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 and to also combat balance sheet impairments preventing banks from lending.

An important consideration for policymakers is whether monetary policy works any differently during a *financial* crisis.[2] 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, depending on the nature of financial frictions facing lenders. 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. 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. The answer is informative about financial crises and the nature of financial frictions lenders face. Moreover, understanding

[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).

[2] This question was raised by policymakers in the Great Recession. Taking the view that financial crises dampen monetary policy, the October 28-29 FOMC Minutes report: "Some members were concerned that the effectiveness of cuts in the target federal funds rate may have been diminished by the financial dislocations, suggesting that further policy action might have limited efficacy in promoting a recovery in economic growth." In 2009, former Federal Reserve Governor Rick Mishkin took the opposing view, writing: "The quality of balance sheets of households and firms is a key element of the financial accelerator mechanism ... a macroeconomic downturn tends to ... [exacerbate] the impact of frictions in credit markets and [reinforce] the propagation of the adverse feedback loop...the fallacy that monetary policy is ineffective during financial crises is dangerous because it may promote policy inaction when it is most needed" (Mishkin, 2009).

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 LSAPs and bank recapitalization.

The primary contribution of this paper is to empirically document and interpret the 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 changes in 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.[3] Identification exploits both high frequency identification of monetary policy shocks and a natural experiment in which otherwise similar CUs 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 substantially *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. First, 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 tend to *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.

[3] The CU totals are from the *Monthly Credit Union Estimates* produced by the Credit Union National Association. Market share calculations not made available by CUNA are computed using Flow of Funds data.

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

To estimate the effects of asset losses, I exploit plausibly exogenous variation in a unique asset held by CUs. During the Great Recession, a critical juncture through which the financial crisis reached CUs 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 CUs. Paid-in equity from CUs 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 47% of their assets by 2006. Corporates' ABS-related losses were charged against CUs' investment capital, creating significant asset losses for some CUs.

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

The identifying variation in investment capital is similar to that of a shift-share instrument. The share of ownership and choice of Corporate determined a CU's idiosyncratic exposure to the collapse of ABS markets. Two main assumptions are required to identify the effect of asset losses and the interaction with monetary policy. Namely, CUs 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's sensitivity to monetary policy *prior* to the 2008 crisis.[4]

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 is more local compared to syndicated lending, with many households borrowing from nearby banks.[5] 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. These instruments are plausibly unrelated to a bank's corporate loan portfolio but, given the central role of mortgages in the crisis, this is less plausible for a bank's 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.[6] This has two key implications. First, asset losses *increase* the effect of the policy rate on loan originations. A 1% asset losses increases the lending response to a 25 basis point cut in the policy rate by 1.19 percentage points. That is, the same 25 basis point rate cut now triggers a 3.80% increase in lending (versus the average response of 2.61%), which is a 46% stronger reaction in relative terms. The stronger response implies that constraints on policy—such

[4] 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.

[5] 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).

[6] 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.

as the zero-lower-bound (ZLB) or political constraints—are more costly in financial crises featuring creditor asset losses (in terms of forgone loan originations). Additionally, all else equal, monetary easing is more potent in recessions featuring a weakened financial system (such as the Great Recession) versus those in which financial sector health remained stronger (such as the COVID recession). Outside of recessions, when lenders 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 lowering the policy rate *weakens* the causal effect of asset losses on lending. On average, a 1% asset loss reduces loan originations by 6.49 %. When the policy rate falls by 25 basis points, the impact of the same asset loss reduces to a -5.30% decrease (it is 18% weaker in relative terms). Easing can stimulate lending not only directly, but also indirectly by reducing the causal effect of asset losses—it is not merely a countervailing force, but it can also dampen the contractionary impact 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. This substitutability may in part be due to the ability of conventional monetary easing to also increase asset values. 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.

Lastly, I examine how CU deposits and capital structure react to easing and asset losses, shedding light on potential mechanisms driving the heterogeneous lending responses. I find that CUs appear to increase their *supply* of deposits in response to monetary easing, consistent with the deposits channel of monetary policy (Drechsler, Savov and Schnabl, 2017, 2021). Easing lowers the deposit spread (the policy rate minus the deposit rate) and, with a one quarter lag, increases deposits. These responses are stronger when CUs experience asset losses, suggesting that the deposit channel of monetary policy becomes stronger when lenders are in weaker financial health.

Examining capital structure sheds further light on the the role of financial frictions. Asset losses prompt CUs to deleverage, reducing their liabilities by more than the decline in assets, leading CU equity to rise on net. However, monetary easing *weakens* the deleveraging response. By allowing CUs to mitigate deleveraging in response to asset losses, monetary easing can help weakened CUs limit the retrenchment of their lending. Additionally, asset losses cause monetary easing to have a stronger, positive effect on leverage. Taken together, these findings suggest that easing alleviates financial frictions, enabling weakened CUs to increase their leverage, deposit supply, and, ultimately, lending.

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.[7] 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.,

[7] 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. My results align more closely 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.[8] These differences need not be regarded as inconsistent. For example, the cross-sectional findings of Jiménez, Ongena, Peydró and Saurina (2012) taken together with my causal estimates suggest factors *correlated* with weak lender health (e.g., unemployment or weak loan demand) dampen the effects of monetary policy, while shocks to lender health causally strengthen the response.

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 dom-

[8] 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.

inant friction is different in future crises, updating the friction in our models is important for accurately predicting the effects of monetary policy.

The finding that monetary easing weakens the *causal* effect of asset losses is an important result for the literature on the macroeconomic consequences of credit supply shocks. Impaired creditor balance sheets played an important role in the 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). The ability of monetary easing to weaken the contractionary effects of asset losses makes it an even more powerful tool in a financial crises.

Lastly, this paper is also the first, to my knowledge, to study monetary transmission via credit unions. Credit unions are an increasingly import source of consumer credit.[9] Depsite this, credit unions have received less attention compared to banks in the financial intermediation literature.[10] A better understanding of similarities and differences between banks and CUs can improve our understanding of how their institutional differences impact their behavior.

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,

[9]CU lending has outpaced bank lending in the years since the Great Recession Cororaton (2020).

[10]For recent examples of analyses of credit unions, see Ramcharan, Van den Heuvel and Verani (2016), Goddard, McKillop and Wilson (2016), DeYoung, Goddard, McKillop and Wilson (2019), Cororaton (2020), and Shahidinejad (2022).

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 *healthier* 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 constraint and a 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. Lending L corresponds to newly originated loans. 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

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

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

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

Under these assumptions on the first and second derivatives of loan demand, equilibrium lending is strictly decreasing in the policy rate (R). When the cost of funds is higher, the 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* $L(R, B) = \min\left\{L^\star(R), \bar{L}(B)\right\}$ *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.1.

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 $R_L'(L), R_L''(L), R_L'''(0) < 0$. 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.1.

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) 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.

Conventional Monetary Policy and Asset Values. Many models of monetary transmission feature "valuation effects" whereby decreases in the policy rate also raise asset values.[11] This constitutes an additional channel, omitted from Models 1 and 2 above, through which easing can increase lending. Allowing this channel can introduce further ambiguities regarding whether assets losses magnify or dampen the pass-through of monetary policy to lending. This is because valuation effects introduce two additional channels through which asset losses and monetary policy interact. These channels depend on (1) whether there are increasing or diminishing returns to asset values (in terms of their impact on lending) and (2) whether balance sheet health amplifies the impact of monetary policy on asset values. Appendix A.2 presents a generalization of the models above, showing how including the valuation channels impacts the comparative statics. This generalized model illustrates how these additional channels introduce further ambiguities that also fundamentally depend on the nature of financial frictions facing the lender.

3 Background on US Credit Unions & Data

The empirical analysis focuses on US credit unions (CUs) 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 CUs, how they became exposed to ABS, and describes the data used in the analysis.

3.1 US Credit Unions

CUs resemble small banks and are an important provider of consumer credit in the US. In 2017, CUs accounted for 13% of mortgage originations and 28% of auto originations (Experian, 2017). Typically smaller than banks, the average CU owned $102 million in assets during the period of analysis (2004 Q2–2011 Q4). Primarily engaging in consumer lending, CUs do not originate commercial and industrial loans, though small business loans comprise a small share of their lending.

A unique feature of CUs is that they are often formed around a shared association,

[11] For a recent notable example, see Bianchi, Lettau and Ludvigson (2022).

typically related to geography or employment.[12] Residential and occupational requirements create frictions to substituting between CUs. Additionally, CUs are structured as not-for-profits, and therefore reinvest earnings instead of paying them out to shareholders. Another important difference between CUs and small banks is that until 2017, CUs could not securitize loans and would instead hold them on their balance sheets.

CUs are regulated by the National Credit Union Administration (NCUA), acting in a similar capacity as the Federal Deposit Insurance Corporate (FDIC) does for banks. CUs face similar style liquidity and leverage rules compared to banks. However, CUs face stricter regulations on the types of asset they can hold, which in practice precluded CUs from directly owning private label ABS.[13]

CUs ultimately became exposed to the ABS market through investments in Corporate Credit Unions ("Corporates"). To improve CU access to correspondent services, the NCUA permitted the formation of Corporates in the 1970s to provide these services.[14] Corporates grew to play an important role in allowing CUs 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 CU cannot sell its stake. The inability to adjust this position meant many CUs 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

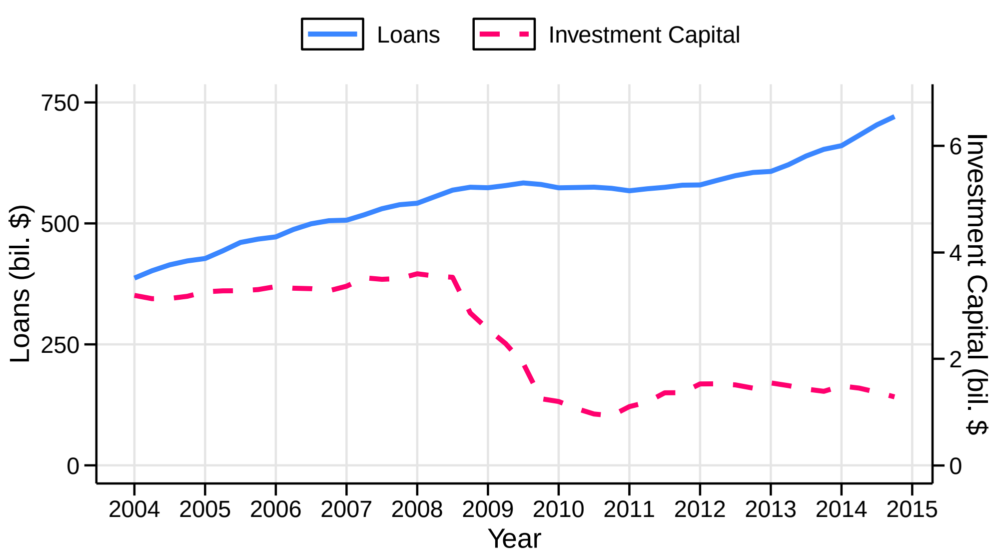
[12]For example, members of the Anoka Hennepin CU must have ties to one of several Minnesota counties. There are also CUs for IMF employees, Chicago firefighters, and teachers in the Duluth school district. See Internet Appendix Table IA.I of Ramcharan, Van den Heuvel and Verani (2016) for a breakdown of CU affiliations in this time period.

