

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

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## Abstract

This paper explores one channel through which financial crises can alter the strength of the credit channel of monetary policy. Analyzing microdata on the universe of US credit unions and exploiting plausibly exogenous variation in exposure to ABS markets, I find that asset losses among lenders increase the sensitivity of their lending to the policy rate. A 10 basis point fall in the two-year Treasury yield generates a 0.86 percentage point increase in quarterly lending growth when assets are unchanged. However, the same policy rate change leads to a 1.15 percentage point increase for a credit union experiencing a one standard deviation asset loss. This is a more than 20% difference relative to median lending growth. Additionally, a 10 basis point policy rate reduction lowers the effect of a one standard deviation asset loss from a 3.20 to 2.91 percentage point decrease in lending growth. These findings suggest that monetary easing is more potent among lenders with recently weakened balance sheets and there exists an additional benefit of monetary easing which reduces the 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. American policymakers responded to the crisis with both conventional and unconventional monetary policy.<sup>1</sup> The goal of these programs was to stimulate bank lending by lowering the cost of capital (conventional policy) and to also combat balance sheet impairments preventing banks from lending (unconventional policy).

An important consideration for policymakers is whether monetary policy works any differently during a *financial* crisis. In particular, this paper explores if the credit channel of conventional monetary policy is more or less effective when banks suffer large asset losses. Empirically, this question is largely unexplored. Moreover, theory may not be the ideal starting point for this question as even simple models can give rise to opposing predictions regarding whether asset losses amplify or attenuate the effects of conventional monetary easing (two such examples are presented in section 2). The answer is not only informative about financial crises, but speaks to the substitutability/complementarity of conventional and unconventional monetary policy. In this paper, I address this question empirically by analyzing the sensitivity of lending to conventional monetary policy and asset losses in a panel dataset of US credit unions.

I find that credit unions experiencing large balance sheet losses are relatively *more* responsive to conventional monetary policy. A credit union with no change in assets increases quarterly lending growth 0.86 percentage points in response to an exogenous 10 basis point decrease in the two-year Treasury yield. But this 10 basis point decrease induces a 1.15 percentage point rise in lending at a credit union experiencing a one standard deviation (1.65%) asset loss. This is a sizable difference compared to -1.38%, the median lending growth rate among credit unions through the sample.

There are two key identification issues that make causal inference challenging when analyzing the effect of changes in the cost of capital and assets losses on institution-level lending. First, there is endogeneity between the policy rate and lending. Changes to the policy rate are motivated by the economic environment and thus react to many factors that influence credit demand throughout the economy. To address this estimation issue

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<sup>1</sup> Here, conventional monetary policy refers to policy directly targeting the cost of capital. Conventional monetary policy can target short rates such as the federal funds rate and one or two-year Treasury notes or longer rates such as ten-year Treasury yields. I also consider attempts to affect future interest rates (forward guidance) as conventional monetary policy. Unconventional monetary policy refers to policies such as large-scale asset purchases with the objective of stabilizing asset prices and balance sheets (e.g., MBS purchases under quantitative easing and TARP).

for the policy rate, I instrument for changes in treasury yields with changes in the price of federal funds rate futures contracts within a narrow window of FOMC announcements (as in [Swanson and Williams, 2014](#); [Gertler and Karadi, 2015](#); [Nakamura and Steinsson, 2015](#); [Wong, 2015](#), among others).

Second, it is also challenging to credibly identify variation in asset losses independent of loan demand and other shocks experienced by lenders. To overcome this, I exploit the unique institutional setting in which credit unions operate to identify a plausibly exogenous asset loss (similarly to [Ramcharan, Van den Heuvel and Verani, 2015](#)). The majority of credit unions providing consumer credit, natural person credit unions (NPCUs), are exposed to the ABS market through ownership of capital in corporate credit unions (CCUs).<sup>2</sup> The key identifying assumption is that credit unions with greater exposure to ABS losses do not also face borrowers whose loan demand is more cyclically sensitive. Both CCU exposure to the ABS market and the extent to which CCU losses were transmitted onto NPCU balance sheets varied significantly for a number of reasons plausibly unrelated to a given NPCU's local loan demand.

This exogeneity is mainly due to seemingly random variation in CCU exposure to ABSs and a limited ability on the part of NPCUs to adjust their exposure. While a number of CCUs had zero exposure to ABSs prior to the financial crisis, some had as much as 65% of their assets in ABSs. NPCU ownership of CCU equity is also subject to minimum duration requirements of up to 20 years, making these holdings quite sticky. Whether the CCU relies more on debt or equity financing also alters the pass-through of a given asset loss to equity-holders. Lastly, a credit union with a relatively smaller share of ownership will experience a smaller asset loss in dollar terms. Conditioning on credit union size, this is largely determined by the decisions of other credit unions on their position size. This means most of the variation in the value of this asset on NPCU balance sheets is due to variation in CCU financial structure and the performance of extremely different CCU portfolios.

This paper contributes to a line of literature exploring how heterogeneous characteristics of financial intermediaries affect the monetary transmission mechanism. Understanding these differential responses to monetary policy is important for successfully implementing policy. Forecasts of the consequences of policy changes based on aggregate data or a typical creditor/borrower can be misleading if there are significant differences in the responses of creditors and borrowers.

Most closely related to this paper are [Kashyap and Stein \(1995\)](#) and [Kashyap and Stein \(2000\)](#), which examine bank-level FDIC Call Report data. In the first, the authors

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<sup>2</sup> Throughout this paper, I refer to the type of credit unions that provide consumer credit interchangeably as NPCUs or simply "credit unions".

find that smaller banks are more sensitive to conventional monetary policy. They expand on this finding in [Kashyap and Stein \(2000\)](#) when they observe that smaller banks tend to have less liquid balance sheets and that lower liquidity makes banks more responsive to monetary policy.<sup>3</sup> Specifically, moving from the 90<sup>th</sup> to 10<sup>th</sup> percentile of liquidity is associated with a 0.6-5.3 percentage point greater fall in lending growth in response to a 100 basis point rise in the federal funds rate. Together, our findings suggest that balance sheet impairment leads to greater sensitivity of bank lending to conventional monetary policy.

More recently, research has documented that the strength of the credit channel of monetary policy varies with economic conditions in many different ways. [Tenreyro and Thwaites \(2016\)](#) finds in aggregate time series data that conventional monetary policy stimulates less credit growth during a recession compared to an expansion. Using detailed balance sheet data from bank Call Reports, [Wieland and Yang \(2016\)](#) find that banks with lower loan origination growth in recent quarters are also less sensitive changes in monetary policy (as measured by the [Romer and Romer \(2004\)](#) shocks). Additionally, [Scharfstein and Sunderam \(2015\)](#), which this paper's empirical strategy most closely resembles, estimates that mortgage refinancing responds 58% less in counties with an additional standard deviation of market concentration compared to a county with average market concentration. I add to this literature by using rich cross-sectional variation in the timing and size of asset losses to document that at the micro-level balance sheets losses strengthen the influence of monetary easing.

This paper is also related to the literature studying balance sheet impairment and credit supply. Credit unions significantly curtailed their lending during the ABS market collapse. A one standard deviation fall in the value of its assets exposed to the ABS market is associated with a 0.23 percentage point decline in lending growth over the next four quarters ([Ramcharan, Van den Heuvel and Verani, 2015](#)). More generally, banks with relatively more illiquid assets on the balance sheets reduced lending more during the crisis ([Cornett, McNutt, Strahan and Tehranian, 2011](#)). The collapse of the ABS market also cutoff non-bank creditors from an important source of finance. In particular, the collapse of the asset-backed commercial paper market, on which captive auto lessors relied for liquidity to fund auto loans, explains 31% of the decline in 2009 car sales relative to 2008.

The above findings are of interest to policymakers as the credit supply channel is an important source of amplification during an economic downturn. Motivated by early work emphasizing the importance of the credit channel of monetary transmission (namely [Bernanke, 1983](#); [Bernanke and Gertler, 1985](#)), empirical research has shown

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<sup>3</sup>[Kashyap and Stein \(2000\)](#) define liquidity as the value of securities to total assets.

that contractions in credit supply can bring about significant losses in consumption, employment, and income. [Ashcraft \(2003\)](#) estimates an elasticity of a county's real income to loan supply of 10% within a year.<sup>4</sup>

Recent research suggests that the fall in consumer credit greatly contributed to the severity of the Great Recession. Reductions in credit supply explain an important share of the decreases in output, employment, and consumption during the Great Recession ([Mondragon, 2015](#); [Midrigan and Philippon, 2011](#)). Lower credit supply reduces household consumption demand which in turn leads to reduced labor demand and employment. Mortgage lending in particular was a key channel through which the crisis was amplified. A reduction in mortgage supply lowers demand for housing and further reduces house prices. Declines in housing net worth stemming from house price decreases can depress consumption significantly; recent research estimates an elasticity of non-durable consumption to house prices on the order of 0.3-0.4% ([Anenberg, Hizmo, Kung and Molloy, 2016](#); [Berger, Guerrieri, Lorenzoni and Vavra, 2015](#); [Mian and Sufi, 2014](#); [Mian, Rao and Sufi, 2013](#)).

The next section presents two toy models of financial intermediation to illustrate the ease with which one can generate opposing predictions of the effect of asset losses on lending's sensitivity to the policy rate. In section 3, I describe the data and the identification strategy. Section 4 presents quantitative results documenting the sensitivity of both total and mortgage lending to the policy rate and asset losses. I decompose the response of lending along its extensive and intensive margins. Monetary easing primarily affects credit through the extensive margin and also induces changes in the composition of the types of loans offered by credit unions. In particular, monetary easing leads credit unions to substitute towards mortgages and away from other types of consumer credit. Additionally, the pass-through of policy rate changes to mortgage rates is also higher among credit unions experiencing asset losses. Section 5 presents several robustness exercises. Lastly, section 6 concludes.

## 2 Models of Financial Intermediation

It is not clear from economic theory whether asset losses will increase or decrease lending's sensitivity to the policy rate. In this section I present two simple models of financial intermediation to illustrate the ease with which we can obtain opposing predictions. Fundamental assumptions about the costs and constraints facing creditors determine

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<sup>4</sup>The author identifies this effect via a natural experiment in which healthy subsidiaries of a defunct bank holding company are forced to close. Over the next 3 years, closure of a subsidiary causes a 2.5% decline in an average county's real income.

this relationship. The two, key, differing assumptions of the models are ad hoc representations of channels present in more nuanced models.<sup>5</sup> Ambiguity regarding this prediction is compounded in more microfounded settings.

In light of this theoretical ambiguity, an empirical investigation has the possibility to shed light on this question where theory is agnostic. The findings of this paper can also be used as criteria for evaluating the empirical validity of models. The inability of a model to replicate the increased sensitivity to the cost of capital of lenders experiencing large asset losses suggests the model may not be useful for studying the credit channel of conventional or unconventional monetary policy.

The first model features a constraint on lending that varies with the size of the intermediary's balance sheet. In this setting, banks with better balance sheets are more sensitive to the cost of capital. The intuition behind this result is that weak balance sheets cause the lending constraint to bind and leave the bank unable to take advantage of a lower cost of capital. This prediction is at odds with the main findings of this paper.

In the second model, the bank faces frictions in raising funds. In particular, risk neutral external creditors perceive the bank as decreasingly likely to repay as the value of its "safe" assets decrease and thus require a risk premium. This model delivers predictions consistent with this paper: the lending of a bank with weaker balance sheets is more sensitive to the cost of capital. Intuitively, a fall in the (risk-free) policy rate lowers external creditors' sensitivity to repayment risk. Since the risk premium is inversely proportional to the probability of repayment, the change in the risk premium is relatively larger among banks with weaker balance sheets. These two models are useful to consider as they reproduce the effects of key mechanisms of widely-studied models of financial intermediation.<sup>6</sup>

## 2.1 A Monopolist with a Capacity Constraint

First, consider the profit-maximization problem of a monopolist bank with a capacity/lending constraint facing a linear demand for funds. The bank can borrow cash at the gross policy rate  $R$ . The financial intermediary is assumed to lend everything that it borrows ( $L$ ). This bank also possesses "safe" assets  $B$ , the value of which define its

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<sup>5</sup>E.g., Kiyotaki and Moore (1997); Gertler and Karadi (2011); Gertler and Kiyotaki (2011); Bernanke, Gertler and Gilchrist (1999); Christiano and Ikeda (2012).

<sup>6</sup>For example, the lending constraint can be compared to capital constraints and imperfect commitment to repay creditors could give rise to a similarly-behaved external finance premium.

maximum loan capacity.<sup>7</sup> The bank solves

$$\begin{aligned} \max_{L \geq 0} \quad & R^L L - RL \\ \text{s.t.} \quad & R^L = a - bL \quad (\text{inverse demand}) \\ & L \leq \bar{L}(B) \quad (\text{capacity constraint}) \end{aligned}$$

where  $L(\cdot)$  is an increasing function.<sup>8</sup> The capacity constraint is an abstraction from regulations and rules that limit the extent to which financial intermediaries can engage in risky lending (e.g., collateral or capital requirements).

Restricting attention to equilibria where the non-negativity constraint is non-binding, if the capacity constraint is non-binding too, optimal lending  $L^*$  is characterized by

$$a - 2bL^* = R.$$

More generally, the equilibrium loan supply function is given by

$$L^*(R, B) = \min \left\{ \frac{a - R}{2b}, \bar{L}(B) \right\}.$$

The prediction of interest from this model is that equilibrium loan supply exhibits increasing differences in  $(-R, B)$ . This is formalized below:

**Proposition 2.1.** *Equilibrium loan supply  $L^*(R, B) = \min \left\{ \frac{a - R}{2b}, \bar{L}(B) \right\}$  has increasing differences in  $(-R, B)$  if  $\bar{L}(\cdot)$  is an increasing function. 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 section B in the appendix.<sup>9</sup>

Increasing differences implies that lending is more responsive to changes in the policy rate when balance sheets are stronger ( $B$  is larger). Improving the bank's balance sheet raises its lending capacity, *enhancing* the positive effects of lowering the cost of capital. Another interpretation of this result is that conventional and unconventional monetary policy are complements. Since unconventional monetary policy directly tar-

<sup>7</sup>One could instead let  $B$  measure net worth.

<sup>8</sup>Note that this is equivalent to maximizing equity  $(R^L L - RL + B)$  as we are taking  $B$  as exogenous.

<sup>9</sup>This result holds under a more general inverse demand function  $R^L(L)$  with an additional assumption. What is necessary for this result is that equilibrium lending  $L(R, B)$  is non-increasing in  $R$ . Applying the implicit function theorem to the monopolist's first-order condition with demand  $R^L(L)$  shows  $\frac{dL(R, B)}{dR} \leq 0 \Leftrightarrow L \frac{d^2 R^L(L)}{dL^2} + 2 \frac{dR^L(L)}{dL} \leq 0$ . This condition is satisfied by a number of demand functions (e.g., CES of the form  $R^L(L) = \zeta L^{-1/\sigma}$  for  $\sigma \geq 1$ .)



gets the value on assets held on financial intermediaries' balance sheets, we can think of unconventional monetary easing as an increase in  $B$ . We can rearrange in the inequality above to also see that this model suggests that empirically we should find a *negative* relationship between the cost of capital and the sensitivity of lending to assets.

