to the crisis.

Another implication of these findings is that conventional and unconventional monetary policy are substitutes, rather than complements. Here unconventional monetary policy refers to policies that directly affect the asset held on lenders balance sheets (such as purchases of MBS). The harmful effects of asset losses do suggest that there is an important role for unconventional monetary policy in countering a credit crunch. However, the greater sensitivity of lenders with asset losses to conventional policy suggests that these two different types of policies are substitutes and not complements. That is, both perform better in the absence of the other. Conventional monetary policy can better stimulate lending after lenders experience asset losses. Symmetrically, unconventional policy that directly targets balance sheets has a large effect on lending in the presence of interest rate increases. Outside of financial crises, another implication is that because strong balance sheets make lending less responsive to changes in the cost of capital, larger *increases* in the cost of capital may be necessary if the goal of policymakers is to reign in a credit boom.

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Appendix

A Summary Statistics

Table A.1: NPCU Summary Statistics (Levels)

	25%	Median	75%	Mean	St. Dev.	Obs.
Assets (mil. $)	6.77	19.05	60	102.1	564.84	166,932
Invest. cap. (mil. $)	-1.73	-0.58	1.65	-1.25	10.79	166,932
$\frac{\text{Investment cap.}}{\text{Assets}}$ (%)	0.56	0.81	0.96	0.78	0.67	166,932
	Panel A: Total Loans YTD					
Volume (mil. $)	3.44	38.96	46.99	42.95	203.26	166,932
Number	393	2,202	2,952	2,997	12,975	159,389
Average size ($)	5,783	8,996	13,374	11,410	18,893	159,389
	Panel B: Fixed Rate Mortgages YTD					
Volume (mil. $)	1.28	28.21	34.67	25.91	82.13	79,569
Number	13	155	206	157	390	79,504
Average size (mil. $)	0.07	0.10	0.15	0.14	1.78	79,023

Table A.2: NPCU Summary Statistics ($100 \times \ln \Delta$)

	25%	Median	75%	Mean	St. Dev.	Obs.
Assets	-1.45	0.56	2.69	0.67	3.74	166,932
Invest. cap.	-1.73	-0.58	1.65	-1.25	10.79	166,932
	Panel A: Total Loans YTD					
Volume	-9.73	-1.38	8.28	-0.41	25.04	166,932
Number	-26.68	-0.3	270.31	15.24	199.14	150,317
Average size	-7.56	-0.97	6.85	0.08	16.96	150,121
	Panel B: Fixed Rate Mortgages YTD					
Volume	-15.85	5.35	28.77	4.29	48.36	70,886
Number	-16.75	6.66	27.2	3.58	45.01	70,575
Average size	-7.05	0	8.46	1.00	21.48	70,602

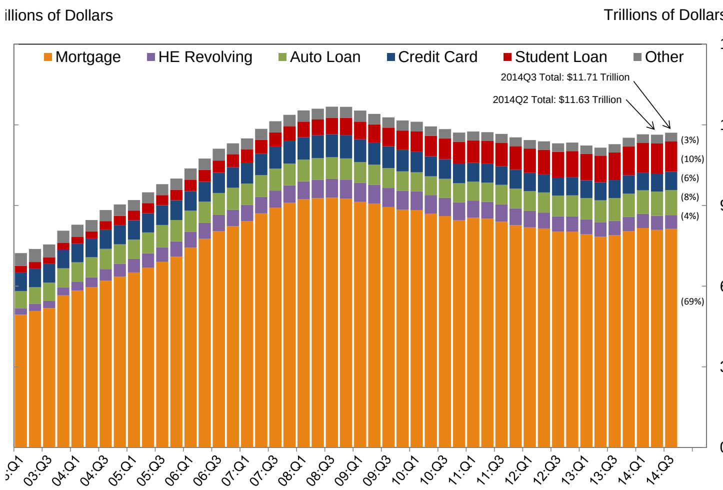
Notes: Statistics in table A.1 and for asset and investment capital in table A.2 are computed for the subsample used in the baseline regression for which the growth in the volume of total loan originations is the dependent variable. Statistics in panels A and B of table A.2 use the actual subsamples for the respective regressions of each independent variable). The top table gives levels and percentages while the bottom table gives logged differences ($\times$100). The data span Q3 2004 to Q4 2011. The volumes and numbers of mortgages are seasonally adjusted.

Table A.3: Additional Summary Statistics

	25th %	Median	75th %	Mean	St. Dev.	Obs.
			Panel A: Panel Data			
$\frac{\text{Loans out.}}{\text{Assets}}$ (%)	47.74	60.34	71.82	59.09	16.99	166,932
Net worth ratio (%)	10.02	12.33	15.75	13.48	4.68	166,932
$100 \times \Delta \ln \text{LLA}_{i,t-1}$	-6.44	0.68	9.15	1.56	34.19	166,576
Members	1,415	3,294	9,168	11,833	51,079	166,932
Mortgage int. rate (basis points)	550	600	661	617	109	104,862
Δ Mortgage int. rate (basis points)	-3.00	0.00	0.00	-2.35	45.98	102,572
UR (%)	4.40	5.6	7.6	6.24	2.54	165,096
$100 \times \Delta$ ln house prices	-0.73	0.49	1.51	0.4	2.52	165,438
Mortgage (%) delinquency rate	1.15	1.91	3.42	2.57	2.21	152,629
			Panel B: Aggregate Time Series Data			
Assets (bil. $)	483.97	607.11	664.63	568.14	138.33	30
Loans out. (bil. $)	306.23	391.66	456.11	377.01	106.07	30
Loans orig. (bil. $)	52.90	112.91	175.12	122.70	69.35	30
Members (mil.)	53.08	76.36	78.92	65.84	17.63	30
ΔR_t	-0.29	0.00	0.25	-0.05	0.54	30
$\Delta \widetilde{R}_t$	-0.02	0.00	0.00	-0.04	0.14	30

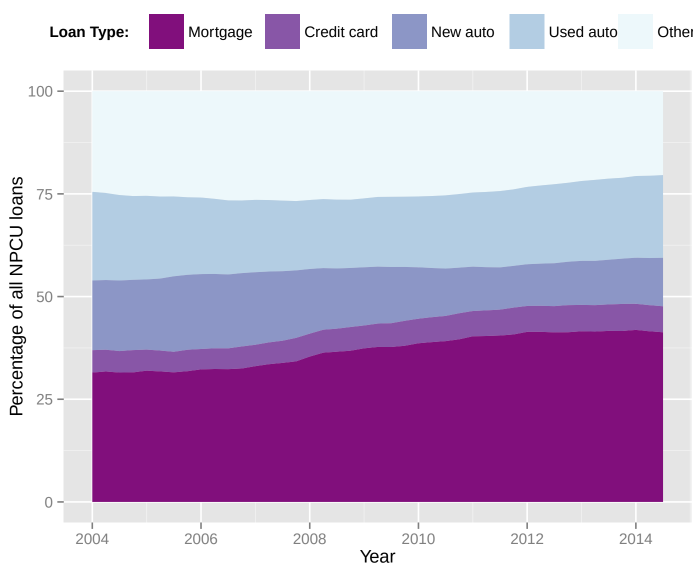
Notes: These statistics are computed from the subsample used in the main regression analysis. The net worth ratio is the ratio of the sum of undivided earnings, regular reserves, appropriation for non-conforming investments, other reserves, uninsured secondary capital, and net income relative to total assets. Above $\Delta \ln LLA_{i,t-1}$ denotes lagged changes in loan loss allowances, which are funds set aside to absorb possible losses on loans. Panel B gives statistics for total assets, loans outstanding, loan originations, and members associated with US credit unions. The last two rows give statistics for the policy rate (the two-year treasury yield in percentage points) and the quarterly Fed Funds futures surprises.

Figure A.1: Composition of US Household Debt



Notes: This graph plots the total debt balance of US households over time. Debt is broken down into mortgages, home equity revolving lines of credit, auto loans, credit card loans, student loans, and all other remaining types of debt. Source: FRBNY Quarterly Report on Household Debt and Credit (November 2014). The data used in constructing this graph are from the FRBNY Consumer Credit Panel/Equifax.