[13]The Federal CU Act defines the securities in which CUs 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.

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

avoided these assets, others held as much as 47% of their balance sheet in private label ABS alone by 2006.[15] 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 CUs through their equity positions in Corporates, while an additional $1.4 billion in special assessments was levied on CUs by the NCUA to cover Corporate losses. These special assessments were charged in proportion to each CU'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.

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 CUs less assessments levied by the NCUA (left y-axis). The right y-axis is total lending by all CUs.

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 CUs. Figure 1 plots the total value of investment capital owned by CUs as well as the total value of loans

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

owned by CUs. Total CU lending slowed in 2008 and plateaued by 2009 until 2012. Prior to the ABS market collapse, CU lending was around $40 billion per year (see Figure 1, left axis). The slowdown in loan originations 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, CUs file detailed financial reports.[16] The data include thousands of CUs 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.[17] 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 CU assets and the variables needed to measure investment capital. In addition to these main variables, the NCUA data include other measures such as the number of CU members, whether the CU is classified as a low-income CU (LICU),[18] mortgage lending, deposits, the net worth ratio measure on which the CU is regulated, and interest expenses.

Appendix Table B.1 presents summary statistics for the sample used in the empirical analysis. This sample is the subset of CUs that have complete information on lending (both total and mortgage), assets, and investment capital during 2004–2011. These data come from 4,639 CUs. This restriction on data completeness mainly omits CUs that do not report mortgage lending consistently. Consequently, the omitted lenders are typically the smallest CUs from the full sample. In this subset, the average CU originates $18.5 million in loans per quarter and has assets valued at $213 million. On average, mortgages comprise 21.2% of CU loans. Loans are 63.5% of CU assets and investment capital constitutes 2.2%

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

[17]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.

[18]CUs 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 CU expands or contracts.

of non-loan assets (with a standard deviation of 1.96%) 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 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 2.49% over the sample period. The 25$^{\text{th}}$, 50$^{\text{th}}$, and 75$^{\text{th}}$ percentile of *changes* in the rate are -28, 1, and 24 basis points (respectively). The median of the absolute value of changes is 26 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 BLS. 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 CU is headquartered. Most CUs 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 CU 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

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

where $\text{LoanOrig}_{i,t}$ is loan originations for CU i during quarter t, reflecting the *flow* of newly originated loans. 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 CU i's assets by the end of period t. The specification includes year and CU fixed effects, as well as quarter fixed effects to account for seasonality. The vector $X_{i,t}$ contains time-varying CU and local economic (county) controls.

We should expect that monetary easing stimulates lending ($\beta_1 > 0$) and asset losses reduce bank lending ($\beta_2 < 0$). But the sign of the interaction term (β_3) is less obvious. A positive interaction would imply both that (1) asset losses amplify the lending response to monetary policy and (2) easing reduces the contractionary effect of asset losses on lending.

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.[19]

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

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

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 change in the value of investment capital ($\text{InvCap}_{i,t}$) from quarter $t-1$ to quarter t. The third is the interaction of the first two instruments. While each of the three instruments are chosen to help predict their endogenous counterpart, note that I impose no restrictions that each instrument predicts *only* its counterpart. This allows, for example, monetary surprises to also predict asset values in addition to the policy rate.

It is important to instrument for both the Treasury rate and assets in order to detect whether monetary easing is *causing* differential sensitivity to asset losses (and vice versa). Only instrumenting for asset losses would make it difficult to rule out whether differences in lending's response to losses in times of low rates is due to the low rates themselves or the macroeconomic climate driving rates down. If we only instrument for monetary policy, one could document how the strength of the credit channel varies on average for healthy versus weak lenders. But without an instrument for asset losses too, we could not speak to whether asset losses *cause* heterogeneity in the credit channel.

[19] 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? 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.

4.2 Identification

The key identifying assumptions for the TSLS framework are that changes in investment capital and the Fed Funds "surprises" are exogenous with respect to other factors that affect lending. In particular, the exclusion restriction requires that the instruments only affect lending through the two-year Treasury rate and CU assets. Next, I discuss the plausibility of these assumptions.

Identifying the Effect of Asset Losses. The variation in CU investment capital is similar to that of a "shift-share" or Bartik-style instrument. The impact on each CU of an aggregate shock—the collapse of the ABS market—depended on that CU's idiosyncratic exposure to ABS through its investment in a Corporate. Two key institutional features make CU exposure plausibly exogenous.

First, CUs had limited ability to adjust their exposure to it during the crisis. Membership and paid-in capital featured minimum duration requirements of three and twenty years (respectively). As a result, CU choices of Corporate and investment size prior to the crisis locked in their exposure to their Corporate's subsequent losses.

Second, the choice of Corporate is largely driven by history and geography (for details, see Ramcharan, Van den Heuvel and Verani, 2016). However, if Corporate losses tended to correlate with regional economic conditions, this could violate the exogeneity assumption. To alleviate this concern, Ramcharan, Van den Heuvel and Verani (2016) carry out a variety of balance and placebo tests, finding that investment capital losses are generally unrelated to local and CU-level pre-crisis characteristics.[20] Rather, the authors argue that managerial idiosyncrasies and misunderstanding of ABS risk played an important role in shaping Corporate exposure to ABS.

The exclusion restrictions pertaining to asset losses require that investment capital

[20]Notably, the authors show that CU exposure to Corporates that failed does not predict the pre-crisis composition of a CU's lending. Additionally, CU leverage and liquidity ratios were similar across Corporates prior to the crisis. They also find that house price growth does not predict changes in CU investment capital during the boom nor does pre-crisis CU lending predict investment capital losses during the ABS market collapse.

losses impact CU lending through assets. When investment capital losses are realized, their direct effect is to reduce the value of CU assets. The impact of investment capital losses on CU equity is less straightforward. If asset losses (resulting from investment capital losses) prompt the CU to reduce their liabilities, then CU equity may on net increase in response to investment capital losses (i.e., losses trigger deleveraging).[21] Therefore, the analogous exclusion restriction may be less tenable if one were to instead instrument for CU equity rather than assets. For this reason, my preferred TSLS specification estimates the effect of asset losses (rather than equity losses).

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. Similarly to Cochrane and Piazzesi (2002), Tang (2015), and Wong (2019), I sum these shocks to obtain a quarterly measure of monetary surprises.[22]

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.[23] 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

[21] Section 6.1 examines the capital structure response to both asset losses and monetary easing and finds that assets losses do indeed increase liabilities and on net reduce equity.

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

[23] 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).

shortly after the announcement reflects changes to investors' beliefs about the level and path of Fed Funds rate. Identification relies on the assumption that during the announcement, futures prices are responding to unexpected changes in the stance of monetary policy, not other news about the economy.

Sample. As in Gertler and Karadi (2015), I truncate my sample at the end of 2011.[24] 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 investigating how asset losses alter the response of CU lending to conventional monetary easing. The models of Section 2 demonstrate that the answer to this question is not a priori obvious from theory alone; it 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. I then present evidence on the robustness of the main results and a placebo test whose results support the exogeneity of investment capital losses.

5.1 Total Lending

Starting with the first stage estimates, I find that they have the expected signs (see Appendix Table C.1). Negative monetary surprises reduce the policy rate, investment capital losses spur asset losses, and the interaction terms are positively related. Negative monetary surprises (easing) also have a positive effect on asset values in the first stage, consistent with the valuation effect discussed at the end of Section 2. Tests for weak instruments and under-identification are overall indicative of valid instruments (see Appendix C).

[24] An additional reason one may have to make this same truncation when studying CUs 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 CUs that impacted incentives to raise or acquire paid-in and membership capital.

Table 1 presents second stage results from estimating Equation (1). The outcome variable is the quarterly volume of loan originations for all credit products. All columns control for lagged log assets and investment capital and include credit union (CU), year, and quarter fixed effects. Column 1 provides a baseline estimate with no additional control variables.[25] 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 CU.[26] 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 25 basis point (bp) decrease in the two-year Treasury rate leads to a 2.61% 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 6.49% decrease in quarterly loan originations for an average CU. How impactful were asset losses due to investment capital in particular? At the height of the crisis, a one standard deviation change in assets induced by investment capital fluctuations was 0.77%.[27] The estimate implies that a 0.77% asset loss would trigger a 4.98% decline in loan originations.

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 percentage point asset loss leads to an additional 1.19 percentage point increase in loan originations in response to a 25 basis point policy rate reduction. This corresponds to a 46% stronger lending response to the same policy rate shock (3.80% versus 2.61%). This result demonstrates that asset losses can have

[25]These controls help account for how growth rates tend to differ for smaller versus larger CUs and for the scale of initial exposure to investment capital.

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

[27]Specifically, I take the standard deviation during 2009 of the log change in investment capital multiplied by the lagged investment capital share of assets.

Table 1: Impact of Monetary Policy and Asset Losses on Loan Originations

	(1)	(2)	(3)
ΔR	-15.84*	-8.62	-10.44**
	(9.05)	(5.42)	(5.16)
$\Delta \ln(\text{Assets})$	6.08**	6.90***	6.49***
	(2.41)	(2.06)	(1.97)
$\Delta R \times \Delta \ln(\text{Assets})$	5.77**	3.94**	4.77**
	(2.82)	(1.93)	(1.87)
lag(ln(Assets))	1.47***	1.51***	1.44***
	(0.19)	(0.17)	(0.17)
lag(ln(InvCap))	0.01***	0.01***	0.01**
	(3e-3)	(3e-3)	(3e-3)
$\ln(\text{members})$		0.01	0.03
		(0.03)	(0.03)
Mtg Share		0.26***	0.26***
		(0.03)	(0.03)
LICU		-0.01	-0.02
		(0.03)	(0.03)
ΔMtg Share		0.19***	0.19***
		(0.03)	(0.03)
Unemployment			-3.03***
			(0.56)
Subprime Pop.			-1.19***
			(0.28)
Observations	78,939	71,671	71,211
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 changes in both the two-year Treasury rate (ΔR) and log assets, and their interaction. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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.

an economically significant effect on the strength of the credit channel of monetary policy. Although an asset loss can cause a CU to lend less overall, by examining the interaction term we can see that CUs 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 25 basis point decrease in the policy rate reduces the impact of a one percentage point asset loss on loan originations from -6.49 to -5.30 percentage points (an 18% 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 interaction of conventional and unconventional monetary policy. Unconventional policies such as large scale asset purchases directly target assets, improving the health of balance sheets. The positive interaction term implies that (1) lending responses less to the policy rate when balance sheets are healthier and (2) decreases in the policy rate dampen the lending response to changes in lenders' asset values. This suggests 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.

