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

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Abstract

How does creditor health impact the pass-through of monetary policy to households? Using data on the universe of US credit unions, I document that creditor 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. Weaker lenders can respond more if they face financial frictions that easing alleviates. The estimates imply constraints on monetary policy become more costly in financial crises featuring 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

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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 (LSAPs).[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 asks if the credit channel of conventional monetary policy is more or less effective when lenders suffer asset losses. The impact of asset losses 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, a weak balance sheet could constrain lending, limiting the ability of a lender to respond to easing.[2] On the other hand, easing could alleviate frictions that would otherwise constrain lending. Lenders with weaker balance sheets, whose lending is more constrained by these frictions, may therefore benefit more from a given policy rate decrease.[3] The answer is informative about financial crises and the nature of financial frictions lenders face. Moreover, understanding how conventional policy and asset losses interact also sheds light on the substitutability/complementarity of conventional monetary policy and unconventional monetary policy tools such as bank recapitalization and LSAPs.

The primary contribution of this paper is to empirically document and interpret the

[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] For example, asset losses could tighten regulatory leverage constraints.

[3] For example, if a weak balance sheet increases the risk premium a lender pays for wholesale financing, a policy rate reduction that also lowers the premium can trigger a larger overall decrease in the cost of capital for a lender with a weaker balance sheet.

impact of asset losses on the credit channel of monetary policy. Using data on the universe of US credit unions (CUs), I estimate the causal effects of the two-year Treasury rate, CU assets, and their interaction on CU loan originations using instrumental variables. CUs 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.[4] Identification exploits both high frequency identification of monetary policy shocks and a natural experiment in which otherwise similar credit unions experienced different asset losses. These asset losses arose from plausibly exogenous exposure to asset-backed securities (ABS) during the Great Recession. Consistent with conventional monetary easing alleviating financial frictions, I document that asset losses *amplify* the lending response to monetary easing.

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 the Treasury rate would *understate* the causal effect of rate reductions on lending.

The key challenge in identifying the causal effect of asset losses on *consumer* credit is disentangling credit supply and demand. The economic conditions driving consumer defaults, and thus lender losses, can also reduce loan demand. This could 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 mea-

[4]The credit union totals are 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.

sure 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, a placebo test finds that investment capital losses during the crisis do not predict differences in lending *prior* to the 2008 crisis.[5]

An advantage of this empirical strategy, over alternatives such as Chodorow-Reich (2014), is that it is better-suited to identify the effect of bank health on *consumer* credit. Consumer lending, compared to syndicated lending is more local, with many households borrowing from nearby banks.[6] This makes it challenging to construct a "leave-out" measure of a bank's consumer credit contraction that is plausibly unrelated to local loan demand. Additionally, the Chodorow-Reich (2014) instruments that measure bank exposure to Lehman Brothers and mortgage-backed securities would be difficult to adapt for studying consumer credit. Given of the central role of mortgages in the crisis, these instruments are plausibly unrelated to a bank's corporate loan portfolio, but this is less likely true for its mortgage portfolio.

Consistent with monetary easing alleviating financial frictions, I estimate a positive interaction term between the two-year Treasury rate (the policy rate) and assets.[7] This has two key implications. First, asset losses *increase* the effect of the policy rate on loan originations. A one standard deviation asset loss ($\approx$ 4.18%) increases the lending response to a 100 basis point fall in the policy rate by 13.3 basis points. This corresponds to a 5% stronger reaction to the policy rate, relative to the average response of a 2.66 percentage point increase in loan originations for the same policy rate shock. The stronger response implies that constraints on policy – such as the zero-lower-bound (ZLB) or political constraints –

[5] Ramcharan, Van den Heuvel and Verani (2016) also documents that the loan composition of CUs was unrelated to whether or not the Corporate that they were connected to failed. Additionally, they find house price growth during the boom is unrelated to investment capital growth in the boom

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

[7] Note that these empirical findings do not "accept" one model of CU lending during the crisis. However, these findings can reject models whose predictions differ from these empirical results.

are more costly in financial crises featuring creditor asset losses (in terms of forgone loan originations). And when banks are in sound financial health, this result suggests policymakers may need to lean harder against the wind to rein in lending.

Second, the positive interaction term also implies that decreasing the policy rate *weakens* the causal effect of asset losses on lending. A one standard deviation asset loss reduces loan originations by 11.85 percentage points with no change in the policy rate. When the policy rate falls by 100 basis points, the impact of the same asset loss is 1% weaker (instead reducing lending by 11.72 percentage points). Easing can stimulate lending not only directly, but also indirectly by reducing the contractionary effects of asset losses.

Moreover, the positive interaction term suggests that conventional monetary policy and unconventional policies that directly target lender assets (such as LSAPs) are substitutes rather than complements. By raising asset values, unconventional policies can diminish the total impact of a given change in the policy rate. And because rate reductions lower lending's sensitivity to assets, conventional easing weakens the effect on lending of both asset losses and gains. An important caveat is that this empirical setting does not directly study an unconventional policy, but rather purely variation in lender asset values. To the extent unconventional policies have other indirect effects on lending (i.e. through channels other than asset values), these indirect channels could differ in their complementarity/substitutability with conventional monetary easing.

Exploring the impact on interest rates, I find that outcomes vary across credit categories. Policy rate decreases are partially passed on to mortgage rates. A 100 basis point policy rate reduction triggers a 6 basis point mortgage rate reduction. In contrast, new auto, used auto, and credit card interest rates *rise* in response to policy rate decreases. A rate increase is consistent with expanding credit to riskier borrowers, who pay higher rates on average. For both auto rates, the interaction of the policy rate and assets is negative. This means asset losses dampen the rise in auto rates induced by easing. However, this finding is similar to the results for lending in that monetary easing is *more* stimulative (in the sense of reducing rates) among credit unions experiencing asset losses.

Lastly, I examine how CU profitability is affected by easing and asset losses to shed light on potential mechanisms driving the heterogeneous lending responses. I find that monetary easing increases deposits and lowers the deposit rate, similarly to results for banks in Drechsler, Savov and Schnabl (2021). This is consistent with an increase in CU supply of deposits, as opposed to a decrease in household demand for deposits. However, asset losses *dampen* the reduction in the deposit rate (but not deposits). This implies higher deposit interest expenses, which *limit* the incentive to lend. However, CU net interest margins (NIMs) rise in response to easing, boosting the profitability of lending.[8] And this rise in profitability is stronger among CUs experiencing asset losses. Because deposit costs fall *less* for weakened CUs, this suggests that the increased profitability must come from higher interest income.

Related Literature. This paper adds to literature on the state dependence of monetary policy by examining the causal effects of financial sector health. Earlier work documents many other sources of heterogeneity in monetary transmission.[9] There have been two prior approaches to study the relationship between financial sector health and the credit channel of monetary policy. The first compares the effect of monetary policy in states of the world featuring recessions and/or financial sector distress (e.g. Tenreyro and Thwaites, 2016; Di Maggio, Kermani and Palmer, 2020). A limitation of this approach is that other events may coincide with states of the world that feature financial sector distress. Comparing the effect of monetary policy across these states may conflate the causal effects of asset losses with those of other events, such as a decline in loan demand.

The second approach compares lenders with stronger or weaker balance sheets (e.g.,

[8]This differs from findings for banks in Drechsler, Savov and Schnabl (2021), which estimates a near-zero effect of the Fed Funds rate on bank NIMs. Section 6.1 discusses how the shorter-maturity of CU consumer lending in comparison with banks could explain this difference.

[9]Notably, this 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), banks have less lending market power (Scharfstein and Sunderam, 2016), banks have more deposit market power (Drechsler, Savov and Schnabl, 2017), interest rates are low (Wang, 2018), and inflation is higher (Jordà, Schularick and Taylor, 2020).

Jiménez, Ongena, Peydró and Saurina, 2012, 2014; Peydró, Polo and Sette, 2021; Caglio, Darst and Kalemli-Özcan, 2021). At the lender-level, net worth and risk exposures are generally endogenous and may also be related to loan demand or lender risk aversion. While this approach can describe how responses to monetary policy vary across groups on average (i.e., healthy versus unhealthy lenders), exogenous variation in lender health is necessary to isolate its *causal* effect on monetary transmission.

Findings differ within and across both prior approaches. For example, Jiménez, Ongena, Peydró and Saurina (2012) finds lowly capitalized banks tend to respond less to monetary policy. In contrast, I find that asset losses *cause* lending to respond more to monetary easing. These results align with those of Kashyap and Stein (2000, 1995), which document smaller banks on average respond more to monetary easing (and their interpretation that this is due to more severe financial frictions). Similarly, Di Maggio, Kermani and Palmer (2020) finds that quantitative easing (QE) stimulated more mortgage refinancing at times when bank health was weaker.[10]

This paper contributes to the literature on the 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 models here also suggest 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.

[10] Darmouni, Giesecke and Rodnyansky (2020) also finds bond-financed firms are more strongly affected by monetary policy because bonds have higher costs of financial distress compared to bank loans. While instead focusing on the borrowing side (and firms instead of households), these findings are similar in spirit too as the stronger firm response comes from more severe financial frictions.

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). The ability of monetary easing to weaken the contractionary effects of asset losses makes it an even more powerful tool in a financial crises.

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 presents two simple models of financial intermediation that give rise to opposing predictions regarding whether asset losses dampen or amplify the lending response to a given change in monetary policy. The models serve to motivate the empirical analysis, but note that the empirical analysis is not intended to validate one specific model of financial intermediation. 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).

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

In the second model, the lender instead faces frictions in raising funds. Risk neutral external creditors perceive the lender as decreasingly likely to repay as the value of its assets decrease, and thus require a risk premium. This model implies that a *weaker* balance sheets causes lending to be more sensitive to the policy rate, in contrast to the first model. This is because the risk premium magnifies the pass-through of changes in the policy rate to the lender'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 lenders is a useful criterion for assessing their empirical validity in the context of the Great Recession.

2.1 Model 1: Lending Constraint

A monopolist lender faces a lending/capacity constraint and household loan demand function that is decreasing in the interest the lender charges (R_L). The lender chooses how much to lend in order to maximize profits. The lender can borrow at the gross (risk-free) policy rate R, lending all borrowed funds L to households. The lender 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 lender 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 lender can purchase. A fall in the value of legacy assets B reduces the amount of consumer lending the lender 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

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

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 lender 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 A.