## 2.2 Repayment Risk and External Finance Premia

In the second model, the bank no longer faces a capacity constraint but the price at which it can borrow depends on the value of its balance sheets. Risk neutral external creditors believe that the bank will fail to repay them with probability  $\Delta(B)$  where  $\Delta(\cdot)$  is a decreasing function of safe assets  $B$ . If the external creditor can borrow/lend at the gross policy rate  $R$ , no arbitrage requires that

$$\tilde{R} = \frac{R}{1 - \Delta(B)}.$$

The intermediary pays the gross interest rate  $\tilde{R}$  to access external funds.

The intermediary chooses lending  $L$  to maximize profits:

$$\begin{aligned} \max_{L \geq 0} \quad & R^L L - \tilde{R} L \\ \text{s.t.} \quad & R^L = a - bL \quad (\text{inverse demand}) \\ & \tilde{R} = \frac{R}{1 - \Delta(B)} \quad (\text{no arbitrage}). \end{aligned}$$

Rewriting the first-order condition characterizes equilibrium lending:

$$L^*(R, B) = \frac{a - R/[1 - \Delta(B)]}{2b}.$$

Differentiating  $L^*(R, B)$  with respect to  $R$  while assuming  $\Delta(B)$  is a decreasing function leads to the following proposition:

**Proposition 2.2.** *Equilibrium loan supply  $L^*(R, B) = \frac{a - R/[1 - \Delta(B)]}{2b}$  has decreasing differences in  $(-R, B)$  if  $\Delta(\cdot)$  is a decreasing function. That is, if  $R' < R$  and  $B' > B$ , then*

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

This model delivers the opposite prediction of the previous capacity constraint model. Here, the lower policy rate  $R$  is partially passed on to the bank by affecting its external creditor's cost of capital. When it is cheaper for the external creditor to obtain



liquid resources to lend, the external creditor can tolerate an even higher default risk and still break even in expectation. Sensitivity to the cost of capital is greatest when default risk is high. Therefore, lending is most responsive to the cost of capital when balance sheets are weaker. We can also interpret this implication as stating that conventional and unconventional monetary policy are substitutes, rather than complements. This model predicts that we should find a *positive* relationship between the cost of capital and lending's sensitivity to asset losses.

### 3 Data and Identification

This section presents the baseline model estimated in section 4, describes the data used in this paper's analysis, and discusses the institutional setting in which credit unions operate. The goal of the empirical analysis is to estimate the effect on lending of asset losses and changes to the policy rate as well as how these two forces interact.

Identifying these effects is challenging as it is likely that unobserved factors simultaneously affect both lending, assets, and the policy rate. To address these concerns, instruments for these endogenous variables are used to estimate their effects via two-stage least squares (TSLS). The baseline model of the second stage is

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

where  $\Delta \ln L_{i,t}$  is the quarterly difference in a logged loan originations for credit union  $i$  over periods  $t$  and  $t - 1$ . The dependent variable is measured as the change in logged loan originations rather than the level of logged loan originations because this captures the stimulative effects of changes in the policy rate and total assets. The outcome of interest in this paper is how a credit union's lending behavior changes, which is reflected in the additional amount of loan originations relative to the previous quarter's following changes in the policy rate and assets.<sup>10</sup> The explanatory variables are the differences in the policy rate ( $\Delta R_{t-1}$ ) and credit union  $i$ 's logged total assets  $\Delta \ln A_{i,t-1}$  from period  $t - 2$  to  $t - 1$ . The main analysis uses the two-year Treasury yield as the policy rate. Three endogenous regressors,  $\Delta R_{t-1}$ ,  $\Delta \ln A_{i,t-1}$ , and  $\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$ ,

<sup>10</sup> For the same reason, the preferred specification of [Scharfstein and Sunderam \(2015\)](#) is also in differences who study the effect of market power on bank lending's sensitivity to MBS yields. Additionally, there is significant autocorrelation in the levels of lending and comparatively little in differences. Therefore a dynamic panel with fixed effects would be the appropriate specification for a model estimated in levels, but this would introduce additional complications due to the incidental parameters problem which generally makes coefficient estimates inconsistent in these regressions.

motivate the TSLS approach.

I instrument for the three endogenous regressors with five variables. First, the quarterly sum of changes in federal funds futures prices within a narrow window of FOMC announcements,  $\Delta \tilde{R}_{t-1}$ , is a source of exogenous variation in the policy rate  $\Delta R_{t-1}$ .<sup>11</sup> The other instruments are related to a unique asset owned by credit unions that, following [Ramcharan, Van den Heuvel and Verani \(2015\)](#), I refer to as "investment capital". Further on in this section, I explain why changes in the value of investment capital are plausibly unrelated to loan demand and are thus an appropriate instrument for total assets. Three variables together instruments for changes in assets  $\Delta \ln A_{i,t-1}$ : the change in the value of logged investment capital  $\Delta \ln C_{i,t-1}$ , the share of investment capital in total assets  $\frac{C_{i,t-2}}{A_{i,t-2}}$ , and the product of these two variables.<sup>12</sup> Lastly, I also use  $\Delta \tilde{R}_{t-1} \times \Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}$  as an instrument for  $\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$ . Of the three instruments associated with asset losses, we would expect  $\Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}$  to be more strongly correlated with  $\Delta \ln A_{i,t-1}$  since it is essentially an imputed change in assets due to changes in investment capital, this helps reduce the chances of weak instruments/under-identification.

The coefficient on the interaction term,  $\beta_3$ , is the focus of the empirical analysis. We expect (and find) that  $\beta_1 < 0$  and  $\beta_2 > 0$ . That is, an increase in the cost of capital or greater asset losses will lower total lending. The sign of  $\beta_3$  characterizes whether or not asset losses make a credit union's lending more or less responsive to changes in the policy rate  $\Delta R_{t-1}$ . If  $\beta_3 > 0$ , then the magnitude of the effect of the cost of capital on lending,  $\beta_1 + \beta_3 \Delta \ln A_{i,t-1}$ , is greater when a credit union's asset decrease in value  $\Delta \ln A_{i,t-1} < 0$ .

The baseline specification includes a year fixed effect to control for unobserved determinants of loan demand and supply that vary each year.<sup>13</sup> A quarter fixed effect helps control for seasonal variation in lending activity. The credit union fixed effect ( $\kappa_i$ ) helps control for NPCU-specific characteristics such as location, field of membership, attitudes towards risk, and any time-invariant unobserved characteristics. A credit union fixed effect encodes the credit union's field of membership, which most often reflects the field of employment of its members/borrowers. Therefore this specification implicitly compares the response of lending among credit unions whose borrowers face

<sup>11</sup> This measure of monetary surprises is in the style of [Kuttner \(2001\)](#). The shocks are summed over the course of a quarter, similarly to [Cochrane and Piazzesi \(2002\)](#), [Tang \(2015\)](#), and [Wong \(2015\)](#).

<sup>12</sup> Intuitively, this multidimensional approach is preferable to only using  $\Delta \ln C_{i,t-1}$  since a 5% change would have a very different effect on total assets depending on whether 1 or 10% of assets consisted of investment capital.

<sup>13</sup> Note that this is not exactly a time fixed effect as the frequency of the data is quarterly. Unfortunately it is not possible to include a proper time fixed effect as I am interested in estimating  $\beta_1$ . Since the policy rate only varies across  $t$ ,  $\Delta R_{t-1}$  would lie in the span of the time fixed effect dummy variables.

similar labor income risks but experience different asset losses at different times.

Next, I describe the exact data used to estimate equation (1). I also describe the credit union industry to lend credibility to the assumptions made to identify the causal effects of asset losses and changes in the cost of capital.

### 3.1 Credit Unions: Data and Background

**NCUA Data** The main dataset used in this analysis is constructed from the National Credit Union Administration's (NCUA) 5300 Call Reports. Every quarter since 2004, credit unions file detailed financial reports.<sup>14</sup> The NCUA data contain a variety of measures of lending activity. I use loan originations year-to-date (YTD).<sup>15</sup> Series are available for both total loan originations and for 30-year fixed-rate mortgages specifically. Both the volume and number of loan originations are available as well. This allows me to examine how both the intensive and extensive margins of lending respond to conventional monetary policy and asset losses.

"Investment capital", the asset used as an explanatory variable, is the sum of several variables. As in [Ramcharan, Van den Heuvel and Verani \(2015\)](#), I sum the value of paid-in capital and membership capital less special assessments levied by the NCUA. The first two are assets held by credit unions whose variation is plausibly unrelated to their respective local loan markets. The assessments, I will argue further below, are also plausibly unrelated to local loan demand. Fluctuations in these assessments are therefore exogenous shocks to the assets held by credit unions.

A number of other variables from the NCUA 5300 Call Reports are also useful as controls. For covariates related to the financial condition of the credit union, I use loan loss allowances and the net worth ratio. Measures related to the financial condition of borrowers are also present. Credit Unions can be classified as low-income credit unions (LICU) if more than 50% of their members are low-income, thus this variable can be included as a dummy. The data contain the number of members at each credit union every quarter. This is an excellent measure of credit union size in comparison to other natural measures such as total assets as the number of members varies less with local and aggregate business cycles.

Credit unions are formed around a shared association, primarily related to employ-

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<sup>14</sup>Data are available back to 1994, but some credit unions only appear in the sample with a semi-annual frequency. The credit unions reporting every quarter tend to be larger than those that reported semi-annually, thus it appears that the missing quarterly observations are not missing random.

<sup>15</sup> The NCUA data contain two measures of lending activity. The first is YTD loan originations at the end of each quarter. The second measure is total loans outstanding. I prefer to analyze year-to-date loan originations because it more accurately reflects the creation of new loans. The stock of outstanding loans decreases when loans are paid off and increases when loans are acquired from a failing credit union.

ment (e.g., IMF employees, teachers in the Duluth school district, or firefighters in Chicago).<sup>16</sup> The occupational and residential requirements of many credit unions make it difficult to substitute away from one credit union to another. This difficulty in substitution makes it less likely the marginal borrowers not receiving a loan switches to another credit union after theirs restricts its supply of credit. Importantly, conditioning on a credit union's field of membership helps control for employment-sector-specific shocks to borrowers – an important determinant of credit demand. This makes it possible to make comparisons of lending's sensitivity to the cost of capital among credit unions with similar borrowers.

**County-Level Controls** In addition to NPCU-specific data, I control for county-level unemployment in some specifications. The benefit of including unemployment is to better account for variation in lending due to changes in loan demand and local business cycles. I aggregate the monthly Bureau of Labor Statistics (BLS) unemployment data to the quarterly level.<sup>17</sup> The BLS data are available for counties in all US states and Puerto Rico.<sup>18</sup> Time-invariant, location-specific characteristics are accounted for with a credit union fixed effect.

I also use the Zillow Housing Value Index (ZHVI) for single-family residences, which is a quarterly house price index constructed by Zillow (at the county-level). The ZHVI is made to reflect a per-house cost (which this paper uses) but a per square foot cost index is also available. The Zillow data cover all US states and Puerto Rico as well.

**The Credit Union Industry** Credit unions are an excellent financial institution to analyze as their lending is extremely local, substituting between credit unions is not easy, and they rely on a simpler model of financial intermediation compared to traditional banks. Credit unions operate in a three-tiered system, with credit unions in different places in the tier specializing in particular kinds of financial services. In the first tier are natural person credit unions (NPCUs) who provide consumer financial services. NPCUs are the type of credit union whose data are used in the empirical analysis. NPCUs operate on a simple model of deposit-funded lending. NPCUs are subject to strict regulations that limit them from taking on exposure to risky securities.<sup>19</sup>

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<sup>16</sup>See table 15 in section A of the appendix for a break down of NPCU affiliations in Q1 2009.

<sup>17</sup>Specifically, I aggregate BLS statistics to their beginning of quarter values.

<sup>18</sup>The NCUA dataset includes NPCUs in all American states, many in Puerto Rico, and several in Guam, the US Virgin Islands, and American Samoa.

<sup>19</sup>The Federal Credit Union Act defines the securities in which NPCUs can invest and prohibits the holding of many risky securities. NCUA regulation 12 C.F.R. §703.140. Section 703.140 permits a select few federal credit unions to make such investments.

To invest unloaned funds, NPCUs turn to corporate credit unions (CCUs) in the second tier of the credit union system. CCUs are owned by NPCUs and provide correspondent banking services exclusively to their member NPCUs.<sup>20</sup> CCUs are funded by deposits and equity owned by their members. Equity in CCUs is sold to their members in two forms: paid-in capital and membership capital. The former typically has a minimum duration of 20 years during which the NPCUs cannot sell its equity stake; the latter has a minimum duration of 3 years. At the third rung of the tier was the (now defunct) US Central Federal Credit Union that acted as a CCU for CCUs.

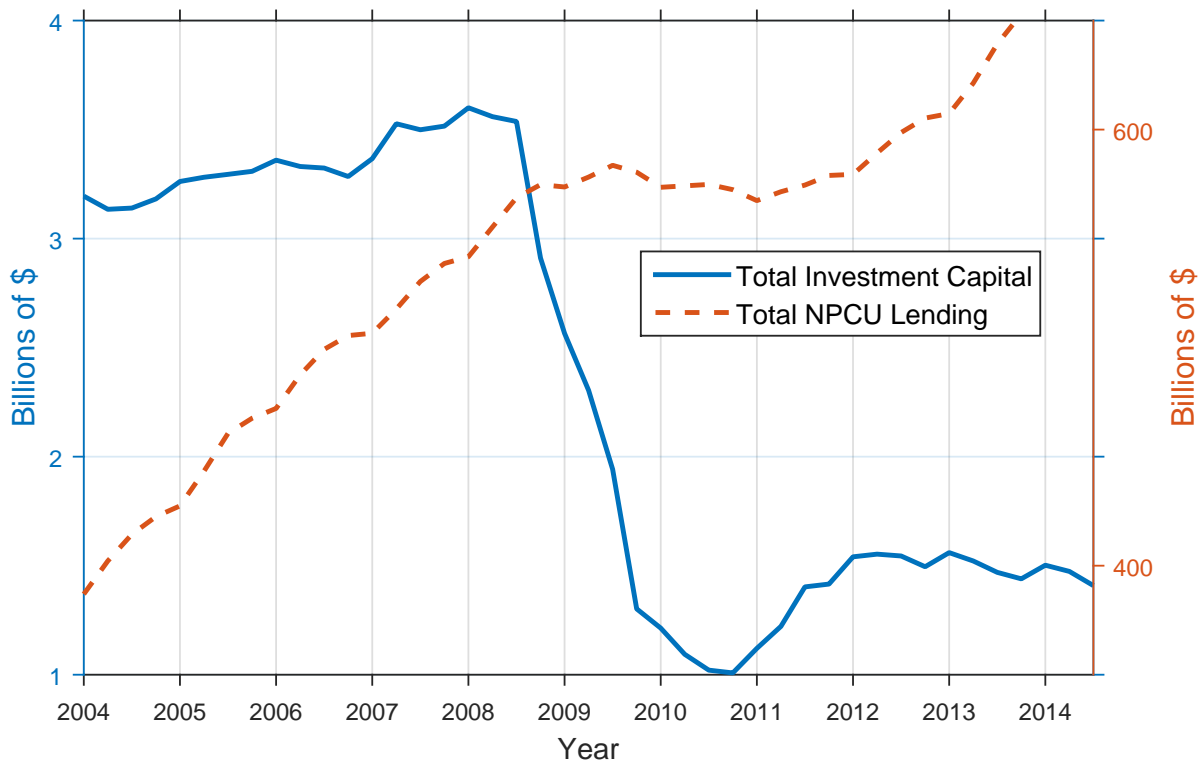


Figure 1: NPCU Investment Capital and Lending

*Note:* This graph plots the sum of all membership and paid-in capital at corporate credit unions owned by natural person credit unions less assessments levied by the NCUA (left y-axis). The right y-axis variable is total lending by all NPCUs. All data are quarterly.