Persistence. Appendix Figure E.1 reports local projections estimates of impulse response functions with respect to all three shocks.[28] The effects of policy rate changes, assets losses, and their interaction on loan originations generally persist for around three to four quarters. The lending response to the policy rate is hump-shaped, peaking in the second quarter with nearly double the effect on lending compared to the initial quarter. The lending response to an asset loss gradually falls over time, reaching zero nearly a year later. The

[28] The regressions replace the outcome variable with leads of the outcome. See Appendix E for details.

interaction term grows slightly until the third quarter and returns to zero within a year.

5.2 Robustness

Local versus Average Treatment Effect. An important limitation of the TSLS estimator is that it identifies a local average treatment effect (LATE). The LATE identifies a weighted average of treatment effects, which generally differs from the unweighted average when treatment effects are heterogeneous. In the binary treatment case, the LATE is the average response among "compliers." With continuous endogenous variables, which this paper has, the LATE upweights observations whose endogenous regressors are more sensitive to the instruments. This is, it upweights observations with higher first stage coefficients.[29] In my application, the LATE upweights CUs whose asset growth is more sensitive to changes in the growth rate of investment capital.[30]

To better understand how the LATE may differ from the average treatment effect (ATE), I estimate the baseline specification within sub-populations that are likely to differ in the strength of their first stage. Specifically, I split the sample into terciles based on the credit union's investment capital share of non-loan assets. *All else equal*, those with a higher share will tend to experience larger absolute asset losses for a given percent change in the value of investment capital.[31] Hence, comparing how estimates vary with this characteristic is suggestive about how the average treatment effects may differ from the LATEs.

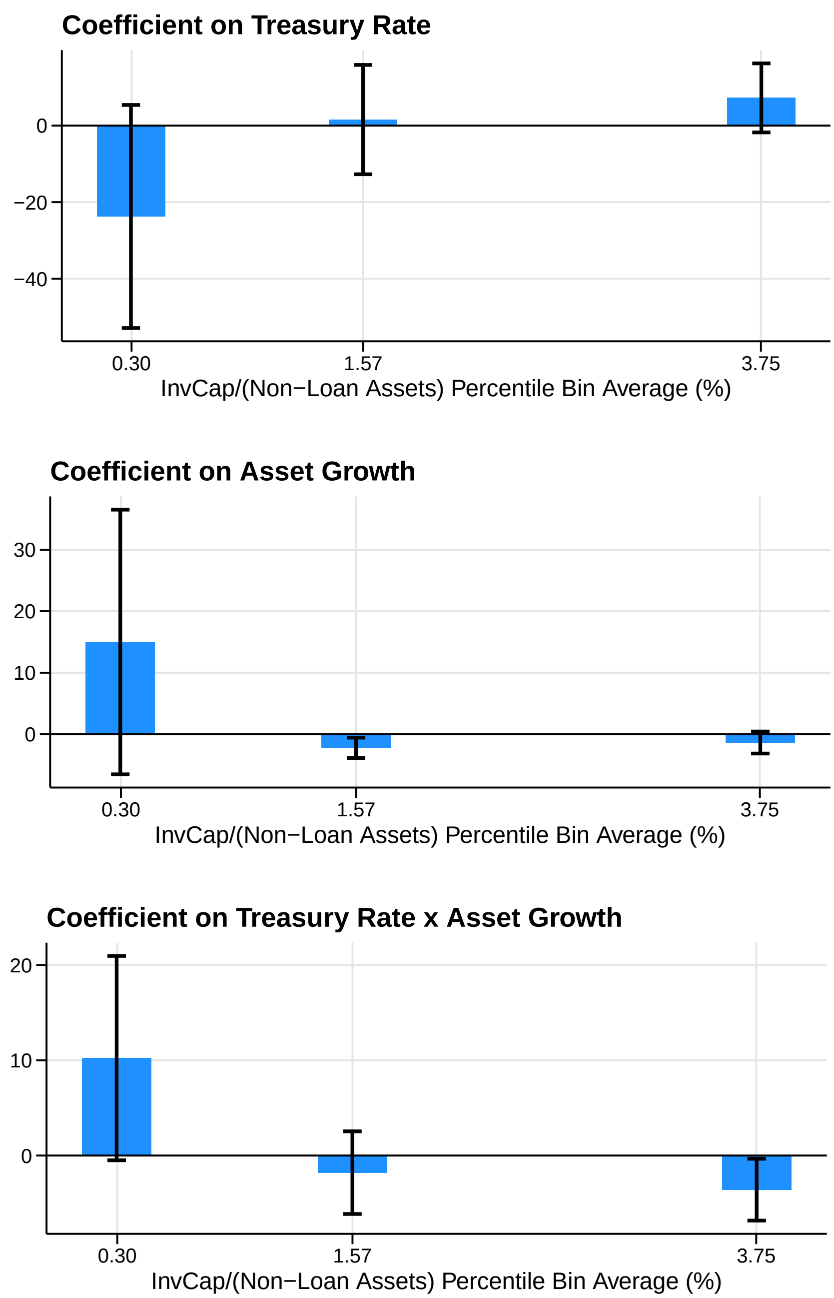
Figure 2 displays estimation results. The specifications use the same fixed effects, controls, and clustering as the baseline specification (specifically, column 3 of Table 1). Because the sample sizes shrink by a third, estimation precision falls. However, there are large differences in point estimates which indicate how the ATE may differ from the LATE. Among

[29] For more on this, see Masten and Torgovitsky (2016). Recent advances make possible identifying a representative 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.

[30] The impact of the monetary surprises on the two-year Treasury rate should be similar across all CUs given the macroeconomic nature of its variation. Therefore, this concern mainly applies in my setting due to potential heterogeneity in the sensitivity of assets to investment capital returns.

[31] 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 2: 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 CU'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.

all sub-populations, the low exposure (leftmost) CUs 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 that the ATE is likely larger than the LATE estimates.

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 remains unchanged to the second decimal place (4.77). Recall that this implies a 1% asset loss increases the lending response to a 25 bp rate reduction by 1.19 percentage points.

The county-level unemployment rate emerges as the only other characteristic to predict economically significant heterogeneity in the policy rate. Lending in counties with a one standard deviation higher unemployment rate experiences a 0.32 percentage point weaker response to a 25 bp change in the policy rate. In this sense, the impact of monetary easing is *dampened* in economically weaker counties. This highlights the value of instrumenting for assets in the empirical strategy, as OLS estimates could conflate the effects of asset losses and a weak economy (which tend to coincide). The coefficients on low-income CU status ("LICU") and the subprime share of the population are also statistically significant but economically small.

Sample, Specification, and Inference Robustness. The baseline results in Table 1 are also robust to several important econometric and data choices. Column 2 of Appendix Table D.1 excludes CUs operating in California from the sample to address a potential threat to identification. Ramcharan, Van den Heuvel and Verani (2016) notes that CUs exposed to one of the largest Corporates (WesCorp) experienced especially large investment capital losses. Many of these CUs 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 monetary policy, asset losses, and their interaction remain similar and statistically significant.

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 advantage of 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, and that there may be limited power remaining to estimate the interaction term. The point estimate for assets roughly halves and remains statistically significant at the 10% level. The coefficient on the interaction term remains similar (3.14 versus the baseline estimate of 4.77), but the estimate loses statistical significance.

Columns 5 and 6 present a "reduced-form" specification that omits the policy rate as an endogenous regressor and instead examines the impact of the monetary surprises (and their interaction with asset losses) directly.[32] This specification delivers qualitatively similar results. They are also quantitatively similar when evaluating the implied effects of a one standard deviation monetary surprise (13.38 bps), compared to baseline estimation's implied effects of a 25 bp change in the two-year Treasury rate.

Next, I use 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.[33] But because the policy rate only varies by time, I also

[32]Specifically, the monetary surprises are an included instrument in this alternative specification. This specification has two endogenous regressors (asset losses and their interaction with monetary surprises) and two excluded instruments (investment capital losses and their interaction with monetary surprises).

[33]See, for example, Beraja, Fuster, Hurst and Vavra (2019); Eichenbaum, Rebelo and Wong (2019); Li, Ma and

examine whether 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. However, asset losses remain statistically significant and the interaction term is significant in the most rigorous specification.[34]

5.3 A Placebo Test with Pre-Crisis Lending

I conduct a placebo test to examine the plausibility of the identifying assumptions. The chief threat to identification is that investment capital losses are correlated with other unobserved CU characteristics that also impact lending. This could bias estimates for both the effect of asset losses (β_2) and the interaction of asset losses and monetary policy (β_3). This could happen if, for example, risk-seeking CUs tended to seek both higher exposure to risky Corporates and concentrated their lending among more cyclically sensitive borrowers. In this scenario, the risk-seeking behavior of the CU could be the true driver of both a greater sensitivity to monetary policy over the cycle and a greater decline in lending during the crisis.

To test for potential confounders, I examine whether CUs that experienced larger investment capital losses during the crisis differed in their sensitivity to monetary policy *prior* to the crisis. The test estimates the following specification via TSLS:

$$\begin{aligned} \ln(\text{LoanOrig}_{i,t}) = {} & \theta_1 \Delta R_t + \theta_2 \left[\Delta R_t \times \text{CrisisLosses}_i\right] \\ & + \theta_3 \left[\Delta R_t \times \text{CrisisLosses}_i \times \text{Post}_t\right] + \theta_4 \left[\text{CrisisLosses}_i \times \text{Post}_t\right] \\ & + \tau \ \text{Year}_t + \kappa_i + \gamma \ \text{Quarter}_t + \zeta X_{i,t} + \varepsilon_{i,t}. \end{aligned} \tag{3}$$

The outcome variable is the same as the main analysis (log quarterly loan originations). And, as before, the regressors include changes in the two-year Treasury rate (ΔR_t). The specification uses the same fixed effects and controls as the main analysis.

Zhao (2019); Wieland and Yang (2020); Xiao (2020); Di Maggio, Kermani and Palmer (2020). In some cases, this literature uses Newey-West standard errors as well.

[34] We should interpret the standard errors with caution as this approach to inference relies on a small number of time clusters (31).

There are two key changes relative to the original specification in terms of regressors used. First, instead of including logged changes in assets as an explanatory variable, the second stage equation now includes a static variable that measures investment capital losses during the crisis (CrisisLosses_i). The second change is that I include interactions with a binary indicator for whether the observations in the post-crisis period (after 2008).

The first stage has analogous changes. The endogenous regressors are the three terms including the policy rate change (ΔR_t). The instruments are the same monetary surprises as before ($\Delta\widetilde{R}$) and two interactions: $\Delta\widetilde{R} \times \text{CrisisLosses}_i$ and $\Delta\widetilde{R} \times$ $\text{CrisisLosses}_i \times$ Post_t.

The purpose of this modified specification is to test whether credit unions that experienced large asset losses were reacting differently to monetary policy *prior* to the occurrence of those losses. If so, we may be concerned that confounders correlated with asset losses are the reason why asset losses appear to alter sensitivity to monetary policy. There are two main coefficients of interest in this placebo test. The first is the interaction between the policy rate and crisis losses (θ_2). This coefficient captures differential sensitivity to monetary policy *before* investment capital losses were realized.