Increasing differences implies that lending is more responsive to changes in the policy rate when balance sheets are stronger (B is larger). Improving the lender'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 lender no longer faces a lending constraint but the price at which it can borrow depends on the value of its balance sheet. Risk neutral external creditors believe that the lender 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 lender 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 lender 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 in the 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 lender'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 lender's cost of capital, increasing lending. Additionally, a lower (risk-free) policy rate R reduces the lender'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 A.

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 lender'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 lender's cost of capital. These predictions match the empirical findings presented in the next sections.

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 asset 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.[11] 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 important 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 precluded credit unions from directly owning private label ABS.[12]

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

[11] 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 Internet Appendix Table IA.I of Ramcharan, Van den Heuvel and Verani (2016) for a breakdown of credit union affiliations in this time period.

[12] 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.

these services.[13] 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.

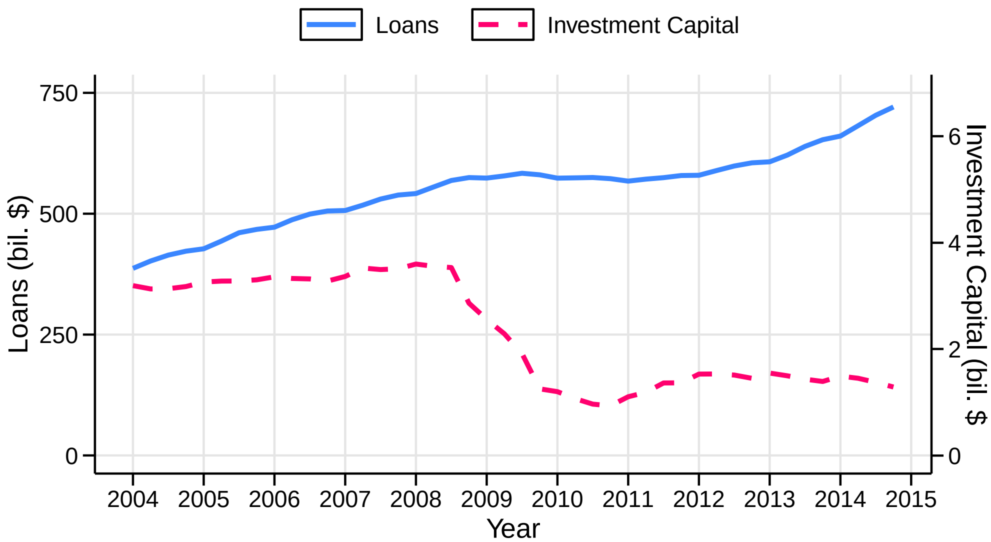
Credit Union Asset Losses During the Great Recession. Some Corporates gained significant exposure to private label ABS in the early 2000s. While some Corporates fully avoided these assets, others held as much as 41% of their balance sheet in private label ABS alone by 2006.[14] During the 2007-2009 collapse 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, Van den Heuvel and Verani (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, left axis). The slowdown in loan originations

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

[14]See Tables B.3 and B.4 for information on Corporates' balance sheets in 2006 and 2009 (respectively).

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.

coincides with the large decrease in investment capital (right axis).

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.[15] The data include thousands of credit unions operating in each US state.

The main outcomes of interest available in the NCUA data are quarterly loan originations and a measure of the typical interest rate charged on various credit products.[16] Interest rate data is available for 30-year fixed rate mortgages, auto loans (new and used, separately), credit cards, and other unsecured consumer debt. The NCUA data also include total credit union assets and the variables needed to measure investment capital.

[15] 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.

[16] The NCUA data report loan originations year-to-date, so calculating the difference over time is necessary to measure originations in quarters two to four.

In addition to these main variables, the NCUA data include other measures such as the number of credit union members, whether the credit union is classified as a low-income credit union (LICU),[17] mortgage lending, deposits, the net worth ratio measure on which the credit union is regulated, and interest expenses.

Appendix Table B.1 presents summary statistics for the sample used in empirical analysis. This sample is the subset of credit unions that have complete information on lending (both total and mortgage), assets, and investment capital during 2004-2011. These data come from 4,803 credit unions. This restriction on data completeness mainly omits credit unions that do not report mortgage lending consistently. Consequently, the omitted lenders are typically the smallest credit unions from the full sample. In this subset, the average credit union originates $19.7 million in loans per quarter and has assets valued at $237.6 million. On average, mortgages comprise 21.7% of credit union loans. Loans are 62.9% of credit union assets and investment capital constitutes 1.87% of non-loan assets (with a standard deviation of 1.98%) on average.

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 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

[17] Credit unions receive this designation if more than 50% of their members are low-income. This classification can change over time as member income changes or as the credit union expands or contracts.

Open Market Committee (FOMC) makes monetary policy announcements. Section 4.2 provides further detail on the construction.

Appendix Table B.2 presents summary statistics for the two-year Treasury rate, its quarterly changes, and the monetary surprises. The average value of the two-year Treasury rate is 2.47% over the sample period. The 25$^{\text{th}}$, 50$^{\text{th}}$, and 75$^{\text{th}}$ percentile of *changes* in the rate are -29, 0, and -23 basis points (respectively). The median of the absolute value of changes is 27.5 basis points. The monetary surprises are typically much smaller, with a mean of around 4 basis points.

Additional Data. Throughout, I include two time-varying measures of local economic activity. First, I use quarterly data on county-level unemployment from the Bureau of Labor Statistics. Second, I also use measures of the subprime share of the county's population calculated from the Federal Reserve Bank of New York/Equifax Consumer Credit Panel (accessed via GeoFRED). I merge these variables into the NCUA data based on the county in which the credit union is headquartered. Most credit unions will have their operations also located in the same county. The summary statistics reported in Appendix Table B.1 also include these county-level measures, which are calculated after these variables are merged into the credit union panel.

4 Empirical Strategy

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

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

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

where $\text{Loans}_{i,t}$ is loan originations for credit union i during quarter t. Among the explanatory variables, ΔR_t denotes the quarterly change in the two-year Treasury rate (from $t-1$ to t) and $\text{Assets}_{i,t}$ is the value of credit union i's assets by the end of period t. The specification includes year and credit union fixed effects, as well as quarter fixed effects to account for seasonality. The vector $X_{i,t}$ contains time-varying credit union and local economic (county) controls. The credit union fixed effect means that the TSLS estimation is exploiting variation in assets and investment capital *within* a credit union.

We expect a negative coefficient on the policy rate (β_1), meaning that interest rate reductions boost lending. Because asset losses errode bank health, we anticipate that β_2 is positive. The models of Section 2 demonstrate that the sign of the interaction term β_3 depends on the nature of financial frictions lenders face. A positive interaction term (β_3) has two implications. First, higher asset values dampens the response to a given change in the policy rate. Second, monetary easing reduces the impact of asset losses on lending. Therefore, a positive interaction term is consistent with weaker lenders facing financial frictions that are alleviated by monetary easing.

There are three first-stage equations: two for each endogenous regressor (the policy rate and assets) and a third for their interaction. Letting $Z_{i,t}$ denote a 3×1 vector of these endogenous regressors, the first-stage system of equations is

$$\begin{aligned} Z_{i,t} = \alpha_1 \Delta \widetilde{R}_t + \alpha_2 \ln(\text{InvCap}_{i,t}) + \alpha_3 \left[\Delta \widetilde{R}_t \times \ln(\text{InvCap}_{i,t}) \right] \\ + \widetilde{\tau}\ \text{Year}_t + \widetilde{\kappa}_i + \widetilde{\gamma}\ \text{Quarter}_t + \widetilde{\zeta} X_{i,t} + \nu_{i,t}. \end{aligned} \tag{2}$$

where each α term is a 3×1 vector of first-stage coefficients. There are three instruments in total. The first, $\Delta \widetilde{R}_t$, is the sum of high frequency "monetary surprises" during quarter t. I construct these surprises from Fed Funds futures contract price data in the style of Kuttner (2001), which I describe in more detail in Section 4.2. The second is the logged value of investment capital ($\text{InvCap}_{i,t}$) by the end of quarter t. The third is the interaction of the first two instruments. With three instruments and three endogenous regressors, the system is exactly identified.

OLS estimation of Equation (1) would likely be biased. Because macroeconomic declines can prompt both policymakers to lower rates and depress lending, OLS estimates of β_1 would likely be biased upwards. Additionally, local economic declines can trigger both increases in delinquency (that reduce creditor assets) and declines in loan demand, 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 sample comes from a time when lending was slowing, OLS estimates are likely biased downwards.[18]

It is important to instrument for both the Treasury rate and assets in order to ascertain whether monetary easing is *causing* differential sensitivity to asset losses (and vice versa). Only instrumenting for assets would make it difficult to rule out whether differences in lending's response to assets in times of low rates is due to the low rates themselves or the macroeconomic climate driving rates down. In the terminology of (Kashyap and Stein, 2000), we risk conflating the causal effect of monetary policy with lenders' "cyclical sensitivity." If we only instrument for monetary policy and not assets, one could document how the strength of the credit channel varies on average for high versus low asset value lenders. But without an instrument for assets too, we could not speak to whether asset losses *cause* heterogeneity in the credit channel nor quantify its importance in shaping this heterogeneity.

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. Namely, this means that these shocks are uncorrelated with local loan demand, credit union characteristics, and macroeconomic trends. Moreover, the exclusion

[18]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.

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 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. First, 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 B.3 and B.4 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 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, Van den Heuvel and Verani (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 contracting with credit unions located in a specific state or region up until the late 1990s (NCUA, 2009; Ramcharan, Van den Heuvel and Verani, 2016).

Identifying the Effect of 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), Tang (2015), and Wong (2019), I sum these shocks to a quarterly frequency to obtain a quarterly measure of monetary surprises.[19]

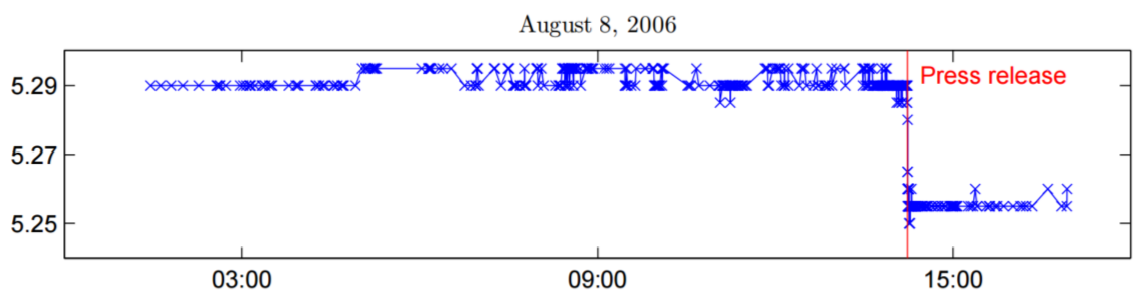
The key identifying assumption of this high frequency approach is that movements in futures prices in this narrow window around FOMC announcements are uncorrelated with the state of the economy.[20] Intuitively, the idea is that the price just prior to the announcement reflects investor information on the current state of the economy. The price change shortly after the announcement reflects changes to investors' beliefs about the level and

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

[20] 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).