Unlike NPCUs, CCUs can invest in private-label ABS. While some CCUs fully avoided exposure to these securities that performed poorly during the financial crisis, others held as much as 65% of their assets in ABS in 2006.<sup>21</sup> During the 2007-2009 collapse of the ABS market, CCUs experienced nearly \$30 billion in total unrealized losses while having \$2.4 billion in retained earnings between all CCUs. During 2005-2010,

<sup>20</sup>For example, securities safekeeping, electronic payment services, automated settlement. Outside the credit union system, small banks typically rely on large commercial banks for such services.

<sup>21</sup>See tables 16 and 17 for more information on CCU balance sheets.

\$5.6 billion of these losses were passed on to NPCUs through their equity positions in CCUs and an additional \$1.4 billion in special assessments was levied on NPCUs by the National Credit Union Agency (NCUA) to cover CCU losses. These special assessments were charged in proportion to each NPCU's share of insured deposits relative to all deposits insured by the NCUA and thus their size is likely unrelated to local determinants of lending activity.<sup>22</sup>

Aggregate NPCU total lending growth slowed in 2008 and plateaued by 2009 until about 2012. Consistently, credit union lending grew by around \$40 billion per year (see figure 1, right axis) prior to the ABS market collapse. The slowdown in lending growth coincides with the large decrease in the total value of all NPCU-owned investment capital (left axis). In the middle of 2008, as CCUs recorded large losses from ABS, investment capital fell sharply from about \$3.5 billion to \$1 billion. The ABS losses borne by the CCUs were large enough render several of them insolvent.<sup>23</sup>

### 3.2 Identification

If one were to estimate (1) with OLS, the coefficients would likely be biased. First, the FOMC influences the policy rate with the explicit intention of reacting to macroeconomic developments that related to loan demand (e.g., declines in national income or a reduction in credit supply). Second, a credit union's assets are very closely related to its lending. Loans comprise a significant portion of a credit union's assets – typically 60%. Moreover, we would expect many shocks (such as a rise in delinquencies) to simultaneously affect the accumulation of many assets including loans.

To obtain consistent estimates of the coefficients of (1) I instrument for the three endogenous regressors with five instrumental variables. The instruments related to the policy rate are constructed from the change in federal funds futures contract prices within a narrow window of FOMC announcements. The instruments related to asset losses are constructed from measures of each credit union's investment capital. The key identifying assumption for these instruments are that they are exogenous with respect to aggregate macroeconomic phenomena and local determinants of loan demand. In what follows, I discuss why these are reasonable assumptions.

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<sup>22</sup>The main results of this paper are unchanged if investment capital is computed as only paid-in capital and membership capital.

<sup>23</sup>Additional summary statistics are available in tables 1 and 2 in section A of the appendix.

### 3.2.1 Asset Losses

Heterogeneity in the relative size and timing of investment capital losses identifies the effect of asset losses on lending as well as lending's sensitivity to the policy rate. The identifying assumption here is that credit unions relatively more exposed to movements in ABS prices do not tend to have loan demand that is also more sensitive to ABS price movements. The interaction term is also identified if these same borrowers do not become relatively more responsive to conventional monetary easing when ABS prices decline.

Why is it plausible that fluctuations in a credit union's investment capital value and not systematically related to local determinants of loan demand? Minimum duration requirements of up to 20 years on paid-in and membership capital make it impossible for credit unions to close these positions until long after they are created. This makes it more likely that when we observe a decrease in investment capital value that this is truly a valuation effect and not the result of liquidating a position. This makes the number of investment capital "shares" relatively sticky. Thus much of variation in investment capital is due changes in the value of the assets owned by the CCUs to which a credit union is exposed and the determinants of the pass-through of asset losses to different CCU equity holders.

One source of heterogeneity in changes in CCU asset value is that CCUs assembled extremely different portfolios, which may be attributed to management idiosyncrasies (Ramcharan, Van den Heuvel and Verani, 2015). CCUs varied greatly in their exposure to the private-label ABS markets. In the beginning of 2006, one CCU had as much as 41% of their assets in private-label MBS while some had zero exposure.<sup>24</sup> As a result, the performance of CCU investments varies dramatically. Even during the Great Recession, some CCUs experienced growth in the value of their assets while some CCUs were rendered insolvent by their asset losses.<sup>25</sup>

Differences in each NPCU's choice of CCUs introduces additional variation to investment capital growth. Prior to the crises, high grade ABS were generally regarded as extremely safe assets. It is unlikely that particularly risk-seeking NPCUs selected risky CCUs. In fact, the NCUA has successfully argued in court that the risks of many ABS were misrepresented to managers at CCUs. This suggests CCUs and NPCUs did not anticipate the size and extent of the ABS losses. To the extent that this risk-seeking

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<sup>24</sup>Table 16 reports these measures for all CCUs in Q1 2006 and shows that there was significant variation in private-label ABS exposure.

<sup>25</sup>Within-county variation in investment capital losses among credit unions during the ABS market collapse is displayed in figure 8. To get a sense of cross-county variation, the average investment capital loss within each county during the same time frame is reported in figure 7.



behavior is time invariant, the inclusion of a credit union fixed effect rules out this NPCU characteristic as a source of omitted variable bias. A placebo test in section C.2.4 also gives evidence that the pre-crisis lending behavior of credit unions that went on to experience large asset losses was not systematically different from those that did not have such losses.

Lastly, the financial structure of each CCU affects the extent to which asset losses are charged against its equity. Suppose two CCUs own the same assets, but one is primarily financed by debt (deposits) and the other by equity. The debt-financed CCU has less equity to absorb the same asset loss; its equity investors thus experience a relatively greater decline in investment capital value compared to shareholders of the equity-financed CCU. Additionally, the each NPCU's relative share of ownership of a CCU, which depends on the decisions of many other NPCUs, influences which shareholders experience larger losses. Heterogeneity in the financial structure of a CCU is an additional source of variation in the ABS-related losses borne by NPCUs, plausibly unrelated to determinants of local loan demand.

For a typical bank, with greater regulatory freedom to invest in private-label ABS, it is more difficult to think of an asset analogous to investment capital which would be

Unfortunately, measuring ABS-exposure of non-NPCU banks is much more challenging. These banks not only have direct exposure but are linked through other assets and financial services to other banks with ABS exposure. This makes the size the ABS-related losses at banks difficult to quantify. Absent such a measure, it is not possible to meaningfully apply the coefficients estimated in this paper to non-NPCU banks. As mentioned in the main text, shocks to such a measure for non-NPCU banks is unlikely to be exogenous to other determinants of credit supply and demand.

### 3.2.2 Conventional Monetary Policy

Identifying the effect of monetary policy on lending also presents potential identification challenges. In this paper, I use high frequency data on federal funds futures contract prices near FOMC announcements to construct an instrument for quarterly changes in two-year Treasury note yields.<sup>26</sup> The idea is that this instrument captures surprise changes in the stance of monetary policy unrelated to contemporaneous economic events. Below I describe potential sources of bias and motivate this paper's hybrid high frequency identification and instrumental variables approach.

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<sup>26</sup>I also include inter-meeting policy rate announcements. The dates and federal funds futures rate surprises (computed as in Kuttner, 2001) are those used in Tang (2015).

**Bias** In contrast to time series analyses with aggregate data, simultaneity is an unlikely source of potential bias in an analysis of microdata as the Federal Open Market Committee (FOMC) is not setting the policy rate in response to individual credit unions or counties. However, both observed and unobserved determinants of lending are likely related to the aggregate conditions that motivate the FOMC to engage in monetary easing. Therefore omitted variable bias remains a source of endogeneity.

For ease of exposition, consider the problem estimating the coefficient  $\beta$  when the true model of interest is

$$L_{i,t} = \beta R_{t-1} + \gamma F_{t-1} + \eta_{i,t} \quad (2)$$

where  $L_{i,t}$  is a measure of lending activity at a creditor  $i$  at time  $t$ ,  $R_t$  is the policy rate,  $F_t$  is an unobserved, time-varying factor of loan demand (e.g., expectations of future income, labor or housing market conditions, developments in financial markets, etc.), and  $\eta_{i,t}$  is white noise uncorrelated with  $R_{t-1}$ . Suppose also that

$$R_t = \pi F_t + v_t$$

The above captures the idea that the FOMC sets the policy rate in response to factors an econometrician does not directly observe.

If we regress  $L_{i,t}$  on  $R_{t-1}$  in an attempt to estimate equation (2), our OLS coefficient is asymptotically biased:

$$\begin{aligned} \text{plim}(\hat{\beta}) &= \frac{\text{Cov}(L_{i,t}, R_{t-1})}{\sigma_R^2} \\ &= \beta + 0 + \frac{\text{Cov}(\gamma F_{t-1}, R_{t-1})}{\sigma_R^2} \\ &= \beta + \gamma\pi. \end{aligned}$$

Suppose that the latent factor  $F_{t-1}$  is positively related to lending. If the FOMC takes this factor into consideration when setting the policy rate, it is reasonable to expect that when  $F_t$  decreases, the FOMC would desire to lower  $R_t$  to counteract the contractionary effect of  $F_t$  on lending. More generally, one would expect  $\gamma$  and  $\pi$  to have the same sign. Therefore we would tend to overestimate  $\beta$  in this misspecified regression. By similar reasoning, one would expect inconsistent estimation of coefficients in the baseline specification (1) using OLS.

There are three ways to obtain consistent estimates of an interaction term such as  $\beta_3$  of equation (1). First, one could omit the policy rate as a regressor (but still include the interaction term) as in [Wieland and Yang \(2016\)](#) and include a time fixed effect to absorb

these time-varying factors. However, if the pure effect of the policy rate on lending and the *relative* change in this effect in the presence of asset losses is of interest, this cannot be discerned from this method.

Second, one could estimate exogenous innovations in the policy rate from a structural vector autoregression (SVAR). This is a measure also taken by [Wieland and Yang \(2016\)](#) who recover the structural residuals from a SVAR in the style of [Romer and Romer \(2004\)](#). However, one disadvantage of this approach when using post-ZLB data is that a binding ZLB would lead to mismeasurement of the structural shocks in the standard [Romer and Romer \(2004\)](#) or [Christiano, Eichenbaum and Evans \(1996\)](#) SVAR.<sup>27</sup>

Third, is the methodology employed by this paper: high frequency identification of monetary policy shocks. This approach uses high frequency data on federal funds futures contracts near FOMC announcements to construct a measure of monetary policy surprises. This method addresses the original omitted variable bias problem, the concerns raised with the first two approaches, and is more appropriate when the model involves financial variables.

The underlying assumption of high frequency identification is that movements in the futures prices in a narrow window around FOMC announcements are only due to unexpected changes in the stance of monetary policy. The key idea is that the pre-announcement price has already incorporated other relevant news about the economy and that no other news within the window affects the post-announcement price. See figure 2 below for an example of futures prices on an FOMC announcement day.

**Construction of Monetary Surprises** Federal funds futures contracts have durations in increments of months; the shortest is the one-month contract. Monthly futures contracts pay out the average of the effective federal funds rate over the contract period.

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<sup>27</sup>E.g., consider the approach of [Christiano, Eichenbaum and Evans \(1996\)](#) for recovering exogenous monetary policy innovations and let

$$R_t = \max \left\{ \sum_{j=1}^J B_{R,j} Y_{t-j} + u_t, 0 \right\}$$

denote the true interest rate equation of a VAR where  $R_t$  is the policy rate and  $Y_t$  is a vector of macroeconomic aggregates. Suppose we estimate  $B_{R,j}$  consistently by dropping observations from the post-ZLB period. However, it is still not possible to recover the reduced-form shocks – let alone the structural shocks – during the post-ZLB period even with consistent coefficient estimates. If we subtract the fitted values  $\hat{R}_t = \sum_{j=1}^J B_{R,j} Y_{t-j}$  from the observed values of  $R_t$ , we are computing

$$\hat{u}_t = (R_t - \hat{R}_t) = \max\{u_t, -\hat{R}_t\}.$$

When the effective lower bound on the nominal rate is binding, this formula does not return  $u_t$  but instead  $-\hat{R}_t$ . This is especially problematic as  $\hat{R}_t$  is likely closely related to omitted factors like  $F_t$ .

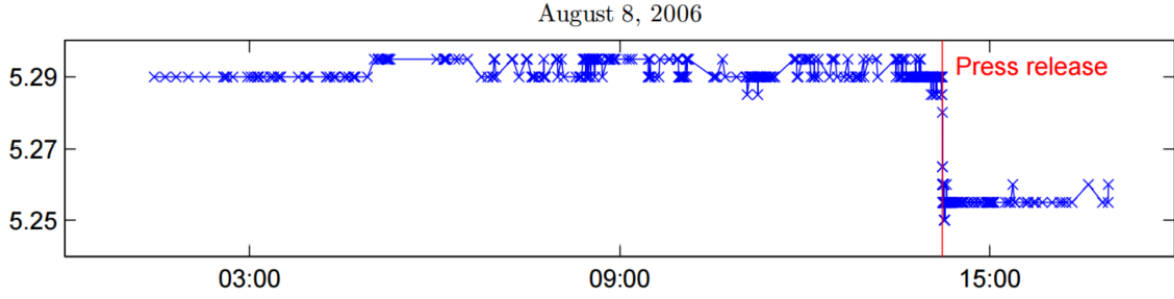


Figure 2: Federal Funds Futures Surprises

*Note:* This graph is from [Gorodnichenko and Weber \(2016\)](#). The plot displays tick-by-tick prices for federal funds futures contracts traded on the Chicago Mercantile Exchange Globex electronic trading platform on a day where an FOMC announcement occurred (the vertical line). The FOMC began their practice of announcing their target rate following each meeting as of February, 1994. This announcement usually takes place at 2:15 p.m. Eastern Time.

On the  $d^{\text{th}}$  day of a contract that settles at the end of a month with  $M$  days, its price should reflect market expectations of the federal funds rate for the remaining  $M - d$  days. More precisely, at time  $t$ , the futures price  $f_t$  for the contract should be

$$f_t = \frac{d}{M} \bar{R} + \frac{M-d}{M} \mathbb{E}_t \hat{R}$$

where  $\bar{R}$  is the average effective federal funds rate over the days leading up to the FOMC announcement at time  $t$  and  $\hat{R}$  is the average rate for the rest of the month.<sup>28</sup> As in [Kuttner \(2001\)](#), differencing the futures prices and adjusting for how far we are into the current month gives the monetary policy shock

$$\mu_t = \mathbb{E}_t \hat{R} - \mathbb{E}_{t-\Delta t} \hat{R} = \frac{M}{M-d} (f_t - f_{t-\Delta t}).$$

The shocks I use are exactly those from [Tang \(2015\)](#). As in [Wong \(2015\)](#) and similarly to [Piazzesi and Swanson \(2008\)](#), I sum these shocks over the course of a quarter to match the frequency of the NCUA data.