The second coefficient of interest is the triple interaction (θ_3), adding an interaction with the post crisis indicator. A negative triple interaction would indicate that CUs experiencing asset losses during the crisis were more responsive to monetary policy *during* the crisis. This triple interaction is a form of continuous difference-in-difference estimator, comparing "high" versus "low" treatment CUs after treatment has begun (i.e., the crisis).

Appendix Table D.4 reports placebo test estimation results for three different windows measuring investment capital losses ("CrisisLosses_i"): 2008 to 2009, 2008 to 2010, and 2008 to 2011. Examining the pre-crisis interaction term, crisis losses do not strongly predict differential sensitivity to monetary policy. This coefficient is moderately-sized, implying a one standard deviation crisis loss leads to approximately a 27 bp *weaker* lending response to a 25 bp change in the policy rate. The coefficient is statistically significant at the 10% level in only one of the three specifications. In contrast, the coefficient on the interaction *during* the crisis is larger in magnitude, and highly significant in one specification. This coefficient implies that a one standard deviation asset loss during the crisis led to a 2.21% stronger lending response to a 25 bp policy rate change during the crisis. Investment capital losses only strongly predict differential sensitivity to monetary policy during the crisis, not prior to the crisis. These results are consistent with investment capital related losses not being correlated with an omitted factor related to monetary policy sensitivity.

These results complement the identification discussion of Section 4.2. That discussion highlights why CUs seeking out risky Corporates is an unlikely source of bias. It also describes findings from Ramcharan, Van den Heuvel and Verani (2016) that investment capital losses were unrelated to pre-crisis CU and local economic conditions.[35] Taken together, these results and the above findings suggest that investment capital is a plausibly exogenous shock to CU assets.

6 Mechanisms and Interpretation

This section presents additional evidence to help further interpret the response of lending to monetary easing and asset losses. I first explore potential mechanisms behind the stronger response among weakened CUs. After this, I examine how general equilibrium could alter the total effect of monetary policy and asset losses. Finally, I discuss differences between CUs and banks—and implications of these differences for external validity.

6.1 Mechanisms

Why do asset losses cause CU lending to be more sensitive to conventional monetary policy? In the second model of Section 2, financially weakened CUs experience a greater improvement in access to external funding following expansionary monetary policy. With deposits being the primary source of funding for CUs, I start by investigating how their quantity, price (deposit spread), and net interest margins (NIMs) react to policy rate changes and asset losses. I find evidence consistent with the deposits channel of monetary policy found among banks in prior work (Drechsler, Savov and Schnabl, 2017). Notably, the deposits

[35]For example, Ramcharan, Van den Heuvel and Verani (2016) 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.

channel is *stronger* for CUs experiencing asset losses. Next, to further investigate whether easing alleviates financial frictions, I examine how asset losses alter the impact of easing on CU capital structure.

Specifically I estimate the baseline Equation (1), replacing the outcome variable with the log change in deposits, the deposit spread (the policy rate minus the CU's deposit rate), the net interest margin (NIM), the log change in liabilities, and the log change in equity.[36] Appendix Table B.1 reports summary statistics for these variables. The average CU NIM is 2.28%, which is on the low end of values typically observed for banks.[37] Table 2 reports estimation results. I also estimate impulse response functions via local projections, as deposits may respond with a lag (see Figure 3 and Appendix E).

Deposits. CUs appears to increase their supply of deposits in response to monetary easing. On impact, the coefficient for deposit growth is negative but marginally statistically insignificant. But, after one quarter, the effect on deposits grows and becomes statistically significant (Figure 3). The coefficient for the deposit spread is positive and statistically significant on impact; it remains similar through the following quarter. Recall that the deposit spread is, in essence, the "price" CUs charge for supplying deposits. Deposit prices falling and quantities rising in response to easing is consistent with CUs increasing their supply of deposits. This suggests that the deposits channel of monetary policy studied in Drechsler, Savov and Schnabl (2017) is also operative for credit unions.

Quantitatively, the point estimates imply that a 25 bp decrease in the policy rate leads to a 0.15% increase in deposits and a 17.5 bp decrease in the deposit spread (i.e., the deposit rate falls 7.5 bp) on impact. In the following quarter deposits rise an additional 0.76% and the deposit spread remains similarly elevated.

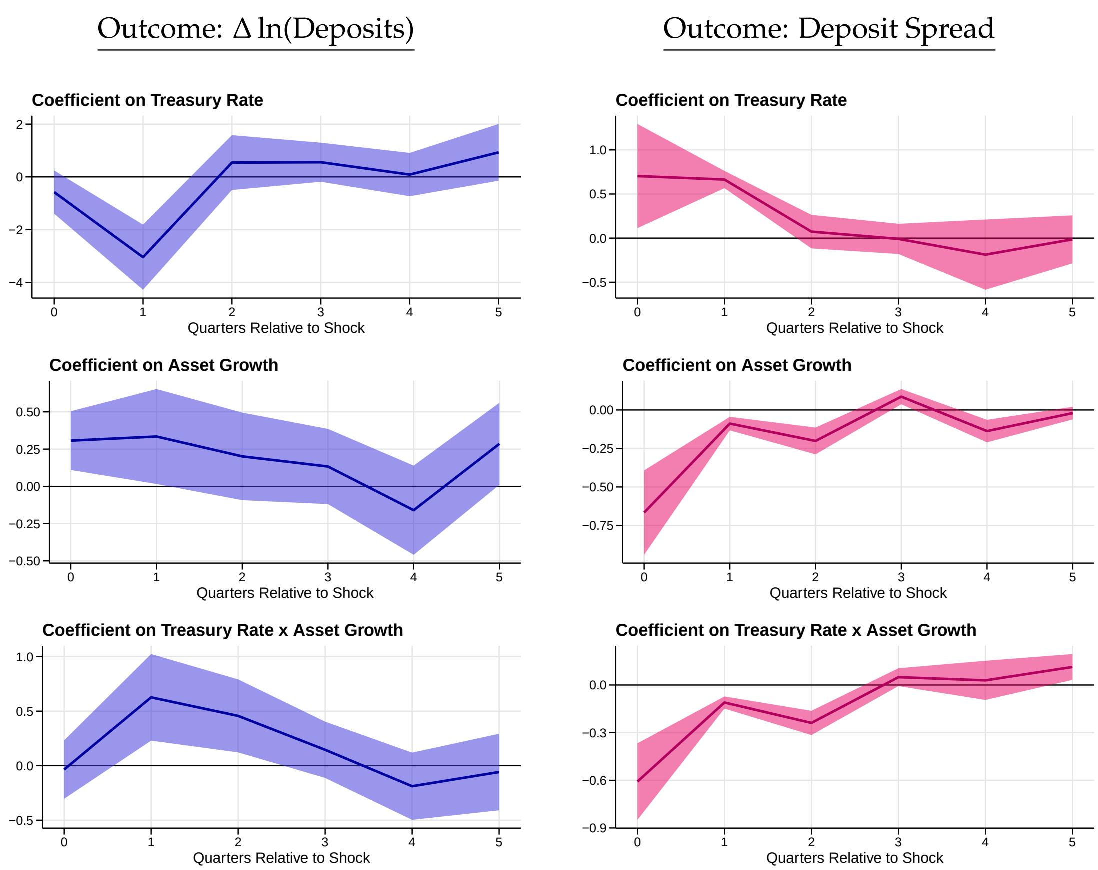
The interaction term is initially small and insignificant for deposits, however it becomes positive and significant by the following quarter. In this quarter, the interaction

[36] 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.

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

coefficient of 0.63 implies that a 1% asset loss leads to an additional 0.16 % rise in deposits in response to a 25 bp rate cut (a 20% stronger response in relative terms). The interaction term for the deposit spread is negative both quarters. Both interaction terms imply that asset losses *amplify* the responses of both prices and quantities to easing. Together, this implies that the deposits channel is *stronger* for CUs experiencing asset losses. Therefore, the deposits channel appears to be an important reason why the lending of CUs experiencing asset losses reacts more strongly to easing.

Figure 3: Impulse Response Functions for Deposit Growth and Deposit Spreads



Notes: The outcome variables are the change in logged deposits (left) and the deposit spread (right). These graphs plot quarterly impulse response functions to changes in the two-year Treasury rate and asset losses (plus their interaction). Estimates are obtained by local projections. Estimation uses the same set of controls, fixed effects, and clustering as the last column of Table 1. Specifically, I estimate same second stage Equation (1) but replace the outcome variable with various leads. The first stage equation is the same.

Table 2: Mechanisms

	$\Delta\ln(\text{Deposits})$ (1)	Dep. Spread (2)	NIM (3)
ΔR	-0.58	0.70**	-1.16**
	(0.42)	(0.30)	(0.52)
$\Delta\ln(\text{Assets})$	0.31***	-0.67***	0.91***
	(0.10)	(0.14)	(0.19)
$\Delta R \times \Delta\ln(\text{Assets})$	-0.04	-0.61***	0.64***
	(0.14)	(0.12)	(0.19)
lag(ln(Assets))	-0.03***	-0.06***	0.07***
	(0.01)	(0.01)	(0.02)
lag(ln(InvCap))	4e-5	1e-5	-2e-4
	(1e-4)	(2e-4)	(2e-4)
ln(members)	2e-3	3e-3	3e-3
	(1e-3)	(2e-3)	(3e-3)
Mtg Share	2e-3	3e-3**	-5e-3**
	(1e-3)	(1e-3)	(2e-3)
LICU	-3e-4	-1e-3	1e-3
	(2e-3)	(2e-3)	(2e-3)
ΔMtg Share	3e-3***	4e-3***	-0.01***
	(1e-3)	(1e-3)	(2e-3)
Unemployment	-0.15***	-0.13***	0.12**
	(0.04)	(0.04)	(0.06)
Subprime Pop.	0.01	-0.02	0.01
	(0.02)	(0.02)	(0.02)
Observations	71,211	71,146	71,211
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 changes in both the two-year Treasury rate (ΔR) and log assets, and their interaction. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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.

Asset losses appear to reduce CU deposit supply. Deposit growth falls in the wake of an asset loss, gradually reverting to pre-loss rates after two to three quarters. The deposit spread also rises on impact and returns to previous level within a year. As with easing, these opposing movements in prices and quantities point to changes in deposit supply. Additionally, the interaction terms indicate that monetary easing *dampens* the response of both deposit growth and spreads to asset losses. Quantitatively, the point estimates indicate that, on impact, a 1% asset loss reduces deposits by 0.31% and increases the deposit spread by 67 bp (both effects are statistically significant).

Taken together, deposit supply appears to plays an important role in how CUs react to both monetary policy and asset losses. CUs expand the supply of deposits to accommodate increases in lending and contract them when scaling lending back. Moreover, the strength of these deposit supply changes are also altered by monetary policy and asset losses.