Figure A.2: NPCU Lending Composition



Notes: This graph shows the percentage of NPCU lending comprised of mortgage loans, credit card loans, new auto loans, used auto loans, and "other" loans. The "other" loans consist of home equity lines of credit (9.9% in March 2015), member business loans (7.4% in March 2015), and other unsecured personal loans (4.3% in March 2015).

B Proof of Propositions 1 and 2

Proposition 1 *Equilibrium loan supply $L(R,B) = \min\{L^\star(R), \bar{L}(B)\}$ has increasing differences in $(-R,B)$ if $\bar{L}(\cdot)$ is an increasing function, $R_L'(L) < 0$, and $R_L''(L) < 0$. That is, $R' < R$ and $B' > B$, imply*

$$L(R',B') - L(R,B') \geq L(R',B) - L(R,B).$$

Proof. First, note that $L^\star(R)$ is decreasing in R. To see this, note that when the lending constraint is non-binding, lending is characterized by:

$$R_L'(L)L + R_L(L) = R.$$

Implicitly differentiating the above equation with respect to R we have

$$\frac{dL}{dR} = \left[R_L''(L)L + 2R_L'(L)\right]^{-1},$$

which is negative under the assumptions $R_L''(L), R_L'(L) < 0$.

Given $R' < R$ and $B' > B$, since $L^\star(R)$ is strictly decreasing in R, the difference in lending under R versus R' is characterized by the following piecewise function:

$$L(R',B') - L(R,B') = \begin{cases} L^\star(R') - L^\star(R) & : \bar{L}(B') > L^\star(R') \\ \bar{L}(B') - L^\star(R) & : \bar{L}(B') \in (L^\star(R), L^\star(R')] \\ 0 & : \bar{L}(B') \leq L^\star(R) \end{cases}$$

To see $L(R,B) = \min\{L^\star(R), \bar{L}(B)\}$ has increasing differences in $(-R,B)$, consider the three cases for the functional form of $L(R',B') - L(R,B')$.

Case 1: Never Constrained for B'. Suppose $\bar{L}(B') > L^\star(R')$. This implies $L(R',B') - L(R,B') = L^\star(R') - L^\star(R)$. If $\bar{L}(B) > L^\star(R')$, then $L(R',B) - L(R,B) = L^\star(R') - L^\star(R) = L(R',B') - L(R,B')$, and there is no difference the change in lending for B versus B'. If instead $\bar{L}(B) le L^\star(R')$, then

$$\begin{aligned} L(R',B) - L(R,B) &\leq \bar{L}(B) - \min\{L^\star(R), \bar{L}(B)\} \\ &= \max\{0, \bar{L}(B) - L^\star(R)\} \\ &\leq \max\{0, L^\star(R') - L^\star(R)\} \\ &= L^\star(R') - L^\star(R) \\ &= L(R',B') - L(R,B'). \end{aligned}$$

Case 2: Sometimes Unconstrained for B'. Suppose $\bar{L}(B') \in (L^\star(R), L^\star(R')]$. Because lending is constrained at (B',R'), lending is also constrained for $B < B'$ at $R' < R$ since

$\bar{L}(\cdot)$ is decreasing (by assumption). This implies

$$\begin{aligned} L(R', B) - L(R, B) &= \bar{L}(B) - \min\{L^\star(R), \bar{L}(B)\} \\ &= \max\{0, \bar{L}(B) - L^\star(R)\} \\ &\leq \bar{L}(B') - L^\star(R) \\ &= L(R', B') - L(R, B'). \end{aligned}$$

Case 3: Always Constrained for B'. Suppose $\bar{L}(B') \leq L^\star(R)$. Since $\bar{L}(\cdot)$ is decreasing (by assumption), $\bar{L}(B) < L^\star(R)$. That is, since the bank is already constrained at the higher asset value B' for R, they remain constrained at the lower asset value for R. Since unconstrained lending is decreasing in R, if lending is constrained at R it must also stay constrained at $R' < R$ for $B < B'$. Therefore, $L(R', B') - L(R, B') = L(R', B) - L(R, B) = 0$ and

$$L(R', B') - L(R, B') \geq L(R', B) - L(R, B).$$

Thus in every case, we have

$$L(R', B') - L(R, B') \geq L(R', B) - L(R, B).$$

□

Proposition 2 *Equilibrium loan supply $L(R, B)$ has decreasing differences in $(-R, B)$ if $\Delta(\cdot)$ is a weakly decreasing function and $R_L'(L), R_L''(L) < 0$. That is, if $R' < R$ and $B' > B$, then*

$$L(R', B) - L(R, B) \geq L(R', B') - L(R, B').$$

Proof. Implicitly differentiating the first order condition, $R_L'(L)L + R_L(L) = \widetilde{R}$, we can characterize the marginal effect of a change in the policy rate R:

$$\frac{dL}{dR} = \frac{[1 - \Delta(B)]^{-1}}{R_L''(L)L + 2R_L'(L)} < 0.$$

The above term is negative under the assumptions $R_L''(L), R_L'(L) < 0$ and $\Delta \in [0, 1)$. Differentiating the above with respect to default risk $\Delta(B)$ yields:

$$\frac{d^2L}{dLd\Delta} = \frac{[1 - \Delta(B)]^{-2}}{R_L''(L)L + 2R_L'(L)} < 0$$

which is also negatively under the same assumptions. The negative first and cross-partial derivatives imply that lending has decreasing differences in $(-R, -\Delta(B))$.

Because default risk $\Delta(B)$ is weakly decreasing in B, for $\Delta(B) \neq \Delta(B')$, decreasing differences in $(-R, -\Delta(B))$ imply

$$L(R', B) - L(R, B) > L(R, B') > L(R', B') - L(R, B').$$

If $\Delta(B) = \Delta(B')$, then

$$L(R', B) - L(R, B) > L(R, B') = L(R', B') - L(R, B').$$

Therefore, lending $L(R,B)$ has decreasing differences in $(-R,B)$:

$$L(R',B) - L(R,B) > L(R,B') \geq L(R',B') - L(R,B').$$

for $R' < R$ and $B' > B$. □

C Tables

C1 Main Results

Table C.4: Total Lending (volume)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔR_{t-1}	-8.58***	-8.86***	-9.45***	-10.20***	-8.56***	-9.46***	-10.15***
	(3.07)	(3.14)	(3.52)	(3.75)	(3.15)	(3.60)	(3.81)
$\Delta \ln A_{i,t-1}$	1.94	1.76	1.93	1.9	1.4	1.47	1.43
	(1.24)	(1.23)	(1.33)	(1.45)	(0.98)	(1.02)	(1.13)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	1.78**	1.82**	1.98**	2.10**	1.69**	1.90**	2.01**
	(0.77)	(0.77)	(0.88)	(0.94)	(0.73)	(0.83)	(0.88)
$\text{UR}_{i,t-2}$		-0.06	-0.06	0.08		-0.05	0.1
		(0.18)	(0.18)	(0.17)		(0.17)	(0.16)
$\Delta \ln(\text{House Prices}_{i,t})$			-10.86	-9.81		-10.25	-9.41
			(20.07)	(18.23)		(21.38)	(19.18)
$\text{Mort. Delinq.}_{i,t-1}$				0.04			0.01
				(0.14)			(0.13)
$\ln \text{Members}_{i,t-1}$					-0.74	-0.48	-0.6
					(1.67)	(1.76)	(1.99)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$					0.17	0.15	0.13
					(0.36)	(0.38)	(0.44)
$\Delta \ln(\text{LLA}_{i,t-1})$					0.12	0.19	0.2
					(0.26)	(0.26)	(0.28)
Observations	166,932	165,104	163,775	150,628	166,553	163,401	150,293