Ideally, one would compute the surprises in the futures rate within a 30 minute

<sup>28</sup>Here I've assumed that there is no risk premium to economize on notation. This would be the case in an efficient market with risk-neutral investors. Otherwise it would appear additively in the price above. In practice, we can more realistically assume that the risk premium does not change over the announcement period. It would then be differenced out in the computation of the monetary surprise. Assuming a constant risk premium at this high of frequency is a standard assumption, employed in [Nakamura and Steinsson \(2015\)](#); [Gertler and Karadi \(2015\)](#); [Wong \(2015\)](#) for example. [Nakamura and Steinsson \(2015\)](#) use a term structure model to show that this assumption is a good approximation of reality. [Piazzesi and Swanson \(2008\)](#) also give evidence that the [Kuttner \(2001\)](#) method of constructing monetary surprises does not appear contaminated by a constant or time-varying risk-premium.

window surrounding FOMC announcements.<sup>29</sup> The monetary surprises of this paper are constructed using a daily window. The crucial assumption that no other factors influence the change in futures prices over the window becomes less credible as the window grows larger. In practice, however, moving from a 30 minute to daily window does not lead to biased estimates but only larger standard errors from increased noise (Gürkaynak, Sack and Swanson, 2005; Nakamura and Steinsson, 2015). This suggests the other factors within the daily window affecting futures prices are not closely related to the *unanticipated* policy changes.<sup>30</sup> This means we can expect increased noise over a daily window but it is unlikely that we now violate the identification assumptions.

One could also use high frequency Treasury yield data as in Gilchrist, López-Salido and Zakrajšek (2014) instead of futures prices. One reason to prefer constructing the monetary surprise using federal funds futures is that as the underlying Treasury bond's maturity increases, it is increasingly possible that the change in the yield reflects changes in the term premium rather than expectations.<sup>31</sup> Another concern noted in Piazzesi and Swanson (2008) is that although shorter-term assets such as federal funds futures contracts have smaller time-variation in their term premia, the presence of a constant term premium could contaminate futures surprises constructed based on the difference between the realized target rate and the target rate forecast by futures contracts prior to the announcement. However, Piazzesi and Swanson (2008) also show that the Kuttner (2001) construction of monetary surprises appears purged of term premia. Therefore, I find it more conservative to adhere to the Kuttner (2001) manner of constructing surprises from futures contract prices.

An additional advantage of high frequency identification is that its identifying assumptions are more credible in models containing financial variables. In many applications of the timing-based identification strategy of Christiano, Eichenbaum and Evans (1996), it is reasonable to assume that variables such as prices and real GDP respond after a month or a quarter to a policy rate shock. However these assumptions are less credible in the presence of financial variables (Gertler and Karadi, 2015). Especially during the Great Recession, the FOMC likely considered asset prices, financial market liquidity, overall credit availability and many other financial factors that respond rapidly to changes in the policy rate.

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<sup>29</sup>Standard practice for an intraday window is to compute the difference in futures prices 10 minutes before and 20 minutes after an FOMC announcement.

<sup>30</sup>This is not too surprising if we think the effect of other *unanticipated* news is generally not related to unanticipated FOMC policy moves.

<sup>31</sup>Hanson and Stein (2015) suggests that the term premium response is a significant portion of the reaction of Treasury yields around FOMC announcements. For another helpful discussion of the findings of Hanson and Stein (2015) in the context of high-frequency identification, see Gertler and Karadi (2015).

**Choice of Policy Rate** I instrument for the quarterly change in the two-year, nominal, on-the-run, Treasury rate with the quarterly monetary surprises. Why is this particular yield a good choice of policy rate? There are several reasons.

First, one and two-year Treasury rates are more closely related to other important interest rates than the federal funds rate itself. In particular, [Gertler and Karadi \(2015\)](#) instrument for the federal funds rate with futures surprises and find that it does not have a major effect on Moody's Baa spread or the 30-year mortgage spread. But the one and two year yields do have economically and statistically significant effects on these rates. This suggests that short-term Treasury rates are more relevant channels for the transmission of monetary policy to the financial sector.

Second, the two-year Treasury rate is well-suited to capture the effects of forward guidance (i.e., announcements regarding the future path of the federal funds rate). The two-year yield is preferable to the one-year as two years is about the horizon at which the FOMC's forward guidance policy operates ([Bernanke, Reinhart and Sack, 2004](#); [Gürkaynak, Sack and Swanson, 2005](#); [Swanson and Williams, 2014](#); [Hanson and Stein, 2015](#)). As the federal funds rate neared the ZLB in 2008, the FOMC increasingly relied on asserting commitment to maintain low rates as a means of monetary stimulus.<sup>32</sup>

Even prior to 2008, the FOMC's influence on expectations of future rates was the central channel through which conventional monetary policy operated. [Gürkaynak, Sack and Swanson \(2005\)](#) decompose the effect of monetary policy surprises (in the style of [Kuttner, 2001](#)) on Treasury yields into two factors: surprises due to changes in the current rate target and those related to the path of future monetary policy ("target" and "path" factors, respectively). They find that FOMC announcements mainly operate through changes in expectations (the path factor). Therefore, as in [Swanson and Williams \(2014\)](#); [Gertler and Karadi \(2015\)](#); [Hanson and Stein \(2015\)](#), I assume changes in the two-year nominal Treasury yield embody both the target and path surprises.<sup>33</sup>

Lastly, distinguishing between nominal and real yields does not appear important for estimation. Using TIPS data, a number of studies (e.g., [Gilchrist, López-Salido and Zakrajšek, 2014](#); [Gertler and Karadi, 2015](#); [Hanson and Stein, 2015](#); [Nakamura and Steinsson, 2015](#)) show there is little inflation response to monetary policy surprises.

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<sup>32</sup>[Gertler and Karadi \(2015\)](#) conceptually prefers the two-year rate for the same reasoning. They find that the one-year yield performs better in terms of a higher F-statistic and obtain their main results using this measure as the two-year yield appears to be a weak instrument in their application. However, weak instruments do not appear to be a problem in my sample, therefore I use the two-year rate.

<sup>33</sup>[Swanson and Williams \(2014\)](#) also verify, with intraday Treasury yield data, that the response of the two-year Treasury yield to monetary surprises sufficiently summarizes the effect of monetary policy compared to decomposing the response of the two-year yield into target and path factors. Also, [Gertler and Karadi \(2015\)](#) encounter weak instruments when using both the decomposed target and path factor as instruments. Given this, I prefer not to decompose the response of the two-year Treasury yield.

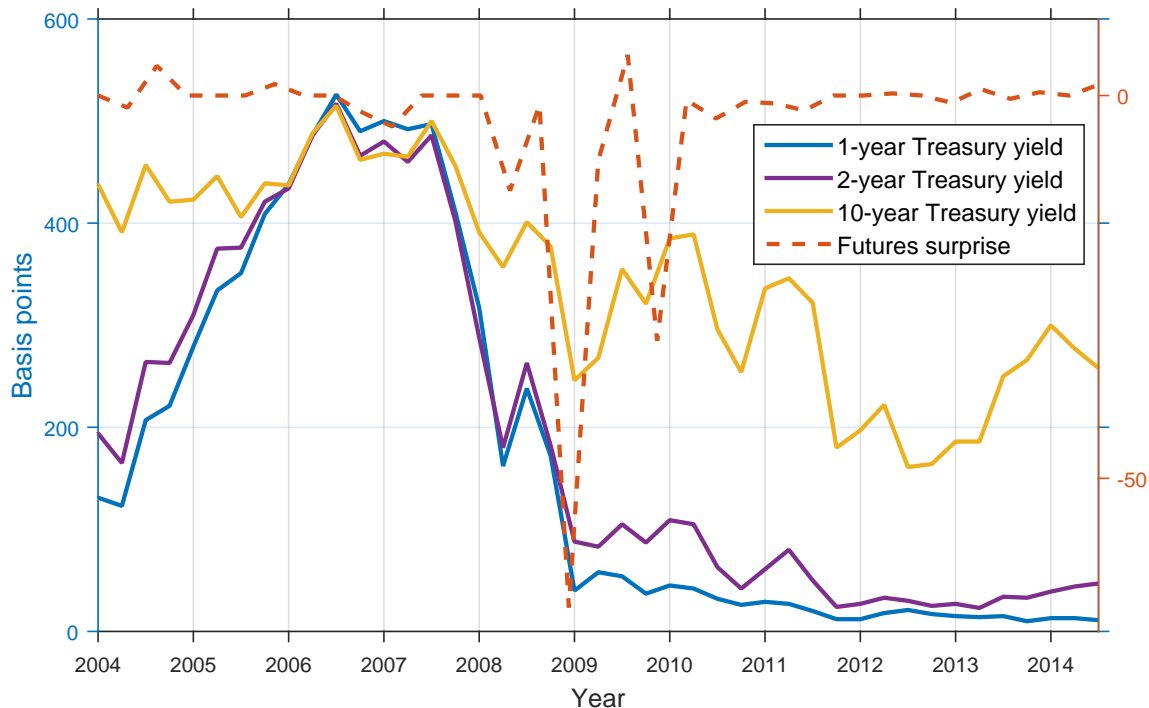


Figure 3: Treasury Yields and Futures Surprises

*Note:* This graph plots (on-the-run) yields for one-year, two-year, and ten-year Treasury notes as solid lines (left y-axis). The right y-axis variable is the sum of federal funds futures price shocks over the quarter. All data are quarterly.

Most of the response to FOMC announcements is borne out by the nominal rates.

As in [Gertler and Karadi \(2015\)](#), I truncate my sample at the end of 2011.<sup>34</sup> Even after the federal rates rate target reached zero in December of 2008, the ZLB was not a constraint on the FOMC's ability to influence the two-year rate until 2012 at the earliest ([Swanson and Williams, 2014](#); [Gilchrist, López-Salido and Zakrajšek, 2014](#)).

## 4 Results

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

<sup>34</sup>An additional reason one may have to make this same truncation when studying credit unions is that a number of corporate credit unions that became insolvent during the crisis were officially shut down in 2012 and a number of new regulations were introduced by the NCUA affecting both corporate and natural person credit unions that affected incentives to raise or acquire paid-in and membership capital.



model

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

are presented first for both the total volume of all loan originations and originations of fixed-rate 30-year mortgages. Table 9 summarizes the economic meaning of the regression results discussed within this section. A cutoff rule is applied for each subsample associated with a given dependent variable to remove outliers.<sup>35</sup> Throughout, I two-way cluster standard errors by year-quarter (time) and state. It is especially important to cluster by time as one independent variable (the policy rate) only varies over time. The inclusion of this variable rules out the possibility of including a time fixed effects. This means that it is likely the error term contains unobserved factors that only vary over time. While these latent factors are assumed uncorrelated with the instrumental variables, which implies estimator consistency, the standard errors will overstate the statistical significance if we do not allow for the residuals to be correlated within each time period. It is also reasonable that there are unobserved NPCU-specific or region-specific characteristics varying over time that also influence lending growth. Therefore I also cluster along the state dimension, which allows for an even more general correlation structure than also clustering by credit unions alone.

The key finding is that asset losses ( $\Delta \ln A_{i,t-1} < 0$ ) increase the positive effect of conventional monetary easing ( $\Delta R_{t-1} < 0$ ) on loan origination growth. Using data on the number of loan originations for both of these groups, I also find that the extensive margin plays a central role and that conventional monetary easing induces substitution towards fixed-rate 30-year mortgages and compared to other types of loans. Next I describe these results in more detail and augment the baseline specification with additional controls. Additional robustness exercises are documented in section 5.

## 4.1 Total Lending

Tables of the regression results discussed throughout this section are available in section C.1 of the appendix. Column 1 of table 4 displays estimates for the baseline model (which includes year, quarter, and NPCU fixed effects) estimated for total loan origina-

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<sup>35</sup> Generally the omitted observations come are those of credit unions that are extremely small or in extremely poor financial health. The most extreme 5% of changes in logged loan originations for each different measure, large or small, are dropped. That is, the 2.5% largest and 2.5% smallest are omitted. I drop credit unions whose logged changes in total assets is in the most extreme 1%. Lastly, I impose the same 5% cutoff rule to logged changes in investment capital and the net worth ratio. I also drop credit unions below the 7.5<sup>th</sup> percentile of members.

tions. Generally the estimates of  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$  are significant at the 1%, 10%, and 5% levels (respectively). Overall the coefficients remain similar with the inclusion of credit union and county-specific control variables and remain precisely estimated.<sup>36</sup>

The first finding is that conventional monetary easing increases total lending growth ( $\beta_1 < 0$ ). A 10 basis point decrease in the policy rate, holding fixed a credit union's assets, leads to an additional 0.86 percentage points of lending growth. This is large compared to the median growth rate of -1.38%. Asset losses, on the other hand, reduce lending ( $\beta_2 > 0$ ). A one standard deviation asset loss ( $\Delta \ln A_{i,t-1} = -1.65\%$ ) reduces total lending growth 3.20 percentage points.

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

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

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

About 28% of stimulated lending growth is due to the reduced sensitivity of lending to asset losses for 1.65% asset loss. The relative role of this channel is increasing (at

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<sup>36</sup> The exception is  $\beta_2$ , which in a few cases shrinks while remaining positive while exceeding the 10% threshold for statistical significance. It does remain significant however when the number of mortgages is the dependent variable (table 7). This only occurs occasionally when adding the Zillow Housing Value Index as a control. There are several explanations for this. First the sample sizes shrink significantly (about 30%) due to limited availability of the Zillow data, therefore there may not be enough variation left to discern the effects of asset losses on lending, leading to larger standard errors. The change in the magnitude of the coefficient is more concerning. House prices are likely endogenous with respect to lending, so this could be inducing significant bias in the coefficients. But it could also mean that assets losses are not perfectly uncorrelated with house prices.

The fact that  $\beta_3$  is hardly affected by the inclusion of the ZHVI suggests that potential problems with estimating  $\beta_2$  do not also apply to  $\beta_3$ . Additionally, this coefficient remains similar even when interacting the ZHVI and the other controls with the policy rate as well as discussed in section 5.1.

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

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

#### 4.1.1 Adding Additional Controls

Columns 2-4 of table 4 add additional controls to the baseline specification. In the spirit of [Ramcharan, Van den Heuvel and Verani \(2015\)](#) and [Scharfstein and Sunderam \(2015\)](#) these covariates reflect other credit union or county-specific characteristics that influence loan demand. The goal associated with adding these controls is to potentially obtain more precise estimates of the main coefficients of interest. Additionally, it suggests that the instruments are valid if coefficients are little-changed by the inclusion of these covariates. However, many of these controls are likely endogenous with lending. For this reason, the baseline specification remains my preferred specification throughout.

Column 2 augments the baseline specification by conditioning on several time-varying NPCU-level characteristics. These variables do not have a statistically significant effect on the volume of lending (total or mortgage). The first characteristic is the logged number of a credit union's members ( $\ln members_{i,t-1}$ ), which reflects the size of a credit union. An advantage of this measure (compared to deposits or total assets) is that it has less cyclical variation. The net worth ratio,  $\frac{Net\ Worth_{i,t-1}}{Assets_{i,t-1}}$ , reflects the financial health of the credit union. This ratio is measured as net worth to total assets and

captures how well-capitalized a credit union is.<sup>37</sup> The difference of logged loan loss allowances ( $\Delta \ln LLA_{i,t-1}$ ) reflects repayment risk. Loan loss allowances are cash set aside to cover future losses on loans. Therefore, this variable reflects a credit union's expectations of near-term lending conditions and default probabilities.