NIM. To shed further light on how lending profitability is impacted by easing and asset losses, I examine the response of CU net interest margins (NIMs). On impact, CU NIMs rise after easing. However, they quickly revert (within one quarter) to previous levels. The initial rise in the NIM is likely due to the lagged response of deposits. Lending reacts strongly on impact, increasing interest income. But after deposits rise, interest expenses grow, eroding the temporary rise in profitability.

Quantitatively, the NIM rises 29 bps following a 25 bp rate cut, before reverting. This response is larger than previous estimates for banks (29 bps versus 0.15 bps, Drechsler, Savov and Schnabl, 2021).[38] 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. CUs do more shorter term consumer lending than

[38]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 25 basis point change in the shorter-term Fed Funds rate is "large" relative to a 25 basis point change in the two-year Treasury rate.

banks—specifically, more auto lending and less mortgage lending.[39] CUs may therefore be less effectively hedging their duration mismatch, leading their NIM to be more sensitive to the policy rate on impact. However, after one quarter, the limited sensitivity of the NIM among CUs is similar to its low sensitivity among banks.

The impact of asset losses on the NIM is also short-lived. A one 1% asset loss leads to a 91 bp decline in the NIM. The lagged response of deposits also likely contributes to this temporary decline. CUs cut lending on impact after an asset loss, reducing interest income. When they reduce the supply of deposits in the following quarter, interest expenses fall, raising the NIM.

The interaction term is initially positive and then also turns to zero. The positive coefficient on impact implies that asset losses amplify the NIM's response to easing and dampen its response to asset losses.

Capital Structure. To explore the possibility that asset losses lead CUs to lend more aggressively relative to their capital, I examine how capital structure responds to the same shocks. Appendix Table C.4 reports estimation results. Both CU equity and liabilities react strongly (and statistically significantly) to asset losses. A 1% asset loss triggers a 3.75% reduction in liabilities, consistent with asset losses limiting lender access to funding and/or decreased lender demand for leverage. Because liabilities fall more than one-for-one with assets, this overall should lead to an *increase* in the lender's equity. Indeed, equity grows by 10.99% in response to a 1% asset loss. This strong deleveraging response may limit CU ability to expand credit, likely contributing to the strong credit supply contraction following asset losses documented in the main results.

The response of CU capital structure to the policy rate is economically significant but imprecisely estimated, so these results should be interpreted with caution. The point esti-

[39]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.

mates imply a 25 basis point decrease in the policy rate leads to 0.27% increase in liabilities and a 1.83% decrease in equity. This suggests that monetary easing encourages CUs to increase their leverage, which may facilitate their increased lending.

The interaction term between the policy rate and asset losses is large, negative, and statistically significant for equity. The estimate indicates that a 25 basis point rate decrease dampens the deleveraging response to asset losses by 1.50 pp (from 10.99% to 9.49%). Additionally, a 1% asset loss leads the coefficient on the policy rate to rise by 6.01, magnifying the impact of a 25 bp rate reduction on equity by an additional -1.50%. This means that CUs facing asset losses take on relatively more leverage in response to easing. The stronger lending response to monetary policy among CUs with asset losses is thus plausibly due to easing alleviating financial frictions, allowing CUs to take on higher leverage.

These results also highlight the value of instrumenting for asset losses rather than comparing lenders with differing financial health. For example, cross-sectional comparisons of the lending response to easing between lenders with differing equity levels/growth could result in different conclusions from the causal estimates. A lender that is reducing leverage is taking steps to improve their financial health in the sense of strengthening capitalization, but they may be doing so *in response* to negative shocks to their financial health. Such cross-sectional comparisons could therefore suggest that lenders with strong/improving financial health are more responsive to monetary easing, while it may actually be *negative* shocks to their financial health *causally* leading them to respond more.

6.2 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 CUs and banks. This would mean that the estimated effect of asset losses would *overstate* the equilibrium impact on credit. However, borrower switching is likely limited for three reasons.

First, there are frictions to switching between CUs. Many CUs have strict membership requirements. Typically, members must live within a certain county or have a particular employer (or be related to such a person). These frictions make it less likely that a potential borrower, already a member at one CU, would switch to another.

Second, CUs generally offer more favorable rates to borrowers than banks, dampening borrower gains to switching from CUs to banks.[40] This reduces the likelihood that a marginal borrower not receiving a loan at a CU would instead obtain it from a bank. Favorable rates offered by CUs can make it profitable for the marginal borrower to wait out a credit crunch and later seek a loan from their CU. This limits the likelihood that banks would fully offset a CU's reduction in lending. During the crisis, both CUs and banks reduced loan originations. But, despite the membership frictions, the market share of CUs in auto and home loan markets *rose* during and after the crisis (Ramcharan, Van den Heuvel and Verani, 2016). This suggests that substitution away from CUs was not significant.

Third, most people tend to live nearby the lenders from which they borrow.[41] 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).

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

[41] 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.

6.3 External Validity

Credit unions are an important provider of US consumer credit. CUs accounted for 13% of mortgage and 28% of auto originations in 2017.[42] In recent years, CUs have gained market share in all major consumer credit segments, while banks have lost ground.[43] 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).[44]. Although CUs are smaller than banks, they still account for an important share of US consumer credit. The findings for this paper therefore apply to credit outcomes for a large population.

An important difference between credit unions and banks is that credit unions are typically smaller than banks. 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.[45] 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. The regulatory minimum for adequate capitalization under this ratio is 6% for CUs and 4% for banks. Net worth to asset ratios in 2017 were 11.0% for CUs and 11.2% for banks. Since CUs operate with greater proximity to their capital requirements, this could 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. CUs are regulated more strictly than banks, with many effectively barred from directly holding assets like private label MBS. As a result, CUs effectively have fewer assets from which to choose

[42] Source: Experian's 2017 Report *The State of Credit Unions*, available at https://perma.cc/P5UM-HHN9.

[43] Over 2015 to 2017, CU market shares (by origination) rose for mortgages (6% to 13%), auto (23% to 28%), personal loans (24% to 26%), and credit cards (3% to 4%). During the same time, bank market shares fell for mortgages (37% to 33%), auto (29% to 25%), personal loans (21% to 16%), and credit cards (97% to 96%). Source: Experian's 2017 Report *The State of Credit Unions*, available at https://perma.cc/P5UM-HHN9.

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

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

when adjusting their portfolio. A possible consequence of these restrictions is the higher ratio of loans to assets among CUs compared to banks (69.7% versus 56.7%).[46] This could also lead CU lending to be more sensitive to both asset losses and monetary policy.[47]

The models of Section 2 illustrate how the interaction between monetary policy and asset losses depends on which financial frictions shape lending. If different frictions dominate for bank and CU lending, we may expect their interactions to have different signs. Ultimately, it would be valuable for future research to explore how conventional monetary policy and asset losses causally interact for banks. And comparisons with the results for CUs 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 lender financial health affects the credit channel of monetary policy. Whether asset losses amplify or attenuate the credit channel depends on the nature of financial frictions affecting lenders. On the 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, asset growth, 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 1% asset loss increases the impact of a given change in the policy rate on lending by 46%. Additionally, a 25 basis point decrease in the policy rate reduces the contractionary effect of asset losses by 18%.

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

[47] 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.

Changes in the supply of deposits appear to be an important channel through which credit unions adjust their lending in response to these shocks. Notably, the deposit channel of monetary policy (Drechsler, Savov and Schnabl, 2017) appears to be *stronger* among CUs experiencing asset losses. This suggests that the deposits channel may be state dependent. A useful direction for future research would be to further investigate additional sources of state dependence in this channel, for both credit unions and banks, and its implications for the efficacy of monetary policy.

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

A Theory Appendix

A.1 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 non-negative lending constraint is non-binding, lending is characterized by:

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

Implicitly differentiating the above equation with respect to R we have

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

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

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

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

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

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

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

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

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

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

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

Thus in every case, we have

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

□

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

$$\frac{dL}{dR} = \frac{[1 - \Delta(B)]^{-1}}{R_L''(L)L + 2R_L'(L)} < 0. \tag{4}$$

The above term is negative under the assumptions $R_L''(L), R_L'(L) < 0$ and $\Delta \in [0, 1)$. The marginal effect of a change in default risk Δ on lending is:

$$\frac{dL}{d\Delta} = \frac{R[1 - \Delta(B)]^{-2}}{R_L''(L)L + 2R_L'(L)} < 0, \tag{5}$$

which is also negative when $R_L''(L), R_L'(L) < 0$ and $\Delta \in [0, 1)$.

Differentiating the marginal effect of default risk, Equation (5), with respect to the policy rate R yields:

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

To see that the above expression is negative note the following. First, we have that the $1 - \Delta(B)$ terms are positive for $\Delta \in [0,1)$. Next, $R_L''(L)L + 2R_L'(L) < 0$ under the assumptions $R_L', R_L'' < 0$. These imply that the first product in the numerator is negative. Turning to the subtracted term, we can see that this term is positive when $\left[\frac{d(R_L''(L)}{dR} + 2\frac{dR_L'}{dR}\right]$ is positive. To see this is the case, we can take the derivatives and rewrite this term as

$$\left[\frac{dR_L''(L)}{dR} + 2\frac{dR_L'}{dR}\right] = \left[R_L'''(L)L + 3R_L''\right]\frac{dL}{dR}.$$

Since $\frac{dL}{dR}$ is negative, when $R_L''', R_L'' < 0$, then the above term is positive. Therefore the numerator is a negative term subtracting a positive term, and the cross-partial is negative. The negative first and cross 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 $B' > B$. □

A.2 Extension: Allowing Monetary Policy to Impact Lender Asset Values

This section presents a generalized model that allows monetary policy to also impact the value of a lender's assets. I re-derive the comparative statics of interest and show how allowing this "valuation effect" impacts the interaction of monetary policy losses and asset losses. In short, allowing this channel introduces additional ambiguities and highlights another dimension in which the nature of financial frictions shapes the interaction term (cross derivative).

Modified Setting. A monopolist lender chooses how much to lend (L) in order to maximize its profits. Changing the earlier notation, let A denote the value of *all* of the lender's legacy assets. Additionally, let B denote the value of a subset of the lender's legacy assets.[48] As before, let R denote the policy rate. The lender faces inverse demand $R_L(L)$ and a cost of funds $\widetilde{R}(A, R)$.[49] Formally, the lender solves

$$\max_{L \geq 0} \quad R_L(L)L - \widetilde{R}(A, R)L.$$

The lender's first order condition is

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

Note that for brevity, I simply write $R_L'(L) = R_L'$.

It is natural to assume that the cost of funds is decreasing in assets B (as a decline in value worsens the lender's health), i.e.,

$$\frac{d\widetilde{R}}{dB} = \frac{\partial \widetilde{R}}{\partial A} \frac{dA}{dB} < 0.$$

[48] This corresponds to the investment capital subset of credit union assets in the empirical analysis.