Notes: The dependent variable is the quarterly difference of logged total year-to-date loan originations. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table C.5: Mortgage Lending (volume)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔR_{t-1}	-44.35***	-45.32***	-44.55***	-45.57***	-43.49***	-43.70**	-45.20***
	(15.79)	(16.46)	(16.92)	(15.28)	(16.07)	(17.25)	(15.78)
$\Delta \ln A_{i,t-1}$	3.24	3.03	3.58	0.66	3.65	3.95	1.54
	(4.16)	(4.02)	(4.12)	(3.95)	(3.36)	(3.39)	(3.31)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	8.78**	8.96**	8.91**	8.55**	8.69**	8.82**	8.60**
	(3.46)	(3.50)	(3.62)	(3.40)	(3.58)	(3.76)	(3.56)
$\text{UR}_{i,t-2}$		0.26	0.11	0.72		0.09	0.63
		(0.80)	(0.75)	(0.85)		(0.70)	(0.80)
$\Delta \ln(\text{House Prices}_{i,t})$			-71.83	-84.25		-68.92	-83.45
			(85.08)	(79.24)		(85.08)	(78.51)
Mort. $\text{Delinq.}_{i,t-1}$				-0.71			-0.61
				(0.55)			(0.50)
$\ln \text{Members}_{i,t-1}$					6.81	7.45	3.18
					(8.76)	(8.94)	(9.59)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$					0.2	0.26	-0.84
					(1.42)	(1.43)	(1.53)
$\Delta \ln(\text{LLA}_{i,t-1})$					-0.89	-0.72	-0.88
					(0.99)	(1.02)	(0.99)
Observations	70,886	70,210	69,767	63,908	70,845	69,726	63,873

Notes: The dependent variable is the quarterly difference of logged total year-to-date originations of 30-year fixed-rate mortgage loans. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table C.6: Total Lending: Extensive vs. Intensive Margins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Number of Loans				Loan Size			
ΔR_{t-1}	-3.18	-4.02	-3.23	-3.97	-6.93***	-6.73***	-7.03***	-6.83***
	(2.28)	(2.53)	(2.37)	(2.59)	(2.01)	(2.27)	(2.08)	(2.33)
$\Delta \ln A_{i,t-1}$	1.98**	1.71*	1.39**	1.22	0.36	0.2	0.38	0.14
	(0.96)	(1.03)	(0.67)	(0.75)	(0.96)	(0.98)	(0.83)	(0.87)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	1.25*	1.32*	1.17*	1.23*	0.92	0.83	0.95	0.84
	(0.66)	(0.69)	(0.60)	(0.64)	(0.61)	(0.65)	(0.60)	(0.64)
$\text{UR}_{i,t-2}$		0.1		0.13		0.08		0.08
		(0.13)		(0.12)		(0.15)		(0.16)
$\Delta \ln(\text{House Prices}_{i,t})$		-2.71		-2.84		-7.25		-7.57
		(13.10)		(13.39)		(9.29)		(9.69)
$\text{Mort. Delinq.}_{i,t-1}$		-0.01		-0.05		0.01		0.01
		(0.11)		(0.10)		(0.09)		(0.09)
$\ln \text{Members}_{i,t-1}$			-2.11	-1.98			1.42	0.84
			(1.37)	(1.62)			(1.49)	(1.77)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$			0.24	0.19			-0.01	-0.1
			(0.27)	(0.31)			(0.28)	(0.27)
$\Delta \ln(\text{LLA}_{i,t-1})$			-0.06	-0.09			-0.1	-0.11
			(0.29)	(0.32)			(0.16)	(0.17)
Observations	150,317	134,970	150,017	134,713	150,121	134,671	149,829	134,421

Notes: The dependent variable in columns 1-4 is the quarterly difference of the logged number of total loan originations YTD. The dependent variables in columns 5-8 is the quarterly difference of logged average loan size (of those originated YTD). Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter level. The sample period is Q3 2004 to Q4 2011. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table C.7: Mortgage Lending: Extensive vs. Intensive Margins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Number of Loans				Loan Size			
ΔR_{t-1}	-44.35***	-45.57***	-43.49***	-45.20***	-43.40***	-43.80***	-42.42***	-43.37***
	(15.79)	(15.28)	(16.07)	(15.78)	(14.61)	(14.32)	(14.66)	(14.63)
$\Delta \ln A_{i,t-1}$	3.24	0.66	3.65	1.54	5.29*	3.45	4.99*	3.51
	(4.16)	(3.95)	(3.36)	(3.31)	(3.20)	(2.98)	(2.58)	(2.57)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	8.78**	8.55**	8.69**	8.60**	8.96***	8.69***	8.74***	8.62***
	(3.46)	(3.40)	(3.58)	(3.56)	(3.10)	(3.00)	(3.15)	(3.12)
$\text{UR}_{i,t-2}$		0.72		0.63		-0.05		-0.06
		(0.85)		(0.80)		(0.69)		(0.66)
$\Delta \ln(\text{House Prices}_{i,t})$		-84.25		-83.45		-107.49		-105.55
		(79.24)		(78.51)		(86.88)		(86.86)
Mort. $\text{Delinq.}_{i,t-1}$		-0.71		-0.61		-0.47		-0.45
		(0.55)		(0.50)		(0.45)		(0.43)
$\ln \text{Members}_{i,t-1}$			6.81	3.18			7.5	4.63
			(8.76)	(9.59)			(7.70)	(8.64)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$			0.2	-0.84			0.88	0.17
			(1.42)	(1.53)			(1.00)	(1.08)
$\Delta \ln(\text{LLA}_{i,t-1})$			-0.89	-0.88			-0.77	-0.66
			(0.99)	(0.99)			(0.78)	(0.79)
Observations	70,886	63,908	70,845	63,873	70,575	63,568	70,533	63,532

Notes: The dependent variable in columns 1-5 is the quarterly difference of the logged number of 30-year fixed-rate mortgage originations YTD. The dependent variables in columns 6-10 is the quarterly difference of logged average 30-year fixed-rate mortgages (of those originated YTD). Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table C.8: Mortgage Interest Rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔR_{t-1}	9.07***	8.58***	8.89***	8.49***	9.18***	9.07***	8.87***
	(2.95)	(3.33)	(3.22)	(3.16)	(3.08)	(3.34)	(3.40)
$\Delta \ln A_{i,t-1}$	-1.84*	-1.82*	-1.91*	-1.05	-1.75**	-1.80**	-1.17
	(1.06)	(1.04)	(1.04)	(0.92)	(0.81)	(0.81)	(0.73)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	-3.08***	-3.02***	-3.11***	-2.78***	-3.09***	-3.13***	-2.88***
	(0.83)	(0.87)	(0.83)	(0.87)	(0.86)	(0.87)	(0.92)
$\text{UR}_{i,t-2}$		0.32	0.29	0.26		0.27	0.24
		(0.29)	(0.28)	(0.31)		(0.27)	(0.31)
$\Delta \ln(\text{House Prices}_{i,t})$			-17.07	-14.54		-16.61	-13.27
			(19.65)	(19.24)		(20.12)	(19.91)
Mort. Delinq.$_{i,t-1}$				0.11			0.09
				(0.14)			(0.14)
$\ln \text{Members}_{i,t-1}$					-6.41***	-6.43**	-5.93**
					(2.43)	(2.50)	(2.51)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$					(0.21)	(0.24)	0.01
					(0.39)	(0.39)	(0.38)
$\Delta \ln(\text{LLA}_{i,t-1})$					-0.57	-0.66*	-0.71*
					(0.40)	(0.40)	(0.37)
Observations	99,950	98,824	98,019	89,771	99,819	97,889	89,650

Notes: The dependent variable is the quarterly difference of the typical interest rate charged on newly-originated fixed-rate 30-year mortgages in basis points. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table C.9: Summary of the Main Results' Economic Meaning

	Panel A: Effects of Policy Rate Changes		
	Effect of ΔR alone $\beta_1 \Delta R$	Effect of ΔR with $\Delta \ln A$ $(\beta_1 + \beta_3 \Delta \ln A)\Delta R$	Median growth rate $100 \times \mathbb{E}\Delta \ln L_{i,t}$
Total loans (volume)	0.86	1.15	-1.38
Total loans (number)	0.32	0.52	-0.3
Total loans (size)	0.69	0.69	-0.97
Mortgages (volume)	4.44	5.88	5.35
Mortgages (number)	4.34	5.82	6.66
Mortgages (size)	–	–	0.00

	Panel B: Effects of Asset Losses		
	Effect of $\Delta \ln A$ alone $\beta_2 \Delta \ln A$	Effect of $\Delta \ln A$ with ΔR $(\beta_2 + \beta_3 \Delta R)\Delta \ln A$	Both $\beta_1 \Delta R + \beta_2 \Delta \ln A$ $\beta_3(\Delta R)(\Delta \ln A)$
Total loans (volume)	-3.20	-2.91	-2.05
Total loans (number)	-3.27	-3.06	-2.74
Total loans (size)	–	–	0.69
Mortgages (volume)	-5.35	-3.90	0.54
Mortgages (number)	-8.73	-7.25	-2.91
Mortgages (size)	–	–	–