Column 3 adds the lagged county-level unemployment rate  $UR_{i,t-2}$  to the baseline specification. The unemployment rate in NPCU  $i$ 's county proxies for unobserved local shocks that affect loan demand and borrower repayment risk. Column 4 also add the change in the logged house prices ( $\Delta \ln ZHVI_{i,t-1}$ ). Limited availability of this variable force the sample size to shrink about 30%. The coefficients on the policy rate and the interaction term a little changed and just as precisely estimated but the estimated effect of asset losses nearly halves and it is no longer significant at even the 10% level.

#### 4.1.2 First Stage and OLS

The first stage of the TSLS estimation and the OLS analogs of the main results (tables 4 and 5) overall support the validity of the identifying assumptions. These estimates, along with the standard statistics testing for over and under-identification with multiple endogenous regressors, are displayed in section C.2.1 of the appendix.

Table 10 reports the first-stage estimation results associated with the baseline specification for total lending (the first column of table 4).<sup>38</sup> As one would expect, the coefficient on the federal funds futures surprises is positive when the dependent variable is the change in the two-year Treasury yield; it is also highly statistically significant. Column 2 shows that there is no statistically significant effect of investment capital on assets when it constitutes 0% of assets. The two interacted instruments and the share of investment capital in total assets are all statistically significant. This column implies that the average change in investment capital (-1.65 percentage points) is associated with a 0.44 percentage point decrease in total assets.<sup>39</sup> Lastly, the third column shows that

<sup>37</sup> In the NCUA data, net worth is defined as the sum of undivided earnings, regular reserves, appropriation for non-conforming investments, other reserves, uninsured secondary capital, and net income. This ratio is one of two used to regulate credit unions and banks. A ratio exceeding 6% implies adequate capitalization, to be well-capitalized it must exceed 7%. The average ratio for the panel I consider is 13%. The corresponding ratios for bank holding companies are 4% and 5% (respectively).

<sup>38</sup> The first stage of the TSLS estimation consists of essentially the same three regressions across all specifications discussed in this paper. The excluded instruments change when additional controls are added and the sample varies slightly based on data availability for the dependent variable. Point estimates for the first stage are similar, as one would expect, across the other specifications. The implications of test statistics are unchanged across specifications too (except in some cases when the Hansen J statistic cannot be computed due to small cluster group sizes).

<sup>39</sup> This is computed using the statistically significant interaction terms in the first stage, the average federal funds futures shock of -0.04 and the average, and the average share of investment capital in total assets (0.78%).

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

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

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

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

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

## 4.2 Mortgage Lending

Next I restrict attention to originations of fixed-rate 30-year mortgages. Mortgages are approximately 35% of credit union lending by volume, the largest lending category among credit unions.<sup>40</sup> Overall I find that mortgage lending is comparatively signifi-

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<sup>40</sup>See figure 5 in section A of the appendix.

cantly more sensitive to both asset losses and changes in the policy rate on average, but the relative effects on sensitivity of one of these shocks to the other is similar.

Given the central role of housing and mortgage markets in the Great Recession, it is valuable to be able to consider this variety of lending separately. A reduction in mortgage credit supply in particular can reduce demand through two channels. First, restricted credit supply in general will lead to lower consumption expenditures. But housing is unique in that housing net worth comprises a substantial share of most household's net worth.<sup>41</sup> Thus an initial fall in demand can lead house prices to fall and reduce the wealth of households already owning a home. In addition to the pure wealth effect of this loss, the lost collateral value of one's home can limit access to finance a further depress consumption (Berger, Guerrieri, Lorenzoni and Vavra, 2015; Mian, Rao and Sufi, 2013).

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

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

### 4.3 Extensive vs. Intensive Margins

Decomposing the response of lending into the number and size of loans suggests that lending primarily responds to both changes in the policy rate and asset losses along the extensive margin. Table 6 reports regressions of the logged quarterly difference in the number of new loan originations of all types in columns 1-4 and those for the

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<sup>41</sup>See figures 4 and 5 in section A of the appendix.



the logged change in the average size of the loans originated in columns 5-8. The same controls as well as year, quarter, and credit union fixed effects are used as in the previous subsections. Table 7 reports analogous regressions for the number and average size of all fixed-rate 30-year mortgages originated.

Table 6 suggests that both margins are important, especially the intensive margin, for total lending. Here a 10 basis point decrease in the policy rate leads to a 0.32 and 0.69 decrease in the growth rate in the volume and size of loans, respectively. In contrast to total lending, the response of mortgage lending is borne out almost entirely by the extensive margin (table 7). The extensive margin appears to account for the entire response of mortgages and the point estimates for mortgage sizes are much smaller. A 10 basis point decrease is associated with a 4.34 rise in the growth rate of the number of mortgage originations.

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

What can rationalize these stark differences in the role of the intensive margin for total and mortgage lending? One explanation is that monetary easing induces substitution towards mortgages and away from other forms of lending. If this were the case, a shift towards issuing fewer loans overall but larger ones like mortgages could make the intensive margin overall appear more important. Table 18 in the online appendix shows that this composition change does in fact occur. A 10 basis point policy rate reduction increases the share of mortgage originations in the total volume of loan originations by 2.80 percentage points. Interestingly, this response is also strengthened by asset losses.

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

Most of the additional controls are statistically insignificant throughout these regressions. The exceptions only occur for the extensive margin of mortgage lending. Here,



rising housing prices are negatively associated with the growth rate of the number of mortgages originated. The median percentage change of 15 basis points in housing prices, measured with the ZHVI, is associated with -0.02 percentage points lower growth in the number of mortgage originations. Since the change in housing prices is lagged, one would most likely expect the negative sign which is observed. This could be the case if rising housing prices discourage households from buying homes and thus taking out mortgages. It is also reasonable that if credit unions see rising house prices as stemming from a speculative boom or in anyway as a harbinger of a housing bust that they may restrict the number of mortgages which they originate to avoid delinquencies.

Loan loss allowances, which grow when credit unions anticipate increased delinquencies, are negatively correlated with the number of mortgage originations as well. This is a plausible sign as lenders may restrict credit when anticipating losses on currently-held mortgages in the near future. The effect of the median change in loan loss allowances of 68 basis points has a very small impact on the number of new mortgages, only lowering the growth rate 0.007 percentage points.

#### 4.4 Mortgage Interest Rates

Another important stimulative effect of conventional monetary policy is to lower the interest rate paid by private borrowers. Using data on the common interest rate charged on fixed-rate 30-year mortgages, I find not only do decreases in the policy rate translate to lower mortgage rates, but that asset losses also amplify this channel (see 8).<sup>42</sup> These signs are also predicted by the second model discussed in section 2.<sup>43</sup>

Interest rate pass-through is incomplete, a feature also found in FDIC Call Report data by [Scharfstein and Sunderam \(2015\)](#) between MBS yields and interest rates on refinanced mortgages. I find that a 10 basis point reduction in the policy rate leads to a 1.74 basis point decrease in the mortgage interest rates charged by credit unions, holding assets fixed. The same conventional monetary easing also leads to a larger 2.70 basis point reduction when a credit union experiences a 1.65% asset loss.

In half of the specifications, the strong, positive effect of asset losses on mortgage interest rates is statistically significant. Thus not only can asset losses induce a credit crunch in the sense of restricting the quantity of credit supplied, but another contractionary effect could also be increasing interest rates. With no changes in the policy

<sup>42</sup>The common rate is the modal rate charged on new originations within the quarter.

<sup>43</sup>In general, if a model (1) is consistent with the signs found for  $\{\beta_1, \beta_2, \beta_3\}$  in the main analysis of the volume of lending and (2) has an equilibrium interest rate that depends negatively on the equilibrium quantity of loans, then it must be that the coefficients for the regression with mortgage rates on the left-hand-side will have the opposite sign.

rate, a 1.65% asset loss leads credit unions to increase mortgage interest rates 3.56 basis points. With 10 basis points of monetary easing, the same asset loss only causes a 2.61 basis point rise in mortgage interest rates. There are significant compared to the average quarterly change of 2.35 basis points.<sup>44</sup>

## 5 Robustness

This section discusses additional evidence supporting the main results of the previous section. First, I include additional interactions between the policy rate and county and credit union characteristics. Estimates of the interaction between asset losses and the policy rate are little-changed suggest that asset losses are a relatively important determinant of the efficacy of the transmission of monetary policy. Another natural question is whether the effects on lending are quickly reversed or even offset soon after changes in the policy rate or asset losses. I find that the effects of both of these shocks are extremely persistent and can depress lending for up to two to three years. Lastly, to assuage concerns that there may have been a time-varying, unobserved characteristic of credit unions that led them to both be exposed to large investment capital losses and have decreased lending growth, I perform a placebo test. This test verifies that pre-crisis lending growth is not predicted by a credit union's subsequent investment capital losses during the recession. Finally, this section concludes with a discussion of how the effects estimated in the previous section could differ under general equilibrium and limitations of external validity.

### 5.1 Alternative Sources of Sensitivity

The main findings are robust to the inclusion of additional interactions terms and overall asset losses are a relatively important determinant of the sensitivity of lending to monetary policy. I augment the baseline specification to include both the credit union and county-level control variables discussed earlier as well as interactions of these variables with the change in the policy rate. I instrument for these interactions for each control  $X_{i,t}$  with the product of the control and the futures surprises (i.e.,  $X_{i,t} \times \Delta \tilde{R}_{t-1}$ ). The robustness of the coefficient on the interaction of asset losses and the policy rate and its statistical precision in spite of the inclusion of these additional interactions suggests that the main results are not spuriously driven by these other determinants of loan demand.

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<sup>44</sup>The signs of these effects are to be expected in a model when equilibrium lending is negatively related to the equilibrium interest rate.

Regression results for total lending and mortgage lending (for volume, number, and average size of originations) are available in table 13. The unemployment rate and house price growth do not appear to affect the sensitivity of credit union lending to monetary policy. On the other hand, the credit union characteristics do appear to affect lending's sensitivity to the policy rate. The first finding is that larger credit unions, measured by the log number of members, is associated with greater sensitivity to monetary policy. This is in contrast to [Kashyap and Stein \(1995\)](#), which found smaller banks, measured by total assets, to be more sensitive to the policy rate.<sup>45</sup>

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

A lower net worth ratio is associated with enhanced sensitivity to the policy rate. This result is similar to the main findings of this paper and [Kashyap and Stein \(2000\)](#) in that it suggests by another measure of balance sheet quality, more financially impaired lenders are more sensitive to conventional monetary policy.<sup>46</sup> Following a 10 basis point

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<sup>45</sup> This difference may stem from my use of log members to measure size compared to their measure based on total assets. It is also possible that the relationship between size may be nonlinear, with lenders the size of large banks less sensitive compared to small banks, small banks more sensitive, and extremely small lenders less sensitive than small banks. Large credit unions are more similar in size to banks considered small in [Kashyap and Stein \(1995\)](#). The smallest credit unions, which are quite small compared to most small banks, may behave differently from small banks/large credit unions. It could also be that if the variation in assets they used to identify the effects on monetary policy was more related to valuation effects/asset losses than fundamental changes in "size", then their measure could have reflected asset losses rather than size.

<sup>46</sup> In contrast to the quarterly asset losses considered in the main analysis, net worth reflects more of a summary of overall financial health. Therefore it more accurately describes the history of many balance sheet shocks rather than a recent, single asset loss.

drop in the policy rate, a one standard deviation (4.68 percentage points) decline in the net worth ratio is associated with 0.15 and 0.51 percentage points greater volume of total and mortgage originations (respectively). Along the extensive margin, growth in the number of mortgage originations responds with 0.54 further percentage points to this same monetary policy shock at a credit union with net worth one standard deviation lower.

Changes in loan loss allowances appear to influence the effect of monetary policy on the average size of loans. This variable is also related to asset losses and a credit union's financial health in that an increase suggests the credit unions anticipates *future* losses on assets. A standard deviation increase in log loan loss allowances (1.75) is correlated with 0.23 additional percentage points of average loan size growth. Section 4.3 presented evidence suggesting monetary easing affects the intensive margin of total lending by also stimulating a shift in loan composition towards mortgages. The findings of this section are consistent with perceptions of greater loan losses amplifying the composition switch towards mortgages in response to monetary easing.

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

## 5.2 Persistence

The effects of asset losses on lending persist for about a year and the those of monetary persist for nearly two years. I find this by estimating the baseline model for the volume of total loan origination growth over various horizons. This exercise examines the impact of a one-time change in the policy rate or asset loss on lending multiple quarters ahead relative to originations at the time of these two shocks. Patterns are similar for the number of loan originations and for mortgage lending (volume and number). Coefficients and 95% confidence intervals from these regressions are displayed in figure 6.

The strongest effect of monetary policy on lending appears to set in around one-two year horizon, in terms of the magnitude of the point estimate. Nearly two years later, loan originations are on average 2% lower following a 10 basis point policy rate cut

relative to originations at the time during which the rate cut took place. After 8 quarters, the estimated effect is not statistically distinguishable from zero. Asset losses have an even more persistent effect on total lending. One year after an initial asset loss of 1.65%, loan originations are about 13% lower on average. This large effect is not surprising if the growth rate of originations is dampened for multiple quarters; this would allow the contractionary effects of the asset loss to compound. Thus it appears to take at least a year for credit union lending to recover to its pre-shock level following a one-time policy rate change or asset loss. Lastly, the interaction term remains statistically different from zero for at least a year. The strength of the interaction grows over time.

### 5.3 Placebo Test

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

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

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

To this end, I estimate a series of cross-sectional regressions of pre-crisis lending on asset losses during the Great Recession, instrumenting for these asset losses with changes in investment capital during the Great Recession.<sup>47</sup> The second stage of these regressions have the form

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

where *PC* and *TGR* denote pre-crisis and the Great Recession, respectively. I consider a variety of windows for measuring defining the pre-crisis and Great Recession periods, which I describe in detail in section C.2.4 of the appendix alongside the regression results. Since the regression is cross-sectional I can no longer include a credit union fixed effect. However, I can exploit within county and with field of membership variation by including fixed effects for these characteristics.

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

## 5.4 General Equilibrium

A natural concern for a partial equilibrium regression analysis is that "local" general equilibrium effects could offset the model's predicted results. Specifically, one might worry that the marginal borrowers who do receive a loan after their credit union experiences an asset loss are able to easily obtain credit elsewhere. If this is the case, then the estimated model would overstate the total effect on credit. Fortunately, these local general equilibrium effects are unlikely to be a significant concern for three reasons.

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

Second, it is unlikely members found it desirable to switch from credit unions to banks. Credit unions consistently offer more favorable rates to borrowers than banks.<sup>48</sup>

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<sup>47</sup>The full set of instruments used in these regressions are the log change in investment capital losses, the initial ratio of investment capital to total assets, and the interaction of these terms.

<sup>48</sup>Credit unions are not-for-profit institutions and use their profits to offer higher deposit interest rates

This makes it less likely that the marginal borrower not receiving a loan at a credit union would instead obtain it from a bank. The competitive rates offered by credit unions make it reasonable that the marginal borrower may find it more profitable to wait out the credit crunch and then obtain a loan from their credit union. Overall, credit would decline and not merely shift to different providers. In fact, the market share of credit unions in auto and housing loans markets rose during and after the crisis ([Ramcharan, Van den Heuvel and Verani, 2015](#)). This suggests that this sort of substitution away from credit unions was not significant.

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

Third, most people tend to live nearby the banks from which they borrow.<sup>49</sup> Whatever frictions prevent households from borrowing at distant banks likely slow the process of searching for a new lender. If households apply to one bank for a loan but are denied, they must recommence a possibly costly search.