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.

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.[21] Even though the Fed funds target rate 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 from investigating how the response of credit union lending to conventional monetary easing is altered by asset losses. The models of Section 2 demonstrate that the answer to this question is not a priori obvious from theory alone; the answer depends on the nature of the financial frictions lenders face. This motivates the empirical investigation of this relationship. I first examine the impact on total lending and then the impact on consumer credit interest rates. The last subsection provides evidence

[21] 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 new regulations were introduced by the NCUA affecting both corporate and natural person credit unions that impacted incentives to raise or acquire paid-in and membership capital.

on the robustness of the main results and presents a placebo test whose results support the exogeneity of investment capital losses.

5.1 Total Lending

Table 1 presents results from estimating Equation (1), the specification discussed in the previous section. The outcome variable is the quarterly volume of loan originations for all credit products. All columns include credit union (CU), year, and quarter fixed effects. Column 1 provides a baseline estimate with no control variables. Column 2 adds CU-level controls and column 3 adds local economic controls. I demean the Treasury rate changes and log assets in the regression. This ensures that the un-interacted Treasury rate and asset coefficients therefore correspond to estimates of the responses for an average credit union.[22] Throughout, I cluster by county to allow for latent determinants of lending to be correlated within counties and over time.

The policy rate coefficient is negative, as expected, indicating that easing increases lending. The estimate in column 3 implies that a 100 basis point decrease in the two-year Treasury rate leads to a 2.66% increase in quarterly loan originations for an average CU. Also as expected, assets have a positive effect on lending. The estimate in column 3 indicates that a one percent decrease in the value of CU assets leads to a 2.83% decrease in quarterly loan originations for an average CU. The standard deviation of log asset growth during the sample period was 0.0418 (i.e., $\approx$ 4.18%), implying that a one standard deviation fall in log asset growth reduces quarterly loan originations by 11.85 percentage points.

The main coefficient of interest is the interaction of the policy rate and log assets. The positive sign means that asset losses amplify the lending response to the policy rate. The coefficient in Column 3 indicates that a one standard deviation asset loss (-0.0418) leads to an additional 13.3 basis point increase in loan originations in response to a 100 basis point policy rate reduction. This corresponds to a 5% stronger lending response to the same policy rate shock (2.79% versus 2.66%). This result demonstrates that asset losses can

[22] I.e., the un-interacted coefficient for one variable is the response conditional on the *other* covariate of interest being at its average value.

Table 1: Total Lending

	(1)	(2)	(3)
ΔR	-3.674***	-3.787***	-2.659**
	(1.047)	(1.076)	(1.110)
ln(Assets)	2.378***	3.146***	2.832***
	(0.469)	(0.603)	(0.605)
$\Delta R \times$ ln(Assets)	3.056***	3.369***	3.185***
	(1.104)	(1.084)	(1.035)
ln(members)		-0.951***	-0.811***
		(0.310)	(0.301)
Mtg Share		0.200***	0.207***
		(0.039)	(0.038)
LICU		-0.064	-0.059
		(0.043)	(0.041)
ΔMtg Share		0.191***	0.187***
		(0.028)	(0.027)
Unemployment			-0.023***
			(0.005)
Subprime Pop.			0.003
			(0.006)
Observations	83164	75383	74899
CU FE	✓	✓	✓
Quarter FE	✓	✓	✓
Year FE	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is log loan originations. The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county.

have an economically significant effect on the strength of the credit channel of monetary policy. Although an asset loss can cause a credit union to lend less overall, by examining the interaction term we can see that credit unions experiencing asset losses are nonetheless more sensitive to conventional monetary easing.

The positive interaction term simultaneously implies that easing reduces the impact of a change in assets on lending. Importantly, this means that easing can reduce the contractionary effects of asset losses. A 100 basis point decrease in the policy rate reduces the impact of a one standard deviation asset loss on loan originations from -11.85 to -11.72 percentage points (a 1% weaker response in relative terms). This means that monetary easing, in addition to its direct effects on lending, has a secondary benefit in financial crises in that it reduces the contractionary effects of asset losses.

The positive interaction term also has implications for the substitutability versus complementarity of conventional and unconventional monetary policy. Unconventional policies such as large scale asset purchases directly target assets, improving the health of balance sheets. Since the interaction term is positive, unconventional policies that boost asset values can diminish the total effect of changes in the policy rate. Similarly, because policy rate reductions decrease lending's sensitivity to assets, conventional easing weakens the effect on lending of both asset losses and gains. Therefore, the positive interaction term implies that conventional and unconventional monetary policies are substitutes rather than complements. An important caveat is that this empirical setting does not directly study an unconventional policy, but rather purely variation in lender asset values. To the extent that unconventional policies have other indirect effects on lending (i.e., through channels other than assets), these indirect channels could differ in their complementarity/substitutability with conventional monetary easing.

Evaluating the First Stage. Appendix Table C.1 reports first stage estimates for the specification including CU and county-level controls. The signs are as expected. A larger monetary surprise predicts an increase in the two-year Treasury rate and a higher value of investment capital predicts higher asset values. The interaction of the two instruments predicts a higher value for the interaction of the endogenous regressors as well.

Results of tests for weak instruments and under-identification are reported in Appendix Table C.2. 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. The Kleibergen-Paap LM statistic strongly rejects the null hypothesis of under-identification with a p-value of 1e-4. The Cragg-Donald Wald statistic exceeds the Stock and Yogo (2005) 5% critical value (44.33 versus 9.53), rejecting weak instruments well below the 5% level. 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 6.26 recommends rejecting weak identification at the 20% level (critical value of 4.99) and nearly the 10% level (critical value of 6.61).

Given the marginal Kleibergen-Paap Wald statistic, it is useful to consider how weak instruments could potentially bias the TSLS estimates. In general, weak instruments cause TSLS to be biased towards OLS estimates. Comparing the TSLS results of Table 1 to their OLS counterparts in Appendix Table C.3 suggests that at worst the TSLS estimates understate the magnitude of the coefficients of interest. The OLS estimate on the Treasury rate is positive while the TSLS estimate is negative. The OLS estimates on log assets and the interaction term are positive but smaller than the TSLS estimates. Importantly, this implies that the conclusion that the interaction term is positive is robust to weak instrument concerns.

5.2 Interest Rates

Table 2 presents estimated effects on interest rates. I examine interest rates for mortgages, new auto loans, used auto loans, credit cards, and other unsecured consumer credit. The CU-level interest rate measure is the modal rate on loans originated during the quarterly reporting period.[23] The specification used for each rate is the same as that of column 3 of Table 1 (replacing the outcome variable with one of the five interest rates).

For mortgages we see that there is partial (6%) pass-through of policy rate changes to mortgage rates. A 100 basis point policy rate reduction leads to a 6 basis point mortgage rate decrease. Note that because the NCUA Call Reports measure the modal interest rate, this measure may be stickier than the average rate at the CU. If the CU's pricing of risk does not change in response to the shock, then it may take a larger change in the composition of borrowers to trigger a change in the modal rate than the average rate. Examining the other rate measures, we see auto and credit card rates *rise* in response to a policy rate decrease. This may initially appear counter-intuitive, as an expansion of supply typically lowers prices. However, if the marginal borrower receiving credit is *riskier*, risk-based pricing could mean the typical rate borrowers face rises.[24] Note that this finding does not rule out that, within individual risk-segments, pricing falls overall.

Assets have a negative relationship with interest rates. This is consistent with asset losses triggering a reduction in credit supply that raises equilibrium prices of credit, inducing movement along credit demand curves within risk-segments. This could also arise from risk-shifting if a financially weakened credit union begins to speculate on riskier borrowers that would receive higher rates even with unchanged risk-based pricing. The effects are largest (and statistically significant) for auto loans (new and used) and unsecured credit. The estimates imply that a one standard deviation asset loss ($\approx 4.18\%$) leads to a 15, 17, and 20 basis point increase in new auto, used auto, and unsecured credit rates.

The interaction terms are generally negative. This leads to implications for how monetary policy alters the impact of asset losses on lending that are similar to the findings for lending: a decrease in the policy rate reduces the contractionary effect of asset losses. The impact of a one standard deviation asset loss on auto interest rates is 2% weaker after a 100 basis point decrease in the policy rates. The interaction is not statistically significant

[23] The NCUA Call Report instructions ask credit unions to "report the most common rate in each category."

[24] In the context of corporate borrowing, Jiménez, Ongena, Peydró and Saurina (2014); Ioannidou, Ongena and Peydró (2015) find monetary easing prompts banks to disproportionately extend credit to riskier firms.

Table 2: Interest Rates

	Mortgage	New Auto	Used Auto	Credit Card	Unsecured
	(1)	(2)	(3)	(4)	(5)
ΔR	0.060***	-0.103***	-0.104***	-0.086**	-0.019
	(0.014)	(0.024)	(0.027)	(0.034)	(0.032)
ln(Assets)	-0.013	-0.036*	-0.041*	-0.016	-0.047*
	(0.009)	(0.019)	(0.021)	(0.027)	(0.025)
$\Delta R \times \ln(\text{Assets})$	-0.009	-0.075**	-0.078**	0.025	-0.046
	(0.016)	(0.029)	(0.032)	(0.038)	(0.040)
ln(members)	0.006	0.017*	0.020**	0.010	0.023**
	(0.004)	(0.009)	(0.010)	(0.014)	(0.012)
Mtg Share	-0.003***	0.001	0.001	-3e-4	0.003**
	(5e-4)	(0.001)	(0.001)	(0.001)	(0.001)
LICU	0.001	5e-4	0.002*	0.002	0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
ΔMtg Share	-0.002***	0.001*	0.001*	-8e-6	0.001**
	(2e-4)	(4e-4)	(5e-4)	(0.001)	(0.001)
Unemployment	-1e-5	-4e-5	-1e4	6e-5	-2e-4
	(8e-5)	(1e-4)	(2e-4)	(2e-4)	(2e-4)
Subprime Pop.	-1e-4	-4e-4**	-4e-4**	-1e-4	-1e-4
	(8e-5)	(2e-4)	(2e-4)	(2e-4)	(2e-4)
Observations	74795	74779	74691	59150	74672
CU FE	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variables are named at the top of each column. Each interest rate is given in percent points (i.e., 1 equals a one percentage point change). The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county.

for other credit products. For monetary easing, the implication differs in that asset losses dampen the *negative* effect of policy rate increases on consumer interest rates. However, it is similar to the results for lending in implying that monetary easing is *more* stimulative (in the sense of reducing rates) among credit unions experiencing asset losses. For new and used auto lending, the estimated interaction terms imply a one standard deviation asset loss causes a 2% change in the magnitude of the coefficient on the policy rate.