	Panel C: Policy Implications	
	Policy rate change to offset $\Delta \ln A$ (basis points) $\left(\frac{-\beta_2 \Delta \ln A}{\beta_1 + \beta_3 \Delta \ln A}\right)$	Response to policy rate due to altered sensitivity $\left(\frac{\beta_3 \Delta \ln A}{\beta_1 + \beta_3 \Delta \ln A}\right)$
Total loans (volume)	-28.79	25.5%
Total loans (number)	-62.32	39.3%
Total loans (size)	–	–
Mortgages (volume)	-9.09	24.6%
Mortgages (number)	-15.00	25.4%
Mortgages (size)	–	–

Notes: This table presents a summary of the economic implications of the main analysis for each category of lending considered. The values presented here are associated with the baseline specification (column 1 of the regression tables). Panel A reports the estimated effect of a 10 basis point decrease in the policy rate (ΔR) first with no changes in assets and then with $\Delta \ln A = -1.65$ (the standard deviation of log assets). The third column of panel A gives the average growth rate in log points of the different types of lending over the sample. Panel B presents the effects of a 1.65 log point asset loss with and without a 10 basis point decrease in the policy rate. The third column of panel B reports the estimated total effect of both the policy rate change and asset losses. It is useful to compare these total effects to the effects of ΔR and $\Delta \ln A$ alone. Lastly, panel C present policy-relevant calculations. First, it reports the predicted change in the policy rate necessary to offset this typical asset loss. In column 2 it gives the share of the effect any policy rate change due to the reduced sensitivity to a typical asset loss.

C2 First Stage and OLS

Table C.10: First Stage Regressions

Dependent variable:	(1) ΔR_{t-1}	(2) $\Delta \ln A_{i,t-1}$	(3) $\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$
$\Delta\widetilde{R}_{t-1}$	1.50***	-1.07	5.88***
	(0.46)	(0.81)	(1.54)
$\Delta \ln C_{i,t-1}$	-0.23*	0.12	-0.03
	(0.14)	(0.35)	(0.29)
$\frac{C_{i,t-2}}{A_{i,t-2}}$	0.14	8.65**	1.59
	(0.53)	(3.44)	(2.43)
$\frac{C_{i,t-2}}{A_{i,t-2}} \times \Delta \ln C_{i,t-1}$	-1.38	28.87***	11.60
	(2.22)	(7.97)	(15.99)
$\Delta\widetilde{R}_{t-1} \times \Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}$	-72.65	-421.57*	1073.26*
	(199.20)	(224.39)	(575.31)
Observations	166,932	166,932	166,932
R^2	0.60	0.24	0.18
F-statistic	29.44	6.29	4.33

Notes: The dependent is given by the first row. Coefficients and standard errors (in parentheses) are multiplied by 100 in columns 2 and 3. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table C.11: Testing of TSLS Assumptions

	Value	Null Hypothesis
Kleibergen-Paap LM Statistic p-value	14.25*** 0.0026	H_0: under-identification (instruments uncorrelated with regressors)
Cragg-Donald Wald Statistic Kleibergen-Paap Wald Statistic	12.28 5.26	H_0: weak identification (instruments weakly correlated with regressors)
Hansen J Statistic p-value	1.038 0.5952	H_0: *not* over-identified (instruments uncorrelated with error term, excluded instruments correctly excluded)

Notes: This table reports test statistics for testing the TSLS identifying assumptions. The 5%, 10%, and 20% critical values for the Cragg-Donald Wald statistic are 9.53, 6.61, and 4.99 (respectively) Stock and Yogo (2005). Critical values for Kleibergen-Paap rank Wald statistic are not tabulated as they vary across applications. Standard practice is to compare the statistic to the associated Cragg-Donald Wald critical value even though the implied p-value is not asymptotically correct (Bazzi and Clemens, 2013).

Table C.12: OLS Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Total Lending (volume)				Mortgage Lending (volume)			
ΔR_{t-1}	-1.44	-1.36	-1.43	-1.33	-1.35**	-1.41***	-1.33**	-1.38***
	(0.92)	(0.87)	(0.91)	(0.86)	(0.56)	(0.49)	(0.55)	(0.48)
$\Delta \ln A_{i,t-1}$	0.11***	0.10**	0.11***	0.10**	-0.03	-0.04	-0.03	-0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.02)	(0.03)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	-0.08	-0.08	-0.09	-0.09	-0.08	-0.07	-0.08	-0.07
	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.05)	(0.06)	(0.05)
$\text{UR}_{i,t-2}$		-0.31*		-0.30*		-0.20*		-0.20*
		(0.18)		(0.18)		(0.12)		(0.12)
$\Delta \ln(\text{House Prices}_{i,t})$		20.40**		20.63**		10.18*		10.43*
		(9.60)		(9.61)		(5.50)		(5.56)
$\text{Mort. Delinq.}_{i,t-1}$		-0.09		-0.1		-0.01		-0.01
		(0.09)		(0.09)		(0.06)		(0.06)
$\ln \text{Members}_{i,t-1}$			-3.37***	-3.78***			0.64	0.25
			(1.02)	(1.17)			(0.52)	(0.68)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$			0.05	0.07			0.11	0.11
			(0.08)	(0.08)			(0.09)	(0.10)
$\Delta \ln(\text{LLA}_{i,t-1})$			0.07	0.2			-0.17	-0.13
			(0.27)	(0.28)			(0.17)	(0.16)
Observations	166,932	150,628	166,553	150,293	150,121	134,671	149,829	134,421

Notes: This table gives the analogous OLS estimates of table C.4. The dependent variable is the quarterly difference of logged total year-to-date loan originations. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

C3 Alternative Sources of Sensitivity

The table below augments the baseline specification by interacting the additional control variables with the policy rate. I instrument for these additional interactions with the control variable (X) multiplied by the Fed Funds futures surprises ($\Delta\widetilde{R}_{t-1} \times X$).

Table C.13: Sensitivity to the Policy Rate

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Lending			Mortgage Lending		
	Volume	Number	Size	Volume	Number	Size
ΔR_{t-1}	6.11	2.66	2.81	16.41	13.71	-3.67
	(4.01)	(2.99)	(4.85)	(30.67)	(29.70)	(6.63)
$\Delta \ln A_{i,t-1}$	1.16	**1.09***	-0.09	1.25	**3.24***	-0.3
	(0.86)	(0.64)	(0.87)	(2.84)	(1.93)	(0.70)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	**1.18***	0.82	0.47	**6.95****	**6.35****	0.52
	(0.67)	(0.51)	(0.69)	(3.31)	(2.92)	(0.80)
$\text{UR}_{i,t-2}$	0.12	**0.17***	0.08	0.78	0.15	0.01
	(0.25)	(0.10)	(0.16)	(0.65)	(0.53)	(0.14)
$\Delta \ln(\text{House Prices}_{i,t})$	9.23	11.49	-4.86	-19.30	-27.86	16.63
	(14.46)	(9.75)	(10.43)	(66.75)	(75.99)	(17.43)
Mort. Delinq.$_{i,t-1}$	0.02	-0.01	0.00	-0.46	-0.51	0.11
	(0.15)	(0.10)	(0.08)	(0.41)	(0.34)	(0.13)
$\ln \text{Members}_{i,t-1}$	-2.79	**-2.84***	-0.16	-2.44	-0.68	0.18
	(1.76)	(1.46)	(1.66)	(8.52)	(7.33)	(1.43)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$	0.41	0.30	0.01	-0.15	1.06	-0.15
	(0.35)	(0.28)	(0.28)	(1.30)	(0.84)	(0.34)
$\Delta \ln(\text{LLA}_{i,t-1})$	0.23	-0.03	-0.28	-1.88	-1.31	-1.00
	(0.31)	(0.34)	(0.21)	(1.61)	(1.13)	(0.65)
$\Delta R_{t-1} \times \text{UR}_{i,t-2}$	-1.11	-0.15	-0.85	-1.58	-1.88	-0.05
	(0.70)	(0.29)	(0.57)	(1.62)	(1.33)	(0.23)
$\Delta R_{t-1} \times \Delta \ln(\text{House Prices}_{i,t})$	-34.70	**-50.66****	8.85	**-140.70****	**-249.12*****	**53.45****
	(24.34)	(22.11)	(17.47)	(69.72)	(67.14)	(26.05)
$\Delta R_{t-1} \times$ Mort. Delinq.$_{i,t-1}$	**0.76****	0.34	**0.42***	1.17	-0.62	**0.82*****
	(0.37)	(0.25)	(0.26)	(1.30)	(1.03)	(0.23)
$\Delta R_{t-1} \times \ln \text{Members}_{i,t-1}$	**-1.87*****	**-0.87****	**-1.01*****	**-6.61*****	**-5.60*****	-0.06
	(0.50)	(0.39)	(0.28)	(2.40)	(2.08)	(0.27)
$\Delta R_{t-1} \times \frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$	**0.37*****	0.10	**0.21***	**0.78*****	**1.12*****	0.04
	(0.06)	(0.10)	(0.12)	(0.25)	(0.20)	(0.13)
$\Delta R_{t-1} \times \Delta \ln(\text{LLA}_{i,t-1})$	0.35	0.17	-1.08	-8.77*	-5.67	**-2.98***
	(1.23)	(1.12)	(0.85)	(5.07)	(5.03)	(1.61)
Observations	150,293	134,713	134,421	63,873	63,532	63,611