In the "global" sense of general equilibrium, one would expect that the contraction in credit supply induced by asset losses would serve as an amplification rather than dampening channel. Contractions in consumer credit are associated with lower demand for durables and non-durables, housing prices, employment, and overall economic activity. In accordance with the financial accelerator literature (e.g., [Bernanke, Gertler and Gilchrist, 1999](#)), this decline in real economic activity further depresses asset prices, weakens creditor balance sheets, and further amplifies the initial decline in credit supply. With respect to this general equilibrium concern, it is likely that the estimated model understates the full general equilibrium effect of asset losses.

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and lower interest rates on loans.

<sup>49</sup>[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.



## 5.5 External Validity

Credit unions an important provider of consumer credit in the US. Therefore, this paper directly studies a major source of consumer credit. In terms of assets, credit unions appear small relative to many banks. As of March 2015, Credit unions owned \$1.2 trillion in assets while US banks owned \$15.8 trillion.<sup>50</sup> The average credit union owned \$185 million in assets in March 2015 while the average US bank owned \$ 2.5 billion.

By volume, credit unions provide 9.2% of consumer loans as of May 2015.<sup>51</sup> Banks and savings institutions accounted for 39.2% of non-revolving consumer consumer credit, financial companies another 20%, and the remaining 31.6 % of the market share goes to non-financial corporations. Although credit unions only owned 4.3% of US housing loans by value in 2010, they owned 17.6% of the *number* US housing loans at this same time. Additionally, credit unions accounted for 24.1% (by number) of auto loans.<sup>52</sup> Because credit unions are responsible for a large number of consumer loans, this means that studying the determinants of NPCU-supplied consumer credit speaks to the financial resources of a large population.

Credit unions and banks comove together and appear similar in a number of ways. Total US consumer credit and the amount owned by credit unions has a correlation coefficient of 0.87.<sup>53</sup> Credit unions and banks have consistently had similar net worth to assets ratios; as of March 2015 this ratio was 10.8 % for credit unions and 11.2 % for US banks on average.<sup>54</sup> The regulatory minimum for adequate capitalization under this ratio is 6% for credit unions and 4% for banks. The stricter capital requirements credit unions face may make them more sensitive to asset losses compared to a similar bank.

Lending at credit unions is also more local. Credit unions are formed around a common association and thus members tend to live in the same region, often the same county. This is in contrast to banks which tend to draw on larger populations for depositors and lenders. Credit unions also tend to have fewer branches, making their lending confined to a much more narrow market. In March, the average credit union had only three branches while the average US bank had fifteen.<sup>55</sup> A potential limit for generalizing the findings of this study to banks is that in general equilibrium bank borrowers may be able to more easily switch to a different credit provider. Banks do not impose

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<sup>50</sup>This figure is from the Q1 2015 US Credit Union Profile produced by CUNA.

<sup>51</sup>This figure is from the May 2015 *Monthly Credit Union Estimates* produced by the Credit Union National Association (CUNA). Additionally, credit unions have consistently provided about 9-11% of consumer credit since the late 1980's.

<sup>52</sup>Market share calculations not made available in CUNA are computed from Flow of Funds data.

<sup>53</sup>Computed from monthly Flow of Funds data spanning January 2004 to May 2015.

<sup>54</sup>These figures are from the Q1 2015 US Credit Union Profile produced by CUNA.

<sup>55</sup>Source: Q1 2015 US Credit Union Profile produced by CUNA.

the same membership requirements and are generally at a competitive disadvantage compared to credit unions in terms of their interest rates. However, the evidence cited in the previous section regarding the local nature of banking suggests it is possible that policy rate changes and asset losses among banks could lead to reductions in the total amount of credit supplied.

## 6 Conclusion

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

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

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

Breaking down the response of lending into its intensive and extensive margins for both total and mortgage lending suggest that monetary easing primarily operates along the extensive margin of lending but it can also induce compositional changes in the types of loans provided. Mortgage lending responds almost entirely to the policy rate along the extensive margin. The intensive margin appears most important when considering the response to total lending to the policy rate. But, monetary easing induces substitution away from other forms of consumer credit (student, auto, and credit card loans, mainly) and towards fixed-rate 30-year mortgages. This can largely account for the seeming importance of the intensive margin for total lending. Credit unions do

not offer larger loans within lending categories but switch to providing types of loans which are generally larger.

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

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

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# Appendix

## A Summary Statistics

Table 1: NPCU Summary Statistics (Levels)

	25%	Median	75%	Mean	St. Dev.	Obs.
Assets (mil. \$)	6.77	19.05	60	102.1	564.84	166,932
Invest. cap. (mil. \$)	-1.73	-0.58	1.65	-1.25	10.79	166,932
$\frac{\text{Investment cap.}}{\text{Assets}}$ (%)	0.56	0.81	0.96	0.78	0.67	166,932

Panel A: Total Loans YTD

Volume (mil. \$)	3.44	38.96	46.99	42.95	203.26	166,932
Number	393	2,202	2,952	2,997	12,975	159,389
Average size (\$)	5,783	8,996	13,374	11,410	18,893	159,389

Panel B: Fixed Rate Mortgages YTD

Volume (mil. \$)	1.28	28.21	34.67	25.91	82.13	79,569
Number	13	155	206	157	390	79,504
Average size (mil. \$)	0.07	0.10	0.15	0.14	1.78	79,023

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

	25%	Median	75%	Mean	St. Dev.	Obs.
Assets	-1.45	0.56	2.69	0.67	3.74	166,932
Invest. cap.	-1.73	-0.58	1.65	-1.25	10.79	166,932

Panel A: Total Loans YTD

Volume	-9.73	-1.38	8.28	-0.41	25.04	166,932
Number	-26.68	-0.3	270.31	15.24	199.14	150,317
Average size	-7.56	-0.97	6.85	0.08	16.96	150,121

Panel B: Fixed Rate Mortgages YTD

Volume	-15.85	5.35	28.77	4.29	48.36	70,886
Number	-16.75	6.66	27.2	3.58	45.01	70,575
Average size	-7.05	0	8.46	1.00	21.48	70,602

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



Table 3: Additional Summary Statistics

	25th %	Median	75th %	Mean	St. Dev.	Obs.
Panel A: Panel Data						
$\frac{\text{Loans out.}}{\text{Assets}}$ (%)	47.74	60.34	71.82	59.09	16.99	166,932
Net worth ratio (%)	10.02	12.33	15.75	13.48	4.68	166,932
$100 \times \Delta \ln LLA_{i,t-1}$	-6.44	0.68	9.15	1.56	34.19	166,576
Members	1,415	3,294	9,168	11,833	51,079	166,932
UR (%)	4.40	5.6	7.6	6.24	2.54	165,096
$100 \times \Delta \ln ZHVI$	-1.16	0.15	1.5	0.24	3.5	117,174
Mortgage rate (basis points)	550	600	661	617	109	104,862
$\Delta$ Mortgage rate (basis points)	-3.00	0.00	0.00	-2.35	45.98	102,572
Panel B: Aggregate Time Series Data						
Assets (bil. \$)	483.97	607.11	664.63	568.14	138.33	30
Loans out. (bil. \$)	306.23	391.66	456.11	377.01	106.07	30
Loans orig. (bil. \$)	52.90	112.91	175.12	122.70	69.35	30
Members (mil.)	53.08	76.36	78.92	65.84	17.63	30
$\Delta R_t$	-0.29	0.00	0.25	-0.05	0.54	30
$\Delta \tilde{R}_t$	-0.02	0.00	0.00	-0.04	0.14	30

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

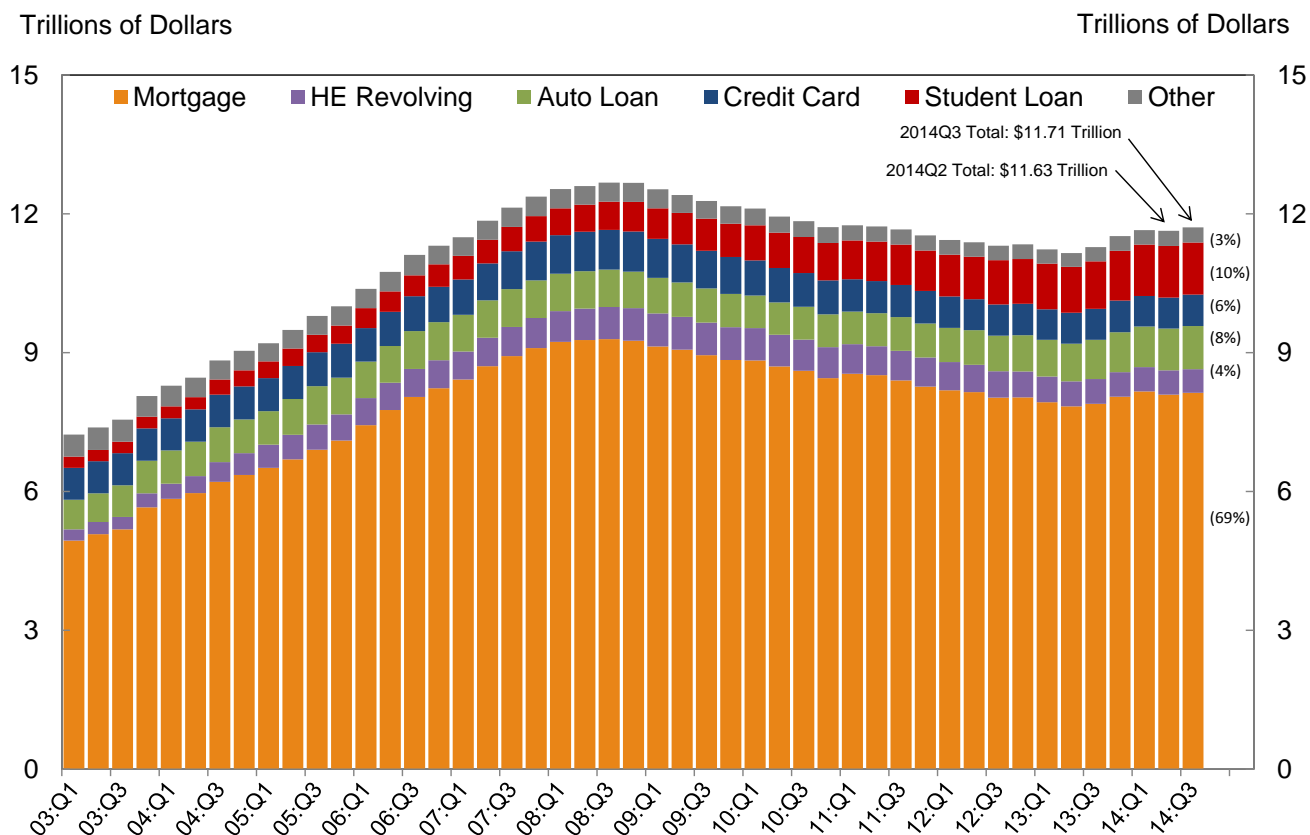


Figure 4: Composition of US Household Debt

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

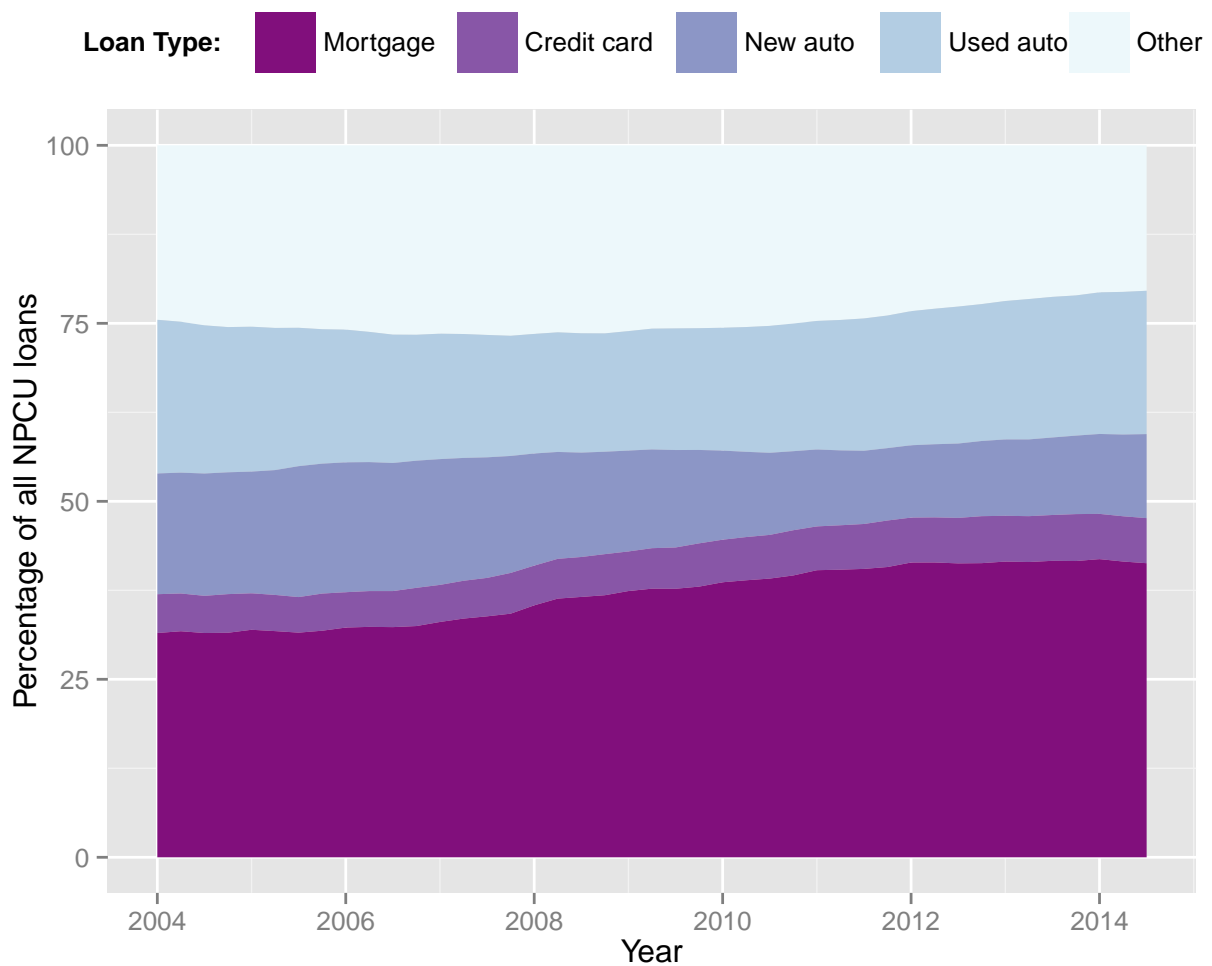


Figure 5: NPCU Lending Composition

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

## B Proof of Proposition 4.1

**Proposition 4.1** *Equilibrium loan supply  $L^*(R, B) = \min \left\{ \frac{a-R}{2b}, \bar{L}(B) \right\}$  has increasing differences in  $(-R, B)$  if  $\bar{L}(\cdot)$  is an increasing function. That is, if  $R' < R$  and  $B' > B$ , then*

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

*Proof.* Let  $R' \leq R$  and  $B' > B$ . There are three possible cases for the effect of decreasing the interest rate from  $R$  to  $R'$  given balance sheet value  $B$  and capacity function  $\bar{L}(\cdot)$ :

$$L^*(R', B) - L^*(R, B) = \begin{cases} \frac{R-R'}{2b} & : \bar{L}(B) \geq \frac{a-R'}{2b} \\ \bar{L}(B) - \frac{a-R}{2b} & : \bar{L}(B) \in \left( \frac{a-R}{2b}, \frac{a-R'}{2b} \right) \\ 0 & : \bar{L}(B) \leq \frac{a-R}{2b} \end{cases}.$$

We can examine the effect of lowering  $B'$  to  $B$  on the difference in lending under each of the three cases above.