5.3 Robustness

Sample, Specification, and Inference Robustness. The baseline results in Table 1 are robust to several important econometric and data choices. Column 2 of Appendix Table D.1 excludes credit unions operating in California from the sample to address a potential threat to identification. Ramcharan, Van den Heuvel and Verani (2016) notes that credit unions exposed to one of the largest Corporates (WesCorp) experienced especially large investment capital losses. Many of these credit unions were California-based and WesCorp's residential mortgage portfolio was also skewed towards California. Excluding California reduces the sample size by about 6%, but estimates for the interaction term and asset losses remain similar. The coefficient on the policy rate loses statistical significance and falls in magnitude (but it remains within the 95% confidence interval of the full sample estimate).

Column 3 constructs monetary surprises to exclude days on which the FOMC announced changes to LSAPs. This provides a measure that more purely reflects conventional monetary policy. Estimates remain similar to the baseline results.

Column 4 adds a time fixed effect. This fixed effect is that it nets out the impact of time-varying (i.e., macroeconomic) factors on lending. The downside is that it is collinear with the policy rate, which prevents estimating a coefficient on the un-interacted policy rate. The point estimates for assets and the interaction fall slightly, but remain statistically significant and within the 95% confidence intervals of the baseline estimates.

Next, I employ an alternative approach to inference. The baseline estimates cluster standard errors by county. This approach follows other work investigating heterogeneity in the transmission of monetary policy that clusters by at least the dimension in which the heterogeneity of interest varies (see, for example, Beraja, Fuster, Hurst and Vavra, 2019; Eichenbaum, Rebelo and Wong, 2019; Li, Ma and Zhao, 2019; Wieland and Yang, 2020; Xiao, 2020; Di Maggio, Kermani and Palmer, 2020).[25] In my setting, this corresponds to CU-level variation in investment capital. Clustering by county allows for unobserved factors to be correlated across credit unions and over time (within counties). But because the policy rate only varies by time, it is useful to confirm that inference is robust to two-way clustering by time and county. This allows for correlation in lending across counties and within time periods. Appendix Table D.2 reports results from two-way clustering. The policy rate coefficient loses statistical significance, but both log assets and the interaction term remain statistically significant. However, we should interpret the standard errors with caution as this approach to inference relies on a small number of time clusters (32).

Alternative Sources of Sensitivity. I next explore the robustness of the positive interaction term to including additional interactions. I adapt the baseline specification of Equation (1) to include additional interactions of the policy rate and the control variables, treating these terms as endogenous regressors. I add interactions of these control variables with the monetary surprises as instruments. Appendix Table D.3 reports regression results. The point estimate for the interaction with assets rises from 3.19 to 15.75., implying a larger effect of asset losses on the pass-through of monetary policy. But the new 95% confidence interval still contains the baseline estimate. In particular, the higher estimate implies a 1% asset loss causes CUs to respond with an additional 0.16 percentage point increase in loan originations in response to a 100 basis point policy rate change.

The interaction of the policy rate with the log number of members is the only other interaction that is statistically significant. The point estimate implies larger credit unions tend to respond more strongly to policy rate changes. Note that we should not interpret this as the *causal* effect of the member count as there is not an instrument for members.

[25]In some cases, this literature uses Newey-West standard errors as well.

Placebo Test: Pre-Crisis Lending I conduct a placebo test to examine the plausibility of the identifying assumptions. The chief threat to identification is that an unobserved CU characteristic caused CUs to both experience larger investment capital related losses and reduce their lending during the crisis. This could happen if, for example, risk-seeking CUs sought higher exposure to risky Corporates and concentrate their lending among more cyclically sensitive borrowers. Such a scenario suggests CUs that had larger investment capital losses were extending more credit during the boom.

The placebo test explores whether CUs that experienced larger investment capital losses during the crisis differed in their lending activity *prior* to the crisis. I estimate the following specification:

$$\begin{aligned} \ln(\text{Loans}_{i,t}) = \sum_{t=2004}^{2011} \left[\gamma_t \Delta \ln \left(\text{InvCap}_i^{Crisis} \right) \times 1[\text{Year}]_t \right] \\ + \tau \text{ Year}_t + \kappa_i + \gamma \text{ Quarter}_t + \xi X_{i,t} + e_{i,t} \end{aligned} \tag{3}$$

where $\Delta \ln \left(\text{InvCap}_i^{Crisis} \right)$ is credit union i's log change in investment capital during the crisis. This specification allows the coefficient on crisis-related losses, γ_t to vary with the year. The specification includes the same controls and fixed effects as the baseline estimates. Appendix Table D.4 reports estimation results measuring crisis-related as the change in investment capital from 2008 to either 2009, 2010, or 2011.

Prior to the collapse of ABS markets in 2008, crisis-related losses generally do not predict differences in lending. A coefficient for 2006 is significant at the 10% level in column 1. In contrast, a bigger crisis-related loss is consistently associated with a statistically significant decrease in lending *during* the crisis – exactly when they should impact lending. Overall, this finding lends greater credibility to the assumption that investment capital is unrelated to other determinants of a credit union's lending. Ramcharan, Van den Heuvel and Verani (2016) provide additional evidence that investment capital losses are plausibly unrelated to potential confounding factors.[26]

[26]For example, Ramcharan, Van den Heuvel and Verani (2016) documents that the loan composition of CUs

6 Mechanisms and Interpretation

This section presents additional evidence to help further interpret the results for lending. I first explore mechanisms underlying the stronger response among credit unions with weakened balances by investigating how credit union funding changes. I then document heterogeneity in estimated treatments effects and use this to discuss implications for the local nature of the TSLS estimates (which identify local average treatment effects). After this, I examine how general equilibrium could affect the total effect of monetary policy and asset losses. Finally, I discuss differences between credit unions and banks and implications of these differences for external validity.

6.1 Mechanisms

Why do asset losses cause credit union lending to be more sensitive to conventional monetary policy? The second model of Section 2 suggests that the profitability of lending – in that specific model, the cost of funds – could be more sensitive to changes in the policy rate. To shed light on this, I estimate the impact of policy rate changes and asset losses on several outcomes related to CU loan costs and profitability. Specifically I estimate the baseline specification in Equation (1) replacing the outcome variable with the log change in deposits, the deposit rate, and the net interest margin (NIM). I measure the deposit rate as the quarterly flow of deposit interest expenses divided by deposits. The net interest margin equals interest income minus interest expenses, divided by total assets. Appendix Table B.1 reports summary statistics for these variables. The average CU NIM is 2.23%, which is on the low end of the value typically observed for banks.[27]

Table 3 reports estimation results. Focusing first on the effect of conventional monetary policy and deposits, the estimates indicate that policy rate reductions increase CU deposits. A 100 basis point decrease in the policy rate causes a 1.30% increase in deposits. At the same time, easing leads to a slightly lower deposit rate. The same 100 basis point policy

was unrelated to whether or not the Corporate that they were connected to failed. Additionally, they find house price growth during the boom is unrelated to investment capital growth in the boom.

[27] Drechsler, Savov and Schnabl (2021) report that bank NIMs have historically ranged from 2.2% to 3.8% since 1955.

Table 3: Mechanisms

	$\Delta\ln(\text{Deposits})$ (1)	Dep. Rate (2)	NIM (3)
ΔR	-1.298***	0.042**	-0.048***
	(0.091)	(0.019)	(0.011)
$\ln(\text{Assets})$	0.053	0.075***	0.022**
	(0.045)	(0.016)	(0.009)
$\Delta R \times \ln(\text{Assets})$	-0.002	0.086***	0.026*
	(0.089)	(0.024)	(0.014)
$\ln(\text{members})$	-0.057**	-0.033***	-0.009*
	(0.023)	(0.009)	(0.004)
Mtg Share	0.002	-0.002***	-0.001***
	(0.002)	(0.001)	(4e-4)
LICU	-0.002	-0.001	-0.001
	(0.002)	(0.001)	(0.001)
ΔMtg Share	0.006***	-0.001***	-5e-4**
	(0.002)	(4e-4)	(2e-4)
Unemployment	-0.002***	0.001***	1e-4
	(4e-4)	(1e-4)	(8e-5)
Subprime Pop.	0.001**	0.001***	3e-4***
	(4e-4)	(2e-4)	(9e-5)
Observations	74899	74720	74470
CU FE	✓	✓	✓
Quarter FE	✓	✓	✓
Year FE	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variables are named at the top of each column. The outcomes are the log change in deposits, the deposit rate, the ratio of non-deposit interest expenses, and the net interest margin (NIM). The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county.

rate reduction leads to a 4 basis point deposit rate decrease. Together, these responses are consistent with easing triggering an increase in credit union supply of deposits, as opposed to shifting household demand for deposits. The negative effect on deposits and positive effect on deposit rates is consistent with findings for banks in Drechsler, Savov and Schnabl (2017). This suggests the deposit channel of monetary policy may operate similarly for banks and credit unions.

Turning to asset losses, a decrease in assets does not have a statistically significant effect on deposit growth. However, a decline in assets is associated with a decrease in deposit rates. A 1% asset loss leads to an 8 basis point decrease in deposit rates. One potential explanation for this response is that financially weakened CUs exploit inertia among depositors to boost retained earnings. A CU can try to recover from an asset loss by retaining more cash through reduced deposit expenses. A sufficiently small change in the deposit rate may avoid prompting depositors to move their funds to a different institution.