[49] Throughout, I assume that B only affects $\widetilde{R}$ through A. I.e., $\frac{d\widetilde{R}}{dB} = \frac{\partial \widetilde{R}}{\partial A} \frac{dA}{dB}$. So it is without loss of generality to write the cost of funds as a function of A and R only. And note that this assumption in turn implies that assets B only impact lending through A.

Specifically, I assume that total assets A decrease the cost of funds $\left(\frac{\partial \widetilde{R}}{\partial A} < 0\right)$ and total assets are increasing in the subset of assets $\left(\frac{dA}{dB} > 0\right)$.

We would also expect monetary easing to decrease the lender's cost of funds. However, now there are two channels at play. In particular, we have:

$$\frac{d\widetilde{R}}{dR} = \underbrace{\frac{\partial \widetilde{R}}{\partial R}}_{\text{direct effect}} + \underbrace{\frac{\partial \widetilde{R}}{\partial A}\frac{dA}{dR}}_{\text{valuation effect}} > 0. \tag{6}$$

In general, we expect the cost of funds to be a function of the risk-free rate and a risk premium. The direct effect comes from the risk-free rate directly changing and also changes that are directly induced in the risk premium (as in Model 2). However, this generalization allows the policy rate to impact assets. Specifically, I assume that $\frac{dA}{dR} < 0$, meaning that the total effect of monetary easing is to increase asset values. When the direct effect is positive and the two terms in the valuation effect are both negative , then the total effect of the policy rate on the cost of funds is unambiguously positive. I maintain the above assumptions about these signs in the comparative statics analysis farther below.

This framework makes two simplifying assumptions for ease of exposition. First, I assume that the cost of funds, $\widetilde{R}$, is differentiable in both total assets A and the policy rate R. This makes it possible to infer the increasing/decreasing differences result simply from the sign of the cross derivative. Second, I abstract away from including constraints (as in Model 1).[50]

Marginal Effect of Asset Losses on Lending. We can implicitly differentiate the lender's first order condition to characterize the impact on lending of a marginal change in assets

[50] Including constraints would lead to a shadow cost/Lagrange multiplier also appearing additively in the first order condition. One could calculate derivatives for these terms and consider cases when marginal changes in the policy rate or assets B alter whether or not the constraints are binding, as in the proof of Proposition 1.

B. The effect is

$$\frac{dL}{dB} = \frac{\frac{d\widetilde{R}}{dB}}{R_L''L + 2R_L'} > 0.$$

The inequality (indicating that it is positive) follows from the assumptions $R_L', R_L'' < 0$ and $\frac{d\widetilde{R}}{dB} < 0$. Intuitively, by lowering the cost of lending, growth in assets B increase lending.

Marginal Effect of Monetary Policy on Lending. Implicitly differentiating the first order condition with respect to the policy rate yields

$$\frac{dL}{dR} = \frac{\frac{d\widetilde{R}}{dR}}{R_L''L + 2R_L'} < 0.$$

Increases in the policy rate decrease lending when the policy rate increases the cost of funds (i.e., the numerator is positive) and $R_L', R_L'' < 0$.

Recall Equation (6), which decomposes the impact of the policy rate on the cost of funds into the direct and valuation effects. Note that the valuation effect provides an additional channel through which easing increases lending (relative to Models 1 and 2).

Interaction Between Asset Losses and Monetary Policy. Differentiating the derivative above with respect to assets B yields the cross derivative of interest:

$$\frac{dL}{dBdR} = \frac{\frac{d^2\widetilde{R}}{dBdR}\left(R_L''L + 2R_L'\right) - \frac{d\widetilde{R}}{dR}\left(R_L'''L + 3R_L''\right)\frac{dL}{dB}}{\left(R_L''L + 2R_L'\right)^2}. \tag{7}$$

Note first that the cross derivative's sign depends only on the sign of the numerator. Currently, our assumptions imply that the R_L derivative terms are negative, the cost of funds is increasing in the policy rate (($\frac{d\widetilde{R}}{dR}$ is positive), and lending is increasing assets B ($\frac{dL}{dB}$ is positive). Therefore, the above is negative if the for the cost of funds, $\frac{d^2\widetilde{R}}{dBdR}$, is negative. Otherwise, the sign is in general ambiguous and depends on the relative magnitude of the two terms in the numerator.

Note also that the valuation effect only alters the above expression through the cross derivative for the cost of funds. Deriving the cross derivative for the cost of funds illustrates how the valuation effect alters the cross derivative for lending. Differentiating Equation (6) with respect to assets B yields:

$$\frac{d^2\widetilde{R}}{dRdB} = \underbrace{\frac{\partial^2\widetilde{R}}{\partial R\partial A}\left(\frac{dA}{dB}\right)}_{\text{altered direct effect}} + \underbrace{\frac{\partial^2\widetilde{R}}{\partial A^2}\left(\frac{dA}{dR}\right)\left(\frac{dA}{dB}\right)}_{\text{curvature effect}} + \underbrace{\frac{\partial\widetilde{R}}{\partial A}\left(\frac{d^2A}{dBdR}\right)}_{\text{scale effect}} \tag{8}$$

Without the valuation effect, the above term would only have the "altered direct effect" above. In this scenario, since assets B have a positive effect on total assets A, the sign of the altered direct effect (and hence the entire expression) would be determined by the sign of the cross partial.

With the valuation effect, the partial derivative features two additional effects that I label the "curvature" and "scale" effects. The curvature effect reflects curvature in the relationship between total assets and the cost of funds $\left(\frac{\partial^2\widetilde{R}}{\partial A^2}\right)$. It reflects curvature in the sense of capturing whether there are diminishing or increasing benefits to having higher total asset values in terms of funding costs. This second derivative is then multiplied by the effects of both the policy rate and assets B, which are negative and positive, respectively, under the assumptions made so far. Given these signs, the curvature effect's sign depends on the sign of $\frac{\partial^2\widetilde{R}}{\partial A^2}$.

A natural assumption may be that the second derivative is positive. This would imply that there are diminishing benefits to a stronger balance sheet in terms of reducing funding costs. Alternatively, it also means that costs are more sensitive to a decline in balance sheet health when the lender has a weaker balance sheet. For the purpose of highlighting the sources of ambiguity in signing the partial derivative of interest in Equation (7), note that one's assumptions about financial frictions facing the lender will generally play an important role in determining the sign of this second derivative. If this term is indeed positive, the curvature effect is overall negative.

The scale effect is so named because it depends on how the value of assets B impact the pass through of changes in the policy rate R to total assets A (and thus ultimately the cost of funds $\widetilde{R}$). This arises through the cross derivative term (of total assets A with respect to assets B and R). A natural assumption for this cross derivative is that is negative. This would imply that a higher value for assets B increases the *magnitude* of the impact of policy rate changes on total asset values A. Intuitively, if a lender has more assets, the absolute increase in values from a percentage change in asset values induced by monetary policy could be larger. This is the sense in which the "scale" of the balance sheet can amplify the impact of monetary policy on funding costs. Since the previous assumptions imply that the partial derivative of funding costs with respect to assets is negative, a negative cross derivative would imply that the scale effect is overall positive. Note that this introduces additional ambiguity into the task of signing the cross derivative of interest (for lending) in Equation (7).

Takeaways from Generalized Model. The analysis above considers a generalized version of Model 2.[51] This generalized model admits a "valuation effect", characterized in Equation (6). In addition to the direct effect, the valuation effect is an additional indirect channel whereby monetary easing increases asset values which in turn decrease the lender's cost of funds.

Allowing the valuation effect introduces further ambiguities. Notably, these ambiguities depend on the nature of financial frictions facing the lender, further illustrating the fundamental linkage between financial frictions and the interaction of monetary policy and asset losses. These ambiguities manifest in the form of "curvature" and "scale" effects. The curvature effect depends on whether there are diminishing or increasing returns to having higher asset values (in terms of how they impact funding costs). The scale effect depends on how balance sheet shocks alter the impact of monetary easing on the lender's assets. Natural assumptions will lead these effects to have opposing signs.[52] Therefore, in the presence of valuation effects, the sign of the interaction of monetary policy and asset

[51] And, as noted above, can readily be adapted to be a generalizations of both Models 1 and 2 with the addition of constraints to the lender's problem.

[52] This is the case in the generalized version of Model 2. A straightforward generalization of Model 2 allows default risk Δ to depend on total assets A rather than just assets B.

losses depends also on the relative magnitude of the scale and curvature effects. These ambiguities highlight how the nature of financial frictions facing lenders shapes the interaction of asset losses and monetary policy.

B Descriptive Statistics

Table B.1: Credit Union Summary Statistics

Statistic	Mean	St. Dev.	Pctl(25)	Median	Pctl(75)	N
Loans Orig. (mil. $)	18.50	108.02	1.64	4.07	12.16	78,939
Assets (mil. $)	213.42	833.21	27.59	62.47	167.80	78,939
$\Delta\ln(\text{Assets})\times 100$	1.18	4.24	-0.88	0.86	2.82	78,939
$\frac{\text{Investment Cap.}}{\text{Assets}}$ (%)	0.65	0.45	0.36	0.67	0.89	78,939
$\frac{\text{Investment Cap.}}{\text{Non-Loan Assets}}$ (%)	2.16	1.96	1.01	1.79	2.78	78,939
$\frac{\text{Loans}}{\text{Assets}}$ (%)	63.54	14.97	53.69	64.80	74.85	78,939
Members (000s)	23.40	75.37	4.24	9.07	21.52	78,939
MtgShr (%)	21.16	18.99	6.39	16.22	31.05	78,939
LICU (%)	8.89	28.46	0.00	0.00	0.00	78,938
Net Worth Ratio (%)	12.02	3.96	9.39	11.16	13.69	78,932
Mort. Rate (%)	6.02	0.95	5.50	6.00	6.50	78,805
Deposit Rate (%)	1.15	0.75	0.58	0.98	1.56	78,862
$\Delta\ln(\text{Deposits})$	1.16	4.52	-1.14	0.81	3.01	78,939
$\frac{\text{Non. Dep. Int.}}{\text{Assets}}$ (%)	0.03	0.07	0.00	5e-5	0.01	78,862
Net Int. Margin (%)	2.28	1.16	1.34	2.19	3.09	78,939
Unemployment (%)	6.42	2.62	4.50	5.73	7.93	78,421
Subprime Pop. (%)	32.37	7.33	27.27	31.45	37.07	78,455

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, %)	2.490	1.680	0.880	2.630	4.120	31
Quarterly Rate Change (ΔR, %)	-0.045	0.530	-0.280	0.010	0.240	31
Monetary Surprises ($\Delta \widetilde{R}$)	-0.041	0.130	-0.018	0.000	0.000	31