Notes: The dependent variables are the quarterly difference of logged, year-to-date, loan originations for total lending (columns 1-3) and fixed-rate 30-year mortgage lending (columns 4-6). Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

C4 Placebo Tests

This robustness check tests if asset losses during the Great Recession are associated with greater sensitivity to the policy rate prior to 2004. Asset losses in the Great Recession ($\Delta^{4\delta} \ln A_{i,\tau}$) vary only in the cross-section and are constructed for four different periods. I instrument for this variable with measures analogous to the three instruments in the main analyses. But instead of using lagged investment capital changes or ratios to total assets, I compute these measures during the same period as asset losses during the great recession. Control variables with limited availability during this period are dropped in these regressions.

Table C.14: Placebo Test: Policy Rate Sensitivity

	(1)	(2)	(3)	(4)
$\tau =$	2009		2010	
$\delta =$	1	2	1	2
ΔR_{t-1}	-87.34	-112.22	-106.22	-44.74
	(194.21)	(142.85)	(73.01)	(40.59)
$\Delta^{4\delta} \ln A_{i,\tau}$	0.53	0.73	0.64	0.11
	(2.08)	(0.95)	(0.72)	(0.15)
$\Delta R_{t-1} \times \Delta^{4\delta} \ln A_{i,\tau}$	7.43	6.67	4.16	0.77
	(24.06)	(10.41)	(3.28)	(1.10)
$\text{UR}_{i,t-2}$	0.10	0.03	0.09	-0.55
	(1.02)	(0.65)	(0.95)	(0.55)
$\ln \text{Members}_{i,t-1}$	0.26	0.76	0.14	0.02
	(5.81)	(5.76)	(4.83)	(4.64)
$\Delta \ln(\text{LLA}_{i,t-1})$	0.01	0.02	-0.01	-0.05
	(0.02)	(0.04)	(0.05)	(0.04)
Observations	60,108	60,028	29,377	29,362

Notes: The dependent variable is the difference of logged year-to-date total loan originations from 1994 Q1 to 2003 Q4. Different from the baseline specification, the covariates related to assets and investment capital are measured once for each credit union for several windows during the Great Recession. Above, $\Delta^{4\delta}$ denotes a difference across δ years. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes year, quarter, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. Statistical significance: 0.1*, 0.05**, and 0.01***.

The next part considers cross-sectional regressions of the annual growth rate of pre-crisis lending on asset losses during the crisis (instrumented for with changes in investment capital, the ratio of investment capital to total assets, and the interaction of these variables). As before, the columns specify the timeframe during which losses in the Great Recession are measured. The goal of this analysis is to verify that credit unions that ended up having larger losses did not tend to either have lower lending growth to begin with or were expanding lending rapidly prior to the bursting of the housing bubble.

Table C.15: Placebo Test: Pre-Crisis Lending

	(1)	(2)	(3)	(4)
$\tau =$	2009		2010	
$\delta =$	1	2	1	2
	Panel A: Pre-Crisis Lending 2004-2005			
$\Delta^{4\delta} \ln A_{i,\tau}$	-0.51	-0.23	0.25	0.11
	(0.78)	(0.34)	(0.74)	(0.39)
Observations	5,348	5,322	4,773	4,755
	Panel B: Pre-Crisis Lending 2005-2006			
$\Delta^{4\delta} \ln A_{i,\tau}$	1.38	0.75*	-0.55	0.31
	(0.90)	(0.39)	(1.13)	(0.58)
Observations	5,494	5,479	4,889	4,875
	Panel C: Pre-Crisis Lending 2006-2007			
$\Delta^{4\delta} \ln A_{i,\tau}$	-0.39	0.01	0.34	0.06
	(0.70)	(0.27)	(0.32)	(0.28)
Observations	5,519	5,524	4,915	4,911

Notes: The dependent variable is the annual difference of logged year-to-date total loan originations over 2005, 2006, and 2007 (panels A, B, and C, respectively). Asset losses, and the corresponding instruments, are measured over several window periods. Above, $\Delta^{4\delta}$ denote a difference across δ years. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes county and credit union field of membership fixed effects; standard errors are clustered by state. Statistical significance: 0.1*, 0.05**, and 0.01***.

D Additional Summary Statistics

Table D.16: Field of membership

Field of membership	NPCUs	Field of membership	NPCUs
Associational		Multiple common bonds	
Faith-based	257	Primarily educational	341
Fraternal	56	Primarily military	67
Other	104	Primarily federal, state, local government	428
Occupational		Primarily chemical	61
Educational	196	Primarily petroleum refining	44
Military	21	Primarily primary and fabricated metals	54
Federal, state, local government	274	Primarily machinery	37
Occupational – manufacturing		Primarily transportation equipment	38
Chemicals	33	Primarily other manufacturing	227
Petroleum refining	13	Primarily finance	73
Primary and fabricated metals	37	Primarily healthcare	177
Machinery	28	Primarily transportation	101
Transportation Equipment	13	Primarily communications and utilities	172
Other	171	Primarily faith-based	73
Occupational – services		Other	
Finance	52	Single common bond – other	13
Healthcare	101	Multiple common bond – other	209
Transportation	22	Non-federal credit union (state chartered)	3,094
Communications and uitilies	101	Community credit union	1,182
Total			7,870

Notes: Most credit unions are formed around a common association and mainly transact with people affiliated with the credit union's particular association. This table shows the number of credit unions associated with each field of membership in Q1 2009.