The interaction term between the policy rate and assets is positive and statistically significant for the deposit rate. The estimate is small and statistically insignificant for deposits. This positive coefficient implies that asset losses *reduce* the pass-through of a policy rate change to deposit rates. This means CUs experiencing asset losses will see a smaller fall in this component of their funding cost. Thus a reduction in deposit rates is unlikely to explain the *stronger* lending response among CUs experiencing asset losses. Deposit costs are the dominant source of interest expenses for CUs, and CUs are more deposit-reliant than typical banks.[28]

Next, I examine a more comprehensive measure of lending profitability: the net interest margin (NIM). Here, we see that monetary easing causes increases in credit unions' NIM, improving their profitability. The decrease in deposit expenses could contribute to this rise in profitability. The overall positive effect of easing means that either interest income falls by less than the decrease in interest expenses, or that interest income increases as well. An increase could come from expanded lending, and expansions to riskier borrowers that pay higher rates on average could amplify the rise. The positive response of

[28]Table B.1 reports that CU non-deposit interest expenses as a share of assets are on average 0.02%.

auto loan rates to easing estimated in Table 2 suggests this could occur.

The CU NIM response to conventional monetary easing is larger than estimates for banks: 4 basis points versus 0.6 basis points per 100 basis point increase in the policy rate (Drechsler, Savov and Schnabl, 2021).[29] Drechsler, Savov and Schnabl (2021) argues that the long-run and sticky nature of banks' deposit franchises hedges duration mismatch against income from long-term fixed-rate lending. Credit unions do more shorter term consumer lending than banks – specifically, relatively more auto lending and less mortgage lending.[30] CUs may therefore be less effective in hedging their duration mismatch, leading their NIM to be more sensitive to the policy rate.

Turning to assets, we see a positive effect of assets on the NIM, raising CU lending profitability. A negative causal effect of assets on the NIM could arise even if interest income and expenses are unchanged. This is because a rise asset values increase the denominator, mechanically lowering the NIM. The positive effect indicates that changes to interest income and expenses dominate this mechanical effect shaping the response to asset losses. Recall also that asset losses lower the deposit rate, which should raise profitability by reducing deposit expenses. Since deposit financing is the vast majority of CU interest expenses, this suggests that the NIM falls with asset losses because of reduced interest income. Since asset losses are associated with higher consumer credit interest rates (Table 2), this must come from the reduction in lending. If a reduction in lending is not met by a similar reduction in deposits, this could cause the NIM to shrink. This implies that asset losses prompt CUs to scale back lending relative to the size of their post-loss balance sheet, enough to lower the profitability of lending.

[29] Note that Drechsler, Savov and Schnabl (2021) uses the Fed Funds rate as the policy rate, instead of the two-year Treasury rate, which means this is not a perfect apples-to-apples comparison. This comparison most likely *understates* the magnitude of the difference in responses. Nakamura and Steinsson (2018) finds that monetary surprises have a larger impact on the two-year Treasury rate compared to shorter maturity Treasuries and T-bills. This suggests a 100 basis point change in the shorter-term Fed Funds rate is "large" relative to a 100 basis point change in the two-year Treasury rate.

[30] During the sample period (2004-2011) mortgages comprised 54.3% of consumer loans on CU balance sheets, compared to 81.7% for US banks. These figures are from the 2011 Q2 and 2012 Q1 Flow of Funds (FOF) Reports (Tables L.115, L.110, and L.114). In this comparison, "banks" are commercial banks and savings institutions. Note that in the FOF, consumer credit excludes mortgages, so I add "consumer credit" to mortgage lending to tabulate the total amount of consumer lending.

Lastly, we see a positive interaction term for the NIM. This indicates that asset losses *increase* the impact of policy rate changes on profitability. A given reduction in the policy rate causes profitability to rise *more* at CUs experiencing asset losses. In this sense, CUs financially weakened by asset losses benefit more from the same change in monetary policy. This higher profitability of lending could contribute to the stronger lending response to monetary easing among financially weakened CUs. Moreover, because deposit costs fall *less* for weakened CUs, this implies that the increased profitability must come from higher interest income.

6.2 Response Heterogeneity

I next investigate two dimensions of heterogeneity in the estimates for lending. This is motivated by limitations of the TSLS estimation, which is that it identifies a local average treatment effect (LATE). The LATE identifies an average response that may be different from the population average. Additionally, any average response may mask heterogeneity in the strength of the treatment effects across credit unions. In the binary treatment case, the LATE is the average response among "compliers". In the case of continuous endogenous variables, which this paper faces, the LATE upweights credit unions whose first stage coefficients are relatively larger (Masten and Torgovitsky, 2016).[31] The impact of the monetary surprises on the two-year Treasury rate should be similar across all credit unions given the macroeconomic nature of its variation. But credit unions with larger investment capital *exposure* would tend to experience larger nominal asset losses, even if the percent change in the value of investment capital is randomly assigned.

To gain a better sense of the population's average response, I estimate the baseline specification within sub-populations that are likely to differ in the impact of investment capital on their assets. I split the sample into terciles based on the credit union's investment capital share of non-loan assets. Those with a higher share will tend to experience larger

[31] Recent advances allow econometricians to identify a representative response or "policy-relevant treatment effect" for IV estimates in the binary treatment case (e.g., Mogstad and Torgovitsky, 2018). But to the best of my knowledge, it is still an outstanding problem in econometrics to adapt these tools for the continuous treatment case.

absolute asset losses for a given percent change in the value of investment capital.[32]

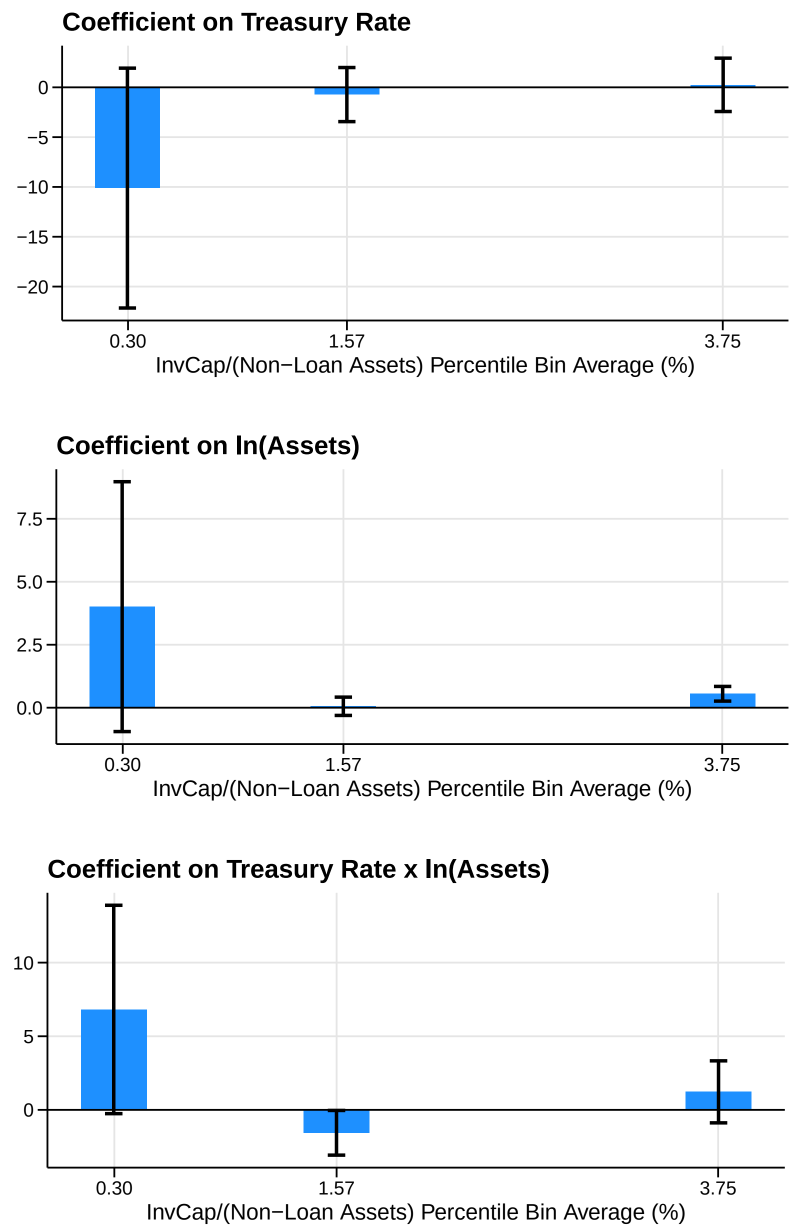
Figure 3 displays estimation results. The specifications use the same fixed effects, controls, and clustering as the baseline specification (specifically, column 3 of Table 1). Because the sample sizes shrink by a third, estimation precision falls. However, there are large differences in point estimates which can still suggest how the population treatment effect may differ from the LATE. Among all sub-populations, the low exposure (leftmost) credit unions have the largest estimated treatment effects for all three covariates (the policy rate, asset losses, and their interaction). The relationship between treatment effect and exposure also appears to be nonlinear, with the smallest effects occurring for the middle tercile. Estimates for the high exposure group are larger than the middle group, but smaller than the low exposure group. The strong response among the lowest exposure CUs suggests that the LATE gives the least weight to the most sensitive CUs. This suggests the population treatment effects are likely larger than the LATE estimates.

Credit union net worth is another dimension in which we might expect heterogeneity in the impacts of monetary easing, assets, and their interaction. For example, lower net worth credit unions may respond more strongly to monetary easing or asset losses because of greater proximity to regulatory constraints. Proximity to regulatory constraints could plausibly exacerbate financial frictions by either increasing the chances a regulatory constraint binds (similarly to model 1 of Section 2). It could also increase financing costs if external creditors become increasingly worried about the likelihood of repayment as the credit union approaches statutory capital minimums (similarly to model 2 of Section 2).

To investigate this, I split the sample into terciles based on the key net worth ratio on which credit unions are regulated. Figure 4 displays estimation results. Consistent with the example discussed here, we see the largest estimates among the lowest net worth credit unions. The larger point estimates for monetary policy and asset losses suggest we can expect stronger effects on lending from changes in these variables when lender net worth is low (though this by itself does not suggest net worth *causes* the responses to strengthen).