**Case 1** If  $\bar{L}(B') \leq \frac{a-R}{2b}$ , since  $\bar{L}(B) < \bar{L}(B')$ , lowering interest rate has the same effect for either  $B$  or  $B'$ :

$$L^*(R', B') - L^*(R, B') = L^*(R', B) - L^*(R, B) = 0.$$

**Case 2** If  $\bar{L}(B') \in \left( \frac{a-R}{2b}, \frac{a-R'}{2b} \right)$ , then

$$\begin{aligned} L^*(R', B) - L^*(R, B) &= \max \left\{ 0, \bar{L}(B) - \frac{a-R}{2b} \right\} \\ &\leq \bar{L}(B') - \frac{a-R}{2b} \\ &= L^*(R', B') - L^*(R, B') \end{aligned}$$

and lending rises more in response to monetary easing when  $B$  is higher.

**Case 3** If  $\bar{L}(B') \geq \frac{a-R'}{2b}$  and  $\bar{L}(B) < \frac{a-R'}{2b}$ :

$$\begin{aligned} L^*(R', B) - L^*(R, B) &= \max \left\{ 0, \bar{L}(B) - \frac{a-R}{2b} \right\} \\ &\leq \max \left\{ 0, \frac{a-R'}{2b} - \frac{a-R}{2b} \right\} \\ &= \frac{R-R'}{2b} \\ &= L^*(R', B') - L^*(R, B'). \end{aligned}$$

Lending increases more following a fall in  $R$  when  $B$  is higher. If instead both  $\bar{L}(B') \geq \frac{a-R'}{2b}$  and if  $\bar{L} \geq \frac{a-R'}{2b}$ , the response of lending is the same for either  $B$  or  $B'$ :

$$L^*(R', B) - L^*(R, B) = \frac{R - R'}{2b} = L^*(R', B') - L^*(R, B').$$

Thus in every case, we have

$$L^*(R', B') - L^*(R, B') \geq L^*(R', B) - L^*(R, B),$$

□

## C Tables

### C.1 Main Results

Table 4: Total Lending (volume)

	(1)	(2)	(3)	(4)
$\Delta R_{t-1}$	-8.58*** (3.02)	-8.56*** (3.09)	-8.90*** (3.15)	-9.81*** (3.52)
$\Delta \ln A_{i,t-1}$	1.94* (1.14)	1.40* (0.75)	1.32* (0.80)	0.71 (0.60)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	1.78** (0.74)	1.69** (0.70)	1.75** (0.70)	1.70** (0.85)
$\ln \text{members}_{i,t-1}$		-0.74 (1.58)	-0.8 (1.67)	-0.94 (1.63)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$		0.17 (0.30)	0.13 (0.32)	-0.11 (0.27)
$\Delta \ln \text{LLA}_{i,t-1}$		0.12 (0.31)	0.14 (0.31)	0.16 (0.38)
$\text{UR}_{i,t-2}$			-0.05 (0.20)	-0.06 (0.29)
$\Delta \ln \text{ZHVI}_{i,t-1}$				3.99 (2.84)
Observations	166,932	166,553	164,728	116,165

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

Table 5: Mortgage Lending (volume)

	(1)	(2)	(3)	(4)
$\Delta R_{t-1}$	-44.35*** (15.26)	-43.49*** (15.50)	-44.42*** (16.03)	-47.35*** (18.17)
$\Delta \ln A_{i,t-1}$	3.24 (4.11)	3.65 (3.33)	3.49 (3.22)	3.96 (3.22)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	8.78** (3.46)	8.69** (3.56)	8.87** (3.60)	9.98** (4.11)
$\ln \text{members}_{i,t-1}$		6.81 (8.59)	6.86 (8.49)	10.05 (8.82)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$		0.2 (1.34)	0.12 (1.33)	0.25 (1.37)
$\Delta \ln \text{LLA}_{i,t-1}$		-0.89 (1.09)	-0.74 (1.05)	-0.95 (1.06)
$\text{UR}_{i,t-2}$			0.23 (0.68)	0.01 (0.90)
$\Delta \ln \text{ZHVI}_{i,t-1}$				-8.16 (9.00)
Observations	70,886	70,845	70,169	50,903

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

Table 6: Total Lending: Extensive vs. Intensive Margins

	Number				Size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta R_{t-1}$	-3.18* (1.71)	-3.23* (1.73)	-3.72** (1.80)	-4.35 (2.89)	-6.93*** (2.13)	-7.03*** (2.23)	-7.09*** (2.27)	-8.70** (3.54)
$\Delta \ln A_{i,t-1}$	1.98** (0.92)	1.39** (0.58)	1.28** (0.64)	1.30 (0.84)	0.36 (0.99)	0.38 (0.83)	0.41 (0.82)	0.91 (1.18)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	1.25** (0.51)	1.17*** (0.43)	1.25*** (0.39)	1.38** (0.64)	0.92 (0.63)	0.95 (0.62)	0.96 (0.61)	1.40 (0.94)
$\ln \text{members}_{i,t-1}$		-2.11 (1.31)	-2.16 (1.34)	-1.61 (1.62)		1.42 (1.43)	1.42 (1.42)	2.23 (1.78)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$		0.24 (0.22)	0.18 (0.26)	0.14 (0.39)		-0.01 (0.28)	-0.01 (0.28)	0.06 (0.48)
$\Delta \ln \text{LLA}_{i,t-1}$		-0.06 (0.29)	-0.04 (0.30)	0.04 (0.34)		-0.1 (0.16)	-0.08 (0.16)	-0.09 (0.18)
$\text{UR}_{i,t-2}$			0.02 (0.08)	0.04 (0.16)			0.08 (0.15)	0.22 (0.25)
$\Delta \ln \text{ZHVI}_{i,t-1}$				3.20 (3.55)				-0.12 (2.26)
Observations	150,317	150,017	148,309	105,157	150,121	149,829	148,125	104,950

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



Table 7: Mortgage Lending: Extensive vs. Intensive Margins

	Number				Size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta R_{t-1}$	-43.40*** (14.52)	-42.42*** (14.52)	-42.64*** (14.83)	-39.71*** (15.12)	-1.93 (4.02)	-1.95 (4.29)	-2.19 (4.43)	-2.05 (5.27)
$\Delta \ln A_{i,t-1}$	5.29* (2.94)	4.99** (2.38)	4.91** (2.35)	4.66** (2.21)	0.42 (0.89)	0.41 (0.71)	0.3 (0.71)	0.43 (0.65)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	8.96*** (3.12)	8.74*** (3.15)	8.83*** (3.17)	8.26** (3.28)	0.64 (0.86)	0.65 (0.92)	0.68 (0.93)	0.88 (1.05)
$\ln \text{members}_{i,t-1}$		7.5 (7.28)	7.54 (7.22)	8.94 (6.88)		1.47 (1.45)	1.40 (1.49)	1.91 (1.60)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$		0.88 (0.84)	0.84 (0.86)	1.09 (0.69)		0.09 (0.32)	0.04 (0.32)	0.13 (0.36)
$\Delta \ln \text{LLA}_{i,t-1}$		-0.77 (0.81)	-0.58 (0.77)	-0.99* (0.54)		-0.75 (0.51)	-0.77 (0.52)	-0.68 (0.48)
$\text{UR}_{i,t-2}$			-0.21 (0.62)	-0.75 (0.71)			-0.03 (0.15)	0.04 (0.25)
$\Delta \ln \text{ZHVI}_{i,t-1}$				-19.71* (11.53)				4.40 (5.55)
Observations	70,575	70,533	69,861	50,664	70,602	70,562	69,887	50,771

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

Table 8: Mortgage Interest Rates

	(1)	(2)	(3)	(4)
$\Delta R_{t-1}$	17.44*** (4.46)	18.01*** (4.58)	17.77*** (5.03)	18.91*** (6.75)
$\Delta \ln A_{i,t-1}$	-2.16 (1.61)	-2.14* (1.27)	-2.17* (1.30)	-1.47 (1.09)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	-5.77*** (1.20)	-5.89*** (1.23)	-5.89*** (1.29)	-6.23*** (1.66)
$\ln \text{members}_{i,t-1}$		-7.73* (4.20)	-7.77* (4.27)	-6.58 (4.40)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$		0.13 (0.58)	0.13 (0.59)	0.56 (0.58)
$\Delta \ln \text{LLA}_{i,t-1}$		-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
$\text{UR}_{i,t-2}$			0.25 (0.44)	0.23 (0.54)
$\Delta \ln \text{ZHVI}_{i,t-1}$				7.24 (5.15)
Observations	102,572	102,443	101,300	73,267

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

Table 9: Summary of the Main Results' Economic Meaning

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

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

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

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

## C.2 Additional Tables

### C.2.1 First Stage and OLS

Table 10: First Stage Regressions

Dependent variable:	(1) $\Delta R_{t-1}$	(2) $\Delta \ln A_{i,t-1}$	(3) $\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$
$\Delta \tilde{R}_{t-1}$	1.50*** (0.45)	-1.07 (0.79)	5.88*** (1.51)
$\Delta \ln C_{i,t-1}$	-0.23* (0.14)	0.12 (0.37)	-0.03 (0.27)
$\frac{C_{i,t-2}}{A_{i,t-2}}$	0.001 (0.003)	0.09** (0.04)	0.02 (0.03)
$\frac{C_{i,t-2}}{A_{i,t-2}} \times \Delta \ln C_{i,t-1}$	-0.01 (0.02)	0.28*** (0.05)	0.12 (0.15)
$\Delta \tilde{R}_{t-1} \times \Delta \ln C_{i,t-1} \times \frac{C_{i,t-2}}{A_{i,t-2}}$	-0.72 (1.17)	-4.22* (2.29)	10.73* (5.58)
Observations	166,932	166,932	166,932
R <sup>2</sup>	0.60	0.24	0.18
F-statistic	29.44	6.29	27.15

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

Table 11: Testing of TSLS Assumptions

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

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

Table 12: OLS Estimates

	Total Lending (volume)				Mortgage Lending (volume)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta R_{t-1}$	-1.44 (0.92)	-1.43 (0.91)	-1.3 (0.84)	-1.56* (0.93)	-9.06*** (3.01)	-8.92*** (2.95)	-8.55*** (2.79)	-9.85*** (2.98)
$\Delta \ln A_{i,t-1}$	0.11*** (0.04)	0.11*** (0.04)	0.11*** (0.04)	0.09** (0.04)	-0.06 (0.10)	-0.04 (0.10)	-0.03 (0.10)	-0.06 (0.11)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	-0.08 (0.07)	-0.09 (0.07)	-0.09 (0.07)	-0.1 (0.07)	0.21 (0.33)	0.19 (0.33)	0.19 (0.33)	0.31 (0.40)
$\ln \text{members}_{i,t-1}$		-3.37*** (1.10)	-3.46*** (1.13)	-2.81*** (1.08)		-2.52 (3.92)	-2.75 (3.98)	-0.8 (4.72)
$\frac{\text{Net worth}_{i,t-1}}{\text{Assets}_{i,t-1}}$		0.05 (0.08)	0.05 (0.07)	0.04 (0.09)		0.59* (0.32)	0.57* (0.31)	0.69*** (0.24)
$\Delta \ln \text{LLA}_{i,t-1}$		0.07 (0.33)	0.1 (0.33)	0.09 (0.38)		-1.09 (1.14)	-0.91 (1.09)	-0.78 (1.06)
$\text{UR}_{i,t-2}$			-0.42** (0.17)	-0.60** (0.23)			-1.05** (0.44)	-1.66*** (0.62)
$\Delta \ln \text{ZHVI}_{i,t-1}$				5.18 (3.94)				2.75 (5.04)
Observations	166,932	166,553	164,728	116,165	70,886	70,845	70,169	50,903

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

### C.2.2 Alternative Sources of Sensitivity

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

Table 13: Sensitivity to the Policy Rate

	Total Lending			Mortgage Lending		
	Volume (1)	Number (2)	Size (3)	Volume (4)	Number (5)	Size (6)
$\Delta R_{t-1}$	5.64 (3.59)	-0.01 (3.72)	0.89 (5.62)	5.58 (28.01)	11.34 (25.20)	-2.00 (9.36)
$\Delta \ln A_{i,t-1}$	0.52 (0.69)	1.21 (0.82)	0.73 (1.14)	3.61 (3.00)	4.30** (1.96)	0.42 (0.65)
$\Delta R_{t-1} \times \Delta \ln A_{i,t-1}$	1.24* (0.69)	1.21* (0.67)	1.20 (0.90)	9.30** (3.81)	7.33** (3.00)	0.96 (1.09)
$UR_{i,t-2}$	-0.12 (0.27)	0.02 (0.15)	0.18 (0.22)	-0.17 (0.80)	-0.87 (0.63)	0.02 (0.25)
$\Delta \ln ZHVI_{i,t-1}$	6.92 (4.65)	3.47 (5.21)	1.82 (2.17)	-0.67 (7.98)	-13.67 (13.31)	5.18 (5.49)
$\ln members_{i,t-1}$	-2.54 (1.65)	-2.17 (1.61)	1.30 (1.65)	4.98 (8.50)	4.38 (6.63)	1.66 (1.48)
$\frac{Net\ worth_{i,t-1}}{Assets_{i,t-1}}$	0.13 (0.27)	0.24 (0.38)	0.18 (0.44)	0.89 (1.21)	1.74*** (0.58)	0.13 (0.35)
$\Delta \ln LLA_{i,t-1}$	0.11 (0.35)	0.17 (0.38)	-0.33** (0.17)	-2.27 (2.05)	-1.77* (1.05)	-1.26 (0.93)
$\Delta R_{t-1} \times UR_{i,t-2}$	-0.72 (0.60)	-0.08 (0.48)	-0.22 (0.41)	0.17 (1.42)	-1.20 (1.25)	0.39 (0.30)
$\Delta R_{t-1} \times \Delta \ln ZHVI_{i,t-1}$	-10.59 (26.31)	-24.93 (28.22)	6.59 (9.73)	2.02 (68.33)	-25.27 (57.09)	4.18 (14.79)
$\Delta R_{t-1} \times \ln members_{i,t-1}$	-1.73*** (0.55)	-0.71** (0.34)	-1.25*** (0.38)	-6.80*** (2.41)	-5.88** (2.13)	-0.25 (0.25)
$\Delta R_{t-1} \times \frac{Net\ worth_{i,t-1}}{Assets_{i,t-1}}$	0.31*** (0.09)	0.18 (0.14)	0.21* (0.12)	1.09*** (0.34)	1.16*** (0.35)	0.01 (0.19)
$\Delta R_{t-1} \times \Delta \ln LLA_{i,t-1}$	0.01 (1.31)	0.99 (1.46)	-1.32** (0.63)	-6.81 (7.93)	-3.58 (5.93)	-4.23 (2.66)
Observations	116,165	105,157	104,950	50,903	50,664	50,771