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. $)	$\frac{\text{Equity}}{\text{Assets}}$ (%)	$\frac{\text{NS Liabilities}}{\text{Assets}}$ (%)	$\frac{\text{PIMBS}}{\text{Assets}}$ (%)	$\frac{\text{ABS}}{\text{Assets}}$ (%)
US Central	45.07	1.91	10.28	23.26	66.93
Western Corporate	26.26	3.39	18.70	47.21	71.07
Southwest Corporate	11.73	1.99	10.05	13.67	35.04
Members United	6.37	3.33	7.41	0.35	32.60
Empire Corporate	4.48	3.39	5.53	14.63	34.79
Southeast Corporate	4.18	2.95	6.28	8.04	29.26
Corporate One	3.52	3.16	6.98	5.25	38.91
System United Corporate	3.03	2.88	11.27	2.22	14.73
Central Corporate	3.02	3.06	12.91	1.17	7.89
Mid-Atlantic Corporate	2.93	2.48	7.16	0.30	2.08
First Carolina Corporate	2.19	3.66	9.20	0.00	6.63
Constitution Corporate	1.75	2.41	5.24	23.23	44.11
Catalyst Corporate	1.66	2.86	4.27	0.00	2.21
Corporate Central	1.65	3.57	29.31	0.00	9.32
Eastern Corporate	1.49	3.89	4.71	0.54	12.87
VaCorp	1.14	2.86	8.94	0.00	8.19
Volunteer Corporate	1.13	2.25	8.93	1.29	9.48
Northwest Corporate	1.07	3.05	9.70	7.83	17.37
Corporate America	1.02	2.86	12.42	3.93	18.17
First Corporate	1.01	3.10	11.83	0.00	7.66
Missouri Corporate	0.79	4.87	7.55	0.00	0.00
TriCorp	0.69	2.41	11.00	0.00	1.34
Kentucky Corporate	0.52	3.58	4.47	0.00	0.00
Kansas Corporate	0.47	3.44	13.40	0.00	4.06
West Virginia Corporate	0.29	2.91	5.47	0.00	0.00
C. Credit Union Fund, Inc.	0.25	3.75	9.30	0.00	0.97
Treasure State Corporate	0.21	3.12	8.72	0.00	0.00
Iowa Corporate Central	0.21	7.50	21.11	0.00	0.44
Midwest Corporate	0.21	3.37	10.12	0.00	0.29
Louisiana Corporate	0.20	3.33	8.23	1.36	9.35
LICU Corporate	0.01	26.43	0.66	0.00	0.00
Mean	4.15	3.99	9.71	4.98	15.67
SD	9.07	4.28	5.46	10.20	19.39

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. $)	$\frac{\text{Equity}}{\text{Assets}}$ (%)	$\frac{\text{NS Liab.}}{\text{Assets}}$ (%)	$\frac{\text{PIMBS}}{\text{Assets}}$ (%)	$\frac{\text{ABS}}{\text{Assets}}$ (%)
US Central	35.07	-19.03	43.36	13.43	52.09
Western Corporate	21.11	-40.64	46.21	15.96	31.79
Members United	8.37	-13.62	2.94	22.53	31.37
Southwest Corporate	7.92	-14.11	0.59	14.86	30.22
Mid-Atlantic Corporate	3.82	0.12	1.30	0.00	3.34
Southeast Corporate	3.33	-3.05	0.88	3.03	14.18
Corporate One	3.30	-6.26	3.94	4.41	53.72
Central Corporate	2.97	-0.65	3.61	0.25	11.17
Catalyst Corporate	2.52	-0.02	0.16	0.00	7.13
Corporate America	2.19	2.36	8.83	4.23	55.04
First Carolina Corporate	1.78	-1.38	6.16	0.94	20.39
Corporate Central	1.77	3.49	6.63	0.00	36.58
Volunteer Corporate	1.55	0.02	14.94	0.32	18.25
VaCorp	1.44	-0.07	0.39	0.00	4.99
Constitution Corporate	1.29	-16.21	2.01	20.71	33.60
First Corporate	0.95	-1.69	0.25	1.04	19.91
TriCorp	0.95	0.10	0.13	0.00	1.24
Missouri Corporate	0.90	-0.01	3.16	0.00	0.00
Eastern Corporate	0.84	2.32	1.70	0.86	26.93
Kentucky Corporate	0.44	-0.45	0.19	0.00	0.00
Treasure State Corporate	0.37	0.01	0.05	0.00	0.00
Kansas Corporate	0.34	0.06	5.39	0.00	12.89
Midwest Corporate	0.19	0.00	0.22	0.00	7.73
Louisiana Corporate	0.16	-1.51	3.30	0.53	15.50
Iowa Corporate Central	0.09	6.13	0.16	0.00	0.22
Mean	4.15	-4.16	6.26	4.12	19.53
SD	7.78	9.88	12.10	7.12	17.34

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)	$\Delta \ln(\text{Assets})$ (2)	$\Delta R \times \Delta \ln(\text{Assets})$ (3)
$\Delta \widetilde{R}$	0.02***	-0.02***	0.06***
	(5e-5)	(1e-3)	(1e-3)
$\Delta \ln(\text{InvCap})$	-9e-5***	2e-3***	-5e-4
	(2e-5)	(4e-4)	(3e-4)
$\Delta \widetilde{R} \times \Delta \ln(\text{InvCap})$	-3e-6*	-0.0001	2e-4**
	(2e-6)	(9e-5)	(9e-5)
lag(ln(Assets))	3e-4**	-0.08***	-0.01***
	(1e-4)	(4e-3)	(3e-3)
lag(ln(InvCap))	-1e-5	6e-4**	-5e-5
	(1e-5)	(2e-4)	(1e-4)
ln(members)	-3e-4**	3e-3	-3e-3
	(1e-4)	(3e-3)	(2e-3)
Mtg Share	1e-3***	0.01***	-5e-4
	(1e-4)	(2e-3)	(8e-4)
LICU	-8e-5	-4e-4	-1e-3
	(1e-4)	(2e-3)	(9e-4)
ΔMtg Share	9e-4***	0.01***	-4e-4
	(1e-4)	(2e-3)	(7e-4)
Unemployment	-0.02***	-0.24***	0.10***
	(2e-3)	(3e-2)	(1e-2)
Subprime Pop.	-3e-3	-0.02	0.02**
	(2e-3)	(2e-2)	(1e-2)
Observations	71,211	71,211	71,211
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. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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	24.74	H_0: under-identification (instruments
p-value	<1e-4	uncorrelated with regressors)
Cragg-Donald Wald Statistic	14.50	H_0: weak identification (instruments
Kleibergen-Paap Wald Statistic	7.36	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).

With multiple endogenous regressors, two separate tests are used to detect 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 smaller than 1e-4. The Cragg-Donald Wald statistic exceeds the Stock and Yogo (2005) 5% critical value (14.50 versus 9.53), rejecting weak instruments at 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 7.36 recommends rejecting weak identification at the 10% level (critical value of 6.61).

Weak instruments are therefore unlikely to be a concern. 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 asset growth and the interaction term are positive but smaller than the TSLS estimates. This implies that the conclusion that the interaction term is positive is robust to weak instrument concerns.

Table C.3: OLS Estimates

	(1)	(2)	(3)
ΔR	2.04***	1.73***	1.33***
	(0.34)	(0.33)	(0.32)
$\Delta \ln(\text{Assets})$	1.78***	1.76***	1.70***
	(0.07)	(0.08)	(0.08)
$\Delta R \times \Delta \ln(\text{Assets})$	-0.01	-2e-3	0.10
	(0.08)	(0.09)	(0.09)
lag(ln(Assets))	1.07***	1.06***	1.01***
	(0.03)	(0.04)	(0.03)
lag(ln(InvCap))	0.01***	0.01***	0.01**
	(3e-3)	(3e-3)	(3e-3)
$\ln(\text{members})$		0.02	0.03
		(0.03)	(0.03)
Mtg Share		0.28***	0.28***
		(0.03)	(0.03)
LICU		-0.02	-0.02
		(0.03)	(0.03)
ΔMtg Share		0.22***	0.21***
		(0.02)	(0.02)
Unemployment			-3.42***
			(0.36)
Subprime Pop.			-1.15***
			(0.32)
Observations	78,939	71,671	71,211
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 changes in both the two-year Treasury rate (ΔR) and log assets, and their interaction. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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.4: Capital Structure Response to Shocks

	$\Delta \ln(\text{Liabilities})$ (1)	$\Delta \ln(\text{Equity})$ (2)
ΔR	-1.07	7.32
	(2.29)	(9.63)
$\Delta \ln(\text{Assets})$	3.75***	-10.99***
	(0.69)	(3.08)
$\Delta R \times \Delta \ln(\text{Assets})$	1.17	-6.01*
	(0.77)	(3.30)
lag(ln(Assets))	0.22***	-0.96***
	(0.06)	(0.26)
lag(ln(InvCap))	-2e-3***	0.01***
	(7e-4)	(3e-3)
$\ln(\text{members})$	-4e-3	0.01
	(0.01)	(0.04)
Mtg Share	-0.02**	0.07**
	(0.01)	(0.03)
LICU	3e-3	-0.01
	(0.01)	(0.03)
ΔMtg Share	-0.02***	0.08***
	(0.01)	(0.03)
Unemployment	0.50**	-1.95**
	(0.23)	(0.94)
Subprime Pop.	0.05	-0.22
	(0.07)	(0.29)
Observations	71,206	71,194
CU FE	✓	✓
Quarter FE	✓	✓
Year FE	✓	✓

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

Notes: This table reports TSLS estimates using the specification of Equation (1) for variables describing changes in the credit union's capital structure (named at the top of each column). The three explanatory variables are: the quarterly changes in both the two-year Treasury rate (ΔR) and log assets, and their interaction. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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	No CA	Conv. MP	Time FE	Reduced Form: No Time FE	Reduced Form: Time FE
	(1)	(2)	(3)	(4)	(5)	(6)
ΔR	-10.44**	-11.21**	-9.58*			
	(5.16)	(5.11)	(5.30)			
$\Delta \widetilde{R}$					-0.18*	
					(0.10)	
$\Delta \ln(\text{Assets})$	6.49***	4.77***	6.80***	3.37*	6.43***	3.21*
	(1.97)	(1.64)	(2.45)	(1.83)	(1.92)	(1.76)
$\Delta R \times \Delta \ln(\text{Assets})$	4.77**	4.62**	4.87**	3.14		
	(1.87)	(1.80)	(2.31)	(2.55)		
$\Delta \widetilde{R} \times \Delta \ln(\text{Assets})$					0.10**	0.08
					(0.04)	(0.07)
Observations	71,211	66,720	68,890	71,211	71,211	71,211
CU FE	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Time 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. Columns 5-6 instead include the monetary surprises ($\Delta \widetilde{R}$) directly, treating them as an included instrument. The units for the surprises here are basis points; their standard deviation over the sample period is 13.38 basis points. Column 6 also adds time fixed effects. Due to collinearity, time fixed effects preclude estimating the un-interacted effect of the policy rate. Coefficients on controls are omitted for brevity. The three explanatory variables are: the quarterly changes in both the two-year Treasury rate (ΔR) and log assets, and their interaction. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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	-15.84	-8.62	-10.44
	(15.41)	(8.14)	(8.14)
$\Delta \ln(\text{Assets})$	6.08**	6.90**	6.49**
	(2.94)	(2.81)	(2.71)
$\Delta R \times \Delta \ln(\text{Assets})$	5.77	3.94	4.77*
	(3.84)	(2.39)	(2.40)
lag(ln(Assets))	1.47***	1.51***	1.44***
	(0.24)	(0.24)	(0.23)
lag(ln(InvCap))	0.01***	0.01***	0.01***
	(3e-3)	(2e-3)	(2e-3)
$\ln(\text{members})$		0.01	0.03
		(0.04)	(0.04)
Mtg Share		0.26***	0.26***
		(0.05)	(0.05)
LICU		-0.01	-0.02
		(0.03)	(0.03)
ΔMtg Share		0.19***	0.19***
		(0.04)	(0.04)
Unemployment			-3.03***
			(0.95)
Subprime Pop.			-1.19***
			(0.33)
Observations	78,939	71,671	71,211
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 changes in both the two-year Treasury rate (ΔR) and log assets, and their interaction. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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	-8.39* (4.36)	
$\Delta \ln(\text{Assets})$	6.48*** (1.97)	4.77*** (1.79)
$\ln(\text{members})$	0.03 (0.03)	-0.01 (0.01)
Mtg Share	0.26*** (0.03)	0.01 (0.05)
LICU	-0.02 (0.03)	-0.05** (0.02)
ΔMtg Share	0.18*** (0.03)	-0.05 (0.05)
Unemployment	-3.03*** (0.55)	1.28** (0.52)
Subprime Pop.	-1.13*** (0.28)	-0.17** (0.08)
lag(ln(Assets))	1.44*** (0.17)	
lag(ln(InvCap))	0.01** (3e-3)	
Observations	71,211	
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 changes in both the two-year Treasury rate (ΔR) and log assets, and their interaction. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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: Monetary Policy Sensitivity Placebo Test