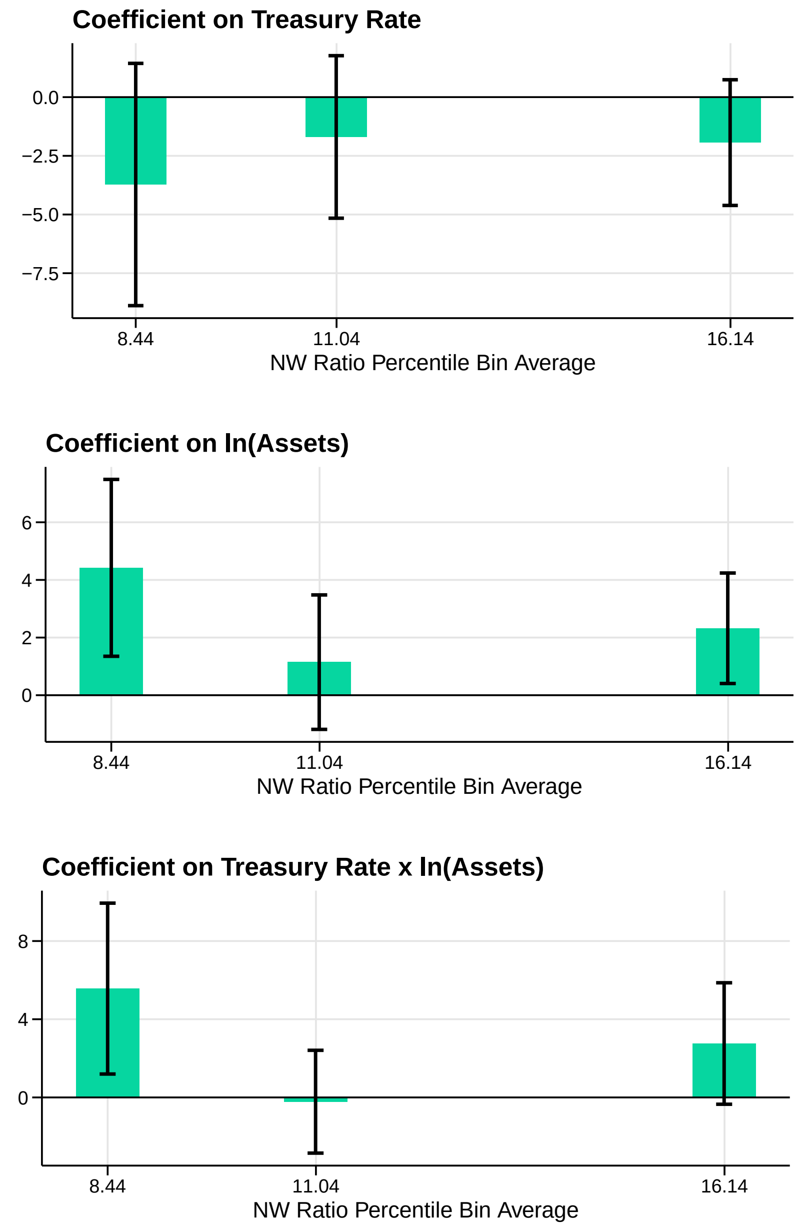
[32] As expected, the first stage estimates for monetary surprises are stable across the terciles while coefficients on assets and the interaction grow with exposure to investment capital (results available by request).

Figure 3: Heterogeneity in Responses by Investment Capital Share of Non-Loan Assets



Notes: These graphs plot point estimates obtained by estimating the baseline specification of Equation (1) within subsets of the data. The bars denote 95% confidence intervals. The subsets are constructed by splitting the sample into terciles based on the credit union's investment capital share of non-loan assets. Estimation uses the same set of controls, fixed effects, and clustering as the last column of Table 1. Full tables including point estimates for controls are available by request.

Figure 4: Heterogeneity in Responses by Net Worth



Notes: These graphs plot point estimates obtained by estimating the baseline specification of Equation (1) within subsets of the data. The bars denote 95% confidence intervals. The subsets are constructed by splitting the sample into terciles based on the credit union's net worth ratio. Estimation uses the same set of controls, fixed effects, and clustering as the last column of Table 1. Full tables including point estimates for controls are available by request.

The larger interaction term suggests that when lender net worth is lower, we may expect *more* heterogeneity in the lending response due to variation in asset losses. Additionally, the relationship between treatment effect size and net worth appears to be nonlinear for the interaction term, with those in the middle tercile having a near zero point estimate.

6.3 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 that 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. To explore potential substitution across credit unions, I collapse the data used in the main analysis to a county-level panel and re-estimate the baseline specification.[33] Appendix Table E.1 reports estimation results. The magnitudes of the point estimates decrease but retain the same size and overall magnitude. Ramcharan, Van den Heuvel and Verani (2016) also documents that investment capital led to county-level declines in auto sales.

Second, the favorable rates offered by credit unions would dampen borrower desire to switch from credit unions to banks. Credit unions consistently offer more favorable rates to borrowers than banks.[34] This reduces the likelihood that the marginal borrower not receiving a loan at a credit union would instead obtain it from a bank. The favorable rates offered by credit unions make it profitable for the marginal borrower to wait out the credit

[33] I collapse credit-union level variables by summing those measured by absolute amounts and taking the average of those reported in percentage terms. For example, I sum assets within a county and then take the log. I take the average of the mortgage share of lending across credit unions.

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

crunch and later seek a loan from their credit union. This limits the likelihood that banks would fully offset a credit union's reduction in lending. 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.

Third, most people tend to live nearby the lenders from which they borrow.[35] Frictions like search costs or behavioral biases such as inattention may limit household borrowing from distant banks. This can slow the process of searching for a new lender.

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 (Midrigan and Philippon, 2016; 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 full global general equilibrium impact of asset losses on lending. Additionally, amplification over time could compound the long-run impact of asset losses on lending (Mian, Rao and Sufi, 2013; Mian and Sufi, 2014; Berger, Guerrieri, Lorenzoni and Vavra, 2017).

6.4 External Validity

Credit unions are an important provider of consumer credit in the US. CUs accounted for 13% of mortgage and 28% of auto originations in 2017.[36] During the sample period (2004-2011) CUs, held 6.1% of mortgage loans and 19.7% of all other consumer credit (among CUs, commercial banks, and savings institutions).[37]. Although CUs are smaller than banks, they still account for an important share of total US consumer credit. The findings for this paper therefore apply to credit outcomes for a large population.

[35] 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.

[36] These figures are from Experian's 2017 Report *The State of Credit Unions*, available at https://perma.cc/P5UM-HHN9.

[37] These statistics come from the 2011 Q2 and 2012 Q1 Flow of Funds (FOF) Reports (Tables L.115, L.110, and L.114).

How do credit unions differ from banks? As one might expect from their smaller share of consumer lending, the size of the credit union sector as measured by assets is also smaller. In 2017, CU total assets totaled \$1.4 trillion compared to \$17.4 trillion for banks. CUs also operate at a smaller scale. In 2017, average assets per CU were \$246 million compared to \$3.1 billion for banks. The average CU also has four branches whereas the average bank has 16.[38] This smaller scale limits the ability of CUs to diversify their lending and may make them more sensitive to shocks in general. Thus the corresponding estimates for banks may be smaller.

In terms of regulations, CUs face similar-style capital adequacy requirements as banks. Net worth to asset ratios in 2017 were 11.0% for CUs and 11.2% for banks. The regulatory minimum for adequate capitalization under this ratio is 6% for credit unions and 4% for banks. Since CUs operate with greater proximity to their capital requirements, this could also make their lending more sensitive to asset losses. It takes a smaller loss to push the typical CU under its regulatory minimum, which could exacerbate financial frictions. Credit unions are regulated more strictly than banks, with many effectively barred from directly holding assets like private label MBS. A possible consequence of these restrictions is the higher ratio of loans to assets among CUs compared to bank (69.7% versus 56.7%).[39] As a result, CUs effectively have fewer assets to choose from when adjusting their portfolio. This could also lead credit union lending to be more sensitive to both asset losses and monetary policy.[40]

How might the interaction between conventional monetary policy and asset losses differ for banks? This is more challenging to forecast. The models of Section 2 suggest that the answer could change if the dominant financial frictions shaping bank lending differ from those shaping CU lending. One reason to suspect the answer may differ is that the

[38]These figures from the *U.S. Credit Union Profile* for 2017 Q4 produced by the Credit Union National Association (CUNA), available at https://perma.cc/HWM7-7J4S.

[39]These figures from the *U.S. Credit Union Profile* for 2017 Q4 produced by the Credit Union National Association (CUNA), available at https://perma.cc/HWM7-7J4S.

[40]For Italy, Peydró, Polo and Sette (2021) finds that lending among low capitalization banks responds less to monetary policy, with banks instead purchasing more securities.

NIM responds more to monetary policy for CUs compared to banks. Additionally, the impact of easing on the NIM is larger when CUs experience asset losses. However, note that the analysis here cannot isolate and quantify the importance of the NIM in shaping the lending response to monetary policy. Ultimately, it would be valuable for future research to explore how conventional monetary policy and asset losses interact for banks. And comparisons with the results for credit unions in this paper could shed further light on the nature of financial frictions shaping lending for these two major sources of consumer credit.

7 Conclusion

This paper investigates how asset losses affect the credit channel of monetary policy. Using two simple models, this paper illustrates that different financial frictions can cause asset losses to either amplify or attenuate the credit channel of monetary policy. On one hand, a weak balance sheet can constrain lending, limiting the ability of a lender to respond to easing. On the other hand, easing could instead alleviate frictions that would otherwise constrain lending. Lenders with weaker balance sheets, whose lending is more constrained by these frictions, may therefore benefit more from a given policy rate decrease.

I estimate the causal effects of the two-year treasury rate, assets, and their interaction on credit union loan originations. Identification exploits high frequency identification of monetary surprises and a natural experiment in which otherwise similar credit unions experienced different-sized asset losses. I find that asset losses *amplify* the effects of conventional monetary policy on loan originations. Specifically, a one standard deviation asset loss increases the impact of a given change in the policy rate on lending by 5%. Additionally, a 100 basis point decrease in the policy rate reduces the contractionary effect of asset losses by 1%.

These results imply that constraints on conventional monetary policy, such as the ZLB, are more costly in a financial crisis characterized by asset losses. Monetary easing can not only directly stimulate lending but also indirectly stimulate it by weakening the contractionary effects of asset losses on lending. However, these findings also suggest that conventional and unconventional monetary policies are substitutes rather than complements. Here, unconventional monetary policy refers specifically to policies directly targeting assets, such as bank recapitalization or LSAPs. If conventional easing symmetrically weakens the impact of assets on lending, then asset *gains* will also have a lower impact on lending. Outside of financial crises, because strong balance sheets make lending less responsive to changes in the policy rate, larger *increases* in the rate may be necessary to achieve a given reduction in lending to counter a credit boom.