Table D.17: March 2006 Corporate Credit Union Balance Sheets

Name	Assets (bil. $)	Equity (mil. $)	$\frac{\text{Equity}}{\text{Assets}}$ (%)	$\frac{\text{NS Liabilities}}{\text{Assets}}$ (%)	$\frac{\text{GMBS}}{\text{Assets}}$ (%)	$\frac{\text{PIMBS}}{\text{Assets}}$ (%)	$\frac{\text{OABS}}{\text{Assets}}$ (%)	$\frac{\text{ABS}}{\text{Assets}}$ (%)
Western Corporate	26.84	824.77	3.07	31.16	2.43	40.98	21.47	64.89
Southwest Corporate	8.94	235.02	2.63	9.81	1.77	15.96	24.86	42.59
TriCorp	0.50	16.51	3.32	24.88	1.88	0.00	0.07	1.95
Members United	4.76	211.48	4.45	10.68	3.72	0.50	33.77	37.99
VaCorp	0.90	32.30	3.59	16.87	10.67	0.00	0.00	10.67
Southeast Corporate	3.44	122.37	3.56	11.32	5.96	9.83	15.46	31.26
Mid-Atlantic Corporate	2.15	71.92	3.34	9.29	2.63	0.46	0.01	3.10
Empire Corporate	3.44	151.66	4.41	8.40	1.37	16.07	18.82	36.25
Eastern Corporate	1.17	57.92	4.93	10.05	10.37	0.72	5.32	16.41
LICU Corporate	0.01	1.46	27.19	0.18	0.00	0.00	0.00	0.00
Kentucky Corporate	0.38	18.47	4.85	5.45	0.00	0.00	0.00	0.00
Corporate One	3.02	110.65	3.66	23.31	4.06	4.71	31.78	40.55
Midwest Corporate	0.17	6.95	4.03	10.55	0.00	0.00	0.54	0.54
Northwest Corporate	0.88	32.36	3.69	15.63	1.22	7.87	6.29	15.38
Constitution Corporate	1.57	41.29	2.62	8.99	0.79	26.82	22.52	50.13
US Central	35.87	856.78	2.39	23.73	6.55	21.52	42.44	70.51
System United Corporate	2.28	87.44	3.83	15.39	8.73	3.23	8.90	20.86
West Virginia Corporate	0.24	8.43	3.47	12.76	0.00	0.00	0.00	0.00
Catalyst Corporate	1.38	47.46	3.43	6.61	1.28	0.00	1.53	2.81
First Corporate	0.78	31.25	4.03	27.96	6.53	0.00	4.04	10.57
Iowa Corporate Central	0.25	15.95	6.43	16.63	0.16	0.00	0.34	0.50
First Carolina Corporate	1.59	80.16	5.04	13.55	5.28	0.00	4.19	9.46
Corporate America	0.86	29.91	3.49	14.92	9.82	0.00	5.11	14.92
Louisiana Corporate	0.20	6.61	3.36	16.10	4.64	1.50	3.13	9.27
C. Credit Union Fund, Inc.	0.24	9.30	3.88	14.22	0.05	0.00	0.97	1.02
Kansas Corporate	0.36	16.05	4.44	18.87	5.22	0.00	0.21	5.43
Volunteer Corporate	0.89	25.36	2.83	9.54	9.66	1.68	1.16	12.50
Central Corporate	1.99	92.07	4.62	12.78	0.35	1.95	9.29	11.58
Missouri Corporate	0.61	38.55	6.34	10.03	0.00	0.00	0.00	0.00
Corporate Central	1.37	58.47	4.28	50.07	8.21	0.00	3.53	11.74
Treasure State Corporate	0.18	6.64	3.62	12.08	0.00	0.00	0.00	0.00
Mean	3.46	107.92	4.67	15.22	3.66	4.96	8.57	17.19
Standard deviation	7.75	204.08	4.28	9.30	3.62	9.68	11.79	19.81

Notes: This table reports balance sheet characteristics of corporate credit unions. "NS liabilities" refers to non-share and non-equity liabilities, "GMBS" are government and agency mortgage-related issues, "PIMBS" are privately-issued mortgage-related issues, "OABS" are other asset-backed securities", and "ABS" is the sum of GMS, PIMBS, and OABS.

Table D.18: December 2009 Corporate Credit Union Balance Sheets

Name	Assets (bil. $)	Equity (mil. $)	$\frac{\text{Equity}}{\text{Assets}}$ (%)	$\frac{\text{NS Liabilities}}{\text{Assets}}$ (%)	$\frac{\text{GMBS}}{\text{Assets}}$ (%)	$\frac{\text{PIMBS}}{\text{Assets}}$ (%)	$\frac{\text{OABS}}{\text{Assets}}$ (%)	$\frac{\text{ABS}}{\text{Assets}}$ (%)
Western Corporate	21.11	-8580.16	-406.45	46.21	2.89	0.00	12.94	15.83
Southwest Corporate	7.92	-1118.02	-141.11	0.59	0.94	0.00	14.42	15.36
TriCorp	0.95	0.93	0.98	0.13	1.23	0.00	0.01	1.24
Members United	8.37	-1139.81	-136.22	2.94	1.67	0.00	7.17	8.83
VaCorp	1.44	-0.97	-0.68	0.39	4.99	0.00	0.00	5.00
Southeast Corporate	3.33	-101.77	-30.52	0.88	5.10	0.00	6.06	11.16
Mid-Atlantic Corporate	3.82	4.53	1.19	1.30	0.13	0.00	3.22	3.34
Eastern Corporate	0.84	19.63	23.24	1.70	20.71	0.00	5.36	26.07
Kentucky Corporate	0.44	-2.01	-4.54	0.19	0.00	0.00	0.00	0.00
Corporate One	3.30	-206.41	-62.57	3.94	4.28	0.00	45.04	49.31
Midwest Corporate	0.19	-0.01	-0.04	0.22	0.00	0.00	7.73	7.73
Constitution Corporate	1.29	-209.30	-162.05	2.01	2.50	0.00	10.38	12.89
US Central	35.07	-6675.66	-190.33	43.36	3.06	0.00	35.59	38.65
System United Corporate	2.47	-98.19	-39.82	2.03	5.85	0.00	14.02	19.87
West Virginia Corporate	0.24	-1.16	-4.76	1.06	0.00	0.00	0.00	0.00
Catalyst Corporate	2.52	-0.39	-0.15	0.16	7.13	0.00	0.00	7.13
First Corporate	0.95	-16.14	-16.91	0.25	15.76	0.01	3.11	18.88
Iowa Corporate Central	0.09	5.42	61.28	0.16	0.19	0.07	0.03	0.29
First Carolina Corporate	1.78	-24.60	-13.81	6.16	11.95	0.00	7.50	19.46
Corporate America	2.19	51.58	23.58	8.83	49.95	0.00	0.87	50.81
Louisiana Corporate	0.16	-2.40	-15.09	3.30	14.20	0.04	0.78	15.02
Kansas Corporate	0.34	0.20	0.60	5.39	12.85	0.02	0.04	12.91
Volunteer Corporate	1.55	0.32	0.20	14.94	12.56	0.00	5.36	17.93
Central Corporate	2.97	-19.23	-6.49	3.61	9.66	0.00	1.25	10.92
Missouri Corporate	0.90	-0.07	-0.08	3.16	0.00	0.00	0.00	0.00
Corporate Central	1.77	61.85	34.95	6.63	12.48	0.00	24.09	36.58
Treasure State Corporate	0.37	0.05	0.13	0.05	0.00	0.00	0.00	0.00
Mean	3.94	-668.59	-40.20	5.91	7.41	0.01	7.59	15.01
Standard Deviation	7.52	2045.43	95.23	11.70	10.36	0.02	11.24	14.43

Notes: This table reports balance sheet characteristics of corporate credit unions. "NS liabilities" refers to non-share and non-equity liabilities, "GMBS" are government and agency mortgage-related issues, "PIMBS" are privately-issued mortgage-related issues, "OABS" are other asset-backed securities", and "ABS" is the sum of GMS, PIMBS, and OABS. Empire Corporate merged with Mid-States Corporate to form Members United in mid-2006. Northwest Corporate was acquired by Southwest Corporate in 2007. In mid-2007 Member United merged with Central Credit Union Fund, Inc.. These items were not available for LICU Corporate in December 2009.

E Additional Regressions

Table E.19: Share of Mortgages in New Loan Originations

	(1)	(2)	(3)	(4)
ΔR_{t-1}	-27.97**	-27.22**	-28.30**	-31.28**
	(12.00)	(12.38)	(13.03)	(14.76)
$\Delta \ln A_{i,t-1}$	2.56	3.08	2.98	3.28
	(2.90)	(2.34)	(2.28)	(2.42)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	6.28**	6.24**	6.47**	7.59**
	(2.64)	(2.78)	(2.85)	(3.11)
$\ln \text{members}_{i,t-1}$		9.97*	9.99*	13.24**
		(5.20)	(5.12)	(5.36)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$		0.24	0.16	0.23
		(0.99)	(0.99)	(1.18)
$\Delta \ln \text{LLA}_{i,t-1}$		-0.48	-0.46	-1.01
		(1.03)	(1.05)	(1.09)
$\text{UR}_{i,t-1}$			0.22	0.19
			(0.52)	(0.75)
$\Delta \ln \text{ZHVI}_{i,t-1}$				-8.00
				(7.70)
Observations	70,844	70,805	70,129	50,810

Notes: The dependent variable is the quarterly difference of the share of fixed-rate 30-year mortgage originations in the total volume of loan originations. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table E.20: Time Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Lending			Mortgage Lending		
	Volume	Number	Size	Volume	Number	Size
$\Delta \ln A_{i,t-1}$	0.67	4.35	0.81	3.15	3.73	0.16
	(1.68)	(3.76)	(0.66)	(3.83)	(3.51)	(1.57)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	0.94	4.89	-0.05	17.31*	11.96	2.79
	(5.61)	(10.86)	(3.16)	(10.06)	(8.47)	(4.46)
Observations	166,932	150,317	150,121	70,886	70,575	70,602