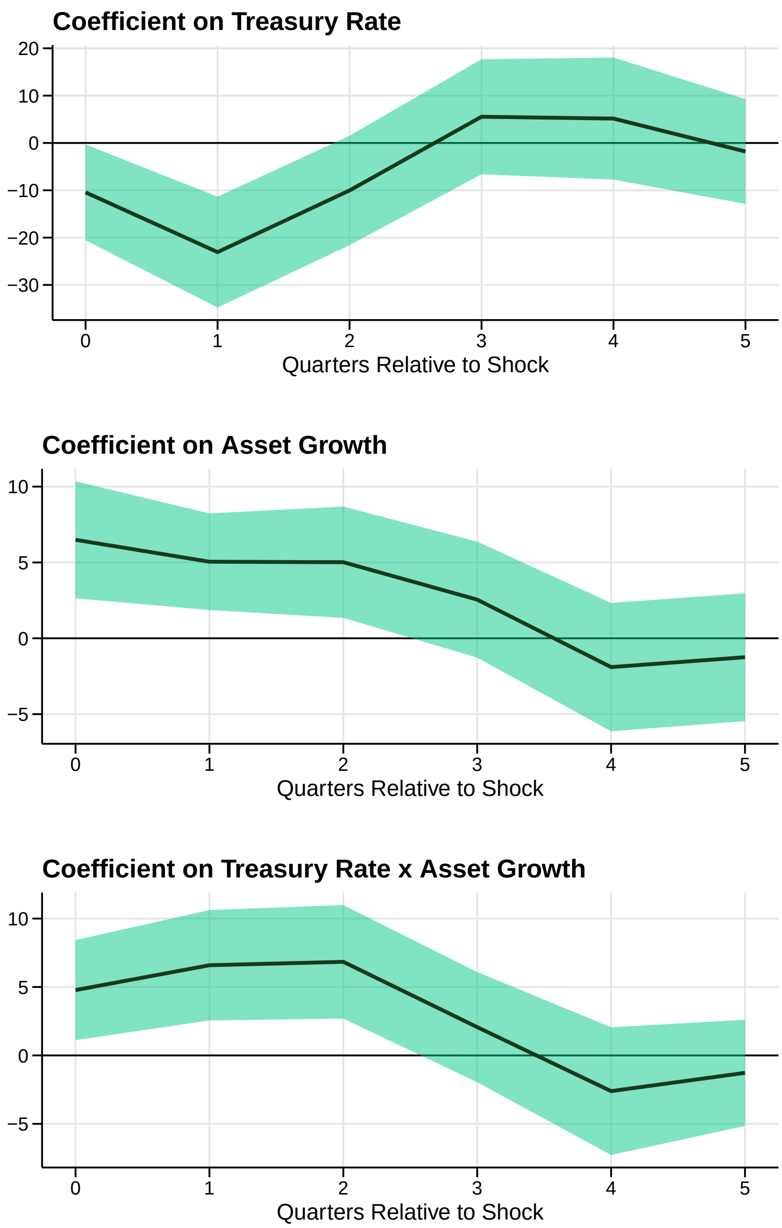
Crisis End Date:	2009	2010	2011
	(1)	(2)	(3)
ΔR	-0.94	-0.94	-0.85
	(0.70)	(0.74)	(0.84)
$\Delta R\times$ Crisis Losses	1.04	1.09*	0.85
	(0.71)	(0.66)	(0.78)
$\Delta R\times$ Crisis Losses $\times$ x Post	-8.84***	-3.71	-2.24
	(3.20)	(3.89)	(2.75)
lag(ln(Assets))	0.89***	0.89***	0.91***
	(0.03)	(0.04)	(0.04)
lag(ln(InvCap))	0.01**	5e-3	0.01***
	(3e-3)	(3e-3)	(3e-3)
ln(members)	0.03	0.03	0.02
	(0.03)	(0.03)	(0.03)
Mtg Share	0.29***	0.29***	0.32***
	(0.03)	(0.03)	(0.04)
LICU	-0.04	-0.03	-0.05
	(0.03)	(0.04)	(0.04)
ΔMtg Share	0.23***	0.23***	0.26***
	(0.03)	(0.03)	(0.03)
Unemployment	-3.78***	-3.72***	-3.82***
	(0.38)	(0.37)	(0.40)
Subprime Pop.	-1.01***	-0.89**	-0.67*
	(0.34)	(0.35)	(0.38)
Crisis Losses $\times$ Post	-0.01	-0.75	0.46
	(0.80)	(0.91)	(0.77)
Observations	64,658	59,475	48,012
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). "Crisis Losses" are the *negative* of the log change in CU-level investment capital from 2008 Q1 (pre-crisis) to Q1 of the end date specified in the column (2009, 2010, or 2011), i.e. $-[\ln(\text{InvCap}_2 008) - \ln(\text{InvCap}_T)]$, because of the negative sign a larger loss has a larger, positive value. And prior to the regression, I demean "Crisis Losses" and divide it by its standard deviation. "Post" is an indicator for whether the year is strictly greater than 2008, splitting the sample into pre and post crisis time periods. All regressors and outcome variables are scaled by 100 prior to regression (i.e., effectively units are in percentage point terms). 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. CU-level controls include log members, the mortgage share of lending, an indicator for whether or not a CU is classified as a low-income CU (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.

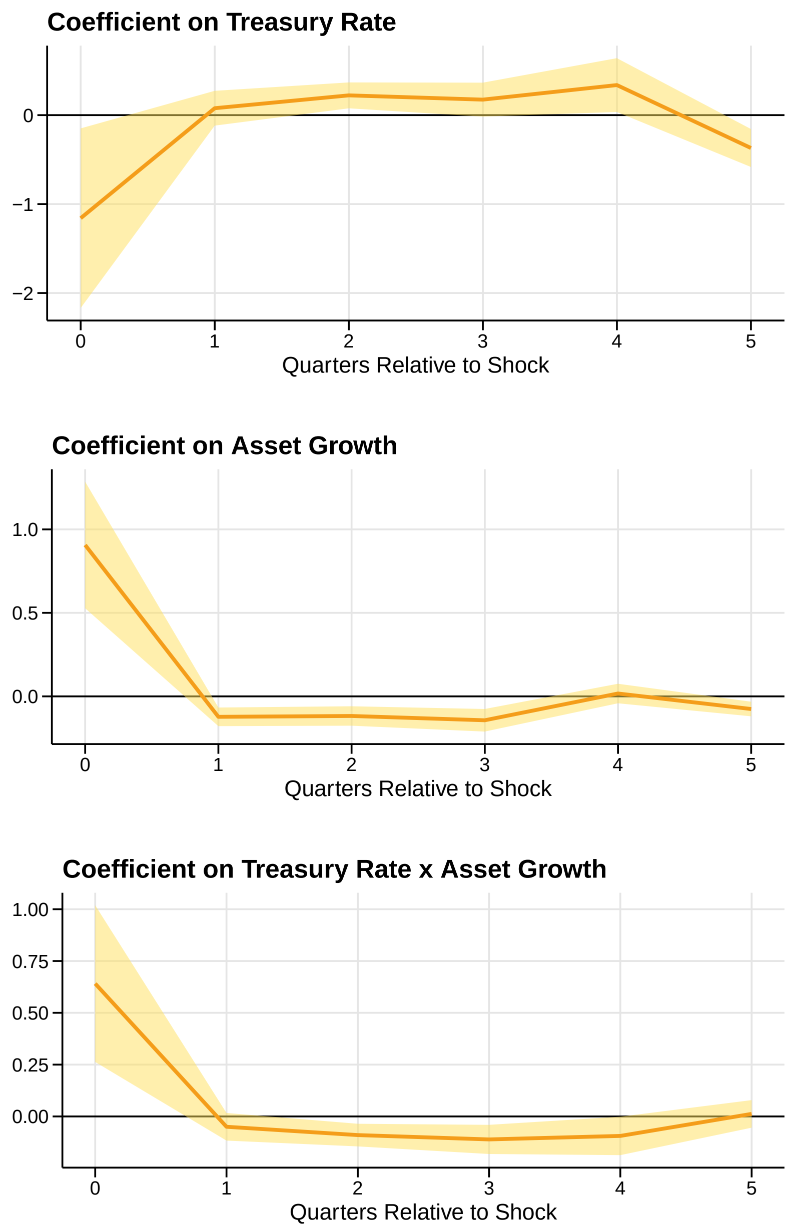
E Local Projections Estimates

Figure E.1: Local Projections for Loan Originations



Notes: The outcome variable is logged loan originations. These graphs plot quarterly impulse response functions to changes in the two-year Treasury rate and asset losses (plus their interaction). Estimates are obtained by local projections. Estimation uses the same set of controls, fixed effects, and clustering as the last column of Table 1. Specifically, I estimate same second stage Equation (1) but replace the outcome variable with various leads. The first stage equation is the same.

Figure E.2: Local Projections for the NIM



Notes: The outcome variable is the NIM. These graphs plot quarterly impulse response functions to changes in the two-year Treasury rate and asset losses (plus their interaction). Estimates are obtained by local projections. Estimation uses the same set of controls, fixed effects, and clustering as the last column of Table 1. Specifically, I estimate same second stage Equation (1) but replace the outcome variable with various leads. The first stage equation is the same.