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

A 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

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

$\square$

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 $B' > B$. $\square$

B Descriptive Statistics

Table B.1: Credit Union Summary Statistics

Statistic	Mean	St. Dev.	Pctl(25)	Median	Pctl(75)	N
Loans Orig. (mil. $)	19.711	107.896	1.674	4.271	13.059	94,453
Assets (mil. $)	237.552	885.655	28.877	67.501	188.432	94,453
ln(Loans Orig.)	15.407	1.524	14.331	15.267	16.385	94,453
ln(Assets)	18.165	1.380	17.179	18.028	19.054	94,453
$\frac{\text{Investment Cap.}}{\text{Assets}}$ (%)	0.569	0.481	0.218	0.598	0.858	94,453
$\frac{\text{Investment Cap.}}{\text{Non-Loan Assets}}$ (%)	1.873	1.980	0.611	1.567	2.581	94,453
$\frac{\text{Loans}}{\text{Assets}}$ (%)	62.946	15.095	53.046	64.180	74.259	94,453
Members (000s)	24.850	77.245	4.328	9.566	23.149	94,453
MtgShr (%)	21.731	19.502	6.529	16.663	31.963	94,453
LICU (%)	8.940	28.532	0.000	0.000	0.000	94,452
Net Worth Ratio (%)	11.875	3.992	9.250	11.000	13.540	94,440
Mort. Rate (%)	5.941	0.972	5.340	5.970	6.500	94,303
New Auto Rate (%)	5.752	1.242	4.990	5.750	6.490	94,267
Used Auto Rate (%)	6.513	1.626	5.500	6.400	7.350	94,104
Credit Card Rate (%)	11.091	2.029	9.900	10.900	12.580	73,726
Unsec. Debt Rate (%)	11.872	2.326	10.150	11.900	13.250	94,092
Deposit Rate (%)	1.077	0.728	0.516	0.897	1.472	94,181
$\Delta \ln(\text{Deposits})$	1.196	4.421	−1.050	0.870	3.019	94,432
$\frac{\text{Non. Dep. Int.}}{\text{Assets}}$ (%)	0.020	0.053	0.000	0.00003	0.006	93,079
Net Int. Margin (%)	2.228	1.140	1.195	2.120	3.043	93,836
Unemployment (%)	6.683	2.725	4.633	6.000	8.300	93,791
Subprime Pop. (%)	32.348	7.338	27.221	31.447	36.954	93,827

Notes: These statistics are computed for the subsample used in the main regression analysis. Loan originations are measured at a quarterly frequency. "MtgShr" refers to the mortgage share of loan originations. The net worth ratio is the key measure of net worth on which credit unions are regulated. The interest rates for credit products are the modal interest rate in the quarter in which the credit union is reporting. The deposit rate, in contrast, is the ratio of deposit interest expenses to total deposits. "Non. Dep. Int." refers to non-deposit interest expenses. Unemployment and the subprime share of the population are measured for the county in which the credit union is located.

Table B.2: Monetary Policy Summary Statistics

Statistic	Mean	St. Dev.	Pctl(25)	Median	Pctl(75)	N
Two-Year Treasury Rate (R, %)	2.472	1.652	0.878	2.285	4.068	32
Quarterly Rate Change (ΔR, %)	-0.052	0.526	-0.293	-0.000	0.230	32
Monetary Surprises ($\Delta\widetilde{R}$)	-0.039	0.131	-0.02	0	0	32

Notes: This table reports summary statistics for the key variables that vary by time: the two-year Treasury rate, its quarterly changes, and the measure of monetary surprises calculated from Fed Funds futures contract price changes. The original monetary surprise data comes from Tang (2015). The construction of the monetary surprises is detailed in Section 4.2.

Table B.3: March 2006 Corporate Credit Union Balance Sheets

Name	Assets (bil. $)	$\frac{\text{Equity}}{\text{Assets}}$ (%)	$\frac{\text{NS Liabilities}}{\text{Assets}}$ (%)	$\frac{\text{PIMBS}}{\text{Assets}}$ (%)	$\frac{\text{ABS}}{\text{Assets}}$ (%)
Western Corporate	26.84	3.07	31.16	40.98	64.89
Southwest Corporate	8.94	2.63	9.81	15.96	42.59
TriCorp	0.50	3.32	24.88	0.00	1.95
Members United	4.76	4.45	10.68	0.50	37.99
VaCorp	0.90	3.59	16.87	0.00	10.67
Southeast Corporate	3.44	3.56	11.32	9.83	31.26
Mid-Atlantic Corporate	2.15	3.34	9.29	0.46	3.10
Empire Corporate	3.44	4.41	8.40	16.07	36.25
Eastern Corporate	1.17	4.93	10.05	0.72	16.41
LICU Corporate	0.01	27.19	0.18	0.00	0.00
Kentucky Corporate	0.38	4.85	5.45	0.00	0.00
Corporate One	3.02	3.66	23.31	4.71	40.55
Midwest Corporate	0.17	4.03	10.55	0.00	0.54
Northwest Corporate	0.88	3.69	15.63	7.87	15.38
Constitution Corporate	1.57	2.62	8.99	26.82	50.13
US Central	35.87	2.39	23.73	21.52	70.51
System United Corporate	2.28	3.83	15.39	3.23	20.86
West Virginia Corporate	0.24	3.47	12.76	0.00	0.00
Catalyst Corporate	1.38	3.43	6.61	0.00	2.81
First Corporate	0.78	4.03	27.96	0.00	10.57
Iowa Corporate Central	0.25	6.43	16.63	0.00	0.50
First Carolina Corporate	1.59	5.04	13.55	0.00	9.46
Corporate America	0.86	3.49	14.92	0.00	14.92
Louisiana Corporate	0.20	3.36	16.10	1.50	9.27
C. Credit Union Fund, Inc.	0.24	3.88	14.22	0.00	1.02
Kansas Corporate	0.36	4.44	18.87	0.00	5.43
Volunteer Corporate	0.89	2.83	9.54	1.68	12.50
Central Corporate	1.99	4.62	12.78	1.95	11.58
Missouri Corporate	0.61	6.34	10.03	0.00	0.00
Corporate Central	1.37	4.28	50.07	0.00	11.74
Treasure State Corporate	0.18	3.62	12.08	0.00	0.00
Mean	3.46	4.67	15.22	4.96	17.19
Standard deviation	7.75	4.28	9.30	9.68	19.81

Notes: This table reports balance sheet characteristics of corporate credit unions. "NS liab." refers to non-share and non-equity liabilities (i.e., non-deposit financing), "PIMBS" are privately-issued mortgage-related issues. The remaining kinds of ABS Corporates invest in, that are counted in the last column but not the PIMBS column, are government and agency mortgage-related issues and other asset-backed securities.

Table B.4: December 2009 Corporate Credit Union Balance Sheets

CCU Name	Assets (bil. $)	$\frac{\text{Equity}}{\text{Assets}}$ (%)	$\frac{\text{NS Liab.}}{\text{Assets}}$ (%)	$\frac{\text{PIMBS}}{\text{Assets}}$ (%)	$\frac{\text{ABS}}{\text{Assets}}$ (%)
Western Corporate	21.11	-406.45	46.21	0.00	15.83
Southwest Corporate	7.92	-141.11	0.59	0.00	15.36
TriCorp	0.95	0.98	0.13	0.00	1.24
Members United	8.37	-136.22	2.94	0.00	8.83
VaCorp	1.44	-0.68	0.39	0.00	5.00
Southeast Corporate	3.33	-30.52	0.88	0.00	11.16
Mid-Atlantic Corporate	3.82	1.19	1.30	0.00	3.34
Eastern Corporate	0.84	23.24	1.70	0.00	26.07
Kentucky Corporate	0.44	-4.54	0.19	0.00	0.00
Corporate One	3.30	-62.57	3.94	0.00	49.31
Midwest Corporate	0.19	-0.04	0.22	0.00	7.73
Constitution Corporate	1.29	-162.05	2.01	0.00	12.89
US Central	35.07	-190.33	43.36	0.00	38.65
System United Corporate	2.47	-39.82	2.03	0.00	19.87
West Virginia Corporate	0.24	-4.76	1.06	0.00	0.00
Catalyst Corporate	2.52	-0.15	0.16	0.00	7.13
First Corporate	0.95	-16.91	0.25	0.01	18.88
Iowa Corporate Central	0.09	61.28	0.16	0.07	0.29
First Carolina Corporate	1.78	-13.81	6.16	0.00	19.46
Corporate America	2.19	23.58	8.83	0.00	50.81
Louisiana Corporate	0.16	-15.09	3.30	0.04	15.02
Kansas Corporate	0.34	0.60	5.39	0.02	12.91
Volunteer Corporate	1.55	0.20	14.94	0.00	17.93
Central Corporate	2.97	-6.49	3.61	0.00	10.92
Missouri Corporate	0.90	-0.08	3.16	0.00	0.00
Corporate Central	1.77	34.95	6.63	0.00	36.58
Treasure State Corporate	0.37	0.13	0.05	0.00	0.00
Mean	3.94	-40.20	5.91	0.01	15.01
Standard Deviation	7.52	95.23	11.70	0.02	14.43

Notes: This table reports balance sheet characteristics of corporate credit unions. "NS liab." refers to non-share and non-equity liabilities (i.e., non-deposit financing), "PIMBS" are privately-issued mortgage-related issues. The remaining kinds of ABS Corporates invest in, that are counted in the last column but not the PIMBS column, are government and agency mortgage-related issues and other asset-backed securities. 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.

C Instrument Evaluation

Table C.1: First Stage

	ΔR (1)	$\ln(\text{Assets})$ (2)	$\Delta R \times \ln(\text{Assets})$ (3)
$\Delta\widetilde{R}$	0.017***	0.018***	-0.002***
	(5e-5)	(0.003)	(0.001)
InvCap	-6e-5***	0.004***	-5e-5***
	(9e-6)	(0.001)	(5e-5)
$\Delta\widetilde{R} \times$ InvCap	-2e-4***	-0.018***	0.013***
	(3e-5)	(0.002)	(0.001)
$\ln(\text{members})$	-7e-5	0.454***	-0.003***
	(9e-5)	(0.050)	(4e-4)
Mtg Share	0.001***	0.037***	-0.001***
	(1e-4)	(0.007)	(3e-4)
LICU	-9e-5	0.018	0.001**
	(4e-4)	(0.013)	(3e-4)
ΔMtg Share	0.001***	0.015***	1e-4
	(1e-4)	(0.004)	(2e-4)
Unemployment	-3e-4***	-0.007***	-2e-4***
	(2e-5)	(0.001)	(5e-5)
Subprime Pop.	5e-5**	-0.008***	8e-5*
	(2e-5)	(0.001)	(4e-5)
Observations	74899	74899	74899
CU FE	✓	✓	✓
Quarter FE	✓	✓	✓
Year FE	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports estimates from the first stage of the TSLS estimation. The outcome variables (the instruments) are named at the top of each column. These are the quarterly change in the two-year Treasury rate, log assets, and their interaction. The three first stage equations are estimated jointly. This table reports the results associated with the specification in the rightmost column of Table 1, which includes the most control variables. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county.