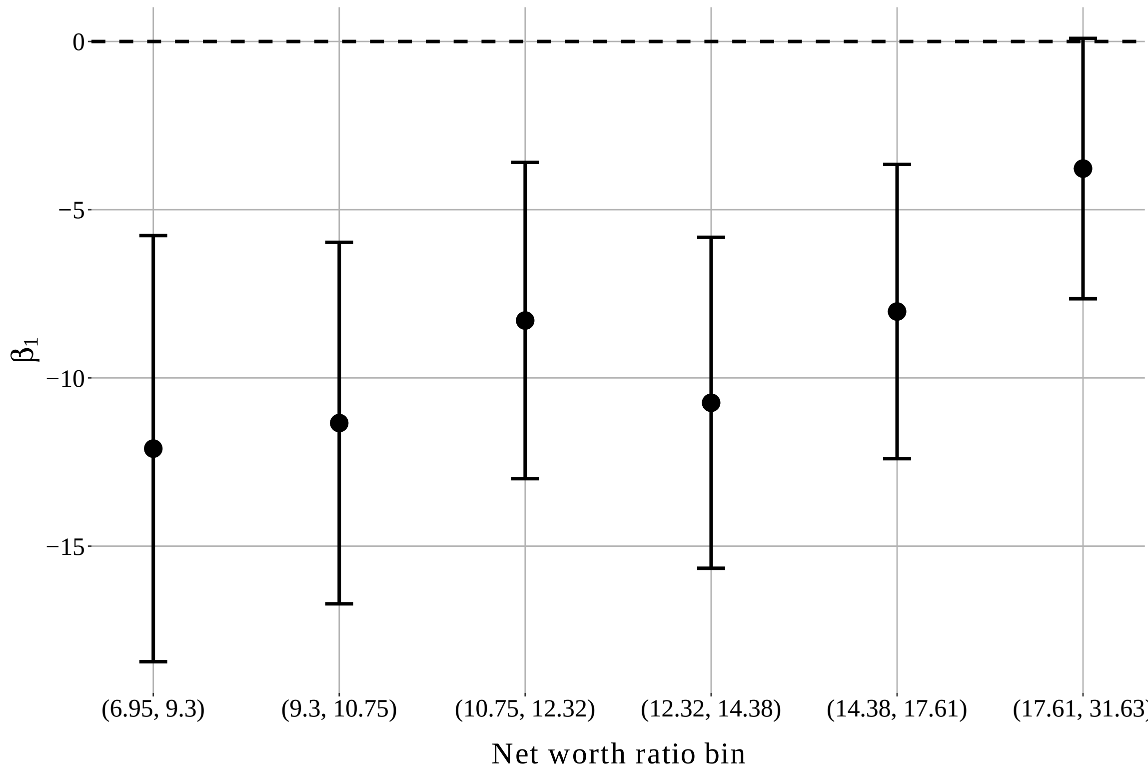
Notes: The dependent variables are the quarterly difference of logged, year-to-date total loan originations. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes time (year-quarter), NPCU, and county-time fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q2 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table E.21: Investment Capital Corr. with Regional and Credit Union Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
$\text{UR}_{i,t-2}$	-0.21				-0.12	-0.13
	(0.26)				(0.29)	(0.24)
$\Delta \ln(\text{House Prices}_{i,t})$		4.37			0.76	-7.64
		(9.43)			(9.75)	(10.35)
Mort. $\text{Delinq.}_{i,t-1}$			-0.21		-0.16	-0.15
			(0.13)		(0.11)	(0.09)
D.ln.abs				-0.02		-0.04
				(0.07)		(0.08)
Observations	98,824	99,063	90,927	48,164	89,771	43,555
R2	0.12	0.11	0.12	0.13	0.12	0.13

Notes: The dependent variable is the product of the quarterly logged difference in investment capital and the share of investment capital in total assets. The timing differences of the dependent variable and the independent variables are the same as in the main regressions. Coefficients and standard errors (in parentheses) are multiplied by 10,000. Given this scaling, the economic magnitude of these coefficients is extremely small and the correlations are close to 0. Every regression includes year, quarter, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q2 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Figure E.3: A Nonlinear Breakdown of Policy Rate Sensitivity By Net Worth



Notes: This graph plots point estimates for the effect of changes in the policy rate on lending conditional on a credit union having its net worth within a particular range. The bars denote the 90% confidence interval. The net worth ratio bins split the sample into six equally-sized quantiles by net worth ratio. This is one of the key ratios on which credit union capital adequacy is regulated. The units for the net worth groups are reported in percentage points. **Regression details:** The dependent variable is the quarterly logged difference in total loan originations year-to-date. Coefficients are multiplied by 100. Each regression includes year, quarter, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q2 2004 to Q4 2011. This regression is identical to the baseline regression except that (1) there are additional endogenous regressors as the policy rate is interacted with dummies for the credit union's net worth ratio bin at time $t-1$ and (2) interactions of the futures surprises with the bin dummies are added to the set of instruments.

The coefficients on $\Delta \ln A_{i,t-1}$ and $\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$ are 0.53 and 1.57, respectively. The coefficient on the interaction term is significant at the 5% level. Compared to the main results, which estimate a value between 1.7-2, this is smaller. This is consistent with part of the effects of asset losses on sensitivity to the policy rate operating through decreased net worth and greater proximity to regulatory minimums. However, the large and significant coefficient suggests that there is still a significant part of the effect of asset losses on sensitivity that is distinct from their effect on regulatory ratios. This could be due to greater external costs of finance as in the 2nd model considered in section 2. Future research may find it worthwhile to better explore the exact channels through which asset losses affect lending and its sensitivity to the policy rate.

Table E.22: Mortgage Subsample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Total Lending (volume)				Mortgage Lending (volume)			
ΔR_{t-1}	-15.06***	-14.83***	-14.89***	-15.36***	-44.35***	-44.55***	-43.49***	-45.20***
	(5.12)	(5.35)	(5.13)	(5.16)	(15.79)	(16.92)	(16.07)	(15.78)
$\Delta \ln A_{i,t-1}$	2.09	2.12	1.76	1.18	3.24	3.58	3.65	1.54
	(1.33)	(1.31)	(1.11)	(1.17)	(4.16)	(4.12)	(3.36)	(3.31)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	2.65**	2.62**	2.56**	2.48**	8.78**	8.91**	8.69**	8.60**
	(1.22)	(1.26)	(1.24)	(1.26)	(3.46)	(3.62)	(3.58)	(3.56)
$\text{UR}_{i,t-2}$		-0.22		-0.03		0.11		0.63
		(0.26)		(0.26)		(0.75)		(0.80)
$\Delta \ln(\text{House Prices}_{i,t})$		-3.15		-2.33		-71.83		-83.45
		(28.38)		(27.53)		(85.08)		(78.51)
$\text{Mort. Delinq.}_{i,t-1}$				-0.18				-0.61
				(0.16)				(0.50)
$\ln \text{Members}_{i,t-1}$			-1.98	-3.41			6.81	3.18
			(2.83)	(2.95)			(8.76)	(9.59)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$			0.42	0.22			0.2	-0.84
			(0.43)	(0.50)			(1.42)	(1.53)
$\Delta \ln(\text{LLA}_{i,t-1})$			0.17	0.32			-0.89	-0.88
			(0.43)	(0.46)			(0.99)	(0.99)
Observations	70,886	69,767	70,845	63,873	70,886	69,767	70,845	63,873