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

### C.2.3 Persistence

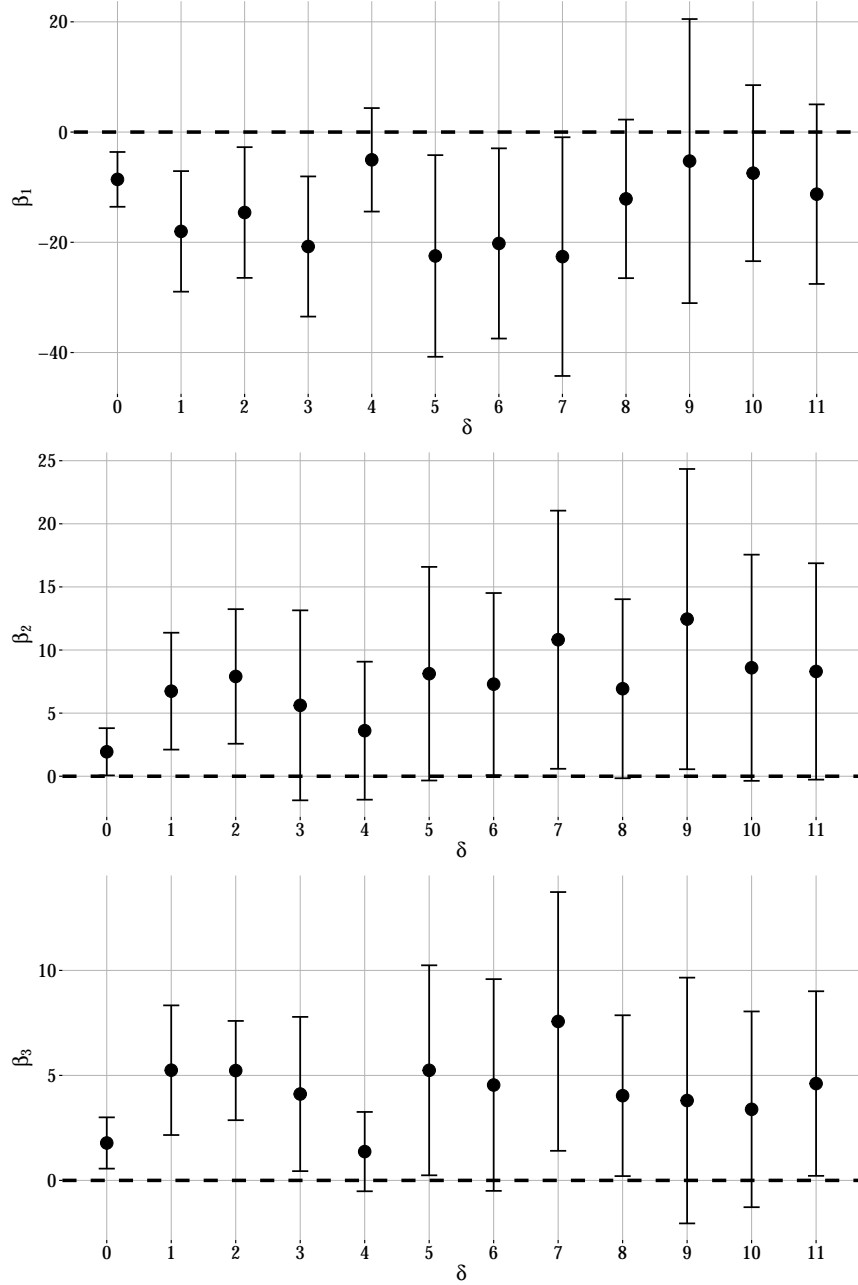


Figure 6: Coefficients Associated with Dependent Variable  $\ln \left( \frac{L_{i,t+\delta}}{L_{i,t-1}} \right)$

*Note:* Each plot displays coefficients and their 90% confidence interval associated with one of twelve regressions. The dependent variable is logged changed in loan originations over horizons of  $\delta + 1$  quarters. The first plot shows coefficients on  $\Delta R_{t-1}$ , the second for  $\Delta \ln A_{i,t-1}$ , and the third for their interaction. Every regression includes quarter, year, and NPCU fixed effects; standard errors are two-way clustered by state and year-quarter. The sample period is Q3 2004 to Q4 2011. Statistical significance: 0.1\*, 0.05\*\*, and 0.01\*\*\*.



### C.2.4 Placebo Test

This exercise regresses the annual growth rate of pre-crisis lending on asset losses during the crisis (instrumented for with changes in investment capital, the ratio of investment capital to total assets, and the interaction of these variables). The rows and columns specify the time-frame over which the independent and dependent variables of each regression are measured respectively. E.g., row 1 of column 1's panel A gives the TSLS estimate associated with regressing the log change in total lending over 2005 to 2006 on the log change in total assets during 2007 to 2009. Note that all of these regressions are purely cross-sectional.

Table 14: Placebo Test: Total Lending

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Total Lending								
	Loan Originations 2005-6				Loan Originations 2006-7			
$\ln \left( \frac{A_{i,2009}}{A_{i,2007}} \right)$	0.75*				0.01			
	(0.39)				(0.27)			
$\ln \left( \frac{A_{i,2009}}{A_{i,2008}} \right)$		1.38				-0.39		
		(0.90)				(0.70)		
$\ln \left( \frac{A_{i,2010}}{A_{i,2009}} \right)$			-0.55				0.34	
			(1.13)				(0.32)	
$\ln \left( \frac{A_{i,2010}}{A_{i,2008}} \right)$				0.31				0.06
				(0.58)				(0.28)
Observations	5,479	5,494	4,889	4,875	5,524	5,519	4,915	4,911
R <sup>2</sup>	0.32	0.31	0.34	0.35	0.23	0.22	0.23	0.23
Panel B: Mortgage Lending								
	Loan Originations 2005-6				Loan Originations 2006-7			
$\ln \left( \frac{A_{i,2009}}{A_{i,2007}} \right)$	0.48				-0.31			
	(0.46)				(0.37)			
$\ln \left( \frac{A_{i,2009}}{A_{i,2008}} \right)$		0.84				0.07		
		(1.17)				(0.58)		
$\ln \left( \frac{A_{i,2010}}{A_{i,2009}} \right)$			0.05				0.21	
			(0.36)				(0.34)	
$\ln \left( \frac{A_{i,2010}}{A_{i,2008}} \right)$				0.01				0.13
				(0.14)				(0.21)
Observations	1,987	1,991	1,753	1,762	2,017	2,019	1,793	1,800
R <sup>2</sup>	0.46	0.43	0.54	0.54	0.32	0.33	0.33	0.34

*Note:* The dependent variable is the difference of logged year-to-date fixed-rate 30-year mortgage originations over 2005-2006 (columns 1-4) or 2006-2007 (columns 5-8). Coefficients and standard errors (in parentheses) are multiplied by 100. Every regression includes county and credit union field of membership fixed effects; standard errors are clustered by state. Statistical significance: 0.1\*, 0.05\*\*, and 0.01\*\*\*.

# Internet Appendix (Not for Publication)

## D Additional Summary Statistics

Table 15: Field of membership

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

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

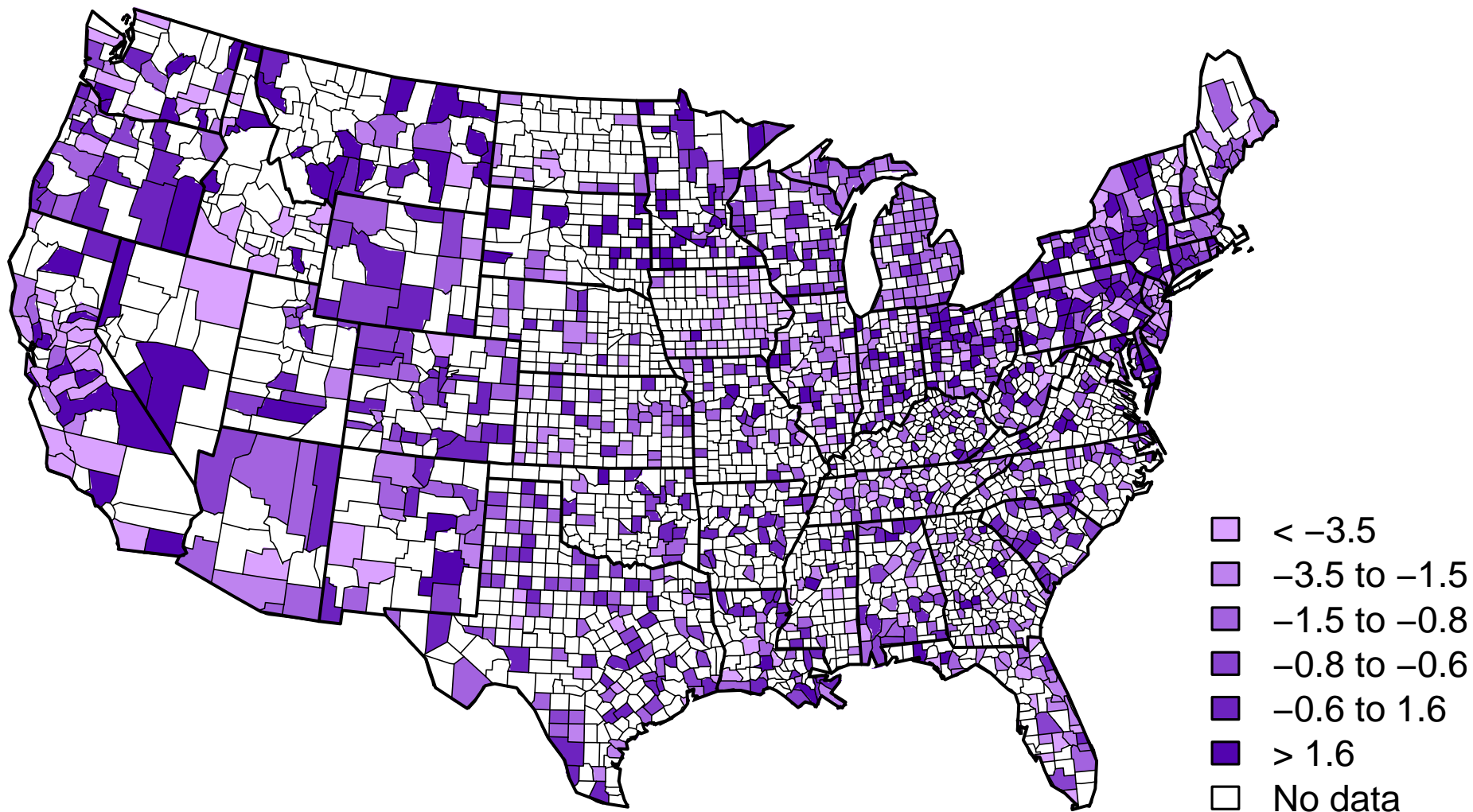


Figure 7: Average Change in Investment Capital Value During 2008 Q4

*Note:* This graph plots the with-in county average logged change in investment capital (multiplied by 100) during from the beginning to the end of 2008 Q4. The subsample used for generating this plot is the same used to estimate the baseline specification for the logged change in total lending. That is, the same outlier credit unions are omitted from this subsample. The variation in color indicates that credit unions typically experienced very different asset losses (or even gains) across counties.

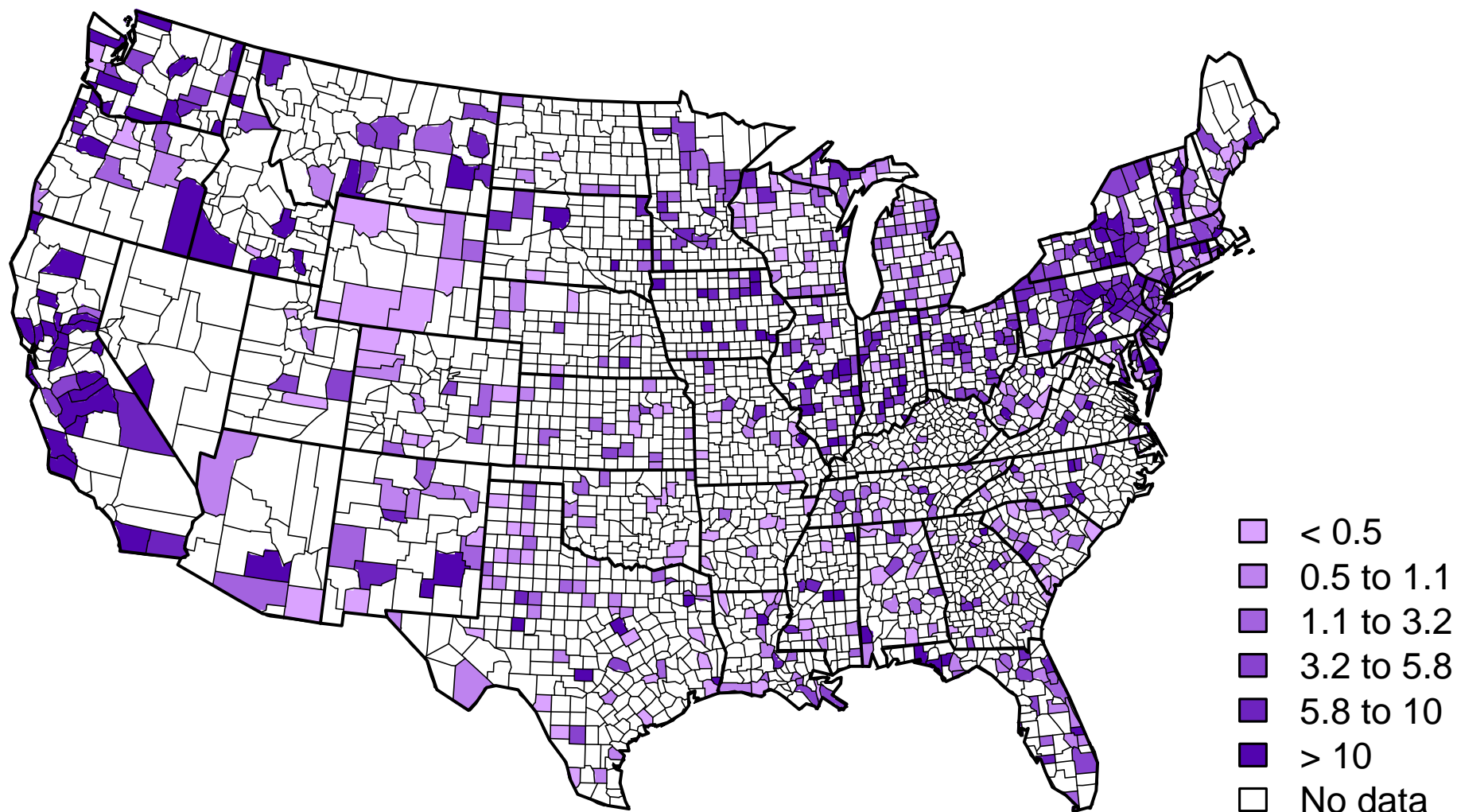


Figure 8: Standard Deviation of Changes in Investment Capital Value During 2008 Q4

*Note:* This graph plots the with-in county mean of logged changes in investment capital (multiplied by 100) from the beginning to the end of 2008 Q4. The subsample used for generating this plot is the same used to estimate the baseline specification for the logged change in total lending. That is, the same outlier credit unions are omitted from this subsample. The prevalence of darker shades indicates that there was significant within-county variation in investment capital losses. Fewer counties report data here as there is no standard deviation to report for counties with only one credit union in the subsample.

Table 16: March 2006 Corporate Credit Union Balance Sheets

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

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

Table 17: December 2009 Corporate Credit Union Balance Sheets

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

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

## E Additional Regressions

Table 18: Share of Mortgages in New Loan Originations

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

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



Table 19: Time Fixed Effects

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

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