Table C.2: Testing of TSLS Assumptions

	Value	Null Hypothesis
Kleibergen-Paap LM Statistic	15.51	H_0: under-identification (instruments
p-value	1e-4	uncorrelated with regressors)
Cragg-Donald Wald Statistic	44.33	H_0: weak identification (instruments
Kleibergen-Paap Wald Statistic	6.26	weakly correlated with regressors)

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.3: OLS Estimates

	(1)	(2)	(3)
ΔR	1.695***	1.267***	0.786**
	(0.322)	(0.315)	(0.312)
ln(Assets)	1.112***	1.140***	1.086***
	(0.033)	(0.036)	(0.031)
$\Delta R \times \ln(\text{Assets})$	0.587**	0.776***	0.691***
	(0.240)	(0.241)	(0.230)
ln(members)		-0.039	-0.025
		(0.029)	(0.027)
Mtg Share		0.269***	0.264***
		(0.029)	(0.029)
LICU		-0.022	-0.026
		(0.032)	(0.032)
ΔMtg Share		0.222***	0.210***
		(0.024)	(0.024)
Unemployment			-0.034***
			(0.004)
Subprime Pop.			-0.011***
			(0.003)
Observations	83164	75383	74899
CU FE	✓	✓	✓
Quarter FE	✓	✓	✓
Year FE	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results from estimating Equation (1) with OLS instead of TSLS. The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county. .

D Robustness

Table D.1: Sample and Specification Robustness

	Baseline (1)	No CA (2)	No LSAPs (3)	Time FE (4)
ΔR	-2.659**	-0.995	-3.611***	
	(1.109)	(0.963)	(1.123)	
ln(Assets)	2.832***	2.315***	2.365***	1.811***
	(0.605)	(0.710)	(0.525)	(0.509)
$\Delta R \times \ln(\text{Assets})$	3.185***	2.140*	2.621***	1.882*
	(1.035)	(1.205)	(0.980)	(0.974)
ln(members)	-0.811***	-0.578*	-0.587**	-0.348
	(0.301)	(0.338)	(0.253)	(0.240)
Mtg Share	0.207***	0.220***	0.217***	0.232***
	(0.038)	(0.039)	(0.035)	(0.034)
LICU	-0.059	-0.054	-0.051	-0.040
	(0.041)	(0.038)	(0.038)	(0.034)
ΔMtg Share	0.187***	0.190***	0.168***	0.179***
	(0.027)	(0.028)	(0.026)	(0.025)
Unemployment	-0.023***	-0.024***	-0.026***	-0.023***
	(0.005)	(0.005)	(0.005)	(0.005)
Subprime Pop.	0.003	0.001	-0.001	-0.007
	(0.006)	(0.006)	(0.005)	(0.005)
Observations	74899	70072	72549	74899
CU FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	
Time FE				✓
Year FE	✓	✓	✓	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is log loan originations. Column 1 reproduces the baseline TSLS estimation results to facilitate comparison. Column 2 omits credit unions operating in California from the sample. Column 3 uses monetary surprises that exclude dates on which the FOMC announced changes to LSAP programs. Column 4 augments the baseline specification to include time fixed effects. Due to collinearity, time fixed effects preclude estimating the un-interacted effect of the policy rate. The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county.

Table D.2: Inference Robustness (Two-Way Clustering)

	(1)	(2)	(3)
ΔR	-3.674	-3.787	-2.659
	(2.664)	(2.574)	(1.832)
ln(Assets)	2.378***	3.146***	2.832**
	(0.800)	(1.101)	(1.098)
$\Delta R \times \ln(\text{Assets})$	3.056*	3.369*	3.185**
	(1.617)	(1.663)	(1.536)
ln(members)		-0.951*	-0.811*
		(0.471)	(0.468)
Mtg Share		0.200***	0.207***
		(0.055)	(0.054)
LICU		-0.064	-0.059
		(0.046)	(0.042)
ΔMtg Share		0.191***	0.187***
		(0.040)	(0.041)
Unemployment			-0.023**
			(0.009)
Subprime Pop.			0.003
			(0.009)
Observations	83164	75383	74899
CU FE	✓	✓	✓
Quarter FE	✓	✓	✓
Year FE	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is log loan originations. This table estimates the baseline specification of Equation (1), but instead two-way clusters standard errors by county and time. The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population.

Table D.3: Alternative Sources of Sensitivity

	Un-interacted (1)	$\times\Delta R$ (2)
ΔR	-2.347*	
	(1.271)	
ln(Assets)	2.902***	15.746**
	(0.615)	(7.431)
ln(members)	-0.842***	-14.390*
	(0.305)	(7.937)
Mtg Share	0.201***	-3.515
	(0.038)	(6.744)
LICU	-0.060	2.953
	(0.041)	(2.836)
ΔMtg Share	0.184***	-4.387
	(0.027)	(5.388)
Unemployment	-0.022***	0.539
	(0.005)	(0.391)
Subprime Pop.	0.003	-0.102
	(0.006)	(0.094)
Observations		74899
CU FE	✓	✓
Quarter FE	✓	✓
Year FE	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is log loan originations. This table reports results from augmenting the baseline specification of Equation (1) to include interactions of the control variables with the policy rate. The un-interacted coefficients are reported in column 1 and the interaction terms are reported in column 2. The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county.

Table D.4: Pre-Crisis Lending Placebo Test

Crisis End Date:	2009 (1)	2010 (2)	2011 (3)
$\Delta \ln \left(\text{InvCap}_i^{Crisis}\right) \times 2004$	0.013	-0.001	-0.006
	(0.009)	(0.009)	(0.009)
$\Delta \ln \left(\text{InvCap}_i^{Crisis}\right) \times 2005$	0.010	0.003	-0.012
	(0.008)	(0.008)	(0.008)
$\Delta \ln \left(\text{InvCap}_i^{Crisis}\right) \times 2006$	0.012*	0.006	-0.005
	(0.007)	(0.007)	(0.007)
$\Delta \ln \left(\text{InvCap}_i^{Crisis}\right) \times 2007$	0.006	0.008	0.005
	(0.006)	(0.007)	(0.006)
$\Delta \ln \left(\text{InvCap}_i^{Crisis}\right) \times 2009$	0.012**	0.014*	0.002
	(0.006)	(0.007)	(0.006)
$\Delta \ln \left(\text{InvCap}_i^{Crisis}\right) \times 2010$	0.020***	0.020***	0.012*
	(0.007)	(0.008)	(0.007)
$\Delta \ln \left(\text{InvCap}_i^{Crisis}\right) \times 2011$	0.001	0.012	0.007
	(0.008)	(0.009)	(0.008)
ln(members)	0.530***	0.571***	0.536***
	(0.060)	(0.055)	(0.060)
Mtg Share	0.354***	0.338***	0.363***
	(0.037)	(0.038)	(0.036)
LICU	-0.007	-0.014	-0.006
	(0.038)	(0.039)	(0.038)
ΔMtg Share	0.281***	0.270***	0.282***
	(0.030)	(0.031)	(0.031)
Unemployment	-0.052***	-0.051***	-0.052***
	(0.005)	(0.005)	(0.005)
Subprime Pop.	-0.026***	-0.026***	-0.026***
	(0.005)	(0.005)	(0.005)
Observations	77176	76827	77190
CU FE	✓	✓	✓
Quarter FE	✓	✓	✓
Year FE	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is log loan originations. This table reports results from estimating Equation (3). $\Delta \ln \left(\text{InvCap}_i^{Crisis}\right)$ is the log change in investment capital from 2008 Q1 to the end date, where the end date is Q1 of the year specified above the column number. A negative value corresponds to investment capital losses. The omitted year is 2008. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. The controls are the same is in the rightmost column of Table 1. Standard errors are clustered by county.

E Interpretation

Table E.1: County-Level Analysis

	Baseline (1)	County-Level (2)
ΔR	-2.659**	-1.203
	(1.110)	(1.099)
ln(Assets)	2.832***	1.101***
	(0.605)	(0.036)
$\Delta R \times \ln(\text{Assets})$	3.185***	1.363**
	(1.035)	(0.579)
ln(members)	-0.811***	0.000
	(0.301)	(0.000)
Mtg Share	0.207***	0.158***
	(0.038)	(0.050)
LICU	-0.059	-0.034
	(0.041)	(0.041)
ΔMtg Share	0.187***	0.128***
	(0.027)	(0.040)
Unemployment	-0.023***	-0.029***
	(0.005)	(0.003)
Subprime Pop.	0.003	-0.011***
	(0.006)	(0.004)
ln(#CUs)		-0.021
		(0.035)
Observations	74899	25103
CU FE	✓	
County FE		✓
Quarter FE	✓	✓
Year FE	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The outcome variable is log loan originations. This is measured at the credit union for column 1 and the county-level for column 2. Column 1 reproduces the baseline estimates for total lending to facilitate comparison. To build the county-level panel, I collapse credit-union level variables by summing those measured by absolute amounts and taking the average of those reported in percentage terms. For example, I sum assets within a county and then take the log. I take the average of the mortgage share of lending across credit unions. The county-level specification adds a control for the log number of credit unions operating in the county. The three explanatory variables are: the quarterly change in the two-year Treasury rate (ΔR) (i.e., 0.01 equals a one percentage point change), log assets, and their interaction. Covariates are demeaned prior to the regression. This means that the coefficient on one of the uninteracted terms corresponds to the treatment effect when the *other* term is at its average value. Credit union-level controls include log members, the mortgage share of lending, an indicator for whether or not a credit union is classified as a low-income credit union (LICU), and the quarterly change in the mortgage share of lending. County-level economic controls include the unemployment rate and the subprime share of the population. Standard errors are clustered by county.