Notes: The dependent variable is the quarterly difference of the volume of total loan originations (columns 1-4) and that of fixed-rate 30-year mortgages (columns 5-8). The sample in columns 1-4 is restricted to be the exact sample for which the main mortgage volume estimates are computed. Larger credit unions tend to have positive mortgage loan originations consistently each quarter and report them. It is not clear if these missing observations are due to failures to report, underreporting of a small volume, or a lack or mortgage lending. This suggests part of the reason the mortgage coefficients are so large is the selection of the this sample towards larger credit unions. This is not surprising as, noted in the regressions that assess other determinants of policy rate sensitivity, credit unions with more members tend to be more responsive to monetary easing. The coefficients for total lending nearly double within this subsample. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes quarter, year, and credit union fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table E.23: Persistence: Total Lending (dependent variable: $\ln L_{i,t+\tau} - \ln L_{i,t-1}$)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\tau =$	0	1	2	3	4	5	6	7	8	9	10	11
						Panel A: Volume						
ΔR_{t-1}	-8.58***	-18.02***	-14.60*	-20.76**	-5.04	-22.48**	-20.21**	-22.60*	-12.12	-5.26	-7.45	-11.27
	(3.07)	(6.66)	(8.00)	(8.34)	(6.15)	(11.03)	(9.97)	(13.41)	(9.11)	(16.65)	(9.97)	(9.57)
$\Delta \ln A_{i,t-1}$	1.94	6.74**	7.91**	5.62	3.61	8.12*	7.30*	10.82**	6.93*	12.45**	8.60*	8.30**
	(1.24)	(2.76)	(3.42)	(4.07)	(2.64)	(4.27)	(4.38)	(5.03)	(4.09)	(5.25)	(4.65)	(4.14)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	1.78**	5.25***	5.23***	4.11*	1.37	5.24*	4.54	7.57**	4.03*	3.80	3.38	4.61*
	(0.77)	(1.85)	(1.74)	(2.37)	(1.39)	(2.89)	(3.00)	(3.70)	(2.34)	(3.71)	(2.90)	(2.59)
Obs.	166,932	166,818	165,978	165,837	165,034	164,789	163,943	163,738	162,955	162,714	161,895	161,705
						Panel B: Number						
ΔR_{t-1}	-3.18	-6.37*	-5.62*	-5.32	-0.97	-12.59*	-7.86	-8.84	-1.83	-0.23	-1.81	-4.53
	(2.28)	(3.57)	(3.38)	(5.98)	(3.86)	(7.21)	(5.97)	(8.93)	(6.44)	(10.90)	(4.74)	(6.46)
$\Delta \ln A_{i,t-1}$	1.98**	3.45**	2.78	4.10*	2.51	7.89**	2.26	6.75*	5.25	8.48**	3.16	6.55*
	(0.96)	(1.69)	(2.32)	(2.15)	(2.33)	(3.43)	(2.85)	(3.68)	(3.57)	(4.14)	(2.99)	(3.35)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	1.25*	2.20**	1.98**	1.73	0.91	4.05**	1.89	3.54	1.76	1.98	1.38	3.19*
	(0.66)	(0.98)	(0.93)	(1.52)	(1.15)	(2.02)	(1.65)	(2.41)	(1.81)	(2.54)	(1.52)	(1.80)
Obs.	150,317	149,784	149,102	149,032	148,369	148,294	147,620	147,670	147,010	146,785	146,101	145,913
						Panel C: Size						
ΔR_{t-1}	-6.93***	-10.75***	-11.36***	-11.55**	-5.29*	-8.86	-15.89**	-16.28**	-11.39**	-4.88	-7.29	-8.54
	(2.01)	(3.28)	(4.27)	(4.59)	(3.02)	(5.66)	(7.18)	(7.93)	(4.54)	(5.98)	(6.49)	(6.88)
$\Delta \ln A_{i,t-1}$	0.36	1.22	1.91	1.19	-0.29	-1.73	2.97	4.39	0.46	2.50	2.38	1.00
	(0.96)	(1.45)	(1.87)	(2.12)	(1.64)	(2.02)	(2.86)	(2.96)	(2.02)	(2.57)	(3.16)	(3.65)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	0.92	2.55***	2.85**	1.63	0.27	0.52	2.91	4.73**	2.37**	1.72	1.96	1.76
	(0.61)	(0.88)	(1.25)	(1.41)	(0.91)	(1.56)	(1.82)	(2.06)	(1.05)	(1.52)	(1.79)	(1.78)
Obs.	150,121	149,592	148,909	148,828	148,152	148,087	147,400	147,436	146,777	146,540	145,855	145,668

Notes: The dependent variables are the quarterly difference of logged, year-to-date total loan originations. The first column corresponds to the baseline regressions. Moving further to the right, the horizon over which the change in lending is measured increases by a quarter. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes time (year-quarter), NPCU, and county-time fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.

Table E.24: Persistence: Mortgage Lending (dependent variable: $\ln L_{i,t+\tau} - \ln L_{i,t-1}$)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\tau =$	0	1	2	3	4	5	6	7	8	9	10	11
						Panel A: Volume						
ΔR_{t-1}	-44.35***	-71.03***	-77.40***	-71.71**	-26.55	-54.06*	-73.86***	-52.71	-27.27	-20.24	-29.77	-27.74
	(15.79)	(17.08)	(23.88)	(29.86)	(29.64)	(29.94)	(28.55)	(37.52)	(39.29)	(35.77)	(29.02)	(25.96)
$\Delta \ln A_{i,t-1}$	3.24	11.53***	16.11***	14.74***	11.99**	13.11*	17.86***	21.41***	16.28***	14.99**	8.52	12.74*
	(4.16)	(4.26)	(4.80)	(5.29)	(5.50)	(7.00)	(6.21)	(7.14)	(6.22)	(7.48)	(6.78)	(6.86)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	8.78**	17.35***	20.76***	14.02**	7.52	10.14	14.41**	16.63**	10.83	9.49	8.20	9.52
	(3.46)	(3.89)	(5.22)	(6.28)	(5.95)	(7.14)	(6.70)	(7.39)	(7.31)	(7.77)	(6.33)	(6.36)
Obs.	70,886	66,144	64,303	64,577	64,542	62,782	61,944	62,425	62,564	61,038	60,383	61,026
						Panel B: Number						
ΔR_{t-1}	-43.40***	-72.66***	-76.92***	-62.30**	-42.62*	-72.02***	-75.89***	-61.13**	-45.33**	-24.71	-20.90	-31.11*
	(14.61)	(16.35)	(21.69)	(24.62)	(25.28)	(26.26)	(24.47)	(25.02)	(21.86)	(23.26)	(18.57)	(18.28)
$\Delta \ln A_{i,t-1}$	5.29*	14.43***	17.03***	16.68***	10.70**	13.18**	16.76***	16.33***	10.46**	9.11	4.22	8.49
	(3.20)	(4.39)	(4.91)	(4.84)	(5.46)	(6.21)	(5.70)	(6.17)	(5.24)	(6.29)	(5.62)	(6.23)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	8.96***	18.48***	20.79***	13.95**	10.24*	13.99**	17.40***	16.75***	12.96***	8.60*	4.53	8.43*
	(3.10)	(3.91)	(4.82)	(5.52)	(5.72)	(6.29)	(6.06)	(5.68)	(4.51)	(4.97)	(4.25)	(4.79)
Obs.	70,575	65,389	63,543	63,750	63,567	61,932	61,106	61,589	61,648	60,258	59,630	60,205
						Panel C: Size						
ΔR_{t-1}	-1.93	3.44	-2.51	-12.43	5.81	7.97	2.16	3.35	3.48	-3.99	-8.88	-5.37
	(3.84)	(8.43)	(5.51)	(11.97)	(11.58)	(12.23)	(9.28)	(15.46)	(14.42)	(14.74)	(11.62)	(13.80)
$\Delta \ln A_{i,t-1}$	0.42	0.06	1.43	0.78	4.24**	3.66	4.84**	7.13**	6.15**	8.49***	6.47**	6.29*
	(0.91)	(2.27)	(1.74)	(2.77)	(1.87)	(2.41)	(2.38)	(2.97)	(2.49)	(3.03)	(3.14)	(3.31)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	0.64	-0.69	1.19	1.54	0.25	-1.04	-1.80	1.62	0.79	3.02	3.97	3.48
	(0.85)	(2.11)	(1.22)	(2.04)	(2.34)	(2.40)	(1.98)	(3.44)	(3.02)	(3.32)	(2.80)	(3.05)
Obs.	70,602	65,531	63,724	63,908	63,848	62,190	61,326	61,753	61,918	60,513	59,838	60,375

Notes: The dependent variables are the quarterly difference of logged, year-to-date fixed-rate 30-year mortgage originations. The first column corresponds to the baseline regressions. Moving further to the right, the horizon over which the change in lending is measured increases by a quarter. Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes time (year-quarter), NPCU, and county-time fixed effects; standard errors are two-way clustered by credit union and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1*, 0.05**, and 0.